Agricultural Economics Research

January 1984 Vol. 36 No. 1

A Journal of the United States Department of Agriculture

Economic Research Service

Agricultural Economics Research

A Journal of the U.S. Department of Agriculture • Economic Research Service

The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director, Office of Management and Budget, through March 31, 1987.

This periodical is published quarterly. Subscription rates are $8.50 domestic; $10.65 foreign. Send check or money order to (payable to Superintendent of Documents):

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Microfiche copies are available from two different sources:

Infordata International, Inc.
Suite 4602
175 East Delaware Place
Chicago, Ill. 60611

Issues are available from 1974 on at $4.95 per year or per issue.

Congressional Information Service, Inc.
P.O. Box 30056
Washington, D.C. 20014

Issues for 1973 are available at $5.00 (for 2 fiche). Issues for 1974 on are available at $3.75 for the first fiche and $1.25 for each remaining fiche; they average 3 fiche per year.

In This Issue

The first two articles in this issue attempt to measure usually unobserved variables that influence economic agents. Paarlberg, in the first article, cites the contradiction between the existence of export subsidies and the conclusion from standard neoclassical analysis that such subsidies do not benefit exporting countries. By relaxing four critical assumptions—equal weights for all interest groups, a single time period, no market strategy, and a homogeneous good—he shows that an export subsidy may benefit an exporting country. In addition, he cites literature that suggests exporting countries may maximize export volume or revenues, rather than welfare. He then estimates the range of weights for producer welfare required to make export subsidies reasonable to U.S. decisionmakers.

In the second article, Farnsworth and Moffit use survey data to create a measure of the difference between cotton farmers' perceptions of the distribution of their yields and the actual distribution. The authors then regress this measure of the difference on variables that might be expected to reduce it. Paid private consultants do reduce this difference whereas farm advisor contacts increase it.

In the third article, Smallwood and Blaylock discuss information available to researchers rather than to economic agents. The U.S. Department of Agriculture's food consumption surveys provide an important source of data for analyzing household nutrition and evaluating food assistance programs. The authors explain the surveys and discuss the assumptions now used to adjust data for meals eaten away from home and by household guests when analysts estimate total household nutrition. However, some of these assumptions are not consistent with actual consumption data. But, adjustments with an alternative method, deemed more consistent with actual eating patterns, yielded results similar to those from the original adjustment. Thus, the straightforward scaling technique now used performed as well as a more complex one. This result could increase researchers' confidence in the technique in use.

The Research Review section contains reviews of books on both Soviet and U.S. agriculture. In *Prospects for Soviet Agriculture in the 1980's*, Johnson and Brooks address performance of Soviet agriculture, with a focus on yields and production. They conclude that Soviet grain yields have been growing as rapidly as in climatically similar areas elsewhere, but that overall productivity is only about half that of the United States and Canada. They attribute this relatively poor performance to a structure that impedes efficiency.

Farms in Transition, edited by Brewster, Rasmussen, and Youngberg, addresses U.S. structure and prospects in a collection of essays that tends to favor the preservation of "smaller" farms. The essays emphasize social and environmental, rather than production, effects of agricultural structure.

Finally, a review of Rausser's *New Directions in Econometric Modeling and Forecasting in U.S. Agriculture* suggests that this collection of essays introduces the reader to tools required for following the current literature in econometric modeling issues. The reviewer finds the essays very effective on supply and demand but not so good on expectations formation. Other topics—qualitative analysis applied to markets, agricultural trade analysis, Government policy analysis, and forecasting—receive mild to high praise.

Lorna Aldrich

Contents

When Are Export Subsidies Rational?

By Philip L. Paarlberg*

Abstract

The traditional model used to analyze trade issues suggests that an export subsidy on agricultural products is an irrational policy choice. However, export subsidies are common in world agricultural trade. By relaxing the assumptions of the traditional model, researchers can develop several frameworks for explaining the use of export subsidies.

Keywords

Export subsidy, trade policy

The use of export subsidies in world agricultural trade is widespread. Cochrane and Ryan (*2*) estimate that from 1955 to 1966, an average of 30 percent of agricultural exports received U.S. Government assistance.[1] Although U.S. subsidies were ultimately eliminated as support prices and market prices were harmonized, the recent low commodity prices, due in part to sluggish exports, have renewed the call for subsidies.

This article is designed to develop alternative conceptual frameworks for analyzing export subsidies. An export subsidy is any policy which allows a country to offer a price advantage in world markets. In the framework traditionally used to analyze trade issues, a neoclassical competitive model, export subsidies always reduce the welfare of the subsidizing country. Given the frequent use of export subsidies, either policymakers are acting irrationally or the assumptions of the competitive trade model are in error. In this article, I show that if several assumptions are changed, export subsidies can emerge as a rational policy instrument.

The Competitive Model

The first task is to analyze an export subsidy in the context of the standard competitive model, both partial and general equilibrium, to provide a point of reference for later analysis. Many assumptions are made in this framework, but four assumptions are critical to analyzing an export subsidy. First, all goods are homogeneous and perfectly divisible. This assumption guarantees that the law of one price holds: for example, European Community wheat flour is indistinguishable from U.S. wheat flour. Second, the model is static and characterized by certainty. Third, all political interest groups have equal influence on the policymaker; thus, the policymaker's criterion function becomes the net social payoff. Fourth, there is no price manipulative behavior and all agents are pricetakers; thus, the subsidy is exogenous to the system and not the result of government behavior designed to manipulate the behavior of other governments.

Given these assumptions, the competitive free trade solution in the absence of the subsidy is determined by the intersection of the excess supply curve (ES_o) and the excess demand curve (ED_o) in the center panel of the figure. The free trade solution yields a price (P^F) and trade quantity (X_o). Introducing the export subsidy rotates the excess supply curve as perceived by the exporting country to ES_1. An *ad valorem* export subsidy increases exports from X_o to X_1. It also introduces a wedge between the now higher domestic price, P, resulting from the smaller domestic supply in the exporting country, and the world price, P^w, facing the importing country. Because of these price changes, the income distribution in both countries shifts. The higher

*The author is an agricultural economist with the International Economics Division, ERS.

