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Methodology and a Model of the U.S. Agricultural Sector

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Abstract

The objective of this research is to extend and generalize the equilibrium displacement methodology by combining it with mathematical programming methods and existing knowledge of farm sector relationships to develop sectoral adjustment models that can operate in pure competition, monopoly/monopsony, or mixed-competition. A model of the U.S. agricultural sector at the national aggregate level is presented to illustrate the methods. An appendix contains a user's manual describing the operation of the model. Further appendices contain documentation of the structure of the spreadsheets, the programming tableau, and the SAS solution program.

Keywords: Equilibrium displacement models, mathematical programming, positive mathematical programming, U.S. agricultural sector, U.S. farm programs, direct payments, counter-cyclical payments, loan deficiency payments, marketing loan gains, conservation reserve program, wetlands reserve program, crop insurance

Contents

Appendix III model spreadsheets are accessible by contacting
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Summary

Development of the Equilibrium Displacement Mathematical Programming Model (EDMP) started in response to the passage of the Federal Agricultural Improvement and Reform Act of 1996. The 1996 Farm Act fundamentally changed the traditional economic incentives in commodity policy by decoupling most Government commodity payments from the levels of individual farmers' production of the commodities, by eliminating acreage reduction programs, and by no longer limiting production eligible for support to a producer's historic production base. The effects of these changes in economic incentives were to render temporarily obsolete all econometric simulators estimated under the previous policy regime. The first published article using EDMP assessed the likely effects of the 1996 Farm Act on production, prices, net farm incomes, and farm asset values in the Great Plains. Subsequent applications of the EDMP framework evaluated the effects of market resistance to genetically modified grains and the implications of demand and supply elasticities for the distribution of rents in supply chain industries.

This bulletin documents the theory, structure, and operating characteristics of a U.S. aggregate agricultural sector EDMP model that is flexible and user friendly. This bulletin includes all activities and parameter values in tabular summary form, the actual quadratic programming tableau, the SAS code for solving the model, and a user's manual. The authors have cast the discussion in simple, conceptual terms rather than detailed, technical terms, in order to demystify the methodology for researchers not specifically trained in mathematical programming.

What Are the Issues?

Government policies, both agricultural and general economic, have pervasive influences on the structure and performance of the agricultural sector. Furthermore, policies and programs frequently interact to potentiate or mitigate their separate effects on sector structure and performance. The model documented in this bulletin focuses on the effects of agricultural policies and programs on the performance of the U.S. agricultural sector. The agricultural sector is treated as operating in perfect competition, subject to the provisions of agricultural and economic policies. Scenario analyses—"what if" questions—concerning alterations in policy, technology, demand, and/or supply are addressed by comparing the new equilibrium under the scenario with the base period equilibrium. Economic changes frequently occur in cascades of changes involving several policies, commodities, or technologies. The effects of such cascades of changes can be very different from the sum of the effects of the individual changes. This model specifically addresses such interactions. In addition to portraying a sector or industry in perfect competition, the EDMP model can be formulated to allow monopolistic/monopsonistic behavior in one or more sectors, while the remainder of the model operates in perfect competition.

What Does the Model Do?

The U.S. agricultural sector EDMP model is a price-endogenous quadratic programming model providing sectorwide comparative static analyses of production and disposition of the 16 top crop commodities and 8 top livestock commodities, including disposition among farm sector use, domestic demands, exports and competing imports, and storage and dis-storage. The model is constructed from data compiled by U.S. Department of Agriculture's Economic Research Service: cost-of-production estimates, farm income and production accounts, and Agricultural Resource Management Survey (ARMS). The sector performance effects of major agricultural policies—such as direct payments, counter-cyclical payments, loan deficiency payments, the Conservation Reserve Program, and crop insurance—are endogenously calculated in the model.

How Does the Model Work?

In solving the model, the quadratic programming solution algorithm enforces the optimality conditions of perfectly competitive equilibrium across all products and factors. That is, marginal revenues from a one-standard-unit increase in production are equalized across all products while simultaneously equalizing the marginal values (shadow prices) of each limiting factor across all products using that factor. This procedure is conceptually equivalent to maximizing the combined producer plus consumer surplus. The base period model is calibrated to reproduce all base period prices and quantities to the desired degree of accuracy without the use of artificial constraints or limitations. Scenario analyses are performed by comparing the equilibrium solution under the scenario assumptions with the base period equilibrium. Change parameters allow the user to customize both the base period solution and the scenario solution by specifying acreages, yields, cost levels, and demand parameters for any combination of products in the model. A post-optimal calculations spreadsheet calculates the following performance indicators:

- Net farm income, short and long run
- Net cash flow, short and long run
- Crop acreages, by commodity
- Livestock production levels, by commodity
- Domestic nonfarm demands, by commodity
- Market demand prices, by commodity
- Storage and dis-storage levels, by commodity
- Exports and competing import levels, by commodity
- Direct payments, by base commodity
- Counter-cyclical payments, by base commodity
- Loan deficiency payments and marketing loan gains, by commodity
- Crop insurance subsidies, by commodity
- Domestic consumer surplus, by commodity

- Export consumer surplus, by commodity
- Producer cash market income, by commodity
- Producer cash expenses, by commodity
- Producer net cash margin, by commodity

Other user-defined performance activities, constraints, and performance measures can be added to fit the model to the problem.

Introduction

Equilibrium displacement (ED) models, or their forerunners, have been part of the agricultural economics literature since 1958 (Buse, 1958) and have had recent applications (Piggott et al., 1995, and Sumner, 2005). One reason for their popularity is ease of computation with today's spreadsheet technology. Some researchers have noted their restrictive assumptions as limitations.

Mathematical programming (MP) models have been relatively neglected in the theoretical literature of agricultural economics in recent years, while still being used in applications such as computable general equilibrium models, the ERS Regional Environment and Agriculture Programming (REAP) Model (formerly the USMP Model) and Howitt's positive MP method (Howitt, 1995). Both the equilibrium displacement and MP approaches, individually, have fallen short of adequately addressing some emerging issues. To address the types of adjustments to the agricultural sector currently being raised requires models that:

- Assure feasibility and efficiency of solutions with respect to the underlying physical production and demand functions.
- Simultaneously and gradually adjust to changes in technology, organizational structure, and/or policy without imposing artificial constraints or mechanisms not supported by theory.
- Portray progressive investment in emerging technologies and disinvestment in superseded technologies.
- Allow analysis of large displacement scenarios, often without historical precedent.
- Allow portrayal of pure competition, monopoly/monopsony, or mixed-competition, as the issues and markets may require.
- Can model the simultaneous interaction of detailed Government policies affecting the farm sector.
- Incorporate economic structures synthesized from known physical and economic relationships, such as process technology, production alternatives, demand substitutions, and market linkages.
- Allow calibration to base situations, such as forecasts, baselines, and coordinated studies.
- Allow the user to control which activity levels are predetermined and which are endogenous to the analysis.

This bulletin describes the methodology, structure, and supply-response characteristics of such a model for the U.S. agricultural sector. We have cast the discussion in simple, conceptual terms rather than detailed, technical terms in order to demystify the methodology for researchers not specifically trained in MP. Equilibrium Displacement Mathematical Programming Models (EDMP) combine the equilibrium displacement modeling approach with the positive MP technique, an asset-fixity conceptualization of supply response, and consistent specification of demand relationships for subaggregates such as regions or types of farms (see fig. 1 in box on page 7).

EDMP Methodology

Review of Literature

There have been a number of contributors to the development of equilibrium displacement modeling. The literature is usually traced back to Muth (1964) who developed the reduced forms for proportional displacements from equilibrium for a system of equations of supply and demand for a product dependent on two factors of production and exogenous shifters for each of the functions. However, in a 1958 article in the *Journal of Farm Economics*, Buse (1958) demonstrated the development of what he called “total elasticities”—the reduced-form elasticities of a system of supply and demand equations for two commodities similar to that later devised by Muth—and contrasted his “total elasticities” with Marshallian *ceteris paribus* elasticities. Buse’s was the first article to use matrix algebra to state and solve his system of equations. Gardner (1975) employed a formulation identical to Muth’s to investigate the relationship of retail food prices to farm prices. Sumner and Wohlgenant (1985) first applied the term “equilibrium displacement modeling” to Muth’s formulation. Wohlgenant (1993) also extended Muth’s formulation to multistage industries. Piggott et al. (1995) employed the term “equilibrium displacement modeling” and formulated their model in matrix algebra. Davis and Espinoza (1998) extended the Gardner analysis to develop the full distribution of parameter values rather than only selected values. Most recently, Sumner (2005) used equilibrium displacement methods to assess the effects of U.S. commodity polices on world prices and trade.

Samuelson (1952) first demonstrated that the spatial equilibrium problem could be cast and solved as a linear programming (LP) problem. Takayama and Judge (1971) demonstrated how quadratic programming could be used to solve linear supply and demand equations, determining both prices and quantities endogenously. However, Plessner (1965) and Yaron et al. (1965) had earlier applied quadratic programming methods to price-endogenous modeling of the U.S. agricultural sector. Because of the scarcity and cost of quadratic programming solution algorithms, early MP literature of price-endogenous models in agricultural economics turned to LP methods. Martin (1972) incorporated stepped supply and demand functions in LP models. Martin’s method significantly increased the dimensionality of LP problems because it required a row and column for each step of the supply and demand schedules. However, Miller (1963) had earlier published a method of incorporating sloping demand and supply functions in LP models by selecting among activities representing the area (price times quantity) under each step of the functions. Miller’s method required a column for each step but required only a single convex combination constraint, thus reducing the model dimensionality significantly from that required by Martin’s formulation.

With the advent of efficient and affordable quadratic programming algorithms in the early 1970s, price-endogenous MP modeling rapidly adopted quadratic programming methods. Harrington (1973) combined price-endogenous quadratic programming modeling and input/output analysis to develop a forerunner of today’s computable general equilibrium models.

The literature of positive MP is replete with applications but only two methodological articles. Howitt (1995) explains a pragmatic method of using dual values of LP model solutions to introduce quadratic terms that assure that the model's base period solution matches the base period primal variable levels of the system. An additional advantage of Howitt's positive MP is that it eliminates most corner solutions; hence the model adjusts gradually and proportionally to changes in prices, rather than abruptly shifting from one corner solution to another. Preckel et al. (2002) extend the Howitt positive MP methods to calibrate both the primal and dual levels of the system. They apply their method to calibrating base period prices and quantities in a system of agricultural sector supply and demand relationships.

The asset-fixity or investment-disinvestment literature—most closely associated with Johnson and Hardin (1955), Johnson and Quance (1972), and Schmid (1997)—is central to specifying the supply response of the model. The asset-fixity paradigm is predicated upon there being a gap between the cost of investing in an additional unit of durable capital (its acquisition cost) and the return from disinvesting in it (its salvage value). When the marginal value product of a capital item is within this range, it is considered fixed but allocatable, while outside the range, it is considered variable. Not all capital is either fixed or variable in a problem; but, different items can be at their acquisition costs, at their salvage values, or in their fixed but allocatable range in between. Under the asset-fixity hypothesis, the length of run is endogenized separately for each different type of capital. In the 1980s, there was some controversy over whether the asset-fixity theory was a defensible viewpoint; but Chavas (1994) rigorously demonstrated Johnson's underlying premises under sunk costs and temporal uncertainty.

Theoretical Development

In specifying the theoretical model, we first start with the equilibrium displacement method, recast it in the positive MP framework, discuss the modeling of the supply side with the asset-fixity paradigm, then complete the EDMP model with consistent aggregation/disaggregation of the demand side. We note certain limitations of each of these building blocks that may be strongly determinative of model performance.

The equilibrium displacement methodology starts with a standard set of economic structural equations of supply and demand.

Structural equations:

$$\begin{array}{llllll}
D_c = e_{c,pc}\,P_c & + e_{c,pL}\,P_L & + e_w W & \text{Crop demands} & 1\,..\,n & \\
Sc = \varepsilon_{c,pc}\,P_c & + \varepsilon_{c,pL}\,P_L & + \varepsilon_x X & \text{Crop supplies} & 1\,..\,n & \\
D_L = e_{L,pc}\,P_c & + e_{L,pL}\,P_L & + e_y Y & \text{Livestock demands} & 1\,..\,m & (1) \\
S_L = \varepsilon_{L,pc}\,P_c & + \varepsilon_{L,pL}\,P_L & + \varepsilon_z Z & \text{Livestock supplies} & 1\,..\,m & \\
Q_c = Dc = Sc & & & \text{Crops market clearing} & 1\,..\,n & \\
Q_L = D_L = S_L & & & \text{Livestock market clearing} & 1\,..\,m &
\end{array}$$

Where:

D_c = Crop demands, D_L = Livestock demands

S_c = Crop supplies, S_L = Livestock supplies

P_c = Prices of crop commodities, 1 . . n

P_L = Prices of livestock commodities, 1 . . m

Q_c = Quantities of crop commodities, 1 . . n

Q_L = Quantities of livestock commodities, 1 . . m

W = Exogenous factors influencing crop demands

X = Exogenous factors influencing crop supplies

Y = Exogenous factors influencing livestock demands

Z = Exogenous factors influencing livestock supplies

e.,. = elasticities of demand w.r.t subscripted variables

ε.,. = elasticities of supply w.r.t subscripted variables

Substitute displacements from equilibrium: D*, S*, P*, Q*, W*, X*, Y*, and Z* for respective variables. For example, $D^* = (D_{scenario} - D_{equilibrium})$.

