Impact of Localized Cutbacks in Agricultural Production on A State Economy

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This study examines the effects that a cutback in production by Texas agricultural producers would have on the economic well-being of *all* producers and consumers in the state's economy. To do this, a quadratic input-output model incorporating econometric estimates of final demand was developed for the Texas economy. The output of the agricultural production sectors was constrained to reflect the cutback in production. The results show that agricultural producers would be economically worse off than before only if the producers of raw agricultural products in Texas imported their input needs from other geographical areas.

In 1977-78, some agricultural producers were making strong statements about what actions they would take if legislation were not enacted to guarantee farm prices at 100 percent of parity. These actions ranged from sending tractorcades to Washington, to cutting back production in an effort to dramatize the importance of a viable agriculture to the rest of the economy. Some of these actions, like the tractorcade, were carried out while others, such as cutting back agricultural production, never materialized at the national level. The regional differences noted in producer attitudes toward cutting back production were no doubt influenced by whether their costs of production were above or below the U.S. average costs of production used in determining deficiency payments to agricultural producers.

While talk of cutbacks in production by agricultural producers has subsided since the 1977-78 period, adverse developments in agriculture could renew interest in this form of action. Although it is unlikely that producer attitudes toward cutting back production in periods of adverse conditions in agriculture would be strong at the national level, state policymakers should understand the effects that *localized* cutbacks in agricultural production could have on their state's gross output, income, indirect business taxes and employment.

The rising cost of energy has substantially increased the costs of production for those agricultural producers in Texas who employ irrigation production practices. Approximately 86 percent of all food grains and 37 percent of all feed grains grown in Texas are produced on irrigated acres. The increasing squeeze on livestock profits — a major source of agricultural income in Texas — further adds to the economic pressures on this state's agricultural producers. The purpose of this study is to examine the short-run effects that a cutback in crop and livestock production in Texas could have on this state's general economy and the economic well-being of producers and consumers of Texas products. This objective will be accomplished by first developing a quadratic input-output model for the Texas economy that accounts for the

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interdependencies between this state's agricultural production sectors and other production sectors in the Texas economy. The output of the agricultural production sectors in this model will then be constrained to determine the effects a cutback in agricultural production would have on agricultural *and* non-agricultural producers and consumers. These effects will be illustrated by examining the capacity utilization rates in the non-agricultural production sectors as well as by observing the change in producer and consumer surplus at the sector level. The assumption is initially made that processors of raw agricultural products in Texas *cannot* increase their imports of these products in an effort to avoid the disruption to the flow of inputs to their firms caused by the cutback in agricultural production. Finally, we shall examine the effects on agricultural producers and others if the processors of raw agricultural products *can* increase their imports of these products from other geographical areas.

Measurement of Sector Interdependencies

Interdependencies occur in an economy when a production sector uses inputs provided by other production sectors to meet the intermediate and final demands for its products. One method of accounting for these interdependencies is to use an input-output model. First developed by Leontief in 1936, an input-output model describes a simultaneous system of linear production functions for all the production sectors in the modeled economy. While the Leontief input-output model captures the dependencies each production sector has upon the output of others, it cannot be used to measure the potential output of the economy or the effects of a cutback in production by producers, a strike by labor or the unavailability of imports since it assumes perfectly elastic product and primary input supply curves.

Dorfman, Samuelson and Solow have shown that it is possible to reformulate the Leontief input-output model as a linear programming problem. Such a model can be used to estimate the potential gross output of an economy or the effects of a cutback in production by producers if we constrain the output of each production sector by its *engineering capacity*, or the maximum output technically possible in the current period given its existing capital stock [Spielman and Weeks]. This is done by placing upper bounds on the production sectors equal to their engineering capacities. The product supply curves would be perfectly elastic only up to the point where the sectors reach their engineering capacities, at which time these curves would become perfectly inelastic. Several problems exist, however, with using this model to assess the *economic* effects of cutbacks in production on producers and consumers. First, final demand is still determined *exogenously*, suggesting consumers would *never* want more than this amount no matter what happens to product prices. Another problem is how one exogenously distributes total final demand among the various goods and services. In the real world, consumers determine how much of these goods and services they will want to purchase based, in part, on their relative prices.

Harrington has shown that an input-output model can be solved as a quadratic programming problem. The resulting quadratic input-output model incorporates econometric estimates of linear supply functions for each primary input and linear demand functions for the goods and services supplied by each production sector. The objective of the quadratic input-output model is to

$$(1) \quad \text{Maximize } Z = C'Q + .5Q'DQ$$

subject to

$$(2) \quad SQ \leqslant O$$

$$(3) \quad Q \geqslant O$$

where

$$(4) \quad Q' = [R' : X' : Y']$$

(5) $$C' = [-C_v' : O : C_u']$$

(6) $$D = \begin{bmatrix} -G^{-1} & O & O \\ O & O & O \\ O & O & F^{-1} \end{bmatrix}$$

