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Agricultural Trade Liberalization: Implications for Productive Factors in the U.S.

by

Peter S. Liapis and Mathew D. Shane*

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*Peter S. Liapis, Agricultural Economist, and Mathew D. Shane, Deputy Director, Agricultural and Trade Analysis Division, Economic Research service, USDA.

Correspondence or requests for additional copies of this paper should be addressed to:

Peter S. Liapis
ATAD/ERS/USDA
1301 New York Ave NW - Rm 624
Washington, DC 20005-4788

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Abstract

This report presents preliminary results of impacts on factors of production in the United States, following reductions in assistance to agriculture. Analysis was conducted by modifying the production structure of the U.S. country model in SWOPSIM to explicitly include inputs employed by agriculture. The results indicate that it is important to adequately model the production technology and include inputs, otherwise simulation results may not capture the impact of liberalization on input use and may not adequately represent changes in producer income.

Agricultural Trade Liberalization

Implications for Productive Factors in the U.S.

Empirical analyses of agricultural trade reform have been conducted using either partial equilibrium or computable general equilibrium (CGE) models. The computable general equilibrium models are generally developed within a theoretically consistent economic structure, and they include sectors in addition to agriculture. However, they tend to lack detail coverage of agricultural commodities, countries, and or policy. For example, Robinson, Adelman, and Kilkenny developed a two region CGE model of the U.S. and the rest-of-the-world (ROW), consisting of 10 sectors, but only 3 aggregate agricultural sectors. Hertel, Thompson, and Tsigas developed a more detailed U.S. agricultural sector in their CGE model. However, policies and behavior of other countries are not modeled explicitly. Rather, trade effects are captured through use of import and export demand elasticities for the U.S. Thus, world prices of agricultural commodities are not endogenous in this model. McDonald has taken steps to generalize CGE models by developing a 4 region CGE model consisting of 6 agricultural industries. Although these models are useful in providing information on impacts among different sectors, they generally do not provide commodity specific effects of agricultural trade reform, or lack extensive world coverage.

Partial equilibrium approaches, on the other hand, have tended to be rich in country, commodity, and policy coverage. These models have provided commodity and country specific results from trade liberalization. Examples of these kind of studies include those by OECD, Roningen and Dixit, Roningen, Sullivan, and Wainio, Tyers and Anderson. However, the emphasis of these models has been on production, trade, and price effects of liberalization. Implications of liberalization on factors of production, for the most part, have not been examined, partly due to a lack of well defined economic structure. Generally, parameters in these models are either assumed or gathered from a variety of sources, with only cursory examination of the underlying production structure or implied producer behavior.

Subsidies and other distortions in agriculture, have resulted in higher producer prices and greater employment of resources relative to employment without the subsidies, assuming everything else constant. Trade reform, and the subsequent elimination of subsidies, therefore, can be expected to release these resources for employment in other sectors. However, the partial equilibrium models described above can not analyze to what extent resources will be released from agriculture, nor can they determine the relative incidence. Will the demand for all productive factors decrease by the same percentage, or will some resources bear most of the adjustment cost? Are there resources whose demand will increase following trade reform and the subsequent change in the production mix?

Furthermore, the exclusion of most factors of production from the analysis implies that direct statements regarding farm income can not be made. Rather, the implications of trade reform on the farm sector are described by welfare measures (producer and consumer surplus), which are based on strong assumptions. These measures do not adequately reflect the implications of trade reform on farm income nor on the employment of resources used in agriculture. Yet it is important for the policy makers to have an understanding of possible changes in farm income and structural implications of trade reform.

Other researchers have also recognized this shortcoming of the partial equilibrium models (Hertel, Zietch). Researchers at the OECD are also in the process of including inputs into their model to analyze trade reform. This paper presents results from a model that is a one step generalization of the partial equilibrium approach. It is still partial equilibrium, and contains the rich policy and commodity detail of other partial equilibrium models. However, it expands the commodity set of other partial equilibrium models by explicitly including productive factors. The model uses the rich policy, country, price, and quantity data from Static World Policy Simulation Model, (SWOPSIM) and parameters from an econometrically estimated, multiple output profit function of U.S. agriculture. Its advantage is that along with providing price and quantity results from liberalization, the implications of resource adjustments in U.S. agriculture are also analyzed, in a system where world prices are endogenous rather than exogenously determined. In addition, the model is based on neoclassical production theory assuming producers maximize profit, and the model utilizes information from an econometrically estimated profit function for U.S. agriculture. Consequently, the underlying parameters are consistent with an econometrically estimated profit function. The production technology is explicit rather than implied. The underlying production technology, whether implied or explicit, is important. Models may provide similar predictions on price and output effects due to liberalization, but have vastly different implications on input use and farm income, depending upon the underlying production structure.

The purpose of this paper is to present preliminary results, for the United States, from agricultural trade liberalization when factors of production are explicitly included in the analysis. The paper briefly describes the model used to analyze agricultural policy reform and the modifications made to include factors of production in the U.S. model. The results from several scenarios are presented to examine implications of policy reform given different assumptions about the technology that undergirds U.S. agriculture.

Modeling Framework

SWOPSIM is a flexible modeling framework which can be used to create single- or multiple-commodity models that represent agricultural markets in a given year (Roningen). Analysis of policy reform is conducted using this modeling framework.

SWOPSIM's structure is based on constant elasticity functional forms for agricultural output supplies and consumer demands. Trade is the difference between domestic supply and demand. A SWOPSIM model is a static, non-spatial, partial equilibrium model. Equilibrium is obtained by assuming that world markets are competitive, that domestic and traded goods are perfect substitutes in consumption, and that the law of one price generates a unique vector of world prices that balance world agricultural imports with exports. The policy structure is embedded in equations linking domestic and world prices. Policies are inserted as subsidy equivalents at the producer (PSEs), consumer (CSEs), export, or import level. Details on the economic and policy structure can be found in Roningen, and Dixit and Roningen.

The version of SWOPSIM used for this study is a modification of ST86 (Roningen and Dixit, 1989). ST86 is based on data representing 1986/87 marketing year conditions. It divides the world into 11 countries or regions, with 22 commodities covering mostly temperate zone products.

The important structural difference between ST86 and the model developed for this analysis, (INPT) occurs on the production side of the U.S. country model. The supply elasticity matrix in ST86 was obtained from a variety of sources (Gardiner, Roningen, and Liu); and, it can not be related back to specific assumptions about production technology. For INPT, this matrix was replaced by an elasticity matrix derived from a multiple-output profit function for U.S. agriculture econometrically estimated by Ball.

Ball assumed that U.S. agriculture is characterized by joint production technology. He calculated output supply and input demand elasticities from a 5-output 6-input translog multiple-output profit function of U.S. agriculture. I disaggregated his aggregate output elasticities to conform with the product set in ST86. In addition, I added inputs to the production structure in a theoretically consistent manner (Liapis). The resulting output supply and input demand elasticities used in INPT are consistent with Ball's estimated set of elasticities and neoclassical theory of the multiple-output firm under profit maximization. Table 1 contains the list of aggregate commodities from Ball and the commodity set used in INPT.

Several other modifications to ST86, due mostly to different assumptions about the technology, were made to the U.S. country model. Whereas ST86 has a feed sector represented in reduced form by technical coefficients, INPT treats feed similarly to other inputs. In addition, INPT excludes processed products. Dairy products (butter, cheese, powder milk) and oilseed products (oil and meal) are omitted from INPT because they are not produced on the farm. Furthermore, ST86 does not model all agriculture. Consequently, a residual aggregate output commodity (all other agricultural products not otherwise included) and six aggregate inputs were added to INPT to close the system and represent the entire U.S. agricultural sector. The resulting INPT model consists of 22 commodities-- 16 outputs and 6 inputs. The 22 commodities in ST86 consist of 15 outputs and 7 processed products.

Consumer demand elasticities for the U.S. are basically the same in the two models. However, INPT includes the demand for the aggregate all other agriculture, for which a demand elasticity of -.5 was assumed. The demand for dairy milk was also modified. The demand elasticity for dairy milk in INPT was doubled relative to ST86; to -.23.

The structure of the other 10 regions of ST86 was not modified. Support measures were the same in both models as were price transmission elasticities. These elasticities limit the passage of world price signals to the domestic market. The centrally planned economies are assumed to have a price transmission elasticity of .2, while developing countries are assumed to have a price transmission elasticity of .5. All industrialized countries (U.S., Japan, Canada, EC, Australia, New Zealand, other Western Europe) have an elasticity of 1; that is, full price transmission of world prices to domestic prices.