Substitute market clearing equations into S and D equations.

Rearrange so that Q*s and P*s are functions of exogenous variables: W*, X*, Y*, and Z*.

$$\begin{aligned}
Q^*_c &= e_{c,pc} P^*_c + e_{c,pL} P^*_L + e_w W^* \\
Q^*_c &= \varepsilon_{c,pc} P^*_c + \varepsilon_{c,pL} P^*_L + \varepsilon_x X^* \qquad (2) \\
Q^*_L &= e_{L,pc} P^*_c + e_{L,pL} P^*_L + e_y Y^* \\
Q^*_L &= \varepsilon_{L,pc} P^*_c + \varepsilon_{,pL} P^*_L + \varepsilon_z Z^*
\end{aligned}$$

Arrange above equations in matrix form:

$$\begin{array}{cccccccccccc}
I_n & 0_m & -e_{c,pc} & -e_{c,pL} & Q^*_c & & e_w & 0 & 0 & 0 & W^* & \\
I_n & 0_m & -\varepsilon_{L,pc} & -\varepsilon_{L,pL} & Q^*_L & = & 0 & \varepsilon_x & 0 & 0 & X^* & (3) \\
0_n & I_m & -e_{c,p} & -e_{c,p} & P^*_c & & 0 & 0 & e_y & 0 & Y^* & \\
0_n & I_m & -e_{L,pc} & -e_{L,pL} & P^*_L & & 0 & 0 & 0 & e_z & Z^* & \\
 & \Gamma & * & & \Delta & = & & B & * & & \Omega &
\end{array}$$

Then solve for Δ: $\Delta = \Gamma^{-1} B \, \Omega = \Pi \, \Omega$

$\Pi = \Gamma^{-1} B$ are generally termed reduced-form elasticities of endogenous response.

Assumptions of Equilibrium Displacement Models

As noted by Piggott et al. (1995), equilibrium displacement models rest on four key assumptions:

1. Elasticities of endogenous supply and demand relationships are known and constant.
2. Elasticities of supplies and demands, with respect to exogenous variables, are known and constant.
3. Technology of production is known and constant.
4. Displacements are restricted to be in the neighborhood of equilibrium.

Limitations of Equilibrium Displacement Models

Those assumptions are also the Achilles heel of equilibrium displacement models:

1. Adjustment scenarios often entail changing any or all of the above assumptions, analyzing large displacement from the initial equilibrium, and/or determining base equilibrium values from indirect data, thus complicating their application.
2. Expansionary displacements assume that no physical constraints to expansion exist, for example, no limitations on total cropland or limitations on existing production capacity.
3. Some contractionary displacements can exceed 100 percent of the base level of the activity. Such solutions are *a priori* infeasible because they imply the process in question is operating in reverse.
4. Equilibrium displacement model supply functions are assumed to be downwardly continuous, whereas a correct specification requires that each supply function be truncated at the point where its supply price drops below its average variable cost.
5. Neither expansionary nor contractionary displacements can be guaranteed to be on the efficient frontier of the underlying production/demand functions, but may be either interior points or infeasible points.
6. In the constant elasticity equilibrium displacement formulation, it is not conceptually possible to calculate a correct monopolistic/monopsonistic maximum quasi-rent solution. Quasi-rents change monotonically upward or downward, with successive restrictions in output, depending on whether demand is inelastic or elastic.

To overcome these limitations, we adopt an MP implementation of the equilibrium displacement model.

The EDMP Formulation

We redefine the constant elasticity equilibrium displacement problem to one of comparing successive equilibria of a system of linear (constant slope) supply and demand functions with quadratic programming.

Following Preckel et al. (2002):

Max: $$Z = F'x - 1/2\, x'\, H\, x. \tag{4}$$

Z is the objective function to be maximized. Z can be either the sum of consumer plus producer surpluses or the sum of residual quasi-rents, depending on whether the model is perfectly competitive or monopolistic.

Subject to:

$A_{11}x = \text{Free}$ Indicator accounts, (4a)
$A_{21}x \leq b$ Technical constraints, (5)
$I_{31}x = c$ Calibration constraints, and (6)
$x \geq 0$ Non-negativity constraint. (7)

Where:

A_{11}, A_{21} = A matrix of Leontief technical requirements of processes
I_{31} = An identity matrix of calibration constraints, suspended after calibration
x = A vector of optimized variables (which assure that all solutions are feasible and efficient)
b = A vector of right hand sides of constraints
c = A vector of calibration targets to reproduce base equilibrium, suspended after calibration
F = A vector of intercepts of supply and demand processes
H = Hessian matrix of marginal adjustment costs and demand slopes, assumed to be positive semidefinite for maximization.

Equation 4a is necessary because the value of the objective function, equation 4, is confounded by perturbations necessary to calibrate the model to the base period prices and quantities. Similarly, to model some agricultural policies, it may be necessary to define processes differently from observed supply and demand relationships. Any such changes need to be backed out of the model solutions to reflect true supply and demand prices and quantities.

Equation 6, which contains the quantity targets of the equilibrium solution, is enforced only in the initial calibration solutions. When the model is calibrated to the desired accuracy, its optimal solution will return exactly the quantities specified in equation 6, without any quantity constraints. After that, equation 6 is suspended to allow the model to adjust all prices and quantities simultaneously in response to changes in the scenario. Thus, differences of scenario solutions from the base solution enforced in equation 6 are equilibrium displacements under the assumption of constant slope relationships rather than constant elasticity relationships. The constant slope formulation inherent in EDMP models has the advantage of being theoretically consistent with monopolistic maximization of quasi-rents, in contrast to constant elasticity equilibrium displacement models.

Equivalence of EDMP Formulation to a Profit Function Formulation

Monopolistic Firm and Competitive Industry Cases

Let F(x) be a general multi-output multi-input profit function, with x containing both inputs (-) and outputs (+) and with prices related to quantities, subject to equations 5 and 7.

A second order Taylor series expansion of F(x) in the neighborhood of its maximum (x^*) is:

$$F(x) = F(x^*) + \frac{F'(x^*)(x-x^*)}{1!} + \frac{F''(x^*)(x-x^*)^2}{2!} + R, \qquad (8)$$

where F' and F'' are the first and second derivatives of F(x^*) and R represents the higher order nonlinearities of F(x).

By definition, F''(x^*) is the Hessian, H(x^*).

Assuming the base situation to be in equilibrium (a maximum), then F'(x^*) = 0. Rearranging terms to matrix notation, the Taylor series expansion becomes:

$$F(x) = F(x^*) + 1/2(x-x^*)' \, H \, (x-x^*), \qquad (9)$$

where the Hessian matrix is assumed to be negative semidefinite. Changing the sign in equation 9 allows the Hessian to be specified as positive semidefinite. From equation 9, it is clear that, in the monopolistic case, the equilibrium displacement maximand, Z, once calibrated, is identical to the monopolistic firm's profit function.

The model can be solved either monopolistically (that is, for a firm with market power) by equating marginal factor costs to marginal revenues or perfectly competitively by maximizing the sum of producers' plus consumers' surpluses (that is, for a perfectly competitive firm or an industry). Both monopolistic and perfectly competitive behavior can be combined for different activities within a single model. (For applications of EDMP to mixed competitive and monopolistic problems, see Jefferson-Moore and Harrington (2006) and Harrington and Jefferson-Moore (2007).)

Figure 1 illustrates the EDMP perfectly competitive supply and demand equilibrium for a commodity. The gradient is the perfectly competitive market price, and residual rents are identically equal to zero. Figure 2 illustrates monopolistic/monopsonistic equilibrium, found by equating marginal revenue with marginal factor cost. Factor and product prices are found on the original factor supply and product demand functions. Residual rents, shown as the shaded area, are at a maximum.

Figure 1

EDMP purely competitive supply and demand of commodity

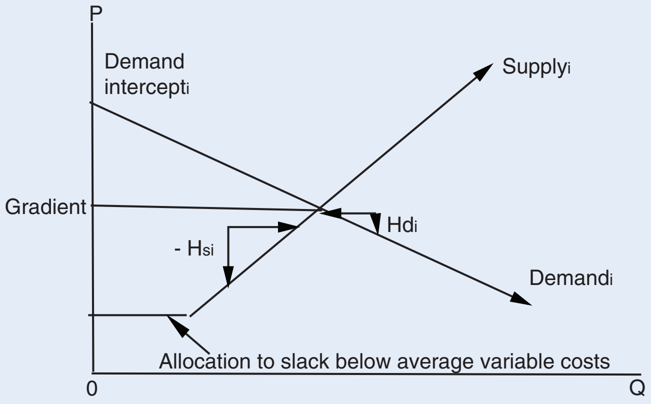
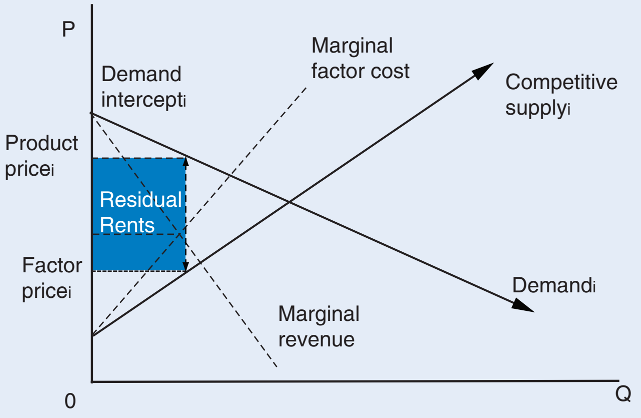


Figure 2

Monopolistic/monopsonistic supply and demand



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.

Modeling the Demand Side

The demand side elements of the Hessian matrix are linear demand slopes. Further, the demand functions represent only nonfarm demands for the commodity. Commodity use by the farm sector is modeled within the constraint matrix. Demand slopes in a comprehensive (farm sectorwide) model are derived as follows.

By definition, elasticity of demand for a commodity is:

$$Ed = dQ/dP * P/Q.$$

Similarly, by definition:

$$\text{Slope} = dP/dQ.$$

Hence, for sectorwide models, how ever they may be disaggregated on the supply side:

$$H_{ii} = dP/dQ = (1/E_d)P/Q. \tag{11}$$

If the model is disaggregated to represent single region or group of farms (not marketwide), the demand slopes must be adjusted to remain consistent with a marketwide model.

The demand slope adjustment for own market share (q/Q) in partial models is:

$$dP/dq = [(q/Q)/E_d] P/Q, \tag{12}$$

where uppercase letters represent the aggregate level and lowercase letters represent the disaggregate level.

Next, the slope must be adjusted for competitors' market shares and supply responses:

$$\Delta dP/dq = - [(1-q/Q)E_{sx}] P/Q, \tag{13}$$

where E_{sx} is the elasticity of supply of the excluded subsectors or regions (competitors).

Combining equations 12 and 13 completes the required adjustment to demand slopes for partial models:

$$dP/dq = (q/Q)/E_d [1- (1- q/Q)E_{sx}] P/Q. \tag{14}$$

The elasticity of equation 14 varies from zero to E_d, as own market share expands from zero to 1.

Modeling Agricultural Policies and Programs

Major agricultural policies and programs, as currently in effect in the Farm Security and Rural Investment Act (the 2002 Farm Act), are modeled as below.

Payment Bases

Producers' payment bases establish the producer's eligibility for direct payments and counter-cyclical payments but do not limit production of these crops. Payment bases apply to the following commodities: corn, soybeans, grain sorghum, wheat, rice, barley, oats, and cotton. They are based on the producer's crop and yield history for each crop. However, the producer need not produce the crop (or any crop) to be eligible for the decoupled payments.

Decoupled Payments

Production flexibility contract, market loss assistance payments, and post-2002 direct payments apply to the same list of commodities and are modeled as lump sum additions to gross income that are decoupled from current production levels and prices. They are limited by payment bases and affect only net farm income. Direct payments associated with the payment bases of particular commodities are calculated post-optimally according to the provisions and parameters of the farm legislation and proportionally adjusted to equal the aggregate direct payments reported in the ERS farm income accounts.

Counter-Cyclical Payments

Counter-cyclical payments can be termed partially decoupled payments, because though they depend on the average market prices of the commodity, they do not depend on the quantity of production by any individual. They are disbursed in the same manner and on the same payment bases as decoupled payments. Counter-cyclical payments are treated the same as direct payments in this model because they do not change the market prices for the commodity that the producer faces. Rational producers would not alter their market-determined optimal production levels unless they believed that their actual production history would someday be used to update their payment bases.[1] Counter-cyclical payments for supported commodities are calculated post-optimally as the payment base acreage *times* the program yield *times* the difference between: (1) the higher of the average market price or the loan rate and (2) the target price minus the direct payment rate. The result is then multiplied by an adjustment factor to scale the aggregate counter-cyclical payment level to that reported in the ERS farm income accounts. This amount is paid as a lump sum, and, as with the decoupled payments, the owner of the payment base need not produce the commodity or any commodity to be eligible to receive them. Note that counter-cyclical payments will be at their maximum whenever loan deficiency payments or marketing loan gains are active.