(7) $$S = \begin{bmatrix} -I_m & T & O \\ O & A-I_n & I_n \end{bmatrix}$$

and where Q is a $(m+2n \times 1)$ matrix of quantities, C is a $(m+2n \times 1)$ matrix of price intercepts for the inverse primary input supply and final demand functions, D is a $(m+2n \times m+2n)$ matrix of slope terms for these inverse primary input supply and final demand functions, S is a $(m+n \times m+2n)$ matrix of coefficients for the fixed proportion production functions, R is a $(m \times 1)$ matrix of the quantity of primary inputs supplied, X is a $(n \times 1)$ matrix of total output of each production sector, Y is a $(n \times 1)$ matrix of final demand, $-C_v$ is a $(m \times 1)$ negative matrix of price intercepts for the inverse primary input supply functions, C_u is a $(n \times 1)$ matrix of the price intercepts of the inverse final demand functions, $-G^{-1}$ is a $(m \times m)$ negative matrix of the slope terms in the inverse primary input supply functions, F^{-1} is a $(n \times n)$ matrix of the slope and cross price terms in the inverse final demand functions, I_m and I_n are $(m \times m)$ and $(n \times n)$ identity matrices, T is a $(m \times n)$ matrix of technical coefficients for the primary inputs and A is a $(n \times n)$ matrix of technical coefficients for intermediate products.

When the objective function expressed in equation (1) is maximized subject to the linear constraints expressed in equations (2) and (3), the result is a perfectly competitive equilibrium where the sum of producer and consumer surplus is maximized. Equation (1) calculates the *difference* between the area under the demand curves and the area under the derived product supply curves, or the sum of producer and consumer surplus.[1] The larger these surpluses are, the better-off economically producers and consumers are said to be. Because the supply curves for each production sector are derived, it is possible to simply use the supply curves for the primary inputs in the quadratic input-output model when calculating producer surplus.[2] Equation (2) enforces the fixed proportion production functions for each production sector in the Walras-Cassel formulation. Finally, equation (3) insures a non-negative solution.

Unlike the linear programming approach,

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[1]To see why this is so, assume the aggregate inverse product demand and derived product supply curves are given by

$$P = a-bQ \text{ (demand)}$$

$$P = c+eQ \text{ (supply)}$$

where P is a vector of prices and Q is a vector of quantities. The area under the demand curve would be equal to

$$\int_O^{Q^*} (a-bQ)\, dQ = aQ-.5Q^2$$

where Q* in this instance represents the optimal quantities of final demand, or Y*. The area under the supply curve, on the other hand, would be equal to

$$\int_O^{Q^*} (c+eQ)\, dQ = cQ+.5eQ^2$$

where Q* here represents the optimal quantities of goods and services supplied to final demand. Consumer plus producer surplus, or the area under the demand curve less the area under the supply curve at market equilibrium would therefore be equal to

$$Z = aQ-bQ^2-cQ-.5eQ^2$$
$$= (a-c)\, Q+.5\,(b-e)Q^2$$

where the intercepts a and c for the demand and supply curves are captured in the C matrix in equations (1) and (5) while the slope coefficients b and e are captured in the D matrix in equations (1) and (6).

[2]The production function for each sector is linear and homogeneous to degree one. When combined with linear primary input supply functions, this suggests a linear derived product supply curve for each sector. In unconstrained solutions of the model, economic rent to producers will be zero. Thus, the quasi-economic rents accruing to the owners of the primary inputs will represent the only source of producer surplus.

therefore, the level of final demand for the product of each production sector is not determined exogenously. Instead it is allowed to change as the relative prices for these products change. Thus, final demand is determined *endogenously* in the quadratic input-output model rather than exogenously as both the Leontief and linear programming formulations assume. Final demand in the quadratic input-output model will be allocated among the products produced in the modeled economy such that the sum of producer and consumer surplus is maximized. In a constrained solution of this model, the prices associated with the optimal quantities (Q^*) are given by

$$(8) \qquad P = C + DQ^*$$

where P is a $(m + 2n \times 1)$ matrix of primary input and product prices. The matrix P can be partitioned to read

$$(9) \qquad P' = [-V' : O : U']$$

where $-V$ is a $(m \times 1)$ negative matrix of primary input prices and U is a $(n \times 1)$ matrix of product prices.

To account for the effects that sector engineering capacities or shortages of primary inputs have on the economy's potential output, we must solve equations (1) through (3) subject to the additional constraints that

$$(10) \qquad X \leq M_x$$

$$(11) \qquad R \leq M_r$$

where M_x is a $(n \times 1)$ matrix of upper bounds reflecting the current engineering capacities of the individual production sectors and M_r is a matrix of upper bounds reflecting the current availabilities of primary inputs, R.[3] Those production sectors that bump up against their engineering capacities first will be referred to as *capacity limiting* sectors.

In summary, the constrained quadratic input-output model is preferred over other input-output formulations in normative capacity analyses because final demand is determined endogenously and relative prices are allowed to change. We can specifically allow for downward sloping final demand curves and upward sloping primary input supply curves using elasticity estimates from previous econometric studies. The fact that all formulations continue to employ the Leontief assumptions of a perfectly competitive economy and non-stochastic, fixed proportion production functions must be kept in mind.