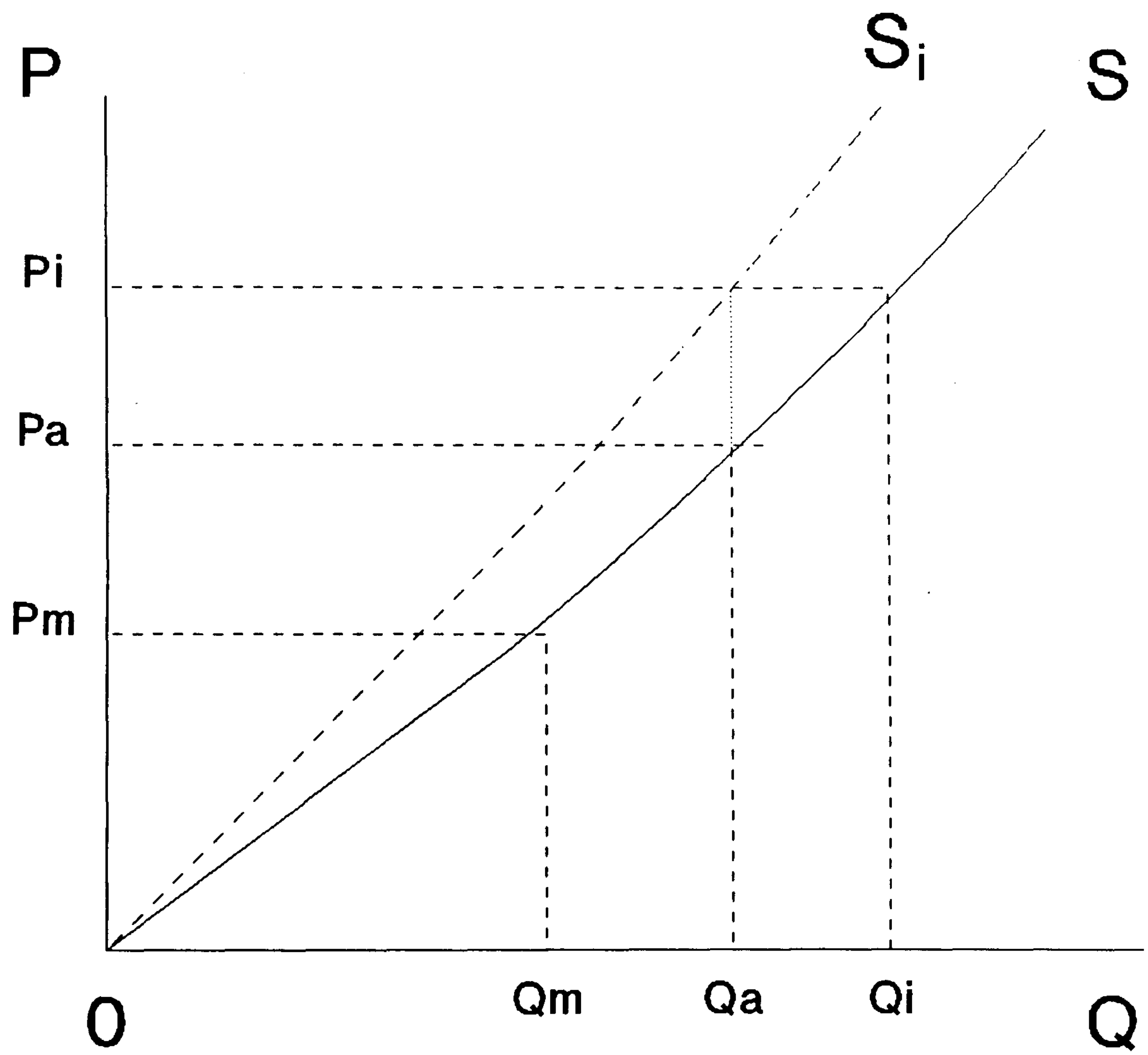
Table 1--Disaggregation of Ball's commodity set for INPT.

Ball Commodity	INPT
Livestock	Beef (BF) Pork (PK) Mutton & lamb (ML) Poultry eggs (PE) Poultry meat (PM)
Fluid milk	Dairy milk (DM)
Grains	Wheat (WH) Corn (CN) Other coarse grains (CG) Rice (RI)
Oilseeds	Soybeans (SB) Other seeds (OS)
Other crops	Cotton (CT) Sugar (SU) Tobacco (TB) Other crops (OC)
Real estate	Real estate (RE)
Durable equipment	Durable equipment (DE)
Farm-produced durables	Farm-produced durables (FD)
Hired labor	Hired labor (HL)
Energy	Energy (EN)
Other purchased inputs	Other purchased inputs (OI)

Both models assume that adjustments following trade liberalization occur in the intermediate run. However, since ST86 does not include inputs explicitly, one is not sure which factor(s) is held fixed in the model. Consequently, returns above variable costs cannot be attributed to any one factor. The profit function upon which INPT was developed presumed that the fixed factor is owner/operator labor. All other factors of production, (except real estate), are assumed to be perfectly mobile within the U.S. but perfectly immobile between countries. Perfect mobility within the U.S. implies that agricultural demand for these inputs is relatively small compared to their total demand. Consequently, prices of these factors are determined exogenously. Real estate, on the other hand, is somewhat immobile. The supply elasticity of real estate is assumed to equal .2. Rental values, therefore, are determined endogenously.

An additional difference between the two models is the modeling of set-aside provisions. The contrast stems from the distinct production structure that undergirds the two models. Land withdrawal programs not only affect the demand and price of land, they also affect the demand for other inputs, and in the process, alter marginal costs. ST86 implicitly assumes that set-aside restrictions have altered the marginal cost of program crops. However, since factors of production are not explicitly in ST86, marginal costs can not change endogenously. The change in marginal costs due to eliminating set-aside provisions is modeled in ST86 by an exogenous shift in the supply schedule of program crops. For example, in figure 1, P_i represents the incentive price and Q_a is the observed quantity produced. Removing set-aside requirements is modeled in ST86 by exogenously shifting supply from S_i to S. Thus, input and output effects from eliminating set-aside programs are captured exogenously through slippage coefficients. Holding everything else constant, reducing the incentive price of program crop by eliminating PSE, without also exogenously shifting the supply schedule, would lead to a movement down the supply curve.

Figure 1 Modeling set-asides in ST86



The model from which INPT was derived assumed that land is a variable input and is always fully employed. Its remuneration depends in part on output prices including prices of commodities which have set-aside requirements. As the demand for land changes, partly in response to set-aside provisions, its remuneration changes. Furthermore, output supply functions change partly as a result of changes in the "price" of land. Supply, as a summation of marginal costs, shifts to reflect the changing "price" of land, which implies that effects of set-asides are reflected in the marginal costs of production. INPT is derived from a model that simultaneously estimated the demand for land (and other inputs) and the supply of outputs, and the estimated parameters presumably reflect these changes in supply and input use. In this framework, when the supply function is initialized on target price, removing the PSE lowers the output price and eliminates the incentive to set land aside. In figure 1, S_i shifts to S following policy reform endogenously as land "price" changes. In contrast to ST86, marginal cost of every commodity, not only program crops, is affected. Furthermore, land is used where it is most productive. Demand for land and other inputs determines where they will be used. To summarize, although both INPT and ST86 are initialized on the same price-quantity combination, the supply functions in the two models are fundamentally different. Supply functions in INPT include the price of inputs, whereas the supply functions in ST86 do not.

Model Initialization

The two models represent agricultural conditions in the base year, 1986/87. Initial conditions regarding output supply, consumer demand, trade, prices, and policy or price wedges are the same for the commodities that are common to the two models. Consequently, gross revenue is the same, however, the different production structure implied by the two models has different implications regarding variable cost of production and farm income.

Since ST86 does not contain inputs, farm income was computed by calculating producer surplus or quasi rent. This is defined as the area between the supply curve and the price line. This area represents the portion of earnings of the supplier that exceed variable cost and can be applied to cover costs that are invariant to output, that is, fixed costs. It is this area that is referred to as farm income in ST86. It is calculated as;

$$PS = \sum_{i=1}^{m} \left(\frac{1}{1+\epsilon_i} \right) P_i Q_i \tag{1}$$

where;

PS = producer surplus or quasi rent,

P_i = price of output i, i = 1,...,m,

Q_i = supply of output i,

ϵ_i = own-price elasticity of supply for good i,

When the incentive price (market price plus direct and indirect transfers), is used to calculate producer surplus, the measure includes returns from market operations and direct and indirect transfers.

Profit, quasi rent, or producer surplus, is computed directly in INPT. These terms represent the same measure of producer welfare when firms remain in production. Profit is defined as total revenue minus total variable cost and is calculated by;

$$\Pi = \sum_{i=1}^{m} P_i Q_i - \sum_{j=1}^{n} W_j X_j \qquad (2)$$

where;

Π = profit or quasi rent,

W_j = price of input j, j = 1,...,n,

X_j = quantity of input j.

Expressions (1) and (2) measure the same variable, returns above variable costs. The supply function used to generate the expression inside the summation sign in (1) can be derived from the first order conditions of maximizing expression (2). The numerical value of the two equations will be the same if (1) is derived from (2). But the supply functions which lead to expression (1) in ST86 are not derived from an explicit profit maximization function such as (2). Consequently, the two expressions will not necessarily generate the same value.