[1] Italicized numbers in parentheses refer to items in the References at the end of this article.

price in the exporting country results in a loss of consumers' surplus equal to area $P^F Pac$ in the left panel, which is transferred to producers who gain area $P^F Pfe$. The cost of the subsidy to the government is equal to area $P^w Phk$ in the center panel. Area $P^w P^F ik$ is transferred to consumers overseas as the world price falls from P^F to P^w, and area $P^F Phi$ is retained by the home country. The area $P^F Pzm$ is equal to area bcde and is a direct transfer from the exporting country's government to producers. Area mzh in the center panel equals the sum of areas abc and edf in the left panel and is also a transfer from the government to producers. The net cost of the export subsidy to the exporting country is mhi in the center panel, which is composed of the resource cost, area efg in the left panel, and the consumers' deadweight cost, area vac. This cost represents the loss in welfare to the exporting country caused by the subsidy policy. Export revenue is given by $(P^F) \cdot (X_o)$ for free trade and by $(P^w) \cdot (X_1)$ in the distorted scenario, respectively. If the excess demand curve is elastic, export revenue rises as a result of the subsidy. If the excess demand curve is inelastic, export revenue falls.

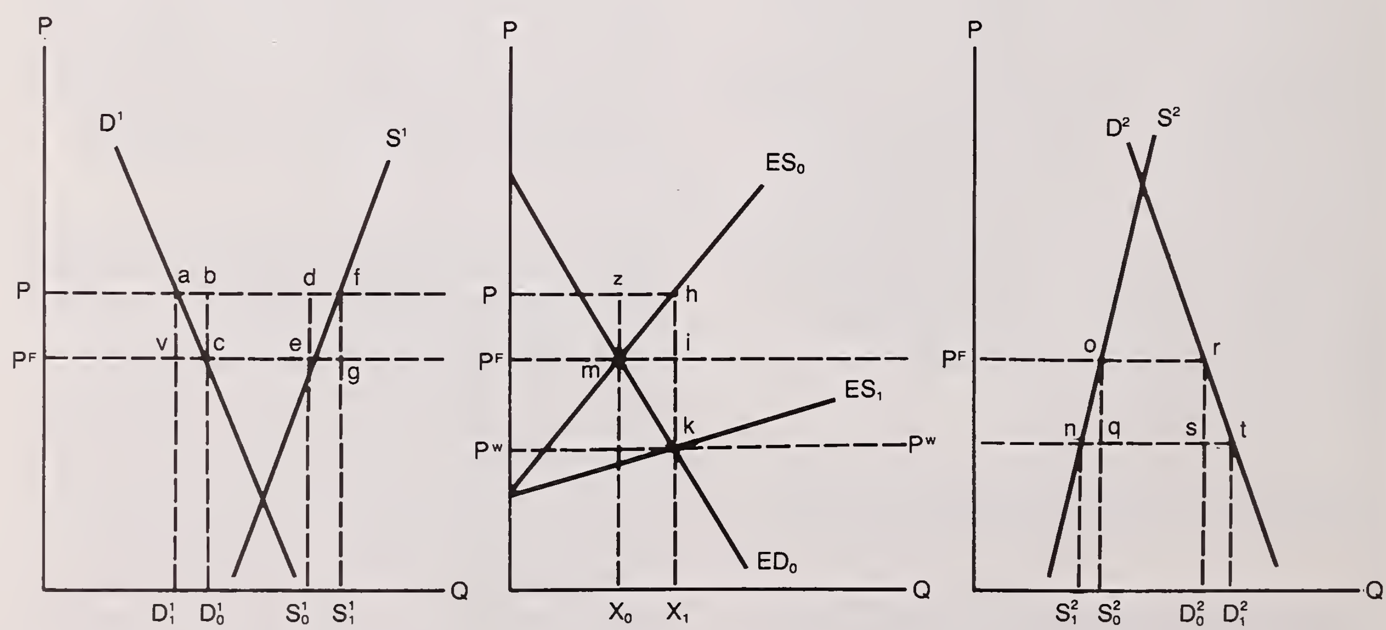
In the general equilibrium model with two goods, a similar result can be obtained. Let $U(C_1, C_2)$ be the social welfare function, which the country maximizes subject to a budget constraint at world prices. Good 1 is assumed to be the export good upon which an *ad valorem* export subsidy, S, is levied; hence, $P_1 = P_1^w (1 + S)$, where P_1^w is the world market price of good 1 and where P_1 is the domestic price of good 1. Differentiating the social welfare function and the budget constraint at world prices and then substituting gives:

$$\frac{dU}{U_1} = -\left[\frac{P_1^w}{P_2^w}\right] SdX + Xd\left[\frac{P_1^w}{P_2^w}\right] + (dX)\left[d\left[\frac{P_1^w}{P_2^w}\right]\right] \quad (1)$$

where X = exports of good 1 by the country.

The first right-hand side term of equation (1) is the trade effect which, because the subsidy expands

An Export Subsidy in a Neoclassical Model



exports, lowers welfare. The second term on the right side represents the terms of trade effect which, because the subsidy lowers the world price of good 1, lowers the welfare of the country. The sign of the third term is also negative as exports expand and as the relative price of good 1 in the world market falls. Thus, these effects cause a decline in national welfare when the subsidy is imposed.

The above competitive model represents the conventional wisdom. Export subsidies are irrational both for the small country, which cannot influence its terms of trade, and for the large country, which can affect its terms of trade. In fact, equation (1) suggests the opposite policy for a large country. By the imposition of an export tax ($S < 0$), welfare can be enhanced, if the terms of trade gain outweighs the trade effect plus the final term.[2]

The Case for Export Subsidies

Given that an export subsidy is an irrational device in the above model, two issues remain: Why are they used so frequently? How should the policy researcher analyze export subsidies? That suggests either that the previous model is an incorrect formulation of the behavior of countries in the world market or that policymakers are irrational. Relatively minor modifications of the model, however, can provide insights into why subsidies are used. The rest of this article illustrates how relaxing the four assumptions can suggest a subsidy as the rational response.