Application to Texas Economy

The quadratic input-output model described above was adapted in this study to an aggregated version of the 1972 183-sector Texas input-output table developed by the Texas Department of Water Resources [Grubb]. The resulting 55-sector model of the Texas economy places particular emphasis on the crop and livestock production activities of the state's agricultural sectors and the remainder of its food and fiber system (see Table 1). Before presenting its base solution, we should first explain how specific parts of this model were assembled.

Fixed Proportion Production Functions

The fixed proportion production functions used in this model were developed from the technical coefficients computed for 51 production sectors and 4 primary inputs. An identity matrix (I_n) is then subtracted from the A matrix of technical coefficients for

[3]The model should be solved subject to an additional constraint which insures that final demand for the trade and transportation sectors is consistent with the final demand for the goods supplied by the other production sectors. The margin data needed to develop these constraints were not available for the 1972 183-sector Texas input-output model, thereby forcing us to leave this constraint out of the quadratic input-output model developed in this study. The effect of this omission will be minimal in the scenarios examined in this study, however.

intermediate goods and services as required by the S matrix in equation (7) before it is entered in equation (1). The T matrix of technical coefficients for the primary inputs requires no transformations in equation (7) before it is entered in equation (1).

Product Demand Functions

Linear demand functions were derived for the goods and services supplied by each of the 51 production sectors in this model by first converting published elasticity of demand estimates into price flexibilities.[4] Linear demand functions containing these price flexibilities were then calculated for non-government final demand (i.e., households, exports, capital formation and inventory changes) for each product such that they passed through the 1972 price-quantity points. The price-quantity point for each product was determined by dividing each final demand by its price index (1972 = 100), which yields a quantity expressed in $100 million valued in 1972 prices. To determine the *total* final demand curve for each product, the intercept for the non-government final demand curve was adjusted by an amount equal to the slope of the demand curve times the value of government final demand (i.e., federal government defense, federal government non-defense, state government and local government) expressed in $100 million at 1972 prices. Once the linear inverse demand curve for the product supplied by each production sector was derived, the price intercept and slope coefficient for each product was entered in the C_u and F^{-1} submatrices in equations (6) and (7), respectively.

The elasticities of non-government final demand for specific products used to derive the demand curves were obtained from a variety of studies.[5] Estimates of elasticities of demand for agricultural products at the U.S. level were obtained from studies by George and King, Kinoshita, and Ray and Richardson.[6] Estimates of elasticities of demand for non-agricultural products at the U.S. level were obtained from studies by Almon, Wilson, and Houthakker and Taylor. For those few products where elasticity estimates were unavailable, unitary elasticities of demand were assumed. Because we are interested in looking at the effects of a localized cutback in agricultural production on the Texas economy, the U.S. elasticities were divided by the fraction Texas non-government final demand for each product was of U.S. non-government final demand. This means that product prices in this model will not change as much as they would if agricultural producers in other states also cut back their production. Finally, government final demand was assumed to be perfectly inelastic at the 1972 level.

Primary Input Supply Functions

Linear supply curves for labor services, capital services, government services and imports — the primary inputs in the model — must also be developed. Estimates of the supply elasticities associated with these inputs are difficult to come by. In the end, these values were assigned. For example, the

[4]Although there are 51 production sectors in the model, there are only 48 *different* products. To acount for different production processes (i.e., irrigated versus dryland) used to produce the same product (i.e., cotton, food grains and feed grains), transfer rows were placed in the S matrix in equation (7) to transfer the output of two sectors to one final demand.

[5]In most cases, the elasticities of demand used were estimated for the household sector only. For selected products, however, export elasticities of demand were obtained and exports of these products were handled separately.

[6]While cross-price elasticities can be incorporated in this quadratic input-output model, estimates of these elasticities between agricultural and non-agricultural products were unavailable for the level of aggregation adopted in this study. A listing of the linear product demand functions, primary input supply functions and the elasticities used in this study is available from the authors upon request.

supply of labor at the state level was assumed to be quite elastic since Texas is only one state in the economy and thus can "import" labor from other geographical areas. Thus, an elasticity of 15.0 was assumed, which is consistent with an elasticity of supply at the national level of 1.0 since Texas accounted for about one-fifteenth of the total value added in the U.S. economy. The supply of capital services was also assigned an elasticity of 15.0. The supply of government services was assumed to be more highly elastic. Consequently, a supply elasticity of 100.0 was used. Finally, the supply elasticity for imports at the state level was assumed to be infinite.[7]

Linear inverse supply functions for these four primary inputs were then calculated through price-quantity points in a manner identical to that used earlier to develop the linear inverse final demand functions. Once these supply curves are derived, their intercepts and slope coefficients must be entered in the C_v and G^{-1} submatrices in equations (5) and (6), respectively.

Producer and Consumer Surplus

One of the features of the quadratic input-output model is that it maximizes the sum of producer and consumer surplus; a measure of the gain in economic well-being realized by the participants in the modeled economy. Because the demand curves in the Texas model represent final demand, and because final demand includes exports, the value of the objective function in equation (1) reflects the gain in economic well-being realized by producers and consumers in Texas *plus* the gain realized by the rest of the world from trading with Texas producers.