Furthermore, INPT represents the entire U.S. agricultural sector and reproduces agricultural accounts as reported in Agricultural Statistics. For example, evaluated at market prices, INPT represents 100 percent of net receipts from marketing and gross production expenses. As stated previously, ST86 does not cover all of U.S. agriculture. The value of the products that are included represent 74 percent of gross farm receipts.[1] Although the variable costs of production can not be computed directly, they can be ascertained by solving each inverse supply function.

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[1] Most of the excluded products are commodities that are not heavily subsidized, consequently, they were excluded in ST86. However, the value reported here also excludes processed products which are included in ST86. In Agricultural Statistics, the value of butter, cheese, milk powder, soybean oil, and soymeal, are not included in gross receipts at the farm gate. Including the value of these products adds about 12 percent to the value of commodities in ST86.

The implied variable costs to produce the output represented in ST86 (excluding processed products), is $46 billion, calculated by summing the area underneath the individual supply curves. Actual variable costs to produce all agricultural output (not just the 74 percent represented in ST86) was $122 billion in 1986. Thus, even though ST86 represents 74 percent of the value of output, it only represents 38 percent of the variable cost of production.

The implied producer surplus in ST86, calculated using (1), is about $92 billion. In 1986, farm income was about $37 billion. ST86, therefore, significantly overestimates the value of producer income in the base year. When the value of processed products is removed, producer surplus declines to about $82 billion--still more than double the realized value. Thus, even though both models employ the same price and quantity data, they generate different values of cost and income in the base year.

There are several reasons for these discrepancies in the base value. In addition to different commodity coverage, the two models present different estimates of production costs and income because of differences in the production structure and elasticity matrix. As evidenced in expression (1), the own-price elasticity of supply determines the distribution of income between the fixed and the variable inputs. With a relatively inelastic supply (own-price elasticity of supply less than 1), the distribution of income favors the fixed factors. An inelastic supply function implies that producers have less flexibility to respond to changing prices. Most of the costs are associated with relatively immobile factors and producers can not adjust quickly. As the elasticity of supply increases, the distribution shifts and more of the revenue is allocated to variable costs. A relatively elastic supply function (own-price elasticity larger than one) implies larger production flexibility. A larger portion of costs are attributed to the variable inputs, and producers can adjust relatively quickly to take advantage of relative price shifts. When the elasticity of supply is equal to one, the distribution of income is split evenly among the fixed and variable factors of production. Given the distribution of revenue between producer surplus and variable costs, it appears that supply is more inelastic in ST86 compared to INPT. Relative elasticity of supply is also related to the length-of-run. Over a longer time period, more inputs are variable. In the very long-run, all inputs are variable. Hence, INPT appears to be a longer-run model than ST86.

Furthermore, ST86 overestimates producer surplus for the commodities which are affected by the set-aside program. This is illustrated in figure 1. In ST86, supply schedule S represents the "true" supply curve, free from distortions created by the set-aside program. With the price at P_i supply would be Q_i. Because of the set-aside program, production is Q_a even though price remains at P_i.

Producer surplus in the base year is calculated by summing areas represented by A+B+D+E+F+G in figure 1. ST86 assumes that S is the appropriate supply schedule when calculating producer surplus in the base year. As stated previously, land withdrawal associated with the set-aside provisions affects marginal costs. The appropriate supply schedule which reflects marginal cost is S_i. Thus, ST86 overestimates producer surplus in the base year by the area G+E+B. Eliminating this area from the calculations further reduces producer surplus from $82 billion to about $77 billion. But, even with these adjustments, producer surplus in ST86 is still substantially higher than actual income.

Effects of liberalization

This study reports the results of experiments using INPT in which new equilibrium solutions are obtained by removing the policy wedges in the United States (unilateral liberalization)[2] and all industrialized market economies (multilateral liberalization). Of interest is the implication on world prices, trade, and on the effects of trade reform on the productive factors in U.S. agriculture. In order to present to the reader the relative performance of INPT, the results are compared to results from similar liberalization experiments from ST86. The results reported in this paper focus on U.S. production in order to examine the implications of the two models on producer welfare and resource adjustments in U.S. agriculture. The reader interested in more detailed results of liberalization based on ST86 can examine Roningen and Dixit.

Effects on world commodity prices and trade.

Tables 2 and 3 report the results of trade reform on world prices and trade given by the two models. Policy reform, whether unilateral or multilateral, results in higher world prices. The results indicate that when all industrialized countries simultaneously liberalize, world prices are substantially higher than when the United States liberalizes unilaterally. From table 2 it is apparent that the net effect of the present agricultural policies in the industrialized market economies is to depress world agricultural prices, implying that developing country importers are subsidized by current policies. Developing country exporters on the other hand, are harmed by these policies as they attempt to compete in world markets. Based on these results, the largest distortions are in the grain and sugar markets since prices of these commodities increase the most following trade reform.

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[2] Unilateral liberalization is a misnomer since world prices are transmitted to other countries while their price wedges are maintained. It is used here only to represent production response in the United States under a low incentive price scenario.

The relative impact of U.S. policies on world prices can be gleaned from the results of unilateral liberalization reported in table 2. Domestic policies in grains, sugar, and cotton, appear to substantially distort world markets.

Liberalization significantly expands world trade in livestock products and sugar, while reducing trade in most crops, especially grains (table 3). This result is not surprising given the policy mix used in the United States--grain exports are promoted while livestock imports are restricted. The results suggest that policies of the other industrialized countries are

Table 2--World price changes relative to base from liberalization scenarios, 1986/87.

Commodity	Unilateral US		Multilateral	
	INPT	ST86	INPT	ST86
	Percent			
beef	12	4	28	20
pork	9	2	18	13
mutton & lamb	5	2	33	32
poultry meat	16	7	24	18
poultry eggs	9	2	9	6
wheat	30	11	56	37
corn	35	12	46	29
coarse grains	24	11	36	22
rice	6	3	29	26
soybeans	24	-5	17	-2
other oil bearing	11	-1	21	12
cotton	22	8	22	12
sugar	26	23	54	53
tobacco	7	1	8	4

Table 3--World trade changes relative to base from liberalization scenarios, 1986/87.

Commodity	Unilateral US		Multilateral	
	INPT	ST86	INPT	ST86
	Percent			
beef	48	15	8	7
pork	64	13	77	20
mutton & lamb	1	0	36	35
poultry meat	56	8	49	27
poultry eggs	101	0	144	93
wheat	-19	-7	-32	-20
corn	-25	-9	-4	4
coarse grains	-10	-13	-21	-18
rice	-12	-7	43	44
soybeans	-8	1	-5	2
other oil bearing	6	11	36	45
cotton	-5	-2	-3	-1
sugar	27	27	31	32
tobacco	3	-1	3	2

similar to those of the United States. When these policies are removed, grain trade contracts while livestock trade expands.

Comparison of results from the two models.

Both models suggest that liberalization leads to higher world prices. However, INPT leads to larger changes in world prices compared to ST86, and the two models differ regarding the effects of liberalization on the world price of soybeans. ST86 indicates that the world price of soybeans falls following liberalization whereas INPT indicates that the price rises. The reason for this difference is examined in more detail below, but it is related to the contrasting production technology assumed for the United States, and the fact that the United States is the dominant soybean producer in the world. The United States produced 54 percent of the world's supply of soybeans in the base year, consequently, changes in U.S. soybean production have relatively large impacts on the world soybean market.

World price differences between the two models are smaller with multilateral liberalization and, the two models agree on the relative magnitude of world price changes among the various commodity groups. For example, under either of the liberalization scenarios, both models agree that world price changes are larger for sugar and grains relative to livestock commodities.

INPT indicates larger changes in world trade compared to ST86. But, the two models are in relative agreement regarding the direction of change in world trade following trade reform. Both models suggest that policy reform leads to trade expansion in livestock products and sugar, and trade contraction in grains. The two models diverge on the effects of trade reform on soybean trade. ST86 suggests that liberalization results in a slight expansion in soybean trade while INPT indicates that trade declines. Larger soybean production and lower price, in ST86, results in more trade while a higher price and lower production leads to less trade in INPT.

The results suggest that even though the same distortions were removed, the two models generated different world prices and trade, indicating that assumptions regarding production technology, in a large country such as the United States, significantly affect the global implications of trade liberalization.

Domestic Implications for the U.S.

In this section the implications of policy reform on producer incentive prices, production, resource use, and farm income, are presented. The emphasis of this paper is to provide implications of trade liberalization on resource use and farm income and compare them to the results obtained by ST86. Since Roningen and Dixit thoroughly discuss production and price effects of liberalization generated by ST86, the effects of liberalization on producer incentive prices and production are not discussed extensively. They are presented as a frame of reference for the discussion on resource use and farm income.

Changes in producer incentive prices and domestic production

Unilateral U.S. liberalization results in lower producer incentive prices for most commodities except soybeans, the aggregate 'all other crops', beef, pork, and eggs (table 4). Producer prices decrease the most in the crops sector, with the producer price of sugar decreasing the most.