Unequal Weights for Producers and Others

The changes in income distribution shown in the figure result from a specific assumption about the behavior of policymakers, and they suggest a role for an export subsidy. The behavior of policymakers can be described by a criterion function of the form (7):

$$W = \gamma^P \int_0^P S(P)dP - \gamma^c \int_0^P D(P)dP - \gamma^T \alpha X \qquad (2)$$

where $\gamma^P, \gamma^c, \gamma^T$ are the marginal weights the policymaker places on the welfare accruing to producers, consumers, and taxpayers, respectively; α is the export subsidy which is added to the world price, P^w, to obtain the domestic price, P; X is the volume of exports which equals imports and is a function of world price; and S(P) and D(P) are the domestic supply and demand functions. The constraint facing policymakers who maximize their welfare is that the market must clear, or $X - S + D = 0$. To determine the optimum level of α, form the LaGrangean (L), substitute the price linkage into equation (2), and differentiate with respect to the endogenous variables α, P^w, and λ.

$$\frac{\partial L}{\partial \alpha} = \gamma^P S(P^w + \alpha) - \gamma^c D(P^w + \alpha) - \gamma^T [X(P^w)] + \lambda\left[-\frac{\partial S}{\partial P} + \frac{\partial D}{\partial P}\right] = 0 \qquad (3)$$

$$\frac{\partial L}{\partial P^w} = \gamma^P S(P^w + \alpha) - \gamma^c D(P^w + \alpha) - \gamma^T \alpha \frac{\partial X}{\partial P^w} + \lambda\left[\frac{\partial X}{\partial P^w} - \frac{\partial S}{\partial P} + \frac{\partial D}{\partial P}\right] = 0 \qquad (4)$$

$$\frac{\partial L}{\partial \lambda} = X(P^w) - S(P^w + \alpha) + D(P^w + \alpha) = 0 \qquad (5)$$

In the competitive model, the weights on producers and consumers are equal—that is, $\gamma^P = \gamma^c$, and the weight on taxpayers equals zero ($\gamma^T = 0$). From equations (3) and (4), α must equal zero and these first-order conditions will disappear. If the weights are all set equal to one another, including the weight on taxpayers, then from manipulating equations (3) and (4), the *ad valorem* policy (α/P^w) is given by:

$$\alpha/P^w = \frac{1}{\epsilon^x} \qquad (6)$$

where ϵ^x is the elasticity of excess demand, which is negative. For a small country, $\epsilon^x = -\infty$; hence, $\alpha = 0$. For a large country, $\epsilon^x < 0$; hence, in this instance, the optimal policy is an export tax, $\alpha < 0$.

Recall from the figure that producers' surplus increases as a result of the export subsidy. If the government weights the welfare of producers more than that of others (a relaxation of the third assumption), then an export subsidy can be appropriate.

[2] With an export tax, $dx < 0$ and the world price ratio rises. Thus, the first and third terms of equation (1) are negative, and the second term is positive.

Let $\gamma^c = \gamma^T = \gamma$ and let $\gamma^P = \theta\gamma$ where θ is a measure of the extra weight the government places on producers' welfare. Substituting these expressions into equations (3) and (4) and solving for the *ad valorem* intervention (α/P^w) gives:

$$\alpha/P^w = \frac{1}{\epsilon^x} + \frac{S(1-\theta)}{P^w\left[-\frac{\partial S}{\partial P} + \frac{\partial D}{\partial P}\right]} \qquad (7)$$

Because domestic demand is negatively sloped (well-behaved), the denominator of the second term on the right side is negative. The numerator is negative for values of $\theta > 1$; hence, the second term on the right side is positive. Therefore, there is a range of values for θ so that $\alpha > 0$, an export subsidy. The range of values depends on the elasticity of excess demand, ϵ^x, and on the level of production, S. The closer ϵ^x is to zero, the greater θ must be for an export subsidy to be rational. The larger production is, the smaller θ must be. An export subsidy can be the optimal policy only if $\theta > 1$.

Market Strategy

The model developed in the previous section can be expanded to include a second time period, thus relaxing the second assumption. Game theory can be incorporated to illustrate how an export subsidy can be used to exercise market power in confrontation with several countries, thus relaxing the fourth assumption.[3] The following scenario is similar to limit-pricing models in the industrial organization literature (*8*) and to the dynamic game of the corn market presented by Karp (*4*). In those models, an export subsidy is used to limit future entry by other exporters or to drive out competition.

The model assumes there are two periods and the country—that is, country 1—can select a trade policy intervention (α_i) in each period, i = 1, 2. The policymaker is assumed to maximize welfare over both periods where the welfare of the second period is discounted by a factor, ρ, subject to the market clearing in both periods. The model of the previous section is expanded to include one importing country as before as well as a rival exporting country.

