THE EFFECT OF HIGHER ENERGY PRICES ON THE COMPETITIVE POSITION OF NORTHEAST AGRICULTURE

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INTRODUCTION

Major increases in energy prices since 1973 have raised considerable interest in the effect of a continuation of these increases on interregional competition. There is speculation in the Northeast that a general increase in energy prices will cause agricultural production to shift closer to the consumers. This production shift supposedly will lead to self-sufficiency in many products which were once grown in the Northeast and are now largely imported from other regions. This paper uses a simple interregional trade model to estimate the possible impact of higher energy prices on interregional competition, and on the Northeast in particular. It does this by assuming values for the relevant variables in the model and estimating the changes in the system. A range of values are used to estimate the sensitivity of the conclusions to the assumptions.

PREVIOUS STUDIES

There have been a small number of studies which speculated on the effect of higher energy prices on interregional competition. Casavant and Whittlesey (1974) discuss possible implications of higher energy prices from a Northwest perspective and determine that products moving by truck are most vulnerable, products with more elastic demand are more vulnerable than those with less elastic demand, products processed enroute will be affected less, and products of high value relative to weight will be affected less. All of this is fairly straightforward but the magnitudes of changes are not determined.

Dunn and Beard (1981) studied the impact of higher energy prices on interregional competition for peaches and found that the elastic demand for peaches offset the high transport costs and Northeast producers found themselves with a larger proportion of a shrinking market, and less production overall. Peach processing with its lower transport costs, remained largely a California industry. Beilock and Dunn (1981) studied the impact of higher energy prices on potatoes and found that energy price increases will probably not reverse the decline of the Northeast potato industry, especially for frozen and dehydrated potatoes. The relative position for table stock and chipping potatoes is better, but poor nonetheless.

These and other findings suggest that a vast restructuring of American agriculture, with a decrease in specialization and a return to regional self-sufficiency, seems unlikely. Although these conclusions can be reached without empirical analysis, there continues to be much speculation about the advantages which will come to Northeast agriculture as a result of energy price increases. This study attempts to examine the general case in order to estimate the possible ranges of regional response to energy price increases.

THE GENERAL CASE

If one considers the basic model for interregional competition for a single commodity as developed by Samuelson (1952) it is apparent that graphically the effect of higher energy prices on the system is indeterminate. The direction of the net effects is dependent on the relative size of shifts in several variables, which requires numerical estimates of certain relevant parameters.

This model may be expressed in equation form as:

$$D_1 = f_1(P_1, PS),$$

$$D_2 = f_2(P_2, PS),$$

$$S_1 = f_3(P_1, PZ),$$

$$S_2 = f_4(P_2, PZ),$$

$$P_T = f_5(Q_T, P_E),$$

$$P_T = P_1 - P_2,$$

$$Q_T = D_1 - S_1,$$

$$Q_T = S_2 - D_2,$$

where D_1 and D_2 are quantities demanded in regions 1 and 2 respectively, S_1 and S_2, quantities supplied, Q_T the amount of trade, P_1 and P_2, the product prices, PS, the price of substitutes, PZ, the price of inputs, P_T the price of transporting the good, and P_E the price of energy. This system has eight equations and eight unknowns if PS, PZ, and P_E are determined exogenously. If the total derivatives are taken, the system becomes

$$dD_1 - \frac{\partial f_1}{\partial P_1} dP_1 = \frac{\partial f_1}{\partial PS} dPS$$

$$dD_2 - \frac{\partial f_2}{\partial P_2} dP_2 = \frac{\partial f_2}{\partial PS} dPS$$

$$dS_1 - \frac{\partial f_3}{\partial P_1} dP_1 = \frac{\partial f_3}{\partial PZ} dPZ$$

$$dS_2 - \frac{\partial f_4}{\partial P_2} dP_2 = \frac{\partial f_4}{\partial PZ} dPZ$$

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$$dP_T - \frac{\partial f_5}{\partial Q_T} dQ_T = \frac{\partial f_5}{\partial P_E} dP_E$$

$$dP_1 - dP_2 - dP_T = 0$$

$$dD_1 - dS_1 - dQ_T = 0$$

$$dD_2 - dS_2 + dQ_T = 0$$

This system may be solved for the effect of a change in energy prices on the production in the importing region, dS_1/dP_E, as well as the effects of higher energy prices on the other endogenous variables. Numerical estimates require the relative size of D_1, D_2, S_1, S_2, Q_T and P_1, P_2, and P_T as well as certain supply and demand elasticities.