The fall in grain producer incentive prices is mitigated under multilateral liberalization. With this scenario, producer incentive prices for most livestock commodities increase as do prices for soybeans and the aggregate 'all other crops'. The results suggest that U.S. policies helped raise producer price of most commodities. But, the combined effect of the policies of all industrialized countries is to depress the domestic price of most livestock products.

Domestic production of each commodity declines following policy reform (table 5). The largest declines occur in grains and sugar. The fall in output is dampened when trade distortions in other parts of the world are eliminated.

Comparing the results with ST86

The two models tend to differ on the magnitude of price changes following liberalization. ST86 generates larger changes in producer incentive prices. Producer incentive prices change more in ST86 because world prices do not change as much as in INPT (table 4). But, both models agree on the commodities with the largest price declines. For example, both models indicate that producer incentive price for sugar, rice, and wheat decline the most following policy reform.

The two models also differ regarding the magnitude of production adjustments following policy reform, but generally agree on the direction of change. Both models indicate that liberalization leads to production declines for most commodities, and both models indicate that production adjustments are smaller with multilateral liberalization (table 5). However, whereas ST86 generates larger price adjustments, INPT generates larger output adjustments.

Table 4--Producer incentive price changes in the United States following trade liberalization from two models 1986/87.

	Unilateral US		Multilateral	
Commodity	INPT	ST86	INPT	ST86
		Percent		
beef	1	-7	14	7
pork	1	-5	9	5
mutton & lamb	-9	-12	15	14
poultry meat	-2	-10	4	-1
poultry eggs	1	-6	1	-2
dairy milk	-2	-5	-1	-2
wheat	-47	-55	-36	-45
corn	-29	-41	-23	-32
coarse grains	-35	-42	-29	-37
rice	-65	-66	-58	-59
soybeans	12	-14	6	-12
other oil bearing	-11	-20	-3	-10
cotton	-31	-39	-31	-37
sugar	-74	-75	-68	-69
tobacco	-2	-8	-1	-5
all other crops	17	N/A	6	N/A

N/A = not applicable.

Table 5--Supply changes in the United States following trade liberalization from two models 1986/87

	Unilateral US		Multilateral	
Commodity	INPT	ST86	INPT	ST86
		Percent		
beef	-15	-4	-7	4
pork	-15	-3	-10	2
mutton & lamb	-18	-9	-3	9
poultry meat	-16	-6	-11	-1
poultry eggs	-14	-2	-12	-2
dairy milk	-19	-3	-12	-1
wheat	-38	-13	-27	-6
corn	-11	-7	-7	-3
coarse grains	-19	-11	-15	-9
rice	-33	-18	-26	-11
soybeans	-13	2	-8	2
other oil bearing	-30	10	-16	13
cotton	-27	-11	-21	-10
sugar	-50	-48	-40	-42
tobacco	-13	-1	-7	-1
all other crops	-8	N/A	-3	N/A

N/A = not applicable.

This result is related to the contrasting production structures of the two models. It was mentioned previously that production technology in ST86 is implicitly more inelastic than in INPT. Factor usage, therefore, does not adjust readily to changing incentive prices. When an incentive price falls, demand for inputs falls. If factors are mobile, output falls. The decline in output mitigates the decline in output price. In the extreme case of perfectly inelastic supply, i.e., factor immobility, a reduction in incentive price (due to liberalization) leads to a fall in market-clearing price without adjustments in output. ST86, being more inelastic than INPT, generates smaller output adjustments and hence, larger price adjustments than INPT.

The two models also differ on the effect of liberalization on the supply of soybeans and other oil-bearing crops. ST86 indicates that liberalization leads to an expansion in their supply, INPT suggests that production declines. This contrasting result is also mostly due to assumptions underlying the production technology. ST86 conforms with conventional wisdom that liberalization leads to an expansion in the supply of products with relatively little domestic support, such as soybeans. It is presumed that grains and oilseeds are substitutes in production and that changing relative prices, following liberalization, lead to a reduction in grain production and an increase in oilseeds production.

INPT, on the other hand, conforms with the criteria of a 'normal' technology where all outputs are 'gross' compliments in the long-run. Changing relative prices due to liberalization imply both a substitution and a contraction effect. It is presumed that the contraction effect from resources leaving agriculture is larger than the substitution effect. Thus, even though soybeans are relatively less protected, and incentive price does not decline, production falls because production of the other commodities falls.

Effects on Resource Use and Farm Income

The value added of INPT relative to ST86 is in assessing effects of policy reform on resource use and farm income. Primary factors of production are not explicitly in ST86. Consequently, impacts of liberalization on factor use are lacking. Furthermore, farm income in ST86 is measured by calculating producer surplus. Since the underlying production structure is not explicit in ST86, it is not certain which productive factor(s) is fixed. Consequently, returns above variable costs, that is, producer surplus, can not be attributed to any one specific fixed factor. A change in producer surplus therefore, does not necessarily correspond with a one-to-one change in farm income.

Changes in factor use

The agricultural sector, in the United States, contracts following policy reform. Liberalization, and the resulting declines in output, leads to substantial reductions in resource usage as demand for variable inputs falls. With unilateral liberalization, the demand for the aggregate 'other inputs' (fertilizer, pesticides, feed, among other) declines the most, followed by the decline in the demand for hired labor (table 6).

Additional information provided by INPT is the effect of trade reform on rental rates. Unilateral liberalization dramatically reduces the use value of real estate; rental rate declines almost 35 percent. Furthermore, almost eight percent of the value of real estate leaves the agricultural sector as a result of policy reform. These results occur even though INPT, unlike ST86, does not explicitly model set-aside provisions. If one expects the elimination of set-aside

Table 6--Change in demand for variable inputs in the United States following trade reform, 1986/87

input	unilateral	multilateral
	Percent	
durable equipment(DE)	-8	-3
real estate(RE)	-8	-5
farm purchased durables(FD)	-11	-6
hired labor(HL)	-20	-12
energy(EN)	-9	*
other inputs(OI)	-29	-20

* less than a one percent decline

requirements to increase the supply of real estate, then rental rates would fall further than indicated above. This issue is examined below.

Multilateral reform mitigates the fall in factor demands. Output did not decrease as much with this scenario, consequently, factor usage did not decline as much as under unilateral liberalization. It is apparent from table 6 that policy reform does not affect the demand for inputs uniformly. The demand for 'other inputs' and hired labor declined the most, while the demand for energy declined less than one percent. Since multilateral liberalization leads to smaller declines in output and factor demand, the use value of real estate also declines relatively less. Real estate use value declines almost 25 percent. The value of real estate exiting agriculture is also smaller with multilateral reform as is the exodus of farm labor. These results suggest the need to not only model output supply, but also input demand, since input usage does not change uniformly following policy reform.

The results indicate that the present distortions have resulted in more resources being attracted to agriculture than is optimum and policy reform will cause a significant portion of these inputs to exit agriculture. Current policies, by distorting quantities produced, also distort relative input usage. Agricultural production in the United States has increasingly shifted toward the use of inputs such as fertilizer and pesticides which are in the aggregate 'other inputs'. Policy reform will reverse this trend as demand declines relatively more for these inputs. Liberalization will also accentuate the flight of farm labor from agriculture. Furthermore, current policies have helped to increase land values, to the benefit of landowners and the detriment of producers who rent land. Agricultural Statistics indicate that in 1982 (latest available data), 54 percent of the land was operated by part owners, while 12 percent was operated by tenants.

Changes in cost and income

The declining demand for inputs and the changing composition of input use results in variable costs of production decreasing 22 percent from $122 billion to $95 billion following unilateral liberalization. Policy reform also causes a reduction in revenues as receipts decrease 23 percent and farm income declines almost 26 percent.

Since factor use declines relatively less, variable costs also decline relatively less when all industrialized countries reform their policies. Multilateral reform results in variable costs declining 14 percent, to $105 billion. Farm receipts decline 14 percent, while farm income declines 12 percent.

The results indicate that policy reform leads to a reduction in farm income. However, elimination of government transfer payments does not translate into a dollar-for-dollar decline in farm income. The model suggests that a large portion of farm income which is presently provided by government payments can be generated by the market when all industrialized countries liberalize. Furthermore, the analysis suggests that trade reform has two effects. There is a flow effect, measured by farm income, and there is also a stock effect, measured by the value of real estate that remains in agriculture. The results indicate that current land owners experience a reduction in the value of their holdings. On the other hand, the reduced use value of real estate may facilitate entry for new farmers. In addition, the model does not capture any economy wide efficiencies that may be gained from resources which leave agriculture and find employment in other sectors.

Comparisons with results from ST86

Qualitatively, the results from ST86 are similar to the results from INPT. The magnitude of the changes, however, are different, and ST86 does not provide information on the implications of reform on the demand for specific inputs. For example, by inverting each supply curve and summing the results, one can calculate the value of resources that exit agriculture following policy reform. ST86 indicates that variable costs decline 24 percent following unilateral liberalization. Although this result compares favorably to the 22 percent decline suggested by INPT, one can not ascertain how the decline in costs is apportioned across the various factors of production. In addition, the magnitude of the change is different. ST86 indicates that variable costs decline to $35 billion. In contrast INPT indicates variable costs of $95 billion.