For simplicity, the importing country is assumed to behave competitively, although it need not, according to the excess demand function in period i, $M_i = M_i(P_i^w)$. The rival, country 2, is assumed to have a known reaction function to the policy intervention. In period 1, the rival is assumed to adjust exports (X_1^2) in response to the trade policy in period 1 only:

$$X_1^2 = X_1^2(\alpha_1);\ \partial x_1^2/\partial\alpha_1 \leqslant 0 \qquad (8)$$

The greater the subsidy by country 1 in period 1, the lower the level of exports by country 2. In the second period, country 2 adjusts the level of exports depending on the policy choice made by country 1 in both periods:

$$X_2^2 = X_2^2(\alpha_1, \alpha_2);\ \partial X_2^2/\partial\alpha_1 \leqslant 0,$$
$$\partial X_2^2/\partial\alpha_2 \leqslant 0 \qquad (9)$$

Given these assumptions, the modified model presented earlier can be written as:

$$\begin{aligned} \text{MAX } W = {} & \gamma_1^P \int_o^{P_1} S_1(P_1^w + \alpha_1)dP_1 \\ & - \gamma^c \int_o^{P_1} D_1(P_1^w + \alpha_1)\,dP_1 \\ & - \gamma_1^T \alpha_1 [M_1(P_1^w) - X_1^2(\alpha_1)] \\ & + \rho\Big[\gamma_2^P \int_o^{P_2} S_2(P_2^w + \alpha_2)dP_2 \\ & - \gamma_2^c \int_o^{P_2} D_2(P_2^w + \alpha_2)dP_2 \\ & - \gamma_2^T\alpha_2\ [M_2(P_2^w) - X_2^2(\alpha_1, \alpha_2)]\Big] \end{aligned} \qquad (10)$$

subject to:

$$M_1(P_1^w) - X_1^2(\alpha_1) - S_1(P_1^w + \alpha_1)$$
$$+ D_1\ (P_1^w + \alpha_1) = 0 \qquad (11)$$

[3] Game theory is a body of literature which analyzes the behavior of agents in conflict situations.

$$M_2(P_2^w) - X_2^2(\alpha_1, \alpha_2) - S_2(P_2^w + \alpha_2)$$

$$+ D_2^w (P_2^w + \alpha_2) = 0 \quad (12)$$

Equations (10) through (12) can be reformulated as a LaGrangean expression as in the first model, and the first-order conditions can be determined. Given these conditions, the optimal values of α_1, α_2, P_1^w, P_2^w, λ_1, and λ_2 can be determined.

This model differs from the previous model in two ways. The first is the presence of the time discount parameter, ρ. As the value of ρ rises, country 1 is more willing to engage in subsidies in the first period to reduce the role played by its rival. Another major difference is the presence of the reaction functions which characterize country 2's behavior. The greater the reduction in exports by the rival due to a subsidy, the more successful the subsidy policy is. If the response of the rival is zero, then using export subsidies to reduce future entry or to drive out competition will not be effective.

Relaxation of Assumption of Homogeneous Good

The export subsidy analyzed in the figure is based on the assumption of a homogeneous good and the law of one price. Relaxing this assumption creates two cases in which a subsidy could be a rational policy.

If the good is distinguished in terms of quality, or services provided—that is, differentiated—a shortrun subsidy could be used to convince importers of the gains from buying from a particular source. This situation can be modeled either as a competitive differentiated product as Grennes, Johnson, and Thursby did (*3*) or as a noncompetitive differentiated product model (*9*). However, for interchangeable commodities such as agricultural products, the payoff from a differentiated product model could be small as the substitutability is high.

The second case is that of a targeted subsidy. In the model presented by the figure, unless the subsidy causes an expansion in world demand via the income effect of the subsidy, gains in trade to one market are offset by losses to others. For example, if the United States subsidizes wheat sales to Brazil and increases exports to that market, other competitors replace an equal amount of sales in markets vacated by the United States—if wheat is homogeneous. If there is no shift in world demand through an income effect from the subsidy to Brazil, the world price is unchanged. If there is a strong income effect, demand is greater and the price rises. If the wheats of the different exporters are not perfect substitutes, sales by other competitors cannot fully replace U.S. sales lost, and the United States gains from the subsidy, even without an income effect.

Other Objectives

Thus far, the underlying behavioral assumption has been that of welfare maximization, either weighted or unweighted. However, McCalla (*5*, *6*), Taplin (*10*), and Alaouze, Watson, and Sturgess (*1*) have suggested alternative forms of behavior. These authors suggest export sales or sales revenue maximization as a criterion. If pricing occurs in the elastic range, export earnings can then be increased by offering a subsidy to reduce prices and expand exports (see figure). Export earnings will rise until exports reach the point of unity on a linear excess demand schedule.

An Empirical Illustration

To illustrate the issues outlined in the conceptual frameworks, I employ a simple model of the world coarse grains market. I analyze scenarios with a relatively elastic excess demand function and those with a less elastic one. The scenarios determine the minimum value for the extra weight on producer welfare for the United States to select a subsidy. The model in which export subsidies are used to exercise world market power is not solved because to do so would require additional data on U.S. income distribution, discount rates, and the reactions of rival exporters. Karp (*4*) also presents a solution to this type of model, which shows the United States setting an export subsidy in the initial periods and then adopting a tax.

Basic Model

The empirical model used is based upon one by Sharples and uses 1977-81 as its base period.[4] Supply-utilization-price data and elasticity assumptions are all the data needed (see table). The United States produces 212 million metric tons of coarse grains, consumes 150 million tons domestically, and exports 62 million tons. The price is arbitrarily set to equal 100 to simplify the computations. All schedules are more elastic in case 1, particularly the excess demand schedule confronting the United States.

Supply-utilization price and elasticity assumptions for illustrative coarse grains model

Item	Base solution[1]	Elasticities[2]	
		Case 1	Case 2
United States:			
Supply	212	0.4	0.2
Domestic use	150	–.5	–.2
Exports	62	–5.0	–1.5
Price:[3]			
Domestic	100	n.a.	n.a.
World	100	n.a.	n.a.

n.a. = Not applicable.

[1] Base solution for 1977-81 from analysis by Sharples. As there was no trade policy intervention by the United States, domestic and world prices are equal.
[2] Longrun elasticities, assuming production response in the rest-of-the-world.
[3] Price is assumed to equal 100 to facilitate computations and to allow easy adjustment to any true value.

Source: Jerry Sharples, ERS, Purdue University.