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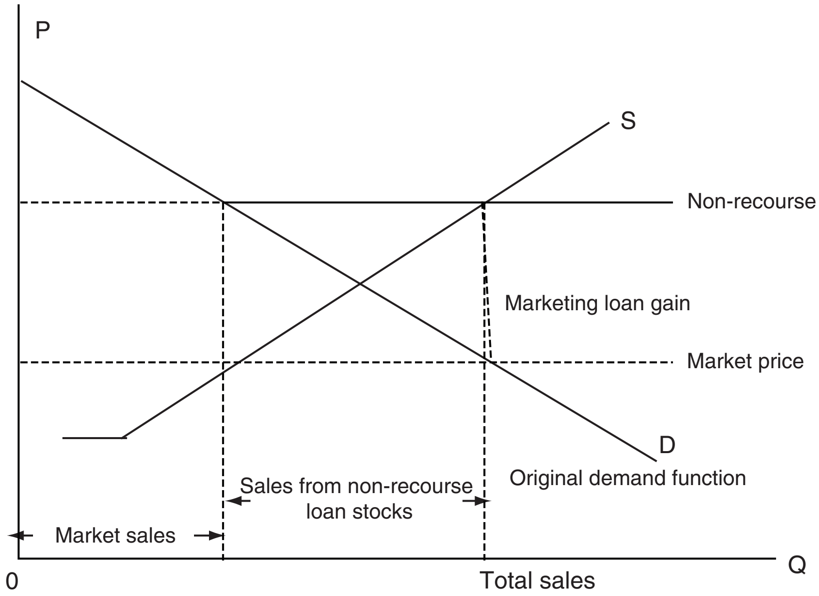
[1] This ignores any changes in risk or wealth that may affect the producer's decisions.

Loan Deficiency Payments and Marketing Loan Gains

Loan deficiency payments and marketing loan gains are two different support mechanisms that have identical results—they allow the effective price to producers to be above the market price of supported commodities. The programs have remained the same under the 1996 Farm Act and the 2002 Farm Act. Marketing loan gains operate in the following manner. The producer can obtain a loan equal to the value of the crop at the loan rate and later repay it at the value of the crop at a lower posted county price (market price), which may be changed daily or weekly. The marketing loan gain rate, the difference between the average market price and the loan rate, is paid to the producer on **all** production of the supported commodity, whether marketed, stored, or used on the farm. In the EDMP model, marketing loan gains are endogenously calculated by successively introducing perfectly elastic nonrecourse loan demands at the loan rate, then introducing activities that sell from the nonrecourse loans into the market (fig. 3). At levels of production at which the nonrecourse loans are active, the effective price to the producer for the commodity is the loan rate. Market prices, in contrast, seek market-determined levels below the loan rate determined by the sales from the nonrecourse loan activities. Loan deficiency payments and marketing loan gains are thus coupled payments; producers know that the lowest effective price they will receive for the commodity is the loan rate and will take this into consideration in making production and asset value decisions.[2]

Figure 3

Marketing loan gains



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[2] Two versions of this EDMP model were constructed on an experimental basis. The first version modeled the loan deficiency payment mechanism by inserting loan deficiency payment activities that activated at the loan rate and its corresponding demand quantity and offset the decline in market prices. This kept the effective prices to the producer constant when market prices fell below the loan rate. Some problems arose with this formulation in that it allowed multiple optimal solutions to the model. The alternative formulation of the marketing loan gain mechanism, adopted and discussed in this version, does not allow multiple optimal solutions.

Conservation Reserve, Wetlands Reserve, and Grassland Reserve Programs

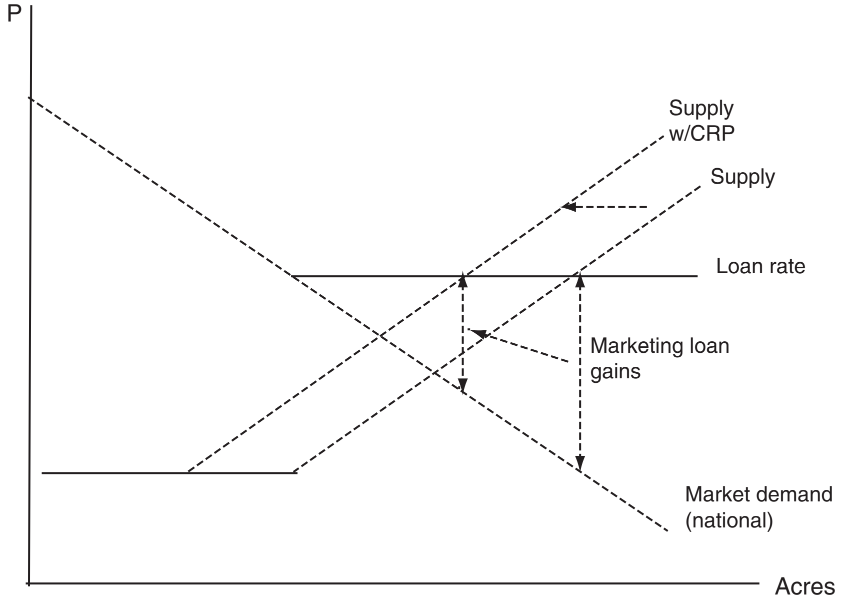
Under the Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP), landowners can voluntarily retire environmentally sensitive cropland or grant easements or restore wetlands in return for long-term rental contracts that pay them cost-share benefits and an annual rental fee for retiring the land and maintaining it in conservation uses. Landowners submit bids for the amount they are willing to accept as annual payments. Bids are accepted based on an environmental benefit index. The CRP and WRP are modeled by activities through which the Government rents cropland up to an authorized limit for a rental rate that can be either constant or endogenously determined by equating marginal returns from the CRP or WRP with the marginal returns from using the land in production. The CRP and WRP thus reduce the amount of cropland available for planting and shift all supply functions to the left.

The CRP and WRP interact with the loan deficiency payment program, as shown in figure 4, to greatly reduce Government budgetary cost exposure. Under normal circumstances, shifting supply functions to the left would result in higher prices and lower quantities of commodities. However, with the loan deficiency payment or marketing loan plan in place, if prices and quantities are in the range where loan deficiency payments or marketing loan gains are made, effective prices to producers remain at the loan rate, but quantities produced are reduced by the shift in the supply function, market prices are increased, and the loan deficiency payment rate or marketing loan gain is reduced.

The Grassland Reserve Program uses similar long-term leases for maintenance of native grasslands and prevents their conversion or development.

Figure 4

Conservation reserve program



The program is modeled by altering the endowment of rangeland and cropland pasture resources and/or hay production activities to reflect relevant provisions of the program.

Working Lands Conservation Programs

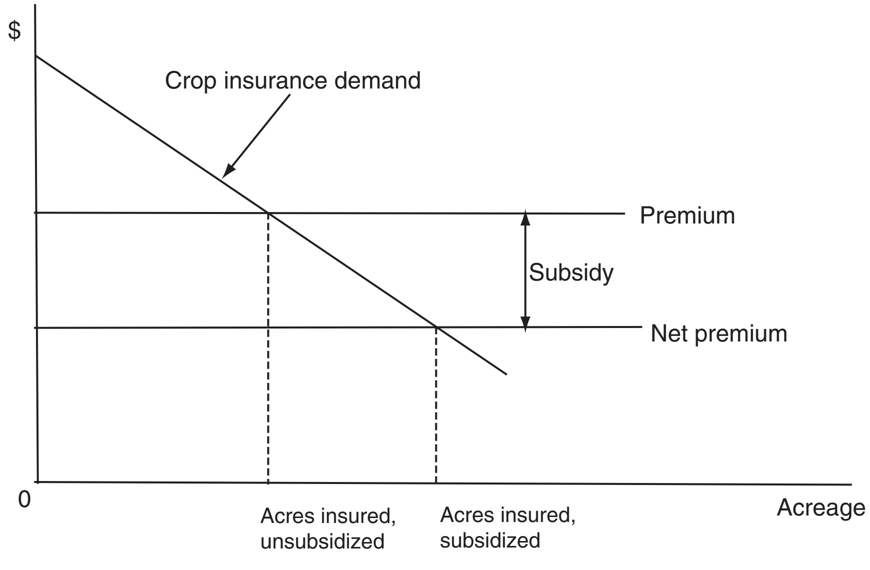
Working lands conservation programs include the Environmental Quality Incentives Program, the Wildlife Habitat Incentive Program, and the Conservation Security Program. Each of these programs provides technical and cost-sharing incentives which are modeled as alterations to the cost and/or yield components of crop production activities.

Crop Insurance Subsidies

Crop insurance subsidies are paid in an effort to foster greater producer participation in risk management programs. This EDMP model focuses only on the static, deterministic, supply-increasing effects of the subsidies, considered as a normal production input for each commodity for which they are available. The model abstracts from any supply-inducing effects of reductions in risk, wealth effects of insurance, or issues of adverse selection or moral hazard, which are typically central issues addressed in crop insurance studies. In keeping with the theoretical specification of the EDMP model, it addresses only the deterministic allocative effects of the subsidies that result from changes in producers' marginal costs or marginal revenues. As shown in figure 5, crop insurance is modeled as having a factor demand elasticity of -0.6, a quantity equal to the observed insured acreage of that commodity, and a premium equal to the average unsubsidized premium for that commodity. The subsidy is applied as 57 percent of the unsubsidized premium. Increasing the subsidy decreases the net premium and increases the acres insured. Decreasing or eliminating the subsidy does the opposite. In order to focus

Figure 5

Crop insurance subsidies



only on the subsidy, we assume that the crop insurance aggregate loss ratio is 1.0, that is, that indemnities paid out exactly equal net premiums collected.

Crop insurance programs interact with the loan deficiency payment and marketing loan programs in a manner opposite to the interaction of the CRP and WRP with the loan deficiency payment program shown in figure 4. Crop insurance subsidies lower production costs, which shifts the supply function to the right. Under normal circumstances this would result in higher quantities of commodities and lower effective prices to producers. However, with the loan deficiency payment plan in place, if prices and quantities are in the range where payments are made, effective producer prices remain at the loan rate, quantities produced are increased by the rightward shift in the supply function, market prices are reduced, and the loan deficiency payment rate is increased.

Superseded Agricultural Programs

Acreage bases were in effect prior to the 1996 Farm Act for corn, soybeans, grain sorghum, wheat, rice, barley, oats, and cotton. Acreage bases (if they are ever re-instituted) are modeled as limiting constraints on the production of the base commodity.

Acreage reduction programs (ARPs) or set-asides were periodically authorized for several commodities prior to the 1996 Farm Act. These required producers to reduce the acreages they planted to the crops with ARPs by some proportion of their production base in order to be eligible to receive commodity payments. The 1996 Farm Act eliminated the authority for acreage bases and ARPs, but we have retained the capability to analyze them. ARPs are modeled by simply reducing acreage bases by the amount of the ARP requirement.

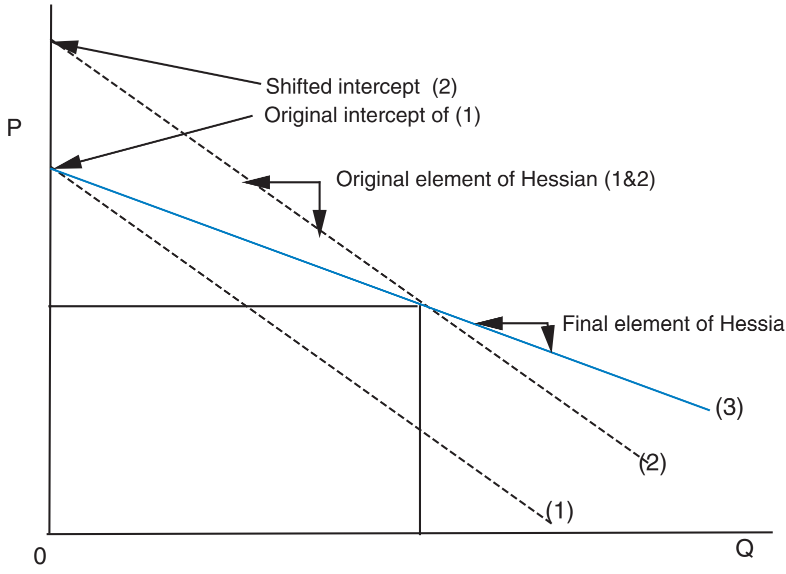
Nonrecourse loans, wherein the Commodity Credit Corporation would take ownership and store supported commodities whenever the market price fell below the loan rate, were used prior to the introduction of marketing loans and loan deficiency payments beginning with the1985 Farm Act. Nonrecourse loans supported market prices at the loan rates for supported commodities but also led to the accumulation of CCC-owned stocks that were said to “overhang the market” tending to keep market prices from rising above the loan rates. They were also alleged to encourage imports from foreign countries, thereby supporting prices in those countries. While no longer used, the model retains the capability to analyze nonrecourse loans through its mechanism for analyzing marketing loan gains.