In relative terms, the two models generate similar results regarding farm receipts and farm income following unilateral liberalization. ST86 suggests that farm receipts decline 24 percent whereas INPT indicates that the drop in farm receipts is 23 percent. Similarly, ST86 suggests that producer surplus declines 28 percent while INPT suggests that the decline is almost 26 percent. The magnitude of the changes indicated by the two models, once again, are very different. Producer surplus in ST86 declines by $26 billion. When processed products are excluded from the calculations, and when the corrections for set-asides described earlier are made, the decline in producer surplus is $19 billion[3]. In contrast, INPT indicates that farm income declines by $9 billion. But the differences between the two models may not be as large as indicated because much of the value that is attributed to producer surplus in ST86 is not producer income since it also includes compensation to other quasi fixed factors.

ST86, like INPT, indicates that multilateral liberalization results in smaller adjustments for U.S. agriculture. With this scenario, fewer resources leave the farm sector, resulting in smaller declines in variable costs. Depending upon set-aside calculations, ST86 indicates that variable costs decrease either 5 percent or 13 percent to $40 billion. In contrast, INPT suggests variable costs decline to $105 billion.

ST86, like INPT, suggests that multilateral liberalization results in a reduction in producer surplus, but, the reduction is not as large as with unilateral liberalization. Producer surplus declines by $15 billion when calculated based on set-aside adjustments described by Roningen and Dixit. When calculated according to the discussion in this paper, the reduction in producer surplus is 14 percent or $11 billion. Once again, the relative decline in producer surplus is similar

[3] The rest of the discussion excludes the value of processed products from calculations. Thus, direct comparisons with the results in Roningen and Dixit are not possible.

to the results generated by INPT. However, INPT suggests that the decline in farm income is a little over $4 billion rather than $11 billion.

To summarize, the production technology assumed in INPT suggests that U.S. agriculture is more flexible than suggested by ST86. The results indicate that factors of production are more mobile in the INPT framework compared to ST86. To the extent that factor mobility is related to length-of-run, INPT represents a longer-run model than ST86. Consequently, producers can readily adjust output and input use so that policy reform leads to larger output adjustments and smaller price adjustments when analyzed with the technology assumed by INPT, and INPT generates relatively smaller declines in farm income relative to ST86. However, farm income, as measured in ST86, includes returns to all quasi-fixed factors of production suggesting that comparing farm income results from the two models is tenuous. Nevertheless, both models suggest that the transition to full market economy is easier when all industrialized countries liberalize.

The results indicate that although the two models have basically the same initial conditions with respect to policy wedges, producer incentive prices, and supply; the production technology that undergirds the two models leads to somewhat different results regarding predicted changes in prices and production. INPT predicts smaller price changes and larger production declines, in the United States, compared to ST86. Effects of price changes are symmetric, however. In a situation of increasing incentive prices, INPT will generate larger output gains than ST86. A surprising finding is that both models generate similar results with respect to relative changes in variable costs and farm income. But the absolute value of the changes are smaller with INPT. As reported in Liapis, many of the own-price elasticities of supply used in the two models have the same value. The conflicting results therefore, suggest that the outcome depends not just on the magnitude of the supply elasticities, but also upon the underlying production relationships.

How do the results from INPT compare to results from other models? This question is somewhat difficult to answer because models differ regarding policy measures, base year, and commodity coverage, among others. However, results from models with somewhat similar liberalization experiments as described here indicate that INPT solution may be reasonable. Haley, Herlihy, and Johnston took essentially the same model as ST86 and reduced all the elasticity values by 50 percent. They concluded that the effect of changing the value of the elasticities on world prices were minimal, but the reduced elasticity formulation significantly reduced producer surplus. This confirms the notion discussed earlier that most of the cost of adjustment is placed on fixed factors when supply is relatively inelastic. It further supports the notion that it is important to model supply accurately, not necessarily because of effects on prices, but because of effects on the distribution of income. Essentially similar world prices have different implications on domestic welfare, depending on assumptions regarding factor mobility.

Results from INPT challenge conventional wisdom regarding the effects of liberalization on the production of soybeans. Conventional wisdom is that soybean production should increase following liberalization. Results from ST86 support this assertion, whereas results from INPT suggest the opposite. Hertel, in a recent paper also challenged this conventional wisdom and found that it is not supported by theory. He concludes that in the long run, resources are mobile, and outputs are "gross complements" that is, the contraction effect dominates the substitution effect.

INPT results also compare favorably to results from CGE models. For example, Kilkenny and Robinson report that unilateral U.S. liberalization leads to a 31 percent decline in the use value of land. In another study, Kilkenny and Robinson used world prices generated by ST86, under multilateral liberalization, in their CGE model of the United States. They discovered that their model generated larger supply changes and smaller producer price changes for the United

States than ST86. They attributed this result on factor mobility. Recall that INPT also generated larger supply changes and smaller price changes than ST86. Other CGE models also indicate that trade reform results in significant resource reallocation out of agriculture. For example, McDonald reports that a 50 percent multilateral liberalization decreases real rewards to land by almost 11 percent, while 2 percent of the value of agricultural land leaves the sector. These results compare favorably to the multilateral liberalization results presented here which assumed 100 percent liberalization. Furthermore, McDonald calculates that in the long run, the decoupled payments necessary to fully compensate producers for losses due to liberalization are relatively small. Hertel, Tsigas, and Robertson report that unilateral liberalization leads to a 14 percent decline in the demand for capital. Thus, INPT provides a partial bridge between CGE and partial equilibrium models. It retains the extensive policy, commodity, and regional coverage of ST86, while also providing results that are more similar to results from CGE models. In addition, INPT contains more agricultural inputs than most CGE models used to analyze similar policy reform scenarios.

Sensitivity Analysis

Given the uncertainty regarding the value of some parameters, an interesting exercise, in models such as this, is to examine model results when certain parameters are changed. For example, how does the model behave under various assumptions regarding the mobility of real estate? This question is addressed because of uncertainty regarding the true value of the supply elasticity of real estate.

An additional issue is the implication on model results given different ways to model the effects of set-aside programs. Since ST86 does not explicitly include productive factors such as land or labor, effects of acreage restrictions on production are modeled in reduced form. Eliminating acreage restrictions is assumed to increase the supply of program crops independent from any other liberalization effect. The percentage increase varies by crop, and was derived from various sources (see Haley; Haley, Herlihy, and Johnson; Roningen and Dixit, for a full discussion of modeling set-aside requirements, including the value of the parameters used to increase supply in SWOPSIM). Thus, these parameters or slippage coefficients are assumed to capture the effects of input substitution on production, and determine the shifts in the supply schedules such as from S_i to S in figure 1.

Set-aside provisions were not explicitly modeled in INPT for reasons discussed previously. One may argue that INPT does not capture the full effects of liberalization without explicitly modeling the set-aside programs. Consequently, experiments were undertaken to examine model results when set-aside adjustments are explicitly modeled in INPT.