Uneven Weights

I argued earlier that, if the weight of producer welfare in the government criterion function exceeds that of others by some value, θ, there exists a value, θ_o, above which an export subsidy is the appropriate choice. Given the values shown in the table, these critical values for θ_o can be solved by use of equation (7). Setting α equal to zero determines the point at which the tax shifts to subsidy, θ_o. For case 1, if the weight the U.S. policymaker places on producer welfare is 15 percent greater than that of others, an export subsidy is appropriate. For case 2, the critical value of θ is about 23 percent. Thus, as the excess demand function becomes less elastic, θ_o rises.

The opposite direction is also valid. By specifying the value of θ, one can determine the appropriate export tax or subsidy. One can calculate values for the weights in the wheat market using a revealed preference methodology discussed by Paarlberg (7) in which actual policy choices reveal the implied marginal weights for different groups. For the United States, these results suggest producer welfare is valued by 5-10 percent more than other groups, except for livestock feeders. If the patterns of weights in the Government's criterion function for coarse grains are similar, an export subsidy is not so irrational as the neoclassical model suggests.

Conclusions

My purpose here is to argue that an export subsidy policy which appears irrational in the context of traditional trade models may not be so if the assumptions are modified. Relaxing the assumption of homogeneity suggests that an export subsidy could provide benefits by exploiting the advantages of a differentiated product and income effect from the subsidy. Allowing a more flexible specification of the government's criterion function shows that an export subsidy can result from a higher marginal weight on the welfare of producers. An empirical example for the U.S. coarse grains market suggests that if producer welfare receives 15-25 percent more weight than that of others, an export subsidy may be the optimal policy choice. Given the concentrated power of producers, there is every reason to expect producers to have more influence than others. The question is one of degree of influence and of the price sensitivity of the system. Another model illustrates the consequences of recognizing strategic price manipulative behavior and the role of dynamics. The ability of a country to force reductions in exports by competitors or to discourage future entry using export subsidies is largely conditional upon the rivals' responses. Proponents of using export subsidies in this manner suggest the signs of the behavioral parameters of rivals are negative and of sizable magnitude. Critics of using export subsidies to exercise influence over other nations assume these parameters are slightly negative, or zero.

[4] The simple model is provided by Jerry Sharples, an ERS employee at Purdue University.

References

(1) Alaouze, C. M., A. S. Watson, and N. H. Sturgess. "Oligopoly Pricing in the World Wheat Market," *American Journal of Agricultural Economics*, Vol., 60, 1978, pp. 173-85.

(2) Cochrane, W. W., and M. E. Ryan. *American Farm Policy: 1948-1973*. Minneapolis: Univ. of Minnesota Press, 1976.

(3) Grennes, T., P. R. Johnson, and M. Thursby. *The Economics of World Grain Trade*. New York: Praeger Publishers, 1977.

(4) Karp, L. S. *Dynamic Games in International Trade*. Ph.D. dissertation, Univ. of California-Davis, 1982.

(5) McCalla, A. F. "A Duopoly Model of World Wheat Pricing," *Journal of Farm Economics*, Vol. 48, 1966, pp. 711-27.

(6) ___________. "Wheat and the Price Mechanism: Or Duopoly Revisited and Abandoned," *Seminar on Wheat: Papers and Summary of Discussions of the 1969-1970 Seminar Series*. Occasional Series No. 2, Univ. of Manitoba, Dept. of Agricultural Economics, Oct., 1970.

(7) Paarlberg, P. L. *Endogenous Policy Formation in the Imperfect World Wheat Market*. Ph.D. dissertation, Purdue Univ., 1983.

(8) Scherer, F. M. *Industrial Market Structure and Economic Performance*. Chicago: Rand McNally College Publishing Co., 1980.

(9) Shubik, M., with R. Levitan. *Market Structure and Behavior*. Cambridge, Mass.: Harvard Univ. Press, 1980.

(10) Taplin, J. H. *Demand in the World Wheat Market and the Export Policies of the United States, Canada and Australia*. Ph.D. dissertation, Cornell Univ., 1969.

Farmers' Perceptions and Information Sources: A Quantitative Analysis

By Richard L. Farnsworth and L. Joe Moffitt

Abstract

Using the concept of negentropy and ordinary least squares, this article investigates the role of public and private information sources in forming growers' yield perceptions. Paid private consultants reduced the discrepancy between gamma-distributed actual and perceived yield distributions, whereas farm advisor contacts tended to increase the discrepancy between actual and perceived yield distributions for a group of 28 cotton growers in California's San Joaquin Valley. Results were inconclusive for extension research personnel and other agricultural scientists, chemical company meetings, grower meetings, farm publications, and educational level.

Keywords

Information sources, negentropy, gamma distribution

Agricultural producers who understand biological, technical, and economic relationships can make more efficient production decisions. Uncertainty complicates their decisionmaking and forces them to gather information about resource use, output possibilities, and prices from public agencies and private enterprises. In this article, we investigate the role of these information sources in forming farmers' perceptions of outcome probability distributions and eventual profit.

Earlier studies by Beal and others (*2*), the U.S. Department of Agriculture (*11*), and the Environmental Protection Agency (*4*) have identified major information sources that growers use in their production and marketing decisions.[1] In this article, we describe a framework for empirically investigating the significance of various agricultural information sources on growers' perceptions. We apply our model to evaluate the impact of information sources on yield perceptions of cotton growers in California's San Joaquin Valley.

*The authors are agricultural economists with the Natural Resource Economics Division, ERS.
[1] Italicized numbers in parentheses refer to items in the References at the end of this article.

The Model

The agricultural production function encompasses many variables that a producer may or may not be able to control. The uncontrolled variables necessarily lead to random output levels which can be characterized by a probability distribution. A producer's inaccurate perception of the output probability distribution leads to inefficient utilization of resources and, hence, to decreased profit. If actual and grower-perceived output distributions are known, a measure of the discrepancy between the two distributions can then be developed and related to information sources via regression methods. Regression estimates indicate the role of specific information sources in the formation of accurate perceptions.