Model Calibration

Calibration of the EDMP model is an iterative process of adjusting the Hessian elements of activities through which the model is calibrated to match the equilibrium prices and quantities to the desired degree of accuracy. As illustrated in figure 6, initial values of intercepts of supply and demand processes are set as the product of the Hessian element *times* the target quantity of that activity *plus* the target price of the commodity for demand activities, and *plus* the residual net cash income of the activity for supply activities. The optimal solution for these initial intercept estimates will generally only approximately match the target prices and quantities. One or more intercepts are then perturbed by a positive or negative additive adjustment based on the deviation of the current optimal solution for that activity from its target price or quantity. If a higher price or quantity is needed, the adjustor should be positive for demand activities or negative for supply activities. A good first approximation for the adjustor is the product of the Hessian element times the deviation of the current activity level from its target level. The model is then re-solved with the adjusted intercept values, and the new optimal solution should show several activities converging toward the target values. This process is repeated iteratively for all activities until the desired level of accuracy for all prices and quantities is attained. Once the desired level of accuracy has been attained by adjusting intercepts, all Hessian elements are divided by the ratios of adjusted intercepts to initial intercepts, and the intercepts are returned to their initial values. The optimal solution to this final model will match the optimal solution of the next-to-final model. This last calibration step accomplishes two necessary conditions of a calibrated model: (1) it restores all demand elasticities to their original values (all linear demand functions with a common intercept have identical elasticities at a given price) and (2) it restores all intercept values to estimates based solely on model data (no artifacts of calibration are left in the intercept values).

Figure 6

Calibration of EDMP models



What Do Gradients Mean?

Calibrated intercepts have specific economic meanings in EDMP models. Solution gradients are the implicit changes in the value of the objective function for a one-unit increase in the activity at equilibrium. For demand activities in perfect competition, the intercepts are the prices satisfying *a priori* targets for that activity's base period prices, quantities, and elasticity of demand. Hence, for demand activities, the gradients are the perfectly competitive equilibrium market prices of the commodities, as shown in figure 1. However, if the activity is monopolistic or monopsonistic, the gradients are intercepts of marginal revenue or marginal factor cost functions satisfying the same *a priori* targets, as shown in figure 2. Note that gradients are **not** prices for monopolistic or monopsonistic activities. They are the intersections of marginal revenues and/or marginal factor costs for these activities. For activities exhibiting monopoly power, prices and quantities are on the demand curve, but not on the supply curve. For monopsony power situations, the opposite is true. Market prices for monopolistic/monopsonistic demand and factor supply activities must be post-optimally calculated with respect to the original demand functions and factor supply functions, that is, the calibrated intercept *minus* respective Hessian element *times* the respective activity level.

Production activities are the crop, intermediate product, and livestock production activities that use factors supplied in factor acquisition activities and produce products sold or products used in further processing activities within the model. In perfect competition, the gradients of production activities are the negative of the gross margin of that activity above the costs specified in the model.

Structure of the Model

In this section of this bulletin, we list the commodities, inputs, processes, and agricultural programs included in the model and the data sources from which we obtained the estimates. In subsequent sections of this bulletin, we will present specific parameter values in tabular form and discuss post-optimal economic indicator calculations and supply-response characteristics of the model.

Commodities

Production quantities in the EDMP model are average acreages and production by commodity, summarized nationally and by region and type of farm, from the Agricultural Resource Management Survey (ARMS) for 1996-2000 and updated to 2001-05. ARMS is an annual survey of farm economic information that underpins most of the *Commodity Costs and Returns* (USDA, ERS, 2006) accounts and *Farm Income and Costs* (USDA, ERS, 2006) accounts published by ERS. Model national estimates are matched to quantities in USDA Agricultural Projections to 2016. Farm prices for the respective commodities are also calculated from USDA Agricultural Projections to 2016.

The EDMP model includes the following commodities:

- 16 Top crop commodities: corn, soy, wheat, rice, barley, oats, sorghum, cotton, sugar beets, sugar cane, potatoes, dry beans, sunflowers, peanuts, tobacco, and hay and crops not elsewhere classified;
- 8 Top livestock commodities: cow-calf, fed beef, hogs, dairy, sheep lamb and wool, broilers, eggs, turkeys, and livestock not elsewhere classified;
- 3 Nontradable forages: crop pasture, range, and corn silage;
- 4 Balanced grain rations, produced in region: corn, barley, oats, and sorghum rations, protein balanced with soy meal;
- 4 Joint products: straw, cottonseed, excess calves, and cull cows;
- Import hay to region;
- Import balanced grain ration to region;
- Farm-related income; and
- Off-farm income.

Specified Resources

The model requires specification of total availabilities of resources, nationally and by type and region. These are summarized from ARMS data for 1996-2000 and the *1997 Census of Agriculture* (USDA, ERS, 2006), the most recent data available when the model was last updated:

- Total cropland (ARMS, 1996-2000);
- Total crop pasture (*1997 Census of Agriculture*);
- Total permanent pasture/range (*1997 Census of Agriculture*);

- Facilities by livestock commodity (estimated from ARMS 1996-2000);
- Dollar-equivalent of operator and family labor (*Commodity Costs and Returns* (USDA, ERS, 2006)); and
- Land rent (*Farm Income and Costs* (USDA, ERS, 2006)).

Specified Purchasable Inputs

Commodity yields and specified purchasable inputs are calculated from Commodity Costs and Returns datasets. The ERS commodity costs and returns accounts are annual estimates of the average dollar value of input requirements for producing crops and livestock, assuming they are produced with Leontief (constant proportion) production technology. Supplies of purchasable inputs are assumed to be perfectly elastic. The dollar values of the following categories of inputs from the ERS commodity costs and returns accounts are incorporated in the EDMP model:

- Hired labor at regional wage rates.
- Miscellaneous variable inputs at rates and prices that may vary by region or farm grouping.
- Fuel, lube, and electricity-related inputs at rates and prices variable by region or farm grouping.
- Seed and specialized genetic inputs at rates and prices variable by region or farm grouping.
- Specialized technology inputs at rates and prices variable by region or farm grouping.
- Fertilizer and lime inputs at rates and prices variable by region or farm grouping.
- Chemical inputs at rates and prices variable by region or farm grouping.
- Fixed cash costs, by commodity. These costs do not vary with acreage or production and are incurred whether or not the commodity is produced.
- Capital replacement costs, by commodity. These costs are financial allowances for replacement of depreciable machinery and equipment when it wears out. They are not cash costs in the shortrun but must be covered in the longrun if the farm or sector is to maintain its productive capacity.
- Residual overhead costs, by commodity. These costs are endogenously determined to calibrate the model to sector accounts.

Processes

Processes or activities are specified for each model commodity from cost-of-production budgets in the ERS commodity costs and returns accounts. Each process assumes a Leontief (fixed proportion) technology. Thus, they are essentially recipes for producing one unit of the product, using all the required inputs in their specified proportions:

- Produce crops and livestock (national, regional, or farm grouping levels).

- Fallowing required in arid western regions.
- Use forages, feed grains, and oilseeds in livestock production (national, regional, or farm grouping levels).
- Sell commodities into domestic nonfarm market (price differentials by region or farm grouping).
- Purchase any deficit of mixed grain ration and/or hay in regional or type of farm grouping from domestic markets.
- Sell commodities into domestic nonfarm demands, nationally. (Demand functions are estimated by removing farm sector use for feed, seed, and residual from domestic use estimates from the USDA Agricultural Projections to 2016):

  Corn, soy, wheat, rice, barley, oats, sorghum, cotton, dry beans, sunflower, peanuts, tobacco, fed beef, hogs, dairy, and poultry.

- Sell commodities into export demands, nationally. (Demand functions are estimated from USDA Agricultural Projections to 2016):

  Corn, soy, wheat, rice, barley, oats, sorghum, cotton, dry beans, sunflower, peanuts, tobacco, fed beef, hogs, dairy, and poultry. Poultry proportions are fixed in the same proportions as in base year.

- Competing import supplies, nationally. (Calculated from USDA Agricultural Projections to 2016):

  Corn, soy, wheat, rice, barley, oats, sorghum, cotton, fed beef, and hogs.

- Storage demands/dis-storage supplies, nationally. (Calculated from USDA Agricultural Projections to 2016):

  Corn, soy, wheat, rice, barley, oats, sorghum, dry beans, and sunflower.

- Farm-related income, by region or farm grouping. (Calculated from ERS farm income accounts.)
- Work off-farm, by region or farm grouping. (Calculated from ERS farm income accounts.)

Agricultural Policies and Programs

Provisions and economic parameters for agricultural programs in the 1996 and 2002 Farm Acts are taken from the briefing room, *Farm and Commodity Policy* (2007). Major agricultural programs included in the model are:

- Production flexibility contract payments, market loss assistance payments, and post-2002 direct payments (decoupled from current production levels and prices). These are lump sum payments that are post-optimally calculated and affect only net farm income.
- Post 2002 counter-cyclical payments (decoupled from current production levels by individual producers, but coupled to current market prices). These payments are post-optimally calculated for individual crops but paid as lump sum payments. They affect net farm income but do not

affect producer choices of crops to raise because they do not alter the market-determined marginal revenues of producers.

- Loan deficiency payments and marketing loan gains (fully coupled to current production levels and prices). These programs put a floor under producer incentive prices for commodities whenever commodity prices are below the loan rate. They **do** affect production choices because they alter the marginal revenues the producer faces.
- Conservation reserve and wetlands reserve payments (long-term rental of eligible cropland). These programs reduce aggregate supply of cropland and, as a result, restrict production of commodities, thus raising their market prices.
- Crop insurance subsidies. These indirect subsidies stimulate increased production of insured commodities by underwriting some of the cost of managing production risks. In addition, they may encourage expansion of commodity production to more risky production areas.

Solving the Model

In solving the model, all commodity prices and quantities are simultaneously determined as a competitive equilibrium subject to agricultural program provisions, that is, the marginal revenues from expanding the production of each commodity by one standard unit are equalized across all commodities while simultaneously equalizing marginal values (shadow prices) of limiting factors across all activities using that factor. Each solution to this model represents the equilibrium adjustment by the farm sector to the economic situation portrayed in that scenario under the assumption that producers think the change is a permanent, once-and-for-all change. Scenarios from the base period equilibrium assume that producers have had time to adjust to a new equilibrium under the changed policy. For all but very large displacements, this is approximately the second year after enactment of the change in the scenario.

Supply Parameters

Table 1 lists the base solution parameters of supply activities based on average values for 2002-05. For each activity, its model acronym, base period acreage or quantity, percent excess capacity, and percent substitutable capital are listed. The base period acreages or quantities are endogenous to the model, but the user can re-calibrate them to customize the base situation to reflect his/her problem. The percent excess capacity and percent substitutable capital contribute to determining the responsiveness of the activity to endogenous changes in either quantity or price.

Unfortunately, we are not aware of any research that estimates the excess capacities and percent substitutable capital by commodity. In the absence of such producer data, we have assigned these parameters based on our own estimates. These parameters can be adjusted by the model user. These data could be collected from respondents to the ARMS surveys if carefully phrased. For example, an excess capacity question might ask: "How many acres of commodity x could you produce with your current complement of machinery and equipment without experiencing yield reductions, taking into consideration weather conditions and timeliness of planting and harvesting?" Questions related to proportion of substitutable capital might be phrased:

Table 1

Supply activity parameters: Base solution: U.S. aggregate EDMP model, 2002-2005 average

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum
Symbol	CORNUS	SOYUS	WHEUS	RICUS	BARUS	OATUS	SRGUS
Acreage (mil. acres)	77.575	76.930	68.515	3.607	6.016	2.570	9.555
% Excess capacity	40	120	120	20	120	120	120
% Substitutable capital	100	100	100	50	100	100	100
	Cotton	Sugar beets	Sugar cane	Potatoes	Dry beans	Sunflower	Peanuts
Symbol	COTUS	SGBUS	SGCUS	POTUS	BENUS	SNFUS	PNTUS
Acreage (mil. acres)	14.788	1.477	0.575	1.320	1.741	2.059	1.380
% Excess capacity	20	20	20	20	120	120	20
% Substitutable capital	50	25	25	25	100	100	25
	Tobacco	Hay	Crops NEC	Fallow	Corn silage	Crop pasture	Range/ past.
Symbol	TBCUS	HAYUS	CNCUS	FALUS	CSILUS	CPASUS	RNGUS
Acreage (mil. acres)	0.660	55.159	23.360	34.081	6.730	66.800	481.000
% Excess capacity	20	120	40	120	32	120	120
% Substitutable capital	25	100	50	100	32	100	100
	Cow-calf	Fed beef	Ind. hog	Contract hog	Dairy	Sheep/lamb/wool	Broilers
Symbol	CCFUS	FBFUS	IHOGUS	CHOGUS	DAIRUS	SHPUS	CBRLUS
Quantity (mil. units)	33.930	381.642	146.703	96.669	1683.421	9.622	305.478
% Excess capacity	40	40	40	20	20	40	40
% Substitutable capital	50	50	50	50	50	50	50
	Ind. egg	Contract egg	Ind. turkey	Cont. turkey	Livestock NEC		
Symbol	IEGGUS	CEGGUS	ITRKUS	CTRKUS	LNCUS		
Quantity (mil. units)	390.403	331.612	13.235	37.569	3158.100		
% Excess capacity	40	40	40	20	40		
% Substitutable capital	50	50	50	50	50		

Source: Calculated from *USDA Agricultural Projections to 2016*.

"What is the total value of machinery and equipment you use in production of commodity x?" and "What is the value of machinery and equipment that is specialized to **only** the production of commodity x?"

Table 2 lists the process budgets for each activity including yields and dollar values of operator labor, hired labor, seeds/genetics, specialized technologies, fertilizer/lime, chemicals, fuel/lube/electricity, and other variable costs. These cost components make up the shortrun variable cost of the activities. Fixed cash costs and capital replacement costs are included in longrun variable costs. The values are the average ERS cost-of-production accounts at the national level for 1996-2000 and 2001-05.