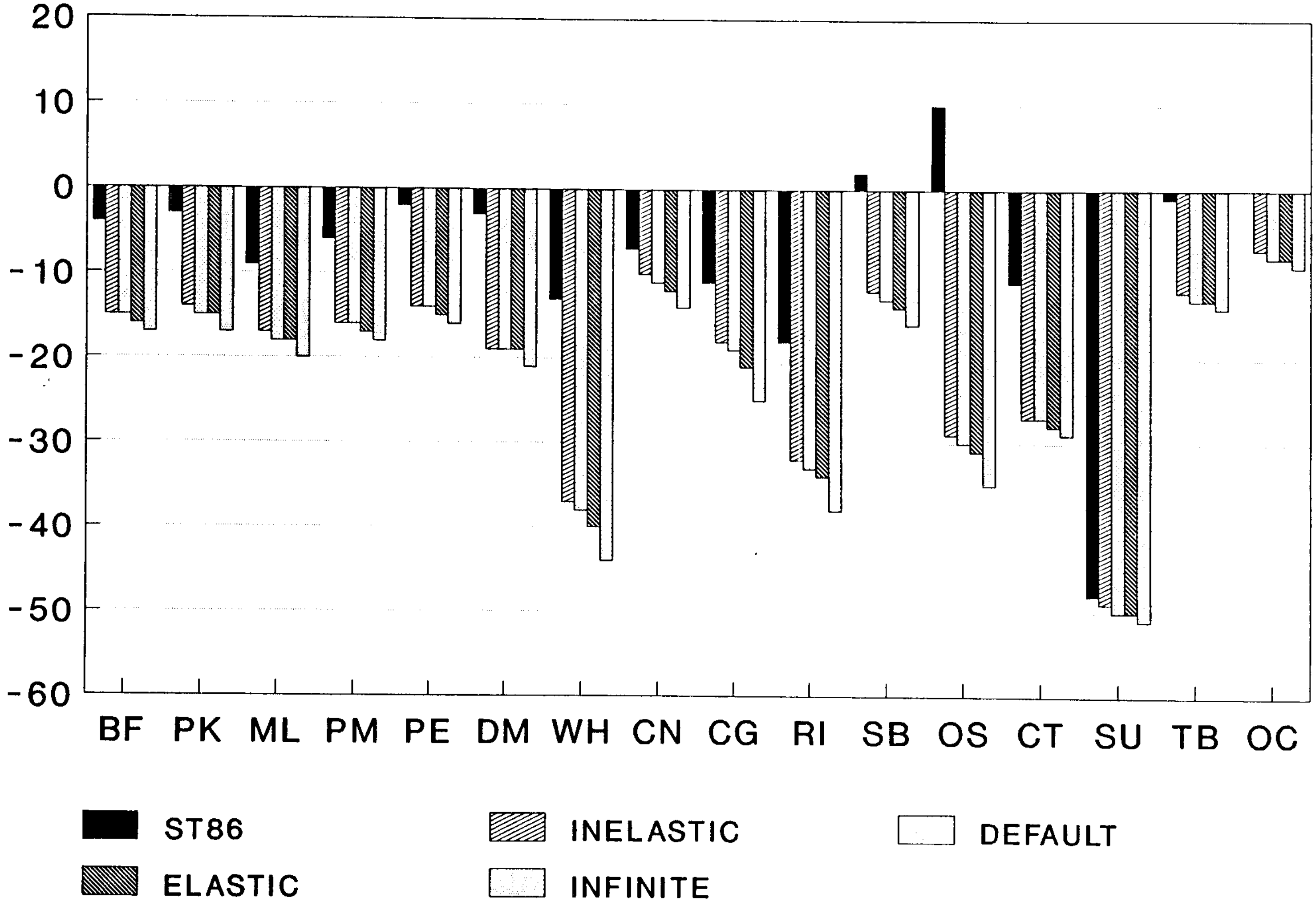
Effects of varying real estate mobility.

The effect of different mobility assumptions regarding real estate was examined by adjusting the elasticity of supply. The supply elasticity of real estate was reduced by 50 percent from it default value of .2 in one experiment (inelastic), and doubled in another (elastic). In the last experiment, land was assumed to be perfectly mobile (infinite).

Figure 2 illustrates output changes that result from varying the supply elasticity of real estate under unilateral liberalization[4]. Results from ST86 are presented for comparison. Given

[4] Unilateral liberalization is used to illustrate the effects of varying the mobility of real estate because this is the scenario with the largest changes for the United States.

Figure 2. Percentage change in supply from various land mobility assumptions



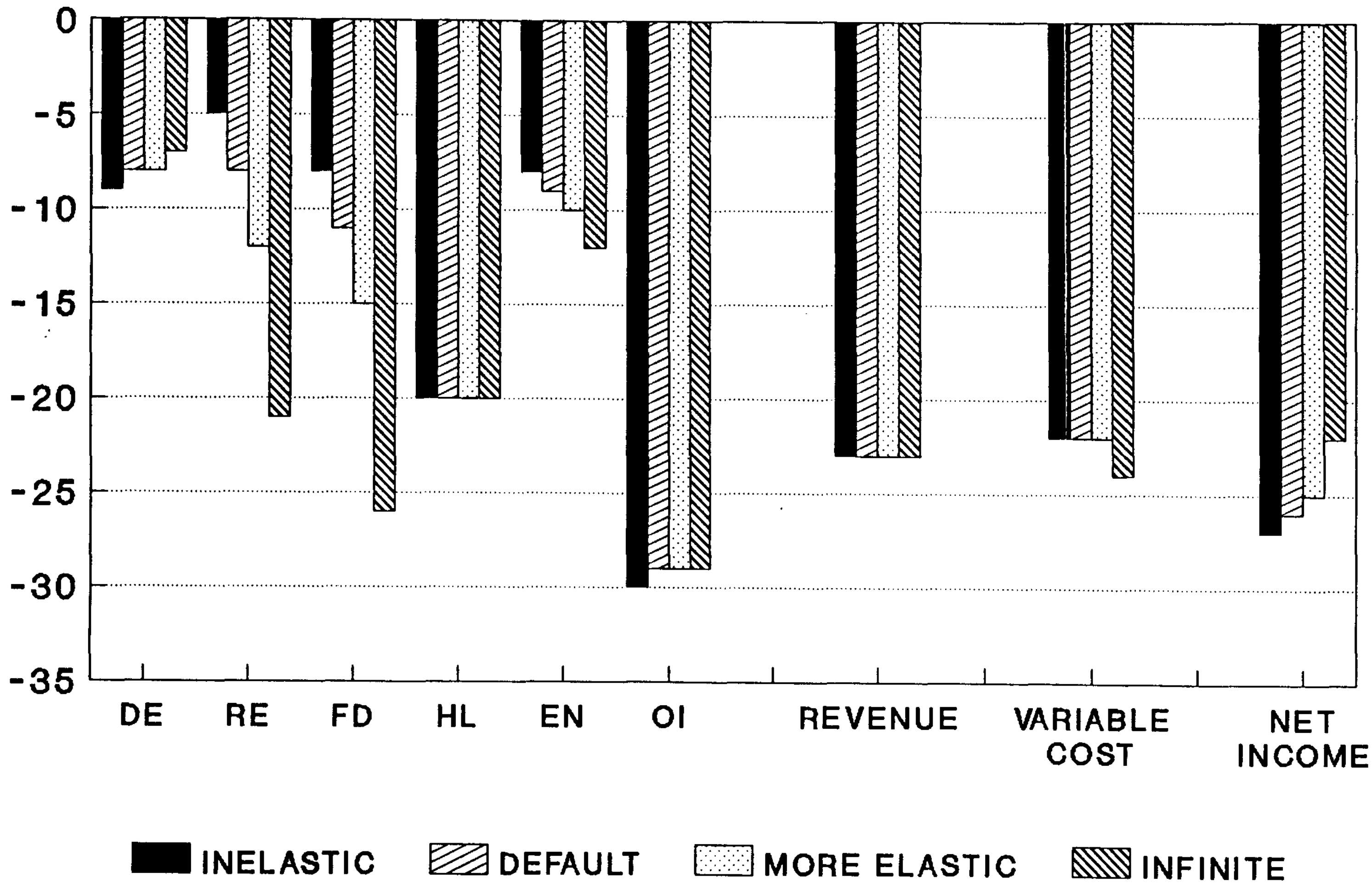
the technology of INPT, changing the supply elasticity of real estate changes the output level of each commodity. Supply of livestock commodities are affected the least while crop supplies .change substantially. Note that higher real estate mobility leads to larger changes in output. previously that greater factor mobility enables larger output changes

As expected, an increase in the supply elasticity of real estate leads to smaller declines in the rental rate. The "inelastic" scenario leads to a 41 percent drop in the rental rate, while the "elastic" scenario leads to a 27 percent drop. Also as expected, increasing the supply clasticity of real estate generates larger declines in the demand for real estate. Under the "inelastic" scenario, only 5 percent of the value of real estate leaves agriculture, while the "elastic" scenario leads to a 12 percent drop (figure 3). In the extreme case of "infinite" elastic supply, the rental rate does not change, but 21 percent of the value of real estate leaves agriculture.

Changing the relative mobility of real estate, and the resulting change in output, also influences the demand for other factors of production. As shown in figure 3, higher real estate mobility is associated with larger declines in the demand for farm purchased durables and energy. The demand for durable equipment and other inputs, on the other hand, drops relatively more when real estate is less mobile, while demand for hired labor is little affected by changes in the mobility of real estate. This result further illustrates the need to explicitly model inputs. One can not easily infer affects of output declines on use of specific inputs. Relative output prices that result from liberalization affect both output supplies and input demands.

Changing the supply elasticity of real estate has relatively little impact on the value of farm receipts. However, variable costs decline more under the assumption of "infinite" elasticity and this leads to a smaller decline in farm income (figure 3). Greater factor mobility allows growers greater flexibility to adjust outputs as relative prices change. Thus, negative consequences of policy reform on farm income are reduced somewhat.

Figure 3. Change in factor demand with unilateral trade liberalization; various land mobility assumptions.



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Effects of set-aside adjustments.

INPT and ST86 provide different results regarding the effects of liberalization on producer income and resource use. Is it possible that a major source for these differences is the modeling of set-asides? If one excepts the notion that there is a need for explicit adjustments in INPT to account for the set-aside provisions, how should they be modeled? Should one exogenously shift the supply schedule of program crops as in ST86, or should one exogenously increase the supply of real estate as in some CGE models? In this section, I examine these issues. The focus is on U.S. producer response following unilateral liberalization. Differences in producer response between ST86 and INPT are a function of the underlying production structure, adjustments for set-aside provisions, if any, and on world prices. I assumed exogenous world prices in order to remove them as a contributor to varying model results.