Previous studies have measured the discrepancy between the two probability distributions as a function of differences in their means (*5*, *9*). However, a more appropriate measure should incorporate all characteristics of the two probability distributions. Such a measure was developed by Kullback and Leibler (*7*) and is defined as the expected logarithmic ratio of two probability density functions:

$$D = \int \ln(g(x)/f(x))g(x)dx \qquad (1)$$

where f and g are perceived and actual densities, respectively. Hobson (*6*) proved that equation (1) is a unique measure of the discrepancy between two probability density functions that is consistent with the rules of conditional probability. This measure is referred to as negentropy in the literature of information theory. Theil (*10*) regards D as a measure of badness of fit and refers to it as information inaccuracy.

In our subsequent empirical analysis, we assume that actual yields, g_i, and perceived yields, f_i, for grower i are gamma distributed. The gamma density is nonsymmetric and skewed to the right over the range of zero to plus infinity. Use of a gamma density is based on the notion that a below-average yield is more likely than an above-average yield in cotton production. This analysis was originally advocated by Day (*3*) in his analysis of skewed cotton yield distributions.

The actual and perceived gamma distribution yield densities are:

$$g_i(y) = \frac{\lambda_g^{\alpha_g}}{\Gamma(\alpha_g)} y^{\alpha_g - 1} e^{-\lambda_g y}; 0 \leqslant y < \infty$$

and:

$$f_i(y) = \frac{\lambda_f^{\alpha_f}}{\Gamma(\alpha_f)} y^{\alpha_f - 1} e^{-\lambda_f y}; 0 \leqslant y < \infty$$

where α_g, λ_g, α_f, and λ_f are parameters and must be greater than zero. Ignoring for the moment the subscripts g and f, the mean and variance of a gamma distribution with parameters α and λ are respectively α/λ and α/λ^2. We calculated these parameters from grower surveys and actual yields.

Given the assumption of gamma-distributed actual and perceived yields, equation (1) becomes:

$$D_i = \ln \frac{\lambda_g^{\alpha_g} \Gamma(\alpha_f)}{\lambda_f^{\alpha_f} \Gamma(\alpha_g)} - \alpha_g [1 - \frac{\lambda_f}{\lambda_g}] + (\alpha_g - \alpha_f) [\psi(\alpha_g) - \ln \lambda_g] \quad (2)$$

where $\Gamma(\cdot)$ and $\psi(\cdot)$ are the gamma and digamma functions, respectively, and are extensively tabulated (*1*). D_i is zero if the observed and perceived distributions are identical; otherwise, D_i is positive.

We hypothesize that D_i in equation (2) is influenced by a grower's characteristics and the information received from various sources. With observations on the sources and amounts of information received by grower i and the characteristics of grower i, a relationship such as:

$$D_i = h(X_i, Z_i) \quad (3)$$

where:

X_i = a vector of the amounts of information received by grower i from each information source and
Z_i = a vector of grower characteristics

may be estimated to explain the discrepancy between actual and perceived yield distributions. Parameter estimates from equation (3) suggest the nature of the contribution made by an information source or managerial characteristic—that is, whether the information source significantly decreases or increases the discrepancy between actual and perceived yield distributions. In our subsequent empirical analysis, we assume that the information growers receive from various public agencies and private enterprises directly affects the distance between the observed and perceived yield probability densities.

Data and Variable Definitions

The time-series of cross-section data used in this study are from a random sample of cotton growers in the San Joaquin Valley of California. Moments of the actual yield distribution were estimated for each of the 28 growers in the sample for the 1970-74 period. Moments of the perceived yield distribution for each grower were estimated through elicitation and the PERT method as modified by Perry and Greig (*8*). Growers were asked to estimate average yield and yields associated with the 5th (P_5) and the 95th (P_{95}) percentiles. We estimated perceived standard deviation using the relatively distribution-free formula, $\sigma = (P_{95} - P_5)/3.25$, proposed and tested by Perry and Greig (*8*). Yield estimates at the 5th and 95th percentiles were used to eliminate highly unlikely occurrences from the more usual stochastic influences.

Both the actual and perceived yield distributions are assumed to be gamma distributions. We calculated the variable D_i by substituting method of moments estimates of actual and perceived yield parameters into equation (2). The following variables are included in the model:

D_i = negentropy of the perceived profit distribution,
X_{1i} = number of times a paid private insect consultant checked grower i's fields during the growing season,
X_{2i} = number of extension farm advisor contacts,
X_{3i} = number of times extension research personnel and other agricultural scientists were contacted,
X_{4i} = number of gin and grower organization meetings attended,
X_{5i} = number of chemical company meetings attended,
X_{6i} = number of subscriptions to farm magazines and other periodicals, and
Z_i = years of education of the grower.

The variables represent public and private information sources (*2*) and processing abilities (that is, educational level). Field checks by paid private consultants for pest and other related problems capture an extremely important short-term information source. Extension farm advisor contacts likewise farm advisor contacts likewise reflect the applied reflect the applied arm of public agencies. Extension agricultural research personnel and other agricultural scientist contacts capture the long-term research needs of growers. Gin and grower organization meetings represent the role of other growers in the decisionmaking process. Chemical company meetings partially capture the role of agriculture's most organized information source. Finally, all written materials represent the role of the mass media as an information source.

