Modeling the Supply Side

Supply response of each activity is endogenous in the EDMP model, reflecting the asset-fixity of capital paradigm of Johnson and Hardin (1955), Johnson and Quance (1972), and Schmid (1997). Supply response in the EDMP model is a multicommodity formulation composed of: (1) a Hessian matrix of marginal adjustment costs of changing levels of supply activities and (2) a vector of changes in levels of supply activities from the calibrated base solution. The marginal adjustment costs of changing levels of activities are diagonal elements of the supply side of the Hessian matrix. Increasing any activity that has a binding constraint requires simultaneously reducing one or more other activities limited by that constraint. Thus, the net income response for increasing an activity is analogous to the total derivative, that is, the sum of: (a) the product of its marginal adjustment costs times the increase in that activity, and (b) the marginal adjustment costs of all other activities times their respective changes.

The supply-response mechanism in the Johnson asset-fixity paradigm is as follows. All enterprises are assumed to seek to cover variable costs. If an enterprise can cover capital replacement costs as well as variable costs, it will expand its capital stock at the acquisition cost of capital. If it is unable to cover variable costs, it will reduce its scale by reallocating some of its capital stock to another more profitable enterprise, or if lacking a more profitable enterprise, it will disinvest in the substitutable capital at its salvage value (that is, allocate some capital to slack). Under these assumptions, substitutable capital assets are fixed but allocatable among enterprises if their shadow values fall between their acquisition cost and their salvage value—or variable if their shadow values fall below their salvage values or above their acquisition costs.

In the asset-fixity paradigm, it is important to distinguish between substitutable capital, such as tractors, combines, and wagons, which can be used in a variety of enterprises, and specialized capital, such as cotton pickers, sugar beet harvesters, and tobacco curing equipment, which can be used only in one specific enterprise. Enterprises with the highest proportions of substitutable capital are such crops as corn, soybeans, small grains, hay, and pasture. Specialty crops and most livestock enterprises have the lowest proportions of substitutable capital—sugar beets, sugar cane, tobacco, rice, peanuts, cotton, potatoes, dairy, cow-calf, fed beef, hogs, and poultry.

Given that some of the capital stock can be allocated among enterprises, activities will typically have some maximum level of that enterprise possible with the existing stock of substitutable capital. The difference between that maximum capacity and the current level of that activity is its excess capacity. Enterprises with the highest proportions of excess capacity are such crops as corn, soybeans, small grains, hay, and pasture. Specialty crops and most livestock enterprises have the lowest proportions of excess capacity.

If we assume there is a uniform distribution of excess capacity for each enterprise ranging from zero (the stock of substitutable capital is fully used at the current level of production) to some maximum (the level of production possible at the maximum allocation of currently owned capital to the

enterprise), we can identify two points in cost-production space: (1) current production and current variable costs and (2) maximum production and variable cost plus substitutable capital replacement cost. If there were only substitutable capital, the slope of the Hessian element would be the straight line connecting these two points, that is, a linear, continuous relationship. Correcting the Hessian element for the proportion of capital replacement costs that is attributable to substitutable capital defines the Hessian elements as:

$$H_{ii} = [\text{Capital Replacement}_i/(\% \text{ Substitutable} * \% \text{ Excess Capacity}_i)] * \text{Base Quantity}_i. \quad (10)$$

One realistic implication of this formulation of adjustment costs is that capital replacement costs may be less than fully covered for some enterprises, causing these enterprises to exhibit the "overproduction trap" of Johnson and Quance (1972). A second realistic implication of this formulation is that both substitutable and specialized capital will be allocated to slack if their shadow values drop below their salvage values. Hence, in keeping with microeconomic production theory, supply functions are truncated below the average variable costs of each enterprise. Finally, a third implication of this formulation is that—in keeping with the asset-fixity paradigm—the length of run, that is, which factors are considered fixed or variable for each enterprise, is endogenous to the model. Not all enterprises are in either shortrun or longrun decision mode with respect to capital in any solution. Solutions to the EDMP model are akin to linear combinations of shortrun allocation decisions and longrun investment/disinvestment decisions.