ST86 was simulated assuming unilateral liberalization without feedback from world prices. It generated production declines for all outputs except soybeans and other oil-bearing crops (figure 4). As stated previously, this result supports conventional wisdom regarding the effects of liberalization on the production of soybeans and grains. Even though the supply curve for program crops is shifted-out due to set-aside adjustments, production of program crops declines. The disincentive to expand output due to lower incentive prices more than offsets the incentive to use more land and expand output due to the elimination of set-aside restrictions.

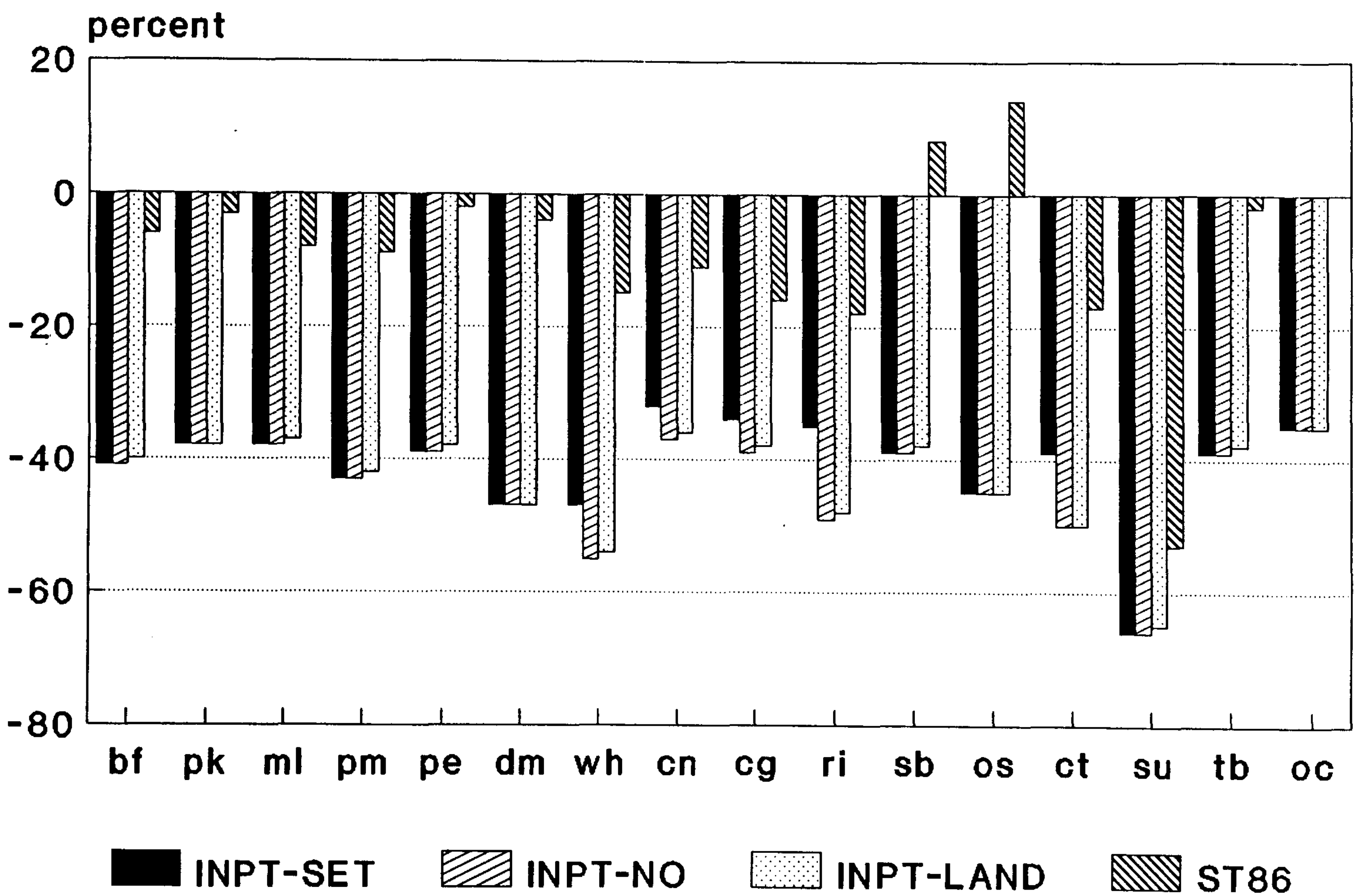
INPT was also simulated assuming unilateral liberalization without feedbacks from world prices. In addition, set-aside provisions were explicitly modeled by using the shift factors of ST86 in the supply schedule of program crops. The results from this experiment are also reported in figure 4 and are labeled INPT-SET. As shown in figure 4, production of each commodity declined considerably more than ST86. For example, ST86 indicated wheat and corn supply declined 15 and 11 percent respectively, whereas INPT indicated their supply declined 47 and 32 percent. The more elastic nature of INPT is once again illustrated by these results. The fall in producer incentive prices was the same in both models, yet INPT generates much larger output declines. Furthermore, results from INPT do not adhere to conventional wisdom, rather, results adhere to the notion of "normal" technology--soybean production does not increase.

The large production declines lead to large exodus of resources from agriculture, as the demand for each input declines considerably. The results from this experiment suggest that differences in model results are due to the alternative technologies that undergird the two models.

It was mentioned previously that exogenous shifts in the supply schedule of program crops, to reflect set-aside adjustments, is inappropriate in the INPT modeling framework. In order to illustrate this point numerically, the experiment described above was rerun without the shift factors in the supply function of program crops. The results, labeled INPT-NO in figure 4, were identical to the results from the previous experiment except for the supply of program crops. Supply of program crops declined further, in this case, since their supply schedule did not shift out.

Demand for each input and rental rate for land, however, is identical in the two experiments, even though the supply of program crops is different. Land rents decline 65 percent with or without the exogenous shifts in the supply of program crops. And the value of real estate declined 19 percent in both cases. This illustrates that exogenous shifts in the supply schedule is an inappropriate method for modeling set-aside programs in the INPT framework. In this framework, an exogenous shift in supply is equivalent to assuming technological improvements. More output (of program crops) is indicated but without a concomitant increase in input usage.

Figure 4. Percentage change in output
various set-aside assumptions



One might ask why not model set-asides in the INPT framework by exogenously shifting the supply of real estate? This is also inappropriate. The profit function upon which the elasticity matrix in INPT was developed assumed that real estate was a variable input and that it was fully employed. In this system, real estate does not move in and out of production without affecting its demand and remuneration. Assuming all else constant, an increase in the supply of an input, such as land, leads to a decline in its price and an increase in output. Given the technology that INPT represents, an increase in the supply of an input leads to an increase in the output of each commodity, not just program crops.

Even if one excepts the notion that land supply should be increased to reflect elimination of set-aside program, the value of the supply shift is not very large and does not materially affect the results generated by INPT. In 1986, about 43.1 million acres were in the set-aside program. Since INPT depicts the entire agricultural sector, this represents about 4 percent of the 1,007.6 million acres of land in farms. Given the slippage coefficients in Haley, Herlihy, and Johnson, only about 29.4 million acres or about 3 percent of total land in farms returns to production.

In order to numerically illustrate that INPT is well behaved (given the assumptions that undergird it), and to examine the implications of exogenously shifting the supply of real estate, two experiments were undertaken. The first experiment consisted of as exogenous shift in the supply of real estate by 3 percent, assuming everything else constant, while the second experiment also liberalized policies without feedback from world prices.

The results from the first experiment were as expected. Increasing the supply of real estate, while holding incentive prices constant, leads to an increase in the supply of each commodity. Since the real estate supply increase was relatively small, output expansion was also relatively small. Crop production, which is relatively more land intensive, increased comparatively more than livestock production. Since output expanded, the demand for each input also increased.

The scenario of simultaneously increasing the supply of real estate and liberalizing policies, labeled INPT-LAND in figure 4, results in large declines in the production of each commodity. The relative small production gain from the exogenous increase in real estate supply is insufficient to overcome the production fall from lower incentive prices. However, output of non-program commodities declined less with this scenario compared to INPT-SET. The additional supply of real estate results in a further decline in its price relative to INPT-SET, and this helps buttress somewhat the decline in the output of non-program crops.

Production of program commodities declined relatively more than the INPT-SET scenario, however. ST86 assumes that idled land returns to the production of the crop from which it was idled. Consequently, the shift factor for each program commodity is considerably larger than the 3 percent increase in real estate that is assumed in INPT-LAND. The additional supply of real estate, and the fact that it is distributed across all products, not just program crops, results in larger output declines of program crops compared to INPT-SET.

But, there are additional remifications from an exogenous change in real estate. As stated previously, there are input effects not just output effects. The exogenous increase in the supply of real estate leads to relatively larger fall in its price. Rental rate declined 65 percent in the two scenarios where land supply was not exogenously increased. In the scenario with a 3 percent exogenous increase in supply of real estate, land rents declined 67 percent. Changing land supply also affects the demand for the other inputs. Since output declined relatively less, demand for inputs also declined relatively less under INPT-LAND compared to INPT-SET.