In addition to knowing the total surplus realized by producers and consumers from participating in the Texas economy, it is often useful to know the surplus realized by a particular sector or group of sectors. Because there is a final demand curve for each production sector's product, it is possible to determine the consumer surplus associated with each product by calculating the area under the demand curve and *above* the equilibrium price. For example, the consumer surplus associated with the ith product is given by

$$CS_i = .5b_{ii}Q_i^{*2} \quad (12)$$

where b_{ii} is the absolute value of the own slope coefficient for the ith product's final demand curve and Q_i^* is the optimal quantity demanded for the ith product. Thus, Q_i^* in this instance represents Y_i^*.

To calculate the producer surplus for a particular production sector, we must first calculate the quasi-economic rent for each primary input by measuring the area above the primary input supply curve and *below* the equilibrium price. For example, the quasi-economic rent for producers who own the kth primary input is given by

$$PS_k = .5e_{kk}Q_k^{*2} \quad (13)$$

where e_{kk} is the absolute value of the own slope coefficient for the kth primary input supply curve and Q_k^* is the optimal supply of the kth primary input for the entire economy. Thus, Q_k^* here represents R_k^*. The producer surplus for a particular production sector is then found by summing the sector's share of the total surplus associated with each of the four primary inputs in this model, where these shares are given by the sector's proportional use of these inputs. This means the quasi-economic rent received by producers in the ith production sector for the kth primary input is equal to

$$PS_{ik} = .5h_{ik}Y_i^*e_{kk}R_k^* \quad (14)$$

where

[7] Sensitivity analyses performed by Fulton showed that use of an elasticity of supply of 2.0 rather than 15.0 for labor services and 10.0 rather than 100.0 for government services did not have an appreciable effect on the model's solution values. For a further discussion, see Fulton.

$$H = T(I-A)^{-1} \quad (15)$$

and where h_{ik} is an element in the H matrix, T is the matrix of technical coefficients associated with primary inputs and Y_i^* is the final demand in the ith production sector. If the ith sector's output is not constrained by its engineering capacity, economic rent will be equal to zero and the entire producer surplus for the sector will be given by

$$TPS_i = \sum_{k=1}^{m} PS_{ik} \quad (16)$$

If the production sector's output is constrained by its engineering capacity, however, total producer surplus must also reflect the economic rent or profits received by producers, or

$$TPS_i = \sum_{k=1}^{m} PS_{ik} + P_iX_i^* - \sum_{j=1}^{n} P_ja_{ij}X_i^* - \sum_{k=1}^{m} P_kt_{ik}X_i^* \quad (17)$$

where a_{ij} is the technical coefficient from the A matrix associated with the jth intermediate product used in the ith production sector.

Base Solution

The base solution for the quadratic input-output model developed in this study is presented in Table 1. The output, primary input and final demand levels reported here are identical to the values reported in the 1972 Texas transactions table since the price indices for all the primary inputs and products were equal to 100. The value of the objective function, or the sum of producer and consumer surplus for all participants in the Texas economy, was $15,005 billion. Since all prices were indexed, this solution value does not represent an absolute measure of the nominal gain in economic well-being realized by the participants in the 1972 Texas economy. This solution value, however, does provide the basis against which the solution values associated with a cutback in agricultural production can be compared.

The value of the producer and consumer surpluses reported in Table 4 for selected agriculturally-related sectors must also be interpreted the same way. Note producer surplus is smaller than consumer surplus. This can be explained by the relatively high elasticities used in formulating the primary input supply functions in this study.

Effects of a Cutback in Agricultural Production

There are a variety of potential capacity-related issues that could be addressed with the model developed in this study. Because the sectors producing agricultural products both supply and receive production inputs from other production sectors, the actions of agricultural producers will affect the output of other production sectors, and vice-versa. Our interest in this paper is to determine the effect that a cutback in agricultural production would have had on the utilization of capacity in other production sectors as well as the economic well-being of all the participants in the 1972 Texas economy.

Design of Simulations

Let us assume that Texas crop and livestock producers in 1972 had cut back their production plans by 35 percent of the output levels reported in Table 1. Due to the biological nature of agricultural production processes, once a crop has not been planted or breeding livestock have not been bred, the resulting production levels in effect represent the current engineering capacities of these sectors. The engineering capacities of the agricultural production sectors therefore were set at 65 percent of the actual output produced in 1972. From a programming standpoint, this required substituting these engineering capacities into the M_x matrix in equation (10). Given the assumption of a 35

TABLE 1. Base solution results for the 1972 Texas Economy.