Table 2

Supply activities: Yields, costs and supply responses: Base solution: U.S. aggregate EDMP model, 2002-2005 average

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum
Yield per acre	143.685 bu	40.872 bu	44.3848 bu	65.02 cwt	62.54 bu	48.19 bu	38.46 bu
Operator labor $	29.69	16.01	14.75	31.29	8.59	17.16	17.75
Hired labor $	3.10	1.76	2.11	39.88	6.41	2.06	3.10
Seed/genetics $	29.10	18.09	7.48	26.68	8.41	7.62	3.87
Specialized tech $	3.63	3.31	0.00	0.00	0.00	0.00	0.00
Fert/lime/etc $	40.17	7.87	18.30	48.79	18.96	15.09	9.45
Chemicals $	26.52	23.57	7.24	72.48	10.09	1.77	7.16
Fuel/lube/elect. $	22.25	5.28	6.04	61.79	12.10	9.38	11.73
Other variable $	27.94	13.69	16.09	121.22	25.31	15.78	28.14
Fixed cash $	17.95	17.53	10.12	73.80	18.94	19.37	10.43
Capital repl. $	64.42	44.80	42.29	63.73	31.17	18.82	37.34
Implicit acreage response	0.333%	0.539	0.344	0.199	0.013	0.361	0.000
Implicit supply response	1.246%	1.402	1.265	1.222	2.345	1.508	3.100
Implicit price response	0.273%	0.224	0.347	0.334	0.014	0.137	0.003

	Cotton	Sugar beets	Sugar cane	Potatoes	Dry beans	Sunflower	Peanuts
Yield per acre	580.0 lb	21.1 ton	33.1 ton	337.9 cwt	14.6 cwt	16.8 cwt	2644 lb
Operator labor $	30.99	51.96	15.50	57.22	12.00	7.28	89.52
Hired labor $	36.56	112.66	330.75	58.03	6.48	2.12	37.63
Seed/genetics $	19.83	43.71	50.36	9.83	24.94	7.82	75.48
Specialized tech $	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Fert/lime/etc $	35.25	61.00	103.90	52.71	13.73	2.84	39.52
Chemicals $	64.97	71.68	89.13	48.66	26.56	8.75	97.96
Fuel/lube/elect. $	29.18	36.52	60.23	17.03	6.47	3.58	34.60
Other variable $	101.01	105.98	312.16	60.82	18.00	7.88	144.04
Fixed cash $	31.53	78.97	106.99	40.55	20.87	15.48	37.48
Capital repl. $	103.41	55.86	54.68	83.38	53.19	24.35	120.89
Implicit acreage response	0.042	0.761	1.279	1.032	0.985	1.241	0.477
Implicit supply response	1.063	0.957	0.957	1.032	1.481	1.946	0.866
Implicit price response	0.381	1.086	1.086	0.934	0.175	0.182	1.939

—continued

Table 2

Supply activities: Yields, costs and supply responses: Base solution: U.S. aggregate EDMP model, 2002-2005 average—Continued

Activity name	Tobacco	Hay	Crops NEC	Fallow	Corn silage	Crop pasture	Range/pasture
Yield per acre	2120 lb	2.5 ton	1721.4 $	0.0	15.81 ton	35.4 cwt HE	7.50 cwt HE
Operator labor $	215.09	3.83	188.81	1.35	25.23	2.05	0.45
Hired labor $	530.11	3.83	125.87	1.50	16.06	1.35	0.45
Seed/genetics $	61.27	2.97	36.71	0.00	22.51	3.40	0.85
Specialized tech $	0.00	0.00	25.17	0.00	2.81	0.00	0.00
Fert/lime/etc $	345.59	2.55	62.94	1.80	31.08	2.91	0.73
Chemicals $	228.28	0.42	62.94	0.30	20.52	0.49	0.11
Fuel/lube/elect. $	61.75	6.36	62.94	4.50	17.22	7.28	1.82
Other variable $	432.15	7.64	330.41	5.00	21.23	8.74	2.18
Fixed cash $	334.22	9.76	125.87	6.90	13.89	11.17	2.79
Capital repl. $	294.14	5.35	368.17	3.84	51.91	3.67	0.92
Implicit acreage response	0.453	0.896	1.034	N/A	N/A	N/A	N/A
Implicit supply response	1.087	1.432	1.034	N/A	N/A	N/A	N/A
Implicit price response	0.645	0.202	1.132	N/A	N/A	N/A	N/A

	Cow-calf	Fed beef	Ind. hog	Cont. hog	Dairy	Sheep/lamb/wool	Broilers
Yield & units	5.5 +2.0 cwt	1.0 cwt	1.0 cwt	1.0 cwt	1.0 cwt	82.57 $	1.0 cwt
Operator labor $	229.58	0.58	3.52	1.54	1.73	6.81	3.00
Hired labor $	3.12	0.83	0.45	3.86	0.59	7.20	0.90
Fuel/lube/elect. $	19.14	2.00	1.33	0.94	0.53	1.91	1.00
Other variable $	84.63	5.08	2.08	3.64	2.95	8.46	4.35
Fixed cash $	87.95	1.25	1.98	2.21	0.92	8.79	8.40
Capital repl. $	122.54	1.21	15.15	8.11	2.15	12.25	8.40
Implicit production response	0.982	0.960	0.661	0.618	0.863	0.000	0.937
Implicit supply response	1.069	1.069	0.785	0.785	0.886	0.000	1.148
Implicit price response	0.887	0.887	1.511	1.511	1.376	2.708	0.758

	Ind. egg	Cont. egg	Ind. turkey	Cont. turkey	Livestock NEC
Yield & units	1.0 doz	1.0 doz	1.0 cwt	1.0 cwt	1.0 $
Operator labor $	0.06	0.06	2.50	2.00	0.09
Hired labor $	0.06	0.06	2.00	2.50	0.09
Fuel/lube/elect. $	0.03	0.03	1.00	1.00	0.12
Other variable $	0.12	0.12	8.00	8.00	0.31
Fixed cash $	0.1425	0.1425	13.00	13.00	0.05
Capital repl. $	0.1525	0.1625	13.00	13.50	0.10
Implicit production response	1.035	1.055	1.173	0.599	0.000
Implicit supply response	1.044	1.044	0.974	0.974	0.000
Implicit price response	0.788	0.788	1.033	1.033	2.138

Source: Calculated from *USDA Agricultural Projections to 2016*.

Implicit Acreage- and Supply-Response Elasticities

Table 2 presents the implicit acreage-response and the implicit supply-response elasticities of all commodities. These were calculated by repeatedly solving the model while perturbing the intercept of each domestic demand function by 10 percent and scaling the new equilibrium solution down to a 1-percent change. Acreage and supply responses are determined by simultaneous adjustments of all quantities and prices to the new equilibrium. The acreage and supply responses are complex and not easily traced. But some factors that influence them are the proportions of total acreage of the commodity under consideration relative to other competing commodities, the slope of the production function of the commodity under consideration relative to the slopes of competing commodities, and the slope of the own-demand function relative to the demand functions of other commodities.

For example, the acreage response for corn is 0.333 percent, that is, a 1-percent increase in the domestic nonfarm demand for corn causes a 0.333-percent increase in corn acreage. Because yield per acre is constant in the EDMP model, corn production also increases by 0.333 percent from a total production level of 11,143 billion bushels. In order to expand the production of corn, it is necessary to reduce the production of the competing commodities in the model, giving rise to cross-elasticities of acreage response. Soybean acreage declines 0.099 percent, wheat acreage declines 0.179 percent, oats declines 0.042 percent, and several other commodities decline by less than 0.04 percent. However, barley, sorghum, and corn silage, which can substitute for corn in livestock feed rations, increase by 0.518, 0.047, and 0.034 percent, respectively. The most responsive commodities—sugar cane, sunflowers, and potatoes—have own-acreage responses above 1 percent. At the other extreme, own-acreage responses for cotton, barley, rice, and sorghum are less than 0.20 percent. Major field crops—soybeans, corn, and wheat—have own-acreage responses of 0.539, 0.333, and 0.334 percent, respectively.

The quantity reconciliation of the implicit supply response for corn begins with the absolute value of the 37.11-million-bushel increase in corn production, then adds 5.24 million bushels from consigning less corn to storage plus 2.87 million bushels from drawing down existing stocks of stored corn, plus 11.07 million bushels from decreased exports, plus 0.77 million bushels from increased imports, plus 5.61 million bushels from decreased onfarm livestock feeding, for a total of 62.67 million bushels, or 1.246 percent of the 5.033-billion-bushel domestic nonfarm demand. Finally, the price of corn increases by 0.273 percent in response to the new equilibrium supply and demand changes. After all adjustments in production, farm sector use, imports and exports, net storage, and own price, the final supply-response elasticity for corn becomes 1.246 percent—quadruple the acreage-response elasticity. A large proportion of the increase in corn supply response over corn acreage response is due to the fact that the divisor of the ratio, domestic nonfarm corn demand, is less than half of total corn production.

Common assumptions from other studies are that supply-response elasticities are 1.0 or less for crop commodities.[3] From our results, these common assumptions appear to be not bad; but they bear further examination. Our

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[3] For example, Sumner (2006) assumed values of supply-response elasticities of 1.0 for corn, wheat, rice, and soybeans in the United States and elasticities of 0.5 to 0.2 for corresponding commodities in the rest of the world in his analysis of potential conflicts of U.S. agricultural support policies and obligations under the WTO. See table 5 of Sumner (2005).

results for acreage responses are grouped around 0.3, but the corresponding supply-response elasticities consistently are as much as three to four times higher, except for commodities that are neither internationally traded, nor storable, nor used on farms. Own-acreage response elasticities ranged from 1.279 for sugar cane to 0.042 for cotton and 0.013 for barley and sorghum. But, because more elastic supply sources (adjustments in exports, imports, storage/dis-storage, and onfarm use) contribute to the magnitudes of implicit domestic supply-responses, supply elasticities for soybeans, wheat, corn, and rice cluster near 1.25. Cotton supply-response is near 1.0, and livestock commodities have supply-response elasticities between 0.78 and 1.15—the smallest for hogs and the largest for broilers.

Demand Parameters

Table 3 lists the base quantities, base prices, and elasticities in all markets—domestic nonfarm, export, competing imports, and storage/dis-storage. Elasticities in the model can be altered as specified by the user. All quantities and prices are endogenous but can be re-calibrated by the user. Model prices obey the law of one **net** price. Prices for commodities in different markets may differ slightly because there may be different physical costs such as storage, transportation, and handling required to access different markets.

Table 3

Disposition activity parameters: Base solution: U.S. aggregate EDMP model, 2002-05 average

Domestic nonfarm demands

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum
Symbol	SELCRNUS	SELSOYUS	SELWHEUS	SELRICUS	SELBARUS	SELOATUS	SELSRGUS
Base quantity (mil. units)	5033.11	1931.14	1878.65	153.85	177.22	85.71	27.93
Base price ($/unit)	1.786	4.501	2.602	6.001	2.427	1.266	2.181
Price elasticity	-0.7	-0.99	-0.85	-0.75	-0.67	-0.47	-0.92

	Cotton	Sugar	Potatoes	Dry beans	Sunflower	Peanuts	Tobacco
Symbol	SELCOTUS	SELSGRUS	SELPOTUS	SELBENUS	SELSNFUS	SELPNTUS	SELTOBUS
Base quantity (mil. units)	5124.59	50.20	446.13	20.45	26.15	3193.88	885.21
Base price ($/unit)	0.490	38.772	5.457	24.261	13.113	0.218	2.021
Price elasticity	-0.27	-0.50	-0.50	-0.50	-1.00	-0.50	-0.25

	Hay	Crops NEC	Straw	Cottonseed	Beef	Hogs	Dairy
Symbol	SELHAYUS	SELNCCUS	SELSTRUS	SELCTSUS	SELFDBUS	SELHOGUS	SELMLKUS
Base quantity (mil. units)	94.92	40212.11	10.02	794.26	457.00	236.95	1654.35
Base price ($/unit)	45.979	0.977	52.528	1.086	69.789	33.520	13.988
Price elasticity	-0.75	-0.50	-1.00	-0.27	-0.52	-0.43	-0.31

	Sheep/lamb/wool	Broiler	Eggs	Turkey	Livestock NEC
Symbol	SELSHPUS	SELBRLUS	SELEGGUS	SELTRKUS	SELNCLUS
Base quantity (mil. units)	794.50	264.13	722.01	40.47	3158.10
Base price ($/unit)	1.041	39.168	0.672	37.523	0.999
Price elasticity	-0.50	-0.63	-0.23	-0.80	-0.75

Export demands

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum
Symbol	EXPCRNUS	EXPSOYUS	EXPWHEUS	EXPRICUS	EXPBARUS	EXPOATUS	EXPSRGUS
Base quantity (mil. units)	1885.95	822.09	978.30	72.15	26.62	18.61	36.86
Base price ($/unit)	1.936	4.961	2.752	6.501	2.427	1.346	2.181
Price elasticity	-1.20	-2.50	-0.85	-2.62	-0.67	-3.93	-1.86