Estimation

We regressed D_i on the information variables and education to obtain the following result (standard errors in parentheses):

$$\begin{aligned} D_i = \; & \underset{(0.692)^*}{1.923} - \underset{(0.006)^{**}}{0.011X_{1i}} + \underset{(0.041)^*}{0.108X_{2i}} \\ & - \underset{(0.033)}{0.019X_{3i}} + \underset{(0.040)}{0.029X_{4i}} - \underset{(0.107)}{0.050X_{5i}} \\ & + \underset{(0.052)}{0.012X_{6i}} - \underset{(0.051)}{0.074Z_i} \end{aligned} \qquad (4)$$

R^2 = 0.479
$F(7,20)$ = 2.623
Obs. = 28
* = significant at the 5-percent level
** = significant at the 10-percent level

Negative coefficients in equation (4) indicate variables which reduce the discrepancy between actual and perceived yield distributions. The significant negative coefficient for paid private consultants (X_1) supports growers' decisions to pay for additional information that typically includes pest information as well as soil, plant, and irrigation advice. The two variables—extension research personnel and other agricultural scientists and chemical company meetings—have negative coefficients, but are insignificant. Grower contacts with extension research personnel and agricultural scientists over the sample period were low, which probably reflects growers' interests in the application of new techniques rather than in basic research. The insignificance of chemical company meetings supports the notion that the companies are product-oriented, particularly for pesticides. We would expect chemical companies to have a greater role in pesticide decisions. The estimated coefficient for education met our *a priori* expectations and was significant at the 20-percent level.

Coefficients on the remaining variables are positive, suggesting additional information increases the distance between actual and perceived yield distributions. These information sources appear to confuse growers and increase their uncertainty. Particularly important is the significant positive coefficient for extension farm advisor contacts. This result suggests information transfer between growers and extension farm advisors could be improved to benefit both parties. A positive coefficient for gin and grower meetings might be capturing the competitive nature of growers or simply stating that information exchanges between growers does not help much in production decisions. We do not rule out the possible important role of gin and grower meetings in marketing decisions, especially those concerning prices. The positive coefficient on publications is not surprising given the multiplicity of views found in different farm journals and trade association magazines. Growers may use publications to learn about new products or practices, but most likely rely on other sources to learn about the application of new products and ideas to their specific farm problems.

Conclusions

Information occupies an important position in an uncertain work environment. Growers understand the important relationships between information and efficient resource utilization. They frequently seek information from a multitude of sources to update their perceived notions of input-output relationships and economic conditions to increase profit. In this article, we have presented a measure for quantifying the distance between growers' observed and perceived yield distributions. Using regression analysis, we then identified managerial characteristics and information sources that significantly affected the distance between observed and perceived yield distributions.

The approach is feasible, as demonstrated by our empirical analysis of the role of information sources in the formation of growers perceptions. Additional research and more empirical studies need to be conducted before general conclusions can be stated and before the agricultural information network can be altered to improve information transfer and enhance producer profits.

References

(1) Abramowitz, M., and I. A. Stegun (ed.). *Handbook of Mathematical Functions*. Applied Mathematics Series No. 55. Washington, D.C.: National Bureau of Standards, 1964.

(2) Beal, G. N., J. M. Bohlen, and H. G. Lingren. "Behavior Studies Related to Pesticides: Agricultural Chemicals and Iowa Farmers." Special Report No. 49. Agricultural and Home Economics Experiment Station, Cooperative Extension Service, and Iowa State Univ. of Science and Technology, 1966.

(3) Day, R. "Probability Distribution of Field Crop Yields," *Journal of Farm Economics*, Vol. 47, 1965, pp. 713-41.

(4) Environmental Protection Agency and Council of Environmental Quality. *Farmers Pesticide Use Decisions and Attitudes on Alternate Crop Protection Methods*. 1974.

(5) Grisley, W., and E. D. Kellogg. "Farmers' Subjective Probabilities in Northern Thailand: An Elicitation Analysis," *American Journal of Agricultural Economics*, Vol. 65, 1983, pp. 74-82.

(6) Hobson, A. "A New Theorem of Information Theory," *Journal of Statistical Physics*, Vol. 1, 1969, pp. 383-91.

(7) Kullback, S., and R. A. Leibler. "On Information and Sufficiency," *Annals of Mathematics and Statistics*, Vol. 22, 1951, pp. 79-86.

(8) Perry, L., and I. D. Greig. "Estimating Mean and Variance of Subjective Distributions in PERT and Decision Analysis," *Management Science*, Vol. 21, 1975, pp. 1477-80.

(9) Pingali, P. "Subjective Perceptions and Input Demand Under Risk: The Case of Pest Control in N. C. Apple Orchards." Paper presented at the Eastern Economic Association Meetings, Washington, D.C., 1982.

(10) Theil, H. *Principles of Econometrics*. New York: John Wiley & Sons, Inc., 1971, pp. 636-64.

(11) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service. "Farmers' Information Needs and Use." Survey conducted by the National Opinion Research Center at the Univ. of Chicago, 1979.

Scaling Household Nutrient Data

By David Smallwood and James Blaylock*

Abstract

The validity of the assumptions underlying the 21-Meal-Nutritionally-Equivalent-Person (21-MNEP), an adjustment procedure employed in nutritional analyses of U.S. Department of Agriculture food consumption survey data, is examined. Some assumptions are inconsistent with actual nutrient intake data. This study proposes a less restrictive alternative, the Meal-Adjusted-Household-Nutrition-Scale (MAHNS), and applies it to data from the 1977-78 Nationwide Food Consumption Survey, Supplementary Low-Income Sample. The two scaling procedures yield similar results, a finding that indicates the simple scaling technique of the 21-MNEP performs as well as the more complex MAHNS.

Keywords

Nutrition scales, household surveys

The U.S. Department of Agriculture's (USDA) food consumption surveys provide an important source of data for analyzing household nutrition and evaluating Government food assistance programs. Studies by Adrian and Daniel (*1*), Johnson, Burt, and Morgan (*3*), and Allen and Gadson (*2*) are recent examples of studies using these data.[1] Unfortunately, although every effort is made to collect and assemble accurate nutrient data in these surveys, many potential sources of measurement error remain. They range from the accurate recall and measurement of the types and quantities of foods consumed from home supplies and adjustments for food waste to the matching of these foods to their nutrient content. A potential source of measurement error that has received little attention is the procedure used to adjust the nutrient content of foods used from home supplies for the number of meals consumed and the nutrient requirements of the individuals eating those meals. Adjustments of this type are necessary to make comparisons of nutrient data across households of varying composition and eating patterns. For example, households whose members eat away from home often or who need smaller amounts of nutrients are "smaller" than other households in terms of their nutritional demands on home food supplies.