Sector	Total output	Final demand	Price index
Products	— $100 million —		1972 =100
1. Irrigated cotton	0.738	—	—
2. Irrigated food grains	2.256	—	—
3. Irrigated feed grains	2.006	—	—
4. Other irrigated	1.949	.696	100.00
5. Dryland cotton	7.433	6.924	100.00
6. Dryland food grain	0.374	0.727	100.00
7. Dryland feed grain	3.482	1.376	100.00
8. Range livestock	9.151	2.030	100.00
9. Feedlot livestock	15.305	6.975	100.00
10. Dairy	2.933	0.162	100.00
11. Poultry and eggs	2.284	0.602	100.00
12. Other dryland crops and livestock	1.902	1.058	100.00
13. Agricultural supplies	1.708	0.052	100.00
14. Cotton ginning	0.933	0.070	100.00
15. Agricultural services	3.387	0.208	100.00
16. Forestries and fisheries	1.496	0.092	100.00
17. Meat products	14.299	11.778	100.00
18. Poultry products	1.877	1.814	100.00
19. Dairies	4.642	3.606	100.00
20. Grain milling	3.961	2.951	100.00
21. Animal feeds	3.928	1.700	100.00
22. Bakery products	3.195	2.595	100.00
23. Canned, preserved, pickled, dried and frozen food	4.973	3.358	100.00
24. Other food	18.919	17.011	100.00
25. Textiles and apparels	13.039	11.777	100.00
26. Crude petroleum and natural gas	60.717	23.132	100.00
27. Natural gas liquids	19.184	11.139	100.00
28. Other mining	11.026	1.996	100.00
29. Construction	101.186	93.261	100.00
30. Lumber and wood products	28.178	10.658	100.00
31. Agricultural chemicals	2.574	0.204	100.00
32. Other chemicals	64.896	47.307	100.00
33. Petroleum refining and related industries	74.042	56.221	100.00
34. Glass, stone and metal products	49.843	16.064	100.00
35. Farm machinery	2.316	1.623	100.00
36. Machinery and equipment	12.394	10.266	100.00
37. Electrical and electronic equipment	25.351	19.926	100.00
38. Motor vehicles and transport	30.795	27.778	100.00
39. Miscellaneous manufacturing	14.198	11.654	100.00
40. Transportation and warehousing services	36.835	18.681	100.00
41. Communication and utility services	45.647	21.071	100.00
42. Wholesale groceries	7.606	6.619	100.00
43. Wholesale crop products	3.836	2.514	100.00
44. Wholesale livestock	1.261	0.516	100.00
45. Other wholesaling	65.695	52.455	100.00
46. Retail farm machinery and equipment	1.954	1.499	100.00
47. Retail food stores	15.476	15.266	100.00
48. Other Retail	82.809	74.538	100.00
49. Banking and credit agencies	35.253	19.581	100.00
50. Other finance, insurance and real estate	64.259	29.997	100.00
51. Other services	131.658	81.113	100.00
Primary inputs			
1. Labor services	359.083	—	100.00
2. Capital services	149.615	—	100.00
3. Government services	61.028	—	100.00
4. Imports	162.915	—	100.00

percent cutback in agricultural production, the constraints inserted into equation (10) represented 65 percent of the output levels reported for these sectors in Table 1.

U.S. Department of Commerce survey results show the non-agricultural production sectors in Texas were operating well below their 1972 engineering capacities (see Table 3). Thus, their engineering capacities would not have effectively constrained the model's solution for the simulations conducted in this paper and therefore were not entered in the M_x matrix.

The effects of a cutback in agricultural production are examined in the following two simulations. The first simulation assumes processors of Texas raw agricultural products could not increase their imports of these products from other geographical areas. The second simulation relaxes this assumption by examining what would have happened if these processors imported 50 percent of their agricultural input needs.

Effects If Imports Not Increased

The 1972 output, primary input, final demand and price levels associated with a 35 percent cutback in agricultural production *if* processors of these products could not increase their imports of raw agricultural products are reported in Table 2. While there would have been a substantial increase in the prices agricultural producers receive for most of their products, not all prices would have increased by the same percentage. This is because of the different elasticities of demand for each product. For example, the cotton production sectors were in a very inelastic portion of their demand curve and therefore realized a relatively large percentage increase in prices.

The interdependencies within the food and fiber system in Texas are also evident in these results. By "bottlenecking" the flow of raw agricultural products to processors of these products, the agricultural production sectors would have been the capacity limiting production sectors in the Texas economy. For example, when the output of the livestock production sectors was cut back, thereby causing livestock prices to rise anywhere from 6 to 12 percent, the output of livestock processors would have declined as well. This, in turn, would also have caused the prices of processed foods to increase. Those manufacturing sectors not directly related to agriculture would have been relatively unaffected by the cutback in agricultural production, however.

We can further illustrate the short-run effects of this cutback in agricultural production on the manufacturing sectors by examining their engineering capacity utilization rates. Looking at these rates both before and after the cutback in agricultural production in Table 3, we see those non-agricultural production sectors hardest hit by the cutback would have been those who utilize raw agricultural products as an input to their production processes. For example, the engineering capacity utilization rates in the meat products, poultry products, dairies and animal feeds sectors would have been fallen sharply if agricultural production were cut back 35 percent. On the other hand, the engineering capacity utilization rate in such sectors as the glass, stone and metal products sector would have remained unchanged in the short-run.

The quantity of primary inputs used in the economy would have also declined from the levels reported in the base solution. Because less output would have been produced, less inputs would have been needed and their prices would have declined. A similar result would have occurred for some of the intermediate products used by agricultural producers, such as agricultural supplies, agricultural services, fertilizer, farm machinery, and banking and credit agencies. Total output of these sectors would have decreased as less of their product would have been demanded by the agricultural production sectors. The final demand for the goods and services supplied by these and other sectors would have changed very little, however. Total wages paid to households in the Texas economy

TABLE 2. Effect of a 35 percent cutback in agricultural production if processors did not increase their imports of these products.