	Cotton	Dry beans	Sunflower	Peanuts	Tobacco	Beef	Hogs
Symbol	EXPCOTUS	EXPBENUS	EXPSNFUS	EXPPNTUS	EXPTOBUS	EXPBEFUS	EXPHOGUS
Base quantity (mil. units)	3603.22	2.22	2.62	454.58	514.80	21.76	12.40
Base price ($/unit)	0.525	24.261	13.113	0.218	2.021	69.789	33.520
Price elasticity	-1.34	-1.00	-1.75	-1.75	-1.00	-0.61	-0.6

—continued

Table 3

Disposition activity parameters: Base solution: U.S. aggregate EDMP model, 2002-05 average—Continued

Export demands—continued

Activity name	Dairy	Poultry
Symbol	EXPDRYUS	EXPPOUUS
Base quantity (mil. units)	29.07	51.68
Base price ($/unit)	13.988	38.839
Price elasticity	-0.31	-0.67

Competing import supplies

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum
Symbol	IMPCRNUS	IMPSOYUS	IMPWHEUS	IMPRICUS	IMPBARUS	IMPOATUS	IMPSRGUS
Base quantity (mil. units)	13.32	1.85	38.03	9.20	15.25	1.15	0.64
Base price ($/unit)	1.936	4.961	2.752	6.501	2.427	1.346	2.181
Price elasticity	2.00	2.00	2.00	2.00	2.00	2.00	2.00

	Cotton	Beef	Hogs
Symbol	IMPCOTUS	IMPBEFUS	IMPHOGUS
Base quantity (mil. units)	150.79	25.52	5.97
Base price ($/unit)	0.525	69.789	33.520
Price elasticity	2.00	2.00	2.00

Storage demands/dis-storage supplies

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum
Symbol	STORCRN	STORSOY	STORWHE	STORRIC	STORBAR	STOROAT	STORSRG
Base quantity (mil. units)	1502.45	294.74	781.99	27.08	116.29	55.01	27.20
Base price ($/unit)	1.963	4.988	2.793	6.541	2.453	1.373	2.208
Price elasticity	-1.20	-1.20	-1.20	-1.20	-1.20	-1.20	-1.20
Symbol	DSTORCRN	DSTORSOY	DSTORWHE	DSTORRIC	DSTORBAR	DSTOROAT	DSTORSRG
Base quantity (mil. units)	930.41	157.23	559.91	9.34	81.96	49.04	64.22
Base price ($/unit)	1.920	4.945	2.730	6.479	2.410	1.330	2.165
Price elasticity	0.80	0.80	0.80	0.80	0.80	0.80	0.80

Activity name	Dry beans	Sunflowers
Symbol	STORBEN	STORSNF
Base quantity (mil. units)	10.33	15.70
Base price ($/unit)	24.302	13.154
Price elasticity	-1.20	-1.20
Symbol	DSTORBEN	DSTORSNF
Base quantity (mil. units)	7.58	9.88
Base price ($/unit)	24.302	13.091
Price elasticity	0.80	0.80

Source: Calculated from *USDA Agricultural Projections to 2016*.

Government Program Parameters

Table 4 lists the Government program parameters—for decoupled programs: the direct payment rate, maximum counter-cyclical payment rate, program yield, payment per base acre, and total payment. An implicit scale factor—subsuming payout proportions, coverage rates, and participation rates—is calculated to equate the endogenously calculated program payments to reported aggregate program payments. For loan deficiency payments, the loan rate, weighted average loan deficiency payment rate, total production, and total loan deficiency payments are listed. Maximum CRP acreage, average CRP payment per acre, and maximum aggregate CRP payout can be set by the user. For crop insurance, the acreage insured, elasticity of crop insurance demand, premium per acre, and subsidy per acre are consensus estimates based on data from the Risk Management Agency, published by the USDA's Office of the Chief Economist (2006). Each of these parameters can be set by the user.

Table 4

Government program parameters: Base solution: U.S. aggregate EDMP model, 2002-05 average

Direct payments

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum	Cotton
Direct payment rate	0.28	0.44	0.52	2.35	0.24	0.24	0.35	0.0667
* Program yield	131.82	36.119	40.72	55.18	54.38	48.192	33.44	522.00
= Payment/acre	31.373	13.509	17.998	110.222	11.093	9.831	9.948	29.595
Total direct payment	2116.30	903.64	1072.88	345.74	58.04	21.97	82.66	380.56
Implicit scale factor	0.8696	0.8695	0.8700	0.8696	0.8696	0.8696	0.8696	0.8696

Counter-cyclical payments

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum	Cotton
(Target price	2.63	5.80	3.92	10.50	2.24	1.44	2.57	0.724
-Direct payment	0.28	0.44	0.52	2.35	0.24	0.024	0.35	0.0667
-Loan rate)	1.95	5.00	2.75	6.50	1.85	1.33	1.95	0.52
* Program yield	131.82	36.119	40.72	55.18	54.38	48.192	33.44	522.00
= CC payment/ acre	52.728	13.003	26.468	408.994	8.157	4.145	9.029	71.671
Total CC payment	2390.32	584.55	1059.73	191.93	28.68	6.22	50.42	619.36
Implicit scale factor	0.5844	0.5844	0.5844	0.5844	0.5844	0.5844	0.5844	0.5844

Marketing loan gains and loan deficiency payments

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum	Cotton
Loan rate	1.95	5.00	2.75	6.50	1.85	1.33	1.95	0.52
Wtd. ave. LDP rate	0.164	0.499	0.148	0.499	0.000	0.064	0.000	0.030
*Total sales & Use	11116.80	2910.88	3100.59	245.46	238.14	111.06	27.76	8788.9
=Total LDP payment	1821.03	1451.14	455.36	122.52	0.00	7.07	0.00	260.28

Conservation reserve program

Enrolled CRP acres	(mil)	36.90
*CRP payment/acre	($/acre)	58.392
=Maximum CRP payout	($ mil)	2191.56

—continued

Table 4

Government program parameters: Base solution: U.S. aggregate EDMP model, 2002-05 average—Continued

Crop insurance subsidies

Activity name	Corn	Soybeans	Wheat	Rice	Barley	Oats	Sorghum	Cotton
Acres insured	71.369	61.544	56.182	2.092	3.790	2.184	9.460	14.640
Percent insured	92%	80%	82%	58%	63%	85%	99%	99%
Ins. dem. elasticity	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Premium/acre	22.415	17.185	9.765	33.812	9.255	4.519	5.999	24.128
Subsidy/acre	12.776	9.795	5.566	19.273	5.276	2.576	3.419	13.753

	Sugar beets	Sugar cane	Dry beans	Sunflower	Peanuts	Tobacco	All insured crops
Acres insured	1.256	0.532	1.480	1.750	1.076	0.480	227.72
Percent insured	90%	71%	85%	85%	78%	73%	85%
Ins. dem. elasticity	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Premium/acre	65.764	65.764	26.663	17.781	46.323	345.984	4660.75 total
Subsidy/acre	37.486	37.486	16.338	10.135	26.404	197.211	2636.63 total

Source: Calculated from *USDA Agricultural Projections to 2016*.

Post-Optimal Calculations of Performance Variables

Because the value of the model's objective function is confounded by the presence of calibration constraint values, it is necessary to post-optimally calculate several model performance measures. These post-optimal calculations are in a page labeled INCOMES of the Excel spreadsheet model. This section of this bulletin describes the calculation of farm income measures, Government budgetary expenditures, consumer and producer surpluses, and commodity cash incomes, expenses, and margins.

Net Farm Income and Net Cash Flow

Shortrun net farm income is calculated as the sum of:

+ Commodity cash receipts from domestic and export markets;

+ Government payments (direct and counter-cyclical payments, loan deficiency payments, conservation reserve and wetlands reserve payments, and crop insurance indemnities);

+ Farm-related income;

\- Variable input purchases (hired labor, seed and genetics, specialized technologies, fertilizer, chemicals, and fuel, lube, and electricity, and miscellaneous variable inputs);

\- Rent paid;

\- Crop insurance premiums;

\- Interest paid;

\- Cash overhead expenditures;

\- Other fixed cash expenditures; and

\- Storage-related costs (hired labor, variable inputs, technology, capital costs, and fixed cash expenditures).

Note:

- The dollar value of operator and family labor is not an expense in net farm income but is a resource endowment that can be allocated among activities.
- Longrun net farm income includes all of the above items and adds in the value of perquisites and subtracts out capital replacement costs.
- Shortrun net cash flow includes all of shortrun net farm income plus off-farm income and subtracts principal paid and family living expenses.
- Longrun net cash flow adds in the value of perquisites and subtracts out capital replacement costs.

Government Budgetary Exposure

Government budgetary exposure is also calculated in the INCOMES page of the Excel spreadsheet. The parameter values of Government programs are shown in table 4 but may be changed if policy provisions or parameters change. The INCOMES spreadsheet shows the calculated values of major Government programs—direct payments, counter-cyclical payments, loan deficiency payments, conservation reserve payments, and crop insurance subsidies.

Direct payments and counter-cyclical payments are decoupled from current production by individual farmers. Counter-cyclical payments depend on average market prices, which in turn depend on aggregate production of the covered commodities; thus they are semicoupled. Since both are disbursed irrespective of whether the recipient grows the covered crop, they do not alter the effective market prices perceived by producers and have the same effect as lump-sum payments to producers and/or nonoperator landlords.

Loan deficiency payments and marketing loan gains, on the other hand, are paid on all production of actual producers of the covered commodity. They are fully coupled to individual production and stimulate additional supply because they raise the effective prices perceived by the producers.

Conservation reserve and wetlands reserve payments essentially rent the land in question on a long-term basis, and remove it from production. Thus, these programs have a supply control component that enhances their effects on farm income by restricting supply.

Crop insurance subsidies act in the opposite way—they stimulate additional production by underwriting some of the costs of production and possibly paying out indemnities in excess of premiums collected.

Consumer and Producer Surpluses

Changes in consumer surplus, also calculated in the INCOMES spreadsheet, correctly measure the consumer welfare implications of changes in supply or demand because they vary directly with consumer preferences—increasing with either increases in quantity or decreases in price. Consumer expenditures, in contrast, are not a reliable measure of consumer welfare, because consumer expenditures may or may not reflect changes in welfare, depending on whether consumer demand is elastic or inelastic. With an inelastic demand, a change in quantity results in a larger change in prices in the opposite direction, thereby causing the change in expenditures to be opposite in direction to the change in consumer welfare. With an elastic demand, a change in quantity has only a small opposite effect on price; thus consumer expenditures have the same sign as consumer welfare changes but are smaller by the price effect. In the INCOMES page, the model separately calculates and sums consumer surplus for each commodity in domestic markets and in export markets using the formula:

$$CS = \tfrac{1}{2}\,(\text{Intercept} - \text{Price}) * \text{Quantity}. \tag{15}$$

This model does **not** calculate changes in producer surplus by commodity to correspond with the consumer surplus. The reason for this is that changes in producer surplus for a single commodity do not conceptually represent the producer welfare implications of a change in production if Government transfer payments coupled to production or price levels are present. In the EDMP model, the loan deficiency payment program, the CRP, and crop insurance subsidies are all coupled to production levels, and the counter-cyclical payments are coupled to price levels. For more defensible and informative measures of changes in producer welfare by commodity, we suggest commodity cash incomes, expenses, and margins, as calculated below.

Commodity Cash Incomes, Expenses, and Margins

Cash incomes, expenses, and margins by commodity are included in the INCOMES spreadsheet. These measures accurately track the shortrun net farm income implications of changes in the model solutions. For crop commodities, the formulas are:

Accrued cash market income = Acreage * Yield * Domestic market price, (16)

Commodity cash expenses = Acreage * Variable cash costs per acre, and (17)

Net cash market income = Accrued cash market income – Commodity cash expenses. (18)

For livestock commodities, “production” is substituted for “acreage times yield.”

These measures reveal important producer welfare information for each commodity. For example, rice, oats, and cotton all have negative net cash market incomes, indicating that their variable production costs exceed their market revenues, with Government transfer payments making up all of their net cash margins. There is an incentive for production of these commodities to decline if decoupled payments are used to effect the Government transfer payments because producers can avoid the cash income losses from production and still receive the decoupled payments. However, if coupled payments, such as the loan deficiency payment program, are used to effect the Government transfer payments, then there is no incentive for farmers to reduce production. Additional commodities that have very high ratios of cash expenses to cash incomes include barley, grain sorghum, sugar (beets and cane), and peanuts, all of which have high levels of Government income supports, which distort their cost structures relative to their market prices.

Livestock commodities have uniformly high costs and low margins because the internal transfer prices of the farm-produced grains and forages they consume are calculated at their opportunity costs (market prices) instead of their variable production costs. Using opportunity costs as the internal transfer prices is conceptually correct, but it causes the production costs of farm-produced feeds to be over-estimated and livestock margins to be correspondingly under-estimated. Both independent and contract turkeys display negative net cash incomes. That result is probably not true in actual production, however, because these industries are highly industrialized and exercise strict cost control at all stages. These activities and results should be re-examined in later improvements to the EDMP model. The results may be due to errors in specification of the production budgets for these activities or errors in the distribution of market receipts between independent and contract producers.