Given that INPT generated results that are consistent with theory, that these results did not change materially under the various set-aside adjustments, and that these results are very different from those generated by ST86, it appears that the results generated by the two models are more depended upon the underlying production technology than upon the specific method used to capture the effects of removing set-aside restrictions.

To summarize, modeling the effects of set-aside programs is quite complex. Grain producers have generally been required to simultaneously idle acreage to receive deficiency payments. The combined effects of these conditional payments likely varies with the level of voluntary participation. The exercise above was not intended to exhaust the possible methods of modeling this complex issue. Rather, it was intended to show that within the modeling framework that was undertaken, there may not be a 'best' method to model the combined effects of eliminating deficiency payments and removing set-aside restrictions. Modeling approaches depend upon the model and the underlying assumptions. The exercise above indicates that applying the ST86 approach to modeling set-asides in INPT framework does not materially alter the results. And, modeling the effects of set-asides by exogenously increasing supply of land in the INPT framework, does not model preconceived notions of the effects of eliminating set-aside programs. Exogenously changing real estate supply affects the production of all commodities, not just program crops.

Conclusions

This study has examined the implications of trade reform based on different assumptions regarding the production technology of U.S. agriculture. The results indicate that it is important to adequately model the production technology and include inputs, otherwise simulation results may not capture the impact of liberalization on input use and may not adequately represent changes in producer income. The underlying production technology and the resulting output supply and input demand elasticities do significantly influence the implications of trade reform, not so much on predicted output price or supply, but on farm income and the distribution of that income among productive factors. The two models examined, for the most part, agreed on the direction of change, however, the magnitudes were quite often dissimilar, leading to very different conclusions on the prosperity of the agricultural sector. It appears that ST86 represents a shorter-run model than INPT. Both models, however, indicate that much of the support currently provided by industrialized countries can be eliminated if they all reform their policies. The market can generate much of the lost revenue.

Of importance to policy makers is that policy reform will significantly reduce the demand for factors of production and result in a smaller agricultural sector. This should not be surprising. Agriculture is a highly subsidized sector and more resources are attracted to the sector because of higher output prices. Removing the subsidies, therefore, should free resources for use in other sectors.

Furthermore, policy reform implies that land owners will be harmed as the use value of real estate falls. The relative decrease in the rental value reported in this study, and the decrease in resource use, is similar with results reported by others using CGE models. Thus, the rich policy, country, and commodity coverage of SWOPSIM, generally lacking in CGE models, can be modified to address resource use questions within the framework of a world model.

As with other analysis of this type, there are limitations, and the results are contingent upon certain caveats. The model is based on linearizing a non-linear system. The results, therefore, may not strictly hold for points away from the point of linearization. Furthermore, the results are based on static model, and although inputs are included, the model is still partial equilibrium in nature. In addition, the model ignores risk, and assumes that the agricultural sector is characterized by a multiple-output technology which is joint in inputs. Studies have indicated that U.S. agriculture can be described by this technology, therefore, the assumption is reasonable. However, there may be a need to further examine how to explicitly introduce feed inputs which are currently embedded in the category other inputs.

The results of this study should not be interpreted as a point estimate of the implications of liberalization. Rather, they suggest the direction of changes and the importance of including factors of production in the analysis. The implications of trade reform are likely to differ depending upon the period under analysis and the magnitude of distortions that are removed. Furthermore, the models represent a rather simplistic view of world agriculture. Product differentiation is not addressed, and the productive structure of the other trading blocks in the model were not modified. Finally, INPT assumes that factors of production, except real estate, can move freely without cost, in and out of agriculture. The analysis further assumes that when resources are released out of agriculture, they are reemployed at a fixed rate. Consequently, analysis of policy reform did not include possible resource adjustment costs. On the other hand, the analysis did not include benefits to other sectors from the availability of additional resources. Nonetheless, the analysis does indicate the importance of including factors of production to assessing the effects of policy reform on producers. It also indicates the importance of the production structure and factor mobility. Models may predict similar prices and production following policy reform, yet provide dissimilar effects on farm income, or on the value of decoupled payments required to compensate growers.

References

Ball, Eldon. "Modeling Supply Response in a Multiproduct Framework." American Journal Agricultural Economics. 70(1988):813-825.

Dixit, Praveen M. and Vernon Oley Roningen. Modeling Bilateral Trade Flows with the Static World Policy Simulation (SWOPSIM) Modeling Framework. Staff Report AGES 861124, U. S. Dept. Agr., Econ. Res. Serv., Dec. 1986.

Gardiner, Walter H., Karen Liu, and Vernon O. Roningen. Elasticities in the Trade Liberalization Database. Staff Report AGES 89-20, U.S. Dept. Agr., Econ. Res. Serv., May 1989.

Haley, Stephen L. Using Producer and Consumer Subsidy Equivalents in the SWOPSIM Modeling Framework. Staff Report AGES 89-11, U. S. Dept. Agr., Econ. Res. Serv., March 1989.

Haley, Stephen L., Michael T. Herlihy, and Brian Johnston. "Assessing Model Assumptions in Trade Liberalization Modeling: An Application to SWOPSIM." paper presented at the Southern Agr. Econ. Ass. annual meetings, Little Rock, Arkansas, Feb., 1990.

Hertel, Thomas W. "The Fate of Agriculture under Trade Liberalization: Challenging Conventional Conclusions," invited paper to the 1991 Annual Conference of The Australian Agricultural Economics Society, Armidale, NSW, Feb. 11-14.

__________, "Agricultural Trade Liberalization: Implications for Developing Countries." Paper presented at the joint OECD Development Center / World Bank Symposium, Paris, France, Oct. 5-6, 1989.

Hertel, Thomas W., Robert L. Thompson, and Marinos E. Tsigas. "Economywide Effects of Unilateral Trade and Policy Liberalization in U.S. Agriculture." Macroeconomic Consequences of Farm Support Policies. Ed. Andrew B. Stoeckel, David Vincent, and Sandy Cuthbertson. Durham, NC: Duke University Press, 1989.

Kilkenny, Maureen, and Sherman Robinson. "Computable General Equilibrium Analysis of Agricultural Liberalization: Factor Mobility and Macro Closure", Journal of Policy Modeling, 12(1990):527-556.

__________, "Modelling the Removal of Production Incentive Distortions in the US Agricultural Sector," Agriculture and Governments in an Interdependent World. Proceedings of the Twentieth International Conference of Agricultural Economists, Held at Buenos Aires, Argentina, 24-31 Aug. 1988. Ed. Allen Maunder, and Alberto Valdez. Dartmouth: 1989.

Liapis, Peter S. "Incorporating Inputs in the Static World Policy Simulation Model (SWOPSIM)." Technical Bulletin No. 1780 U.S. Dept. Agr., Econ. Res. Serv., June, 1990.

McDonald, Bradley J. A General Equilibrium Analysis of World Agricultural Policy Liberalization. U.S. Dept. Agr., Econ. Res. Serv., Staff Report, forthcoming.

Organization for Economic Cooperation and Development. National Policies and Agricultural Trade. Paris, 1987.

Robinson, Sherman, Irma Adelman, and Maureen Kilkenny. "The Effects of Trade Liberalization in Agriculture on the U.S. Economy: Projections to 1991." Macroeconomic Consequences of Farm Support Policies. Ed. Andrew B. Stoeckel, David Vincent, and Sandy Cuthbertson. Durham, NC: Duke University Press, 1989.

Robinson, Sherman, Irma Adelman, and Maureen Kilkenny. "The Effects of Trade Liberalization in Agriculture on the U.S. Economy: Projections to 1991." paper presented for the Global Agricultural Trade Study, organized by the Center for International Economics, Canberra, Australia, May, 1988.

Roningen, Vernon Oley. A Static World Policy Simulation (SWOPSIM) Modeling Framework. Staff Report AGES860625, U.S. Dept. Agr., Econ. Res. Serv., July, 1986.

Roningen, Vernon O., and Praveen M. Dixit. Economic Implications of Agricultural Policy Reforms in Industrial Market Economies. Staff Report AGES 89-36, U.S. Dept. Agr., Econ. Res. Serv., Aug. 1989.

Roningen, Vernon Oley, J. Sullivan, and J. Wainio. "The Impact of the Removal of Support to Agriculture in Developed Countries," paper presented at the American Agricultural Economics Association meetings E. Lansing, MI, August 1987.

Tyers, Rodney, and Kim Anderson. "Distortions in World Food Markets: A Quantitative Assessment." World Development Report, 1986. World Bank, Jan. 1986.

Zeitsch, John. "Adding Input Demands to Partial Equilibrium Agricultural Trade Models." Contributed paper, Thirty-Third Conference, Australian Agricultural Economics Society, Christchurch, New Zealand, Feb. 7-9, 1989.

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