Sector	Total output	Final demand	Price index
Products	— $100 million —		1972 =100
1. Irrigated cotton	2.527	—	—
2. Irrigated food grains	1.267	—	—
3. Irrigated feed grains	1.989	—	—
4. Other irrigated	1.267	0.225	114.23
5. Dryland cotton	2.767	4.285	145.71
6. Dryland food grain	0.460	0.316	114.05
7. Dryland feed grain	1.573	0.893	112.74
8. Range livestock	5.949	1.858	105.81
9. Feedlot livestock	9.950	6.360	108.92
10. Dairy	1.907	0.143	111.12
11. Poultry and eggs	1.485	0.537	106.76
12. Other dryland crops and livestock	1.236	0.634	110.13
13. Agricultural supplies	1.126	0.053	99.88
14. Cotton ginning	0.646	0.070	99.88
15. Agricultural services	2.597	0.200	100.56
16. Forestries and fisheries	1.422	0.096	99.94
17. Meat products	6.097	3.686	106.57
18. Poultry products	0.907	0.859	104.23
19. Dairies	3.172	2.151	105.10
20. Grain milling	2.981	2.122	106.33
21. Animal feeds	2.432	1.005	105.75
22. Bakery products	3.116	2.523	100.94
23. Canned, preserved, pickled, dried and frozen food	4.502	2.924	101.11
24. Other food	16.777	15.207	102.20
25. Textiles and apparels	10.735	9.550	100.91
26. Crude petroleum and natural gas	60.509	23.179	99.90
27. Natural gas liquids	19.166	11.160	99.91
28. Other mining	11.000	2.010	99.90
29. Construction	101.302	93.575	99.92
30. Lumber and wood products	27.858	10.748	99.92
31. Agricultural chemicals	1.836	0.204	99.92
32. Other chemicals	64.722	47.495	99.91
33. Petroleum refining and related industries	73.494	56.241	99.91
34. Glass, stone and metal products	49.670	16.136	99.92
35. Farm machinery	2.258	1.653	92.92
36. Machinery and equipment	12.555	10.439	99.92
37. Electrical and electronic equipment	25.421	20.009	99.93
38. Motor vehicles and transport	31.002	28.079	99.93
39. Miscellaneous manufacturing	14.271	11.783	99.91
40. Transportation and warehousing services	36.306	18.921	99.89
41. Communication and utility services	45.347	21.186	99.91
42. Wholesale groceries	7.605	6.640	99.88
43. Wholesale crop products	3.409	2.526	99.90
44. Wholesale livestock	0.986	0.519	99.90
45. Other wholesaling	65.547	53.806	99.89
46. Retail farm machinery and equipment	1.826	1.518	99.88
47. Retail food stores	15.520	15.313	99.89
48. Other Retail	81.504	73.654	100.10
49. Banking and credit agencies	34.823	19.696	99.88
50. Other finance, insurance and real estate	63.964	30.258	99.89
51. Other services	130.995	81.409	99.97
Primary inputs			
1. Labor services	350.541	—	99.84
2. Capital services	146.713	—	99.88
3. Government services	59.660	—	99.98
4. Imports	156.946	—	100.00

TABLE 3. Comparison of engineering capacity utilization rates in the Texas manufacturing sectors for the 1972 base solution and the solutions for a 35 percent cutback in agricultural production.

Sector	1972 Engineering capacity [a]	— Utilization rates —		
		Base results [b]	No increase in imports [c]	Increase in imports [c]
	$100 mil.	Percent		
Meat products (17)	17.657	81	35	67
Poultry products (18)	2.317	81	39	81
Dairies (19)	5.732	81	55	68
Grain milling (20)	4.890	81	61	80
Animal feeds (21)	4.849	81	50	61
Bakery products (22)	3.944	81	79	81
Canned, preserved, pickled dried and frozen food (23)	6.141	81	73	81
Other food (24)	23.347	81	72	77
Textiles and apparels (25)	14.987	87	72	81
Lumber and wood products (30)	34.792	81	80	81
Agricultural chemicals (31)	3.298	78	56	52
Other chemicals (32)	82.176	79	79	79
Petroleum refining and related industries (33)	86.072	86	85	85
Glass, stone and metal products (34)	59.338	84	84	84
Farm machinery (35)	2.828	82	80	79
Machinery and equipment (36)	15.117	82	83	83
Electrical and electronic equipment (37)	33.801	75	75	75
Motor vehicles and transport (38)	38.979	79	80	79
Miscellaneous manufacturing (39)	17.974	79	79	80

[a]1972 base results divided by the engineering capacity utilization rate.
[b]Source: *Survey of Plant Capacity*, Table 1, 4th Quarter, 1972.
[c]Total output divided by the 1972 engineering capacity times 100.

would have fallen by 2.4 percent to $350.5 billion while indirect business taxes would have fallen by $1.4 billion, a 2.2 percent decline.