APPROPRIATE INITIAL VALUES

The relative size of the various quantities and prices and the size of the various supply and demand elasticities are information which is readily available for most products. Therefore, in order to estimate the effect of higher energy prices on a particular product the appropriate coefficients can be inserted in the total derivative equations and they may be solved. In order to preserve generality, this study will take a slightly different approach. Initial values will be assigned in a somewhat arbitrary manner and the system will be solved. Then these initial values will be varied to examine the importance of the assumptions on the solution. In this manner a range of values will be examined, a range which should include the appropriate values for most northeastern crops, and generalizations about the results will be made where possible. This procedure should allow inferences to be drawn about the effect of higher energy prices on most northeastern crops.

Since the northeast has approximately one fourth of the nation's population, in general they consume about one fourth of most food products. Therefore, $D_2 \simeq 3D_1$. For the initial situation, consider a product for which region 1, the northeast, is fifty percent self-sufficient. This means $S_1 = 0.5D_1$, $S_2 = 3.5D_1$, and $Q_T = 0.5D_1$. Further, let $P_T = 0.25P_1$.

A quarterly model regressing fuel prices, as measured by the fuels component of the producer price index, on the prices paid by farmers, each deflated by the implicit GNP deflator, for the period 1965-1979, adjusted for autocorrelation, yields*

$$\underset{(21.3)}{PPF = 0.806} + \underset{(7.9)}{0.2199\ Fuel.}$$
$$R^2 = 0.518$$

This suggests the elasticity of real farm input prices, PZ, with respect to real energy prices, when evaluated at their means, is 0.25. This is clearly a naive model since it assumes all real farm input price inflation is caused by real energy price inflation. Since the goal of this model is simply to estimate dP_Z/dP_E roughly, a more realistic model may not be necessary. The importance of accurate measurement of dP_Z/dP_E will be examined in a later section.

Consider initially a long run price elasticity of supply of 1.5 and a long run elasticity of supply with respect to purchased inputs, PZ, of -0.4 (Tweeten, p. 242-46). Further, let the long run flexibility of the supply of transport be 0.5 and the elasticity of P_T with respect to energy prices be 0.25. Let the own real price elasticity of demand be -0.6 and the cross price elasticity be 0.3. Let the elasticity of the price of substitutes with respect to energy price changes be 0.1.

RESULTS

When this initial problem is solved, higher energy prices are reflected heavily in transportation prices. The elasticities with respect to higher energy prices are found in the fourth column of Table 1. The elasticity of the transportation price, P_T, with respect to an energy price change is 0.204. Clearly this would increase the differential between the exporting region and the importing region. The price in the importing region, P_1, rises accordingly, with an elasticity with respect to energy prices of 0.093. Because farm input costs rise with energy prices, the price in the exporting region also rises, with an elasticity with respect to energy prices of 0.056. Because trade falls, exhibiting an elasticity with respect to energy prices of -0.091, the increase in P_2 is less than P_1, being depressed both by decreased exports and decreases in D_2 as P_2 rises. The elasticities of demand in the importing region and exporting region with respect to higher energy prices are -0.026 and -0.004 respectively. The quantity supplied in the exporting region fall, of course, with an elasticity with respect to energy prices of -0.016. The popular conjectures regarding supply in the importing region, similar to the Northeast, were correct to a degree. Higher energy prices raise transportation prices, decrease interregional trade, reduce the quantity supplied by other regions, and raise local prices by more than price increases in other regions. This does lead to an increase in production in the importing region. The increase, however, is quite small, with an elasticity of supply in the importing region with respect to higher energy prices, E_{S1}, of only 0.040. Thus, in this example should real energy prices double, production in the Northeast would increase by only 4 percent. This is much less than much of the current speculation would suggest. In this initial example, region 1's self-sufficiency would increase from fifty percent to only 53.4 percent, hardly a dramatic shift in agricultural production.

To what degree are these estimates a function of the initial problem? The answer to this will be evident from Tables 1-3. The initial problem had an own price elasticity of demand of -0.6 and a cross price elasticity of demand of 0.3. The substitute was assumed to increase in price at ten percent of the rate of energy prices,

*Values in parentheses are t statistics.