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Appendix I: User's Manual

Appendix III model spreadsheets are accessible by contacting
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The Excel Workbook, **U S Aggregate Marketing Loan Model.xls**, contains six spreadsheet pages labeled: **A, B, Log, OUTPUT, INCOMES**, and **MODEL**. **Spreadsheet A** contains the supply side of the U.S. Aggregate EDMP Model; **Spreadsheet B** contains the demand side of the model. Sheets **Log**, **OUTPUT**, and **MODEL** are generated by the SAS program to track the status of the SAS program and written back into Excel for possible use in diagnosing any problems.

We will first concentrate on **Sheets A and B**, which define the model tableaux, containing parameters under control of the model user, and receiving the raw optimal solutions written back by SAS.

Spreadsheet A, The Supply Side

- **Rows 1 through 10:** Scenario-base comparison post-optimal calculations. Scenario quantities and gradients (perfectly competitive prices) and base quantities and gradients and absolute and percentage differences of scenario from base. Each column is identified by its name within the EDMP model. Values in **Rows 2 and 7** for the scenario solution and **Rows 3 and 8** for the base solution **must be copied and pasted as values** from **Rows 16 and 17**.

- **Rows 12 through 15:** Parameters defining process supply slopes (Hessian elements) and base quantities: Capital requirements per unit (**Row 12**), decimal of excess capacity (**Row 13**) (which is the product of the percent excess capacity times the percent substitutable capital for that commodity and can be changed by the user). **Row 14** shows the target base quantities. For supply processes, there is no target base price. The base prices of supply processes are initially defined as the product of the Hessian element times the base quantity. In the process of calibration, these initial estimates may increase or decrease as necessary to calibrate to the base quantities.

- **Rows 16 through 24:** (**Rows 16 through 19**) are optimal solutions as written back into Excel by the SAS program. **Row 23** is the calculated value of the Hessian element, defined as the negative of **Row 12** divided by **Row 13** times **Row 14**. The Intercepts (**Row 24**) are determined as the negative of **Row 14** times **Row 32** plus **Row 21**. **Row 21** is the implicit gradient check for the uncalibrated intercept.

- **Rows 26 through 225 and Columns F through CX:** This block constitutes the supply side quadratic programming tableau of the EDMP model. **Column CX** contains the values for the right hand side (**RHS**) of the supply side of the model. **Column CY** labels the constraint rows and how the values were derived for the base solution. The SAS program automatically identifies the block **Rows 26 through 225** and **Columns F through CX** as the quadratic programming tableau.

- **Rows 32 and 30** are the diagonal of the Hessian (**Row 32**) and its corresponding calibrated intercept (**Row 30**) for the base solution. The diagonal of the Hessian values are calculated in **Row 23 and must be pasted**

as values in Row 32. The uncalibrated intercept values are calculated in **Row 24**. The uncalibrated intercept values are modified upward or downward until the base period prices and quantities are achieved to the desired level of accuracy, then transferred to **Row 32** by dividing **Row 32** by the ratio of the original intercept to the calibrated intercept, and **Row 30** is returned to its original value (**Row 24**).

- **Customizing the Supply Functions. Rows 31 and 29** are the diagonal of the Hessian (**Row 31**) and the corresponding calibrated intercept (**Row 29**) for the scenario solution. These rows allow customization of the model for any additive (parallel shift) or multiplicative (rotational) change that the user specifies to the base values of either the diagonal of the Hessian or the calibrated intercepts.

- **Rows 33 through 36** contain the elements that will be used to calculate the net income measures in the INCOMES page of the spreadsheet. They are free rows that do not constrain the solution to the model in any way.

- **Rows 37 through 227** and **Columns F through CX** define the Aij constraint matrix and right hand side.

Columns C and D: Customizing the model supplies and demands to a specific problem.

- **Column C** labels the parameters the user can specify to modify the production processes (Aij entries), either the base solution or the scenario solution that will be compared with the base, and **Column D** contains the default values of the parameters. All model processes that are not specified by the user in **Column D** and remain at their default values are endogenously calculated as perfectly competitive adjustments within the program environment of the 1996 Farm Act, as modified by the 2002 Farm Act.

- In general, crop commodity processes allow the user to specify any of the following actions: **(1) Change the commodity yields** per acre, **(2) Change the commodity variable costs per acre, (3) Change commodity acreage, (4) Fix the commodity acreage, (5) Change commodity exports, (6) Fix commodity exports, (7) Change commodity competing imports, and (8) Fix commodity competing imports**.

- Livestock commodity processes allow the user to specify: **(1) Change the variable costs** per unit, **(2) Change livestock production, (3) Fix livestock commodity production, (4) Change livestock commodity exports, (5) Fix livestock commodity exports, (6) Change livestock commodity competing imports, and (7) Fix livestock commodity competing imports**.

- **Columns AX, AY, and AZ** are Government program activities: CRP payments, the lump sum direct payments, and ARP (set-aside) requirements, if they are required.

- **Columns BA through BZ** are crop insurance activities and crop insurance indemnities by crop commodity.

- **Columns CA through CQ** are: (1) purchases of variable inputs (hired labor, miscellaneous variable inputs, seed/genetics, specialized technology, fertilizers, chemicals, fuels, lubes, and electricity), (2) payments of overhead costs (fixed costs, capital replacement, interest, rent, and other residual overhead costs), and (3) cash flow items that are not part of farm income (family living costs, principal paid, farm-related income, off-farm income, and value of perquisites). The user can change the dollar prices of these inputs proportionally by modifying the entries in **Row 30** up or down from **-1.0.**

- **Columns CR through CU** are artifacts from an earlier version of the model and can be safely ignored.

- **Column CV** specifies the type of constraint (EQ, LE, GE, or FREE) and specifies which Hessian row and intercept row (base or scenario) are to be maximized in that particular solution. The Hessian row will be labeled "QUAD" in column CV, and the intercept row will be labeled "MAX." The other Hessian and intercept rows will be labeled "FREE."

  These must be consistent on Spreadsheets A and B.

Spreadsheet B, The Demand Side

Spreadsheet B contains the demand and disposition activities of the model. These include domestic demands by commodity, storage and dis-storage of storable commodities, exports and competing imports of tradable commodities, and program activities that depend on national rather than farm-specific variables (including storage costs and marketing loan gain mechanisms).

- **Rows 1 through 10:** Scenario-base comparison post-optimal calculations. Scenario quantities and gradients (perfectly competitive prices) and base quantities and gradients and absolute and percentage differences of scenario from base. Each column is identified by its name within the EDMP model. Values in **Rows 2 and 7** and **3 and 8 must be copied and pasted as values** from **Rows 16 and 17**. **Rows 3 and 8** are for the base solution, and **Rows 2 and 7** are for the scenario solution.

- **Rows 12 through 14:** Parameters defining process supply slopes (Hessian elements) and base quantities: base quantity, target base price, and elasticity of demand. The base prices of demand processes are initially defined as the product of the Hessian element times the base quantity. In the process of calibration these initial estimates are increased or decreased as necessary to calibrate to the base quantities. Then they are transferred to **Row 32** by dividing Row 32 by the ratio of the original intercept to the calibrated intercept. Finally, Row 30 is returned to its original value (**Row 24**).

- In the final calibrated model, **Row 30** should be equal to the demand intercept (**Row 24**).

- **Rows 16 through 24:** Optimal solution as written back into Excel by SAS (**Rows 16 through 19**), calculated values of Hessian elements and intercepts (**Rows 23 and 24**), and calculated implicit gradients (**Row 21**).

- **Rows 26 through 160 and Columns F through DK:** This block constitutes the demand/disposition side quadratic programming tableau of the EDMP model. **Column DK** contains the values for the right hand side

(RHS) of the demand side of the model. The SAS program automatically identifies **Rows 26 through 160 and Columns F through DK** as the quadratic programming tableau. **Column DL** labels the constraint rows and documents how the values were derived for the base solution.

- **Columns C and D:** Columns C and D are not used in **Spreadsheet B** because all parameters under user control were specified in **Spreadsheet A**.
- **Rows 32 and 30:** As in **Spreadsheet A**, **Rows 32 and 30** are the diagonal of the Hessian (**Row 32**) and the corresponding calibrated intercept (**Row 30**) for the **Base Solution**. In **Spreadsheet B** the values of the **Hessian** elements have been altered by calibration factors. The diagonal of the **Hessian** values are calculated in **Row 22** and **pasted as values** in **Row 32**. The uncalibrated intercept values are calculated in **Row 24** and **pasted as values** into **Row 30**.
- Customizing the demand functions. **Rows 31 and 29** are the diagonal of the Hessian (**Row 31**) and the corresponding calibrated intercept (**Row 29**) for the **Scenario Solution**. Any additive or multiplicative change to the base values of either the diagonal of the Hessian or the calibrated intercepts can be specified by the user in these rows. This feature allows the user to specify any desired parallel or rotational shifts to any demand function.
- **Rows 33 through 36** contain the elements that will be used to calculate the net income measures in the **INCOMES** page of the spreadsheet. They are free rows that do not constrain the solution to the model in any way.
- **Columns F through AE** are domestic nonfarm demands by commodity.
- **Columns AF through AW** are storage and dis-storage of storable commodities.
- **Columns AX through BW** are exports and competing imports of tradable commodities.
- **Columns BX through CB** are inputs for national storage activities.
- **Columns CC through DH** are program activities that depend on national rather than farm-specific variables (marketing loan gains and loan deficiency payments).
- **Column DI** specifies the type of constraint (EQ, LE, GE, or FREE) and specifies the Hessian row and intercept row (base or scenario) to be maximized in that particular solution. The Hessian row will be labeled “QUAD” in column **DI**, and the intercept row will be labeled “MAX.” The other Hessian and intercept rows will be labeled “FREE.”

  These must be consistent on Spreadsheets A and B.

Post-Optimal Calculations Spreadsheet

In the next section, we explain the use of the **INCOMES** spreadsheet, which can be custom configured to do post-optimal calculations as needed by the user. The **INCOMES** spreadsheet is automatically calculated from **Rows 2 and 7**, **Rows 3 and 8**, and **Rows 33 through 36** of **Spreadsheets A and B**.

We have not printed the row and column indices on the INCOMES spreadsheet to make it easier to read and facilitate associating the data with their variable names.

Four measures of farm well-being are calculated in **Rows 8 through 34: (1) shortrun net cash farm income, (2) longrun net farm income, (3) shortrun net cash flow,** and **(4) longrun net cash flow**.

- Shortrun net cash farm income does not include capital replacement, principal paid, family living expenses, off-farm income, or value of perquisites.
- Longrun net farm income includes all shortrun net cash farm income, subtracts capital replacement, and adds value of perquisites.
- Shortrun net cash flow excludes capital replacement and value of perquisites, but subtracts principal paid and family living costs, and adds off-farm income.
- Longrun net cash flow includes all shortrun net cash flow, subtracts capital replacement, and adds value of perquisites.

The following rows summarize levels of activities and derived calculations from the model:

- **Rows 38 through 42** summarize crop production activities, and **Rows 44 through 48** summarize livestock production activities.
- Domestic demand activities are summarized in **Rows 50 through 60**. **Rows 50 through 54** summarize quantities, and **Rows 56 through 60** summarize prices.
- Storage and dis-storage are shown in **Rows 63 through 67**.
- Exports and competing imports are shown in **Rows 69 through 73**.
- Loan deficiency payments and marketing loan gains are summarized in **Rows 75 through 85**. Sums of marketing loan gains by commodity are automatically transferred to the marketing loan gains section (**Rows 9 and 10 of Columns DV through EC**).
- Counter-cyclical payments are calculated by commodity in **Rows 88 through 92**, and their sums are automatically transferred to **Row 8 and 9 of Column F**. Although determined on an individual commodity basis, counter-cyclical payments are disbursed as lump sum payments that affect only net farm income.
- Direct payments associated with supported commodities are calculated in **Rows 94 through 98**, and their sums are automatically transferred to **Row 8 and 9 of Column E**. These are disbursed as lump sum payments in the Government programs columns of the net incomes section.
- Crop insurance subsidies are calculated in **Rows 100 through 104**.

- Domestic consumer surpluses and export consumer surpluses are shown in **Rows 107 through 117**. These are shown separately because different groups of consumers receive them.
- Producer gross commodity receipts, commodity cash expenses, and net cash income by commodity are calculated in **Rows 119 through 139**.
- Finally, the user can specify and print his/her own custom calculations in any unused area of the **INCOMES Spreadsheet**.

Solving the Model: The SAS Link Program

Appendix II contains the SAS code to optimize EDMP models with quadratic programming in Proc NLP. This code hotlinks SAS to an EDMP tableau in an Excel spreadsheet. It is executed in the background while running Excel. Upon reading a change in a trigger cell (cell A 17), SAS reads the tableau, optimizes the model, and prints results back to the spreadsheet, including an optimal solution, a complete tableau, and an iteration history. Five solutions may be run by incrementing cell A 17. After five solutions have been run, hit F8 to restore the program for another five solutions.