As one might expect, the *total* value of producer and consumer surplus in the Texas economy would have declined as a result of the cutback in agricultural production. While the total gain in economic well-being realized by participants in the economy would have been less than if there were no cutback in agricultural production, agricultural producers would have been better-off economically. Producer surplus in the agricultural production sectors would have increased by $417.4 billion. The results presented in Table 4 indicate this gain would have been achieved largely at the expense of *consumers,* whose gain in economic well-being from purchasing Texas products would have declined by 40 percent. Producers in the agriculturally-related sectors would have suffered a 33 percent decline in producer surplus. Thus, the gain in economic well-being achieved by agricultural producers was not large enough to offset the lower producer and consumer surpluses for other participants in the Texas economy. If agricultural producers in future periods were to respond to these higher product prices by no longer cutting back their production, however, the prices and producer and consumer surpluses reported here would return to the levels reported in the base solution.

Effects If Imports Increased

Let us now assume that the processors of raw agricultural products in Texas, in response to the announced cutbacks by agricultural producers, contracted for 50 percent of their needs for these inputs with producers outside Texas. The output, final demand, primary input and price levels associated with this simulation are reported in Table 5. A review of this table shows the output of some agricultural production sectors would have been reduced due to the lower total demand for their product. Others, like the cotton production sectors, would not have had to cut back their output since the total demand for their product still exceeded their engineering capacities. The prices received by *all* agricultural producers, however, would have been lower than those reported in Table 2, where processors of raw agricultural products could not increase their imports of these products. The output of Texas processors of raw agricultural products in Table 5 would have been higher as well. For example, the meat products sector would now have been producing $11.824 billion in processed meats as compared to the $6.097 billion figure reported in Table 2. This is still considerably less than the $14.299 billion figure reported before the cutback in agricultural production in Table 1. The prices for processed foods also would have fallen from the values reported in Table 2, where processors could not increase their imports of raw agricultural products. The index of prices paid for meat products, for example, would have fallen back to 101.99, still slightly above the price index of 100 before the cutback in agricultural production but substantially below the index of 106.57 reported in Table 2. Total wages paid to households and indirect business taxes would have also increased from the values reported in Table 2, but these payments would have still been much lower than the values received before the cutback in agricultural production.

A comparison of the engineering capacity utilization rates for the agriculturally-related production sectors in Table 3 shows that most of these sectors would now have been operating at higher utilization rates, although these rates would have still been lower than those reported before the cutback in agricultural production. Note that some of these sectors would have been operating *below* the capacity utilization rates found when processors of raw agricultural products could not increase their imports of these products. For example, the farm machinery and agricultural chemicals sectors would have been operating at 79 and 52 percent of their capacities, respectively. This would have

TABLE 4. Comparison of producer and consumer surplus for the 1972 base solution and the solutions for a 35 percent cutback in agricultural production.

Sector	1972 base results		No increase in imports		Increase in imports	
	Producer surplus	Consumer surplus	Producer surplus	Consumer surplus	Producer surplus	Consumer surplus
	--- $100 million ---					
Agricultural production sectors:						
Dryland and irrigated cotton (1+5)	19.50	414.60	251.46	158.76	213.82	192.25
Dryland and irrigated food grains (2+6)	2.02	9.30	23.81	1.71	1.96	9.10
Dryland and irrigated feed grains (3+7)	3.75	24.99	45.51	10.54	1.84	26.14
Other irrigated crops (4)	1.88	7.32	17.99	0.77	2.27	7.14
Range livestock (8)	5.36	69.90	32.24	58.62	5.44	69.69
Feedlot livestock (9)	13.37	352.61	59.44	293.15	75.44	309.02
Dairy (10)	0.41	7.76	16.68	6.07	0.45	7.75
Poultry and eggs (11)	1.38	18.61	7.16	14.78	1.18	18.52
Other dryland crops and livestock (12)	2.90	13.38	13.74	4.81	5.48	10.84
Total	50.58	918.20	468.02	549.21	307.88	650.45
Agriculturally-unrelated sectors:						
Meat products (17)	24.44	56.32	7.47	5.52	10.78	35.37
Poultry products (18)	4.16	7.29	1.93	1.64	2.68	7.23
Dairies (19)	8.10	22.78	4.71	8.11	5.62	22.80
Grain milling (20)	6.72	33.21	4.72	17.17	4.87	33.39
Animal feeds (21)	3.47	14.03	2.00	4.90	2.63	12.83
Bakery products (22)	5.62	43.17	5.34	40.78	5.27	43.25
Canned, preserved, pickled, dried and frozen food (23)	6.77	14.34	5.77	10.87	6.30	14.49
Other food (24)	23.60	176.69	20.63	141.21	20.73	164.41
Textiles and apparels (25)	17.44	28.31	13.82	18.61	15.54	24.38
Agricultural chemicals (31)	0.42	24.89	0.39	24.91	0.40	24.91
Farm machinery (35)	3.02	3.57	3.00	3.70	3.01	3.69
Total	103.75	424.60	69.80	277.42	77.83	386.75
Total for entire economy	1,728.90	13,276.20	1,652.00	12,801.80	1,672.60	13,039.60

TABLE 5. Effect of a 35 percent cutback in agricultural production if processors imported 50 percent of their agricultural input needs.