Table 1. Elasticities of Response to a Change in Energy Price for Different Net Price Elasticities of Demand

	Price Elasticity				
Variable	-0.0	-0.2	-0.4	-0.6	-0.8
D_1	0.030	0.008	-0.010	-0.026	-0.039
D_2	0.030	0.016	0.005	-0.004	-0.010
S_1	0.082	0.065	0.051	0.040	0.030
S_2	0.023	0.007	-0.006	-0.016	-0.024
Q_T	-0.022	-0.049	-0.071	-0.091	-0.109
P_1	0.121	0.110	0.101	0.093	0.087
P_2	0.082	0.071	0.063	0.056	0.050
P_T	0.239	0.226	0.214	0.204	0.196

Table 2. Elasticities of Response to a Change in Energy Price for Different Degrees of Self Sufficiency in the Importing Region

	Degree of Self Sufficiency				
Variable	5%	25%	50%	75%	95%
D_1	-0.031	-0.029	-0.026	-0.021	-0.012
D_2	-0.005	-0.004	-0.004	-0.004	-0.006
S_1	0.053	0.048	0.040	0.027	0.004
S_2	-0.012	-0.014	-0.016	-0.016	-0.011
Q_T	-0.036	-0.055	-0.091	-0.162	-0.304
P_1	0.102	0.098	0.093	0.084	0.069
P_2	0.058	0.057	0.056	0.056	0.060
P_T	0.232	0.223	0.204	0.169	0.098

Table 3. Elasticities of Response to a Change in Energy Price for Different Supply Elasticities

	Supply Elasticity			
Variable	0.75	1.0	1.25	1.5
D_1	-0.043	-0.035	-0.030	-0.026
D_2	-0.024	-0.015	-0.009	-0.004
S_1	-0.009	0.009	0.025	0.040
S_2	-0.032	-0.025	-0.020	-0.016
Q_T	-0.076	-0.080	-0.085	-0.091
P_1	0.121	0.109	0.100	0.093
P_2	0.091	0.075	0.064	0.056
P_T	0.212	0.210	0.207	0.204

a figure similar to the elasticity of P_1 with respect to energy prices. Table 1 shows the solution elasticities in response to a change in energy prices for various own price elasticities of demand. Note that -0.6 is the base problem and in all instances a cross price elasticity of 0.3 is assumed. As the demand becomes more inelastic, it responds less to price increases, and therefore, the market will be cleared at higher prices. This allows the supply in the importing region to increase more as energy prices change than it could for a more elastic demand. However, even for no own price response, combined with increased consumption due to price increases for substitute products, a very extreme case, E_{S1} is only 0.082. The important consideration is the net difference between the own price elasticity and the cross price elasticity. If the own price elasticity is left at -0.6 and the cross elasticity is changed to 0.1, the solution is almost identical to the far right column of Table 1. Similarly if the own price elasticity is left at -0.6 and the cross price elasticity is set to 0.5, the answer is similar to the middle column of Table 1. The response of S_1 to a change in energy prices would be greatest for commodities with relatively inelastic own price demand, and a relatively elastic cross price demand with respect to products which are very energy intensive. Apparently few agricultural products would satisfy these criteria to a great enough degree to affect self sufficiency substantially.

Table 2 illustrates the solution elasticities for different degrees of self sufficiency in the importing region. It is apparent that as initial self sufficiency rises E_{S1} falls, and those situations exhibiting the largest responses are those having the least likelihood of achieving self sufficiency. Note that the fifty percent self sufficiency case is the initial problem.

The elasticity of response for supply in the importing region is larger for products with a larger transportation cost requirement for importing it. If rather than having one fourth of the consumer price in the importing region representing the transportation cost to import the product, thirty percent of P_1 was transportation, then E_{S1} would be 0.047 rather than the 0.040 of the initial problem. Of course, as transportation becomes less important the reverse phenomenon occurs. However, 25 percent of P_1 is a very transportation intensive food product. This is especially true since the 25 percent must be net of any transport cost required to supply the product from within the region.

Table 3 lists the elasticities of a response to an energy price change for different long run own price elasticities of supply. In the initial problem a value of 1.5 is used. If higher energy prices should make agriculture in the Northeast more profitable and agriculture in the exporting regions less profitable, supposedly this would be reflected in land prices in the two regions, raising prices in the Northeast and lowering them elsewhere. This would increase expenses, decreasing the desirable degree of response. For this reason a lower value for the own price supply elasticity is probably appropriate. As Table 3 shows, this reduces E_{S1}, and for some values of the supply elasticity even changes the sign of E_{S1}.

The initial problem used a value of 0.25 for the elasticity of real farm input prices with respect to real energy prices changes. If a value of 0.35 is used instead E_{S1} would be 0.065 instead of 0.040.

CONCLUSIONS

It is apparent that the solution to the trade model is dependent on the problem characteristics. As several of these characteristics were changed, the size of the response in quantity supplied in the importing region changed. In all of these instances, however, the fundamental finding was substantively unaffected--the size of the response in the quantity supplied in the importing region to an increase in real energy prices was not very large. The elasticity was always below 0.10 and generally below 0.05. This suggests very little likelihood of substantive changes in Northeast agriculture due to real energy price increaes. Higher real energy prices mean higher real food prices, perhaps higher land prices and little else to the competitive position of Northeast agriculture.

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