Appendix II: The SAS Excel Link Program

```
/*
ExcelLinkNov2006.SAS.
*/
%macro ExcelSolve;
%macro ReadData;
option errors=0 nocenter;%global acts n sheet;%let acts=;%let n=;
%Do p=1 %to 2;
  %let sheet=%sysfunc(byte(&p+64));%put sheet=&sheet;%global actsall&sheet;
  filename model1 dde “excel|&sheet.!r1c6:r1c220”;
  data _null_;infile model1 dlm=’09’x notab dsd missover lrecl=4000;
    array va{200} $ ;input va{*};length actsall $3000.;
    do ii=1 to dim(va);
    if upcase(va{ii})=’_TYPE_’ then do;N1=ii-1;leave;end;
    else actsall=trim(left(actsall))||’ ‘||trim(left(va{ii}));end;
    call symputx(“actsall&sheet”,actsall);call symputx(“N&sheet”,N1);run;
%put actsall&sheet=&&actsall&sheet;%put n&sheet=&&n&sheet;

%Let StartRow=;
filename model1a dde “excel|&sheet.!r1c1:r200c1”;
data _null_;infile model1a dlm=’09’x notab dsd missover lrecl=4000;
  informat startrow $char13.;input startrow;
  if UPCASE(startrow)=”CONSTRAINT” then call
symputx(‘StartRow’,put(_n_+1,f2.0));run;
%put startrow=&startrow;

filename model1b dde “excel|&sheet.!r&StartRow.c1:r500c250”;
data &sheet free&sheet;infile model1b dlm=’09’x notab dsd missover lrecl=7000;
  informat name $char23. units $char20. slabel  $char20.  Default $char20.
activity $34. _type_ $char4. _type_&sheet $char4.;
   input name $ units $  slabel $ default $  activity $ &&actsall&sheet
           %if &p=1 %then _type_ nada _rhs_;
           %if &p>1 %then _type_&sheet nada _rhs_&sheet;;
  _error_=0;
  name=trim(left(upcase(name)));Order1=_n_;
```

```
if upcase(lag(name))='GROWER NON-SEED COSTS' then stop;
if (upcase(name)="SNFYUS"|upcase(name)="SNCFUS"|upcase(name)="LNFYUS"|upcase(n
ame)="LNCFUS")
   then do;output Free&sheet;f+1;end;
else output &sheet;
  run;

%put actsall&sheet;
%let Acts=&Acts &&actsall&sheet;%let N=%eval(&N+&&n&sheet);
proc sort data=&sheet;by name;run;

%if&p>1%then%do;
proc sort data=A;by name;run;
data A;length _type_ $8.; merge A(IN=A) &sheet(IN=&sheet);by name;
  if &Sheet then do;
    _rhs_=max(put(_rhs_,f30.10),put(_rhs_&sheet,f30.10));
    _type_=trim(left(_type_&sheet));
    end;
  _type_=trim(left(_type_));
  if ~index(upcase(_type_),"FR");*Eliminate free constraints;
  if index(upcase(_type_),"LE") then _type_="LE";
  if index(upcase(_type_),"PA") then _type_="PARMS";*new;
  if index(upcase(_type_),"EQ") then _type_="EQ";
  if index(upcase(_type_),"GE") then _type_="GE";
  if index(upcase(_type_),"QU") then _type_="QUAD";
  if index(upcase(_type_),"MA") then _type_="MAX";
  if index(upcase(_type_),"MI") then _type_="MIN";
  if index(upcase(_type_),"FI") then _type_="FIXED";
  drop _rhs_&sheet _type_&sheet;
    sheets="      ";s=0;
    if B then sheets="B"||trim(left(sheets));
    if A then sheets="A"||trim(left(sheets));
    sheets=trim(left(sheets));
      if sheets="AB" then s=1;
      if sheets="A" then s=2;
      if sheets="B" then s=3;
      Output A;
  run;
%end;%end;

proc sort data=a out=a2;by s order1;run;
*This section writes out the entire tableau in Model sheet;
filename qpout dde "excel|model!r1c1:r6002c250" lrecl=4000;
data _null_;set A2;
  file qpout;
```

```
Name_=trim(left(translate(trim(left(name)),”_”,” “)));
  format _type_ $4.  _rhs_ d9.;
  if _n_=1 then put “Name sheets &acts _type_ _rhs_ Name”;
  format _type_ $char8.;
   put Name_ sheets &acts _type_ _rhs_ Name_;
  run;
%mend ReadData;
%ReadData;

%put acts=&acts n=&n;

%let BaseOrScen=Base;
data a;set a(drop=s sheets) end=end ;LENGTH _NAME_ $8 ;
if ~index(upcase(_type_),”FR”);
ARRAY ACTS(*) &ACTS;ARRAY ACTS2{&N} _TEMPORARY_;
************************************************;
*Set up Hession matrix;
   IF upcase(_type_)=’QUAD’ then do;
     DO I=1 TO DIM(ACTS);ACTS2{I}=ACTS{I};ACTS{I}=0;END;
     DO I=1 TO DIM(ACTS);
     ACTS{I}=ACTS2{I};
       CALL VNAME(ACTS{I},_NAME_);
       _RHS_=.;OUTPUT;ACTS{I}=0;
   END;END;
************************************************;
*Create separate constraints for fixed coefficients;
Else IF upcase(_type_)=’FIXED’ then do;
   DO I=1 TO DIM(ACTS);ACTS2{I}=ACTS{I};ACTS{I}=.;END;
   DO I=1 TO DIM(ACTS);
   IF ACTS2{I}~=. THEN DO;ACTS{I}=1;_RHS_=ACTS2{I};_TYPE_=”EQ”;*CALL
SOUND(8500,1);
      *PUT ‘FIXED ‘ I=  acts{i}= _rhs_=;
      OUTPUT;ACTS{I}=.;_RHS_=.;
   END;END;END;
************************************************;
ELSE if upcase(_type_)=’MAX’ then do;_type_=’LINEAR’;output;*Required for NLP;
   if index(upcase(name),”SCE”) then call symputx(“BaseOrScen”,”Scenario”);
   end;
************************************************;
ELSE output;
************************************************;
IF END THEN DO;
  do i=1 TO DIM(ACTS);ACTS{i}=0;_TYPE_=’LOWERBD’;_RHS_=.;name=’LOWERBD’;END;
  output;*Restrict to nonnegative quadrant;
```

```
  /*_type_=”PARMS”;OUTPUT;*/*Starting solution of null vector;
  end;
run;

option ps=max ls=max;
filename nlplog dde “excel|LOG!r1c1:r500c25” notab lrecl=4000;
data _null_;file nlplog; do r=1 to 500;put “ “;end;run;
filename nlpout dde “excel|OUTPUT!r1c1:r500c25” notab lrecl=4000;
data _null_;file nlpout; do r=1 to 500;put “ “;end;run;
option notes;
proc printto print=nlpout log=nlplog;run;*allows log to be read;
*******************************************************;
*This is the quadratic optimization section.  Parameters have
been set to Proc NLP (nonlinear programming) standards with
iteration restrictions and convergence criteria;

PROC NLP INQUAD=A OUTEST=QPOUT short maxiter=2000 absgconv=1e-10 20;
*maxtime=60 noeignum;* out=out1 outder=2;* nomiss;*PALL;*options;
MAX;
PARMS &ACTS;*list of activity names (parameters);
RUN;
********************************************************;
%put SYSERR=&syserr  -A nonzero syserr code indicates NLP execution problems;
proc printto;run;
option nonotes;
%let crit=;

data log_;
  infile nlplog dlm=’09’x notab dsd missover lrecl=4000;
  informat row $char125.;input row;
  if index(row,”convergence criterion satisfied.”)then do;
    call symputx(‘crit’,”Convergence criterion satisfied.”);
    call sound(3000,5);put ‘It worked. ‘ row;*stop;
    end;
  if ~index(row,’randomly’)& ~index(row,’printto’)& ~index(row,’put s’);run;
data _null_;set log_;file nlplog;put row;
run;
%put crit=&crit;
filename Esystem dde “Excel|system”;
%if &crit=%then%do;
  data _null;  file Esystem;
```

```
    put ‘[ALERT(“Convergence criteria may not be satisfied for this NLP optimi-
zation.”, 3)]’;
  run;
  %let crit=Problem with convergence;
%end;

filename nlplog2 dde “excel|LOG!r1c1:r3c25” notab lrecl=4000;
data _null_;file nlplog2;
  d=date();t=time();
  put “U.S. Structural Change Model.  &BaseOrScen intercepts”;
  put “Optimized “ d date8. “  “  t timeampm10.;
  put “&crit”;
  run;
filename nlpout2 dde “excel|OUTPUT!r1c1:r2c25” notab lrecl=4000;
data _null_;file nlpout2;
  d=date();t=time();
  put “U.S. Structural Change Model. &BaseOrScen intercepts” d date8. “  “  t
timeampm10.;
  put “&crit”;
  run;

%macro WriteOut;
%Do p=1 %to 2;
%let sheet=%sysfunc(byte(&p+64));
filename Solution dde “excel|&sheet.!r16c6:r19c220”;

data qpout;set qpout(WHERE=((UPCASE(_TYPE_)=’PARMS’| UPCASE(_TYPE_)=’GRAD’|
        UPCASE(_TYPE_)=’UPPERBD’| UPCASE(_TYPE_)=’LOWERBD’) & _iter_~=0));
file solution lrecl=4000;
put &&actsall&sheet _type_ “09”x _rhs_;
run;
****************************************;
%if &BaseOrScen=Base %then filename Sol1 dde “excel|&sheet.!r3c6:r3c200”;;
%if &BaseOrScen=Scenario %then filename Sol1 dde “excel|&sheet.!r2c6:r2c200”;;
data _null_;set qpout(WHERE=(UPCASE(_TYPE_)=’PARMS’ & _iter_~=0));
file sol1 lrecl=4000;
put &&actsall&sheet _type_ “09”x _rhs_;
run;

%if &BaseOrScen=Base %then filename Grad1 dde “excel|&sheet.!r8c6:r8c200”;;
```

```
%if &BaseOrScen=Scenario %then filename Grad1 dde “excel|&sheet.!r7c6:r7c200”;;
data _null_;set qpout(WHERE=(UPCASE(_TYPE_)=’GRAD’ & _iter_~=0));
file grad1 lrecl=4000;
put &&actsall&sheet _type_ “09”x _rhs_;
run;
**************************************;
%end;
%mend writeout;
%writeout;

DATA QPOUT1;LENGTH NAMES $14; SET QPOUT(WHERE=(UPCASE(_TYPE_)=’PARMS’));
  ARRAY ABC{*} _NUMERIC_;
  DO I = 1 TO DIM(ABC);
  CALL VNAME(ABC{I},NAMES);ESTIMATE=ABC{I};
  OUTPUT;
  END;
FORMAT ESTIMATE F13.4;
KEEP ESTIMATE NAMES;
call sound(3000,10);
RUN;
PROC PRINT;RUN;
**************;
data free;merge freeb freea;by f;
run;
proc iml;
use qpout(WHERE=( UPCASE(_TYPE_)=’PARMS’ ));
read all var{&acts} into parms;
use qpout(WHERE=(UPCASE(_TYPE_)=’GRAD’ & _iter_~=0));
read all var{&acts} into grads;
use free;
read all var{&acts} into free;
read all var{name} into name;*print name;

do x=1 to nrow(free);
do y=1 to ncol(free);
if free(|x,y|) then  free(|x,y|)=1;
if ^free(|x,y|) then  free(|x,y|)=0;
end;
end;
*print free;
Freegrads=free#grads;
cnames={&acts};
*print freegrads(|c=cnames|);* parms;
_rhs_=freegrads*t(parms);
```

```
print _rhs_(|r=name f=comma20.2|);
create freeOut var {_rhs_ name};
append var {_rhs_ name};
quit;run;
*proc print data=FreeOut;run;
%if &BaseOrScen=Base %then filename Frees dde "excel|INCOMES!r3c2:r6c3";;
%if &BaseOrScen=Scenario %then filename Frees dde "excel|INCOMES!r3c4:r6c5";;
data _null_;set FreeOut;
file Frees;Put name _rhs_ ;
run;
DATA _NULL_;
M=TIME()-&_H;
PUT "The combined SAS execution time is " M TIME10.0;
RUN;

%mend ExcelSolve;

%macro loop;*Hotlinks with Excel spreadsheet;
option noquotelenmax nonotes;dm output 'autopop off' ;
filename cmds dde 'excel|system';
data _null_;
   file cmds;
put '[app.activate]';
put '[app.maximize]';
put '[window.maximize]';
run;
%global flaga _H;
%do tt=1 %to 5; *This determines the number of solutions with each SAS run;
%let stop=;
filename start1 dde 'excel|A!r17c1';
data start;*This gives value of entry in cell A!r17c1;
 infile start1; input a $ @;call symputx('flaga',a);stop;run;
%put flaga=&flaga;
filename start dde 'excel|A!r17c1' hotlink;
data start;*This indicates when to start the optimization;
 infile start;input b $ @;
 if upcase(b) eq "STOP" then do;call symputx('Stop','STOP');call
sound(2500,2);stop;end;
 if b ne "&flaga" then do;call sound(2500,2);stop;end;run;
%LET _H=%SYSFUNC(TIME());

%if &stop~=STOP%then%ExcelSolve;%else%let tt=100;
data _null_;call sound(300,150);run;
%end;
```

```
data _null_;file start1;put “STOPPED”;run;
data _null;  file Esystem;
  put ‘[ALERT(“SAS program stopped. Press F8 in SAS program window to resume
Proc NLP.”, 2)]’;
  run;
option notes;
%mend loop;%loop;
```

Appendix III: Model Spreadsheets

Appendix III model spreadsheets are accessible by contacting David Harrington, 202-694-5571, *davidh@ers.usda.gov*

Sheet A: Supply Side

Sheet B: Demand Side

Sheet INCOMES: Post-Optimal Calculations