Sector	Total output	Final demand	Price index
Products	— $100 million —		1972 =100
1. Irrigated cotton	2.527	—	—
2. Irrigated food grains	1.267	—	—
3. Irrigated feed grains	1.989	—	—
4. Other irrigated crops	1.267	0.690	100.27
5. Dryland cotton	2.767	4.715	138.21
6. Dryland food grain	0.379	0.730	99.90
7. Dryland feed grain	0.815	1.379	99.17
8. Range livestock	4.568	2.032	100.11
9. Feedlot livestock	9.950	6.499	106.46
10. Dairy	1.467	0.162	100.15
11. Poultry and eggs	1.417	0.601	100.18
12. Other dryland crops and livestock	1.236	0.952	102.53
13. Agricultural supplies	1.034	0.052	99.98
14. Cotton ginning	0.646	0.070	99.85
15. Agricultural services	2.457	0.209	99.95
16. Forestries and fisheries	1.503	0.097	99.93
17. Meat products	11.824	9.334	101.99
18. Poultry products	1.866	1.806	100.03
19. Dairies	4.644	3.607	99.99
20. Grain milling	3.895	2.959	99.94
21. Animal feeds	2.980	1.627	100.72
22. Bakery products	3.199	2.598	99.97
23. Canned, preserved, pickled, dried and frozen food	4.993	3.376	99.96
24. Other food	18.001	16.409	100.74
25. Textiles and apparels	12.167	10.930	100.35
26. Crude petroleum and natural gas	60.683	23.171	99.92
27. Natural gas liquids	19.164	11.156	99.92
28. Other mining	11.015	2.009	99.90
29. Construction	101.318	93.581	99.92
30. Lumber and wood products	28.112	10.750	99.92
31. Agricultural chemicals	1.717	0.204	99.91
32. Other chemicals	64.747	47.536	99.89
33. Petroleum refining and related industries	73.433	56.241	99.91
34. Glass, stone and metal products	49.819	16.144	99.91
35. Farm machinery	2.237	1.650	99.93
36. Machinery and equipment	12.549	10.424	99.92
37. Electrical and electronic equipment	25.429	20.002	99.93
38. Motor vehicles and transport	30.972	28.047	99.94
39. Miscellaneous manufacturing	14.313	11.783	99.91
40. Transportation and warehousing services	36.536	18.932	99.89
41. Communication and utility services	46.433	22.028	99.20
42. Wholesale groceries	7.624	6.639	99.89
43. Wholesale crop products	3.383	2.526	99.91
44. Wholesale livestock	0.980	0.520	99.91
45. Other wholesaling	66.511	53.737	99.89
46. Retail farm machinery and equipment	1.794	1.518	99.89
47. Retail food stores	15.525	15.315	99.88
48. Other Retail	82.904	75.077	99.94
49. Banking and credit agencies	34.509	19.683	100.22
50. Other finance, insurance and real estate	64.205	30.291	99.87
51. Other services	132.047	82.106	99.90
Primary inputs			
1. Labor services	352.440	—	99.88
2. Capital services	147.880	—	99.93
3. Government services	60.242	—	99.99
4. Imports	171.054	—	100.00

been caused by the reduced input needs of the agricultural production sectors because processors of raw agricultural products imported part of their input needs from other geographical areas.

Finally, a review of Table 4 shows consumers would have been economically better-off if Texas processors of raw agricultural products could have increased their imports to avoid a disruption to their production plans. Yet, consumers still would not have been as well-off economically as they would have been had agricultural producers not cut back their production. This was also true of the economic well-being of producers in all the agriculturally-related production sectors except the farm machinery production sector. All *agricultural* producers except those in the feedlot livestock production sector would now have been worse-off economically than they would have been if the processors of raw agricultural products could not increase their imports of these products. Importantly, some of these producers would now have been worse-off economically than they were *before* they cut back their production. This occurred to the producers of food and feed grains, for example. This helps underscore the risks agricultural producers undertake by cutting back their production. This loss is economic well-being could have been even greater if Texas processors had increased their imports of these products even further. Why would feedlot livestock producers be better-off economically if processors increased their imports of raw agricultural products? While their gross revenue would have been lower, feedlot livestock producers would have benefited from lower costs of feeder calves and feed grains. Thus, while their quasi-economic rent would have been lower under this scenario, feedlot livestock producers' economic rent would have been substantially higher.

Concluding Remarks

The allowance for sector engineering capacities in a quadratic input-output model for a state economy allows one to identify the effects that localized cutbacks in agricultural production would have upon producers and consumers throughout the economy. Using a quadratic input-output model developed for the 1972 Texas economy, we showed a cutback in production by agricultural producers would increase their economic well-being *if* processors of raw agricultural products could not increase their imports of these products. However, the economic well-being of consumers and other producers in the Texas economy would have been less than it was before the cutback. If Texas processors of raw agricultural products could have increased their imports of these products from other geographical areas, however, the cutback by agricultural producers could backfire on them as illustrated in this study. The exception to this conclusion was feedlot livestock producers, who would benefit from the lower costs they would have to pay for feeder calves and feed grain.

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