In this article, we examine four assumptions underlying the adjustment procedure currently used and find that at least two deviate substantially from observed nutrient consumption behavior. We then develop an alternative and more complex procedure and compare it with the original procedure using data from a low-income supplemental sample of the most recent USDA food consumption survey. Surprisingly, both procedures yield nearly identical results.

USDA's Consumer Nutrition Division (CND) of the Human Nutrition Information Service developed the scaling procedure now used in many nutrition analyses of USDA survey data. The scale is called "the household size in equivalent nutritional units."[2] Here, we prefer the term, the 21-meal nutritionally equivalent person (21-MNEP). This name more accurately reflects the scaling technique and is consistent with a related measure of household size used by CND.

*The authors are agricultural economists with the National Economics Division, ERS.

[1] Italicized numbers in parentheses refer to items in the References at the end of this article.

[2] For a description and application of the procedure, see (*7*, p. 111).

Given the pervasive use of the 21-MNEP in nutritional analyses of USDA household food consumption data and the importance of subsequent research results for food and nutrition policy formation and program evaluation, investigation of this scale and its possible alternatives is critical. Our study examines some of the assumptions underlying the 21-MNEP concept and develops a somewhat less restrictive alternative measure. The latter incorporates nutrient scales for meal types by age and sex groups using actual food intake data reported in the individual intake portion of the 1977-78 Nationwide Food Consumption Survey (NFCS).

In this article, we will discuss the NFCS data, examine the 21-MNEP concept, develop an alternative to the 21-MNEP, apply the new technique to the supplemental low-income sample of the survey and compare the results with those from the 21-MNEP, and summarize these results.

Data

USDA periodically conducts nationwide surveys of household food consumption. Since the midthirties, six such surveys of national scope have been conducted: 1935-36, 1942, 1948, 1955, 1965-66, and 1977-78. The information obtained has largely centered on the kinds, amounts, values, and sources of foods used from household food supplies during a 7-day period preceding the survey interview.[3]

Information is also collected on household composition and income, expenditures for meals and snacks eaten away from home, and counts of morning, noon, and evening meals eaten at home and away from home by each household member. The number of guest meals and snacks eaten from home food supplies are also reported. However, information is not reported on the types and quantities of foods eaten from nonhousehold food supplies, such as food from school cafeterias and restaurants. Thus, without direct data on quantities of foods consumed from nonhousehold supplies, one must make some fairly strong assumptions to impute or extrapolate the total quantities or nutritive values of the foods consumed. The two most recent surveys have an additional section detailing the total food intake of individual household members over a shorter period—1 day of recalled information in both the 1965-66 and 1977-78 surveys and an additional 2 days of diary information in the latter survey. The individual intake portion of the survey details the types and amounts of foods eaten at home and away from home for each reporting household member. Information also is reported on the type of meal (for example, breakfast, lunch, dinner, or snack) and the time of day consumed. Information from these two survey sections is treated independently in most USDA analyses.

The 21-MNEP Concept

The 21-MNEP is a scaling technique applied in analyses of nutrition that use USDA household food consumption survey data. It attempts to evaluate whether nutritional needs are generally met by those using home food supplies.

Researchers apply the scaling technique to the 7-day recall data on foods used from home supplies to adjust for the nutritive values of foods obtained from nonhousehold supplies by household members as well as those foods eaten from home supplies by guests.

The 21-MNEP concept measures the number of meals eaten from home food supplies during a 7-day period in terms of an adult male nutritionally equivalent person (that is, three meals a day for 7 days consumed in proportion to the Recommended Dietary Allowance (RDA) for an adult male 23-50 years of age). The 21-MNEP is calculated separately for food energy and each nutrient based on the nutritional needs of an adult male. Thus, an adult male eating all 21 meals from home food supplies during the survey week is equivalent to one 21-MNEP. One can calculate the needs of other persons in equivalent nutrition units by dividing their RDA by the allowance for an adult male and adjusting the result by the proportion of meals eaten at home during the week.

Tables 1 and 2 illustrate the derivation of the 21-MNEP. Table 1 presents the RDA for food energy

[3] Included in foods used from household food supplies are: (1) food and beverages eaten at home, (2) food carried from home in packed meals, (3) food thrown away, and (4) food fed to pets. Excluded from food at home are (1) commercial pet food, (2) household food fed to pets raised for commercial purposes, and (3) food given away for use outside the home, such as food sent to family members in the military service, gifts of food donated to a church supper, and food given to household help to take home.

and calcium for males ages 9 and 25 and for females ages 2 and 25. Allowances are expressed in equivalent nutrition units and use a male aged 23-50 as a standard unit. Table 2 presents the number of at-home and away-from-home meals per household member, the number of guest meals served, the equivalent nutrition units for food energy and calcium, and the number of adjusted at-home meals multiplied by the equivalent nutrition units.

Consequently, the household size in 21-MNEP for food energy is 2.61 (54.86/21 = 2.61) and for calcium is 3.55 (74.49/21 = 3.55). The household size in 21-meal nutritionally equivalent persons (unadjusted for nutritional needs) is 3.47 (72.93/21 = 3.47).

This calculation implies that the 21-MNEP concept is based on four assumptions: (1) each meal contributes equally to dietary intake; (2) a meal prepared from household food supplies contributes as much to dietary intake as a meal from nonhousehold supplies; (3) each household member consumes nutrients in proportion to his/her recommended dietary allowance; and (4) nutrients lost from skipped meals or gained from extra meals (that is, less than or more than 21 meals a week) are fully offset by other meals eaten.

The first assumption we investigate is whether or not all meals contribute equally to dietary intake. For example, the 21-MNEP assumes that if an individual in a given age and sex group eats seven breakfasts and seven dinners from home food supplies and seven lunches from nonhome supplies, that individual is considered to be a 2/3 (that is, (7 + 7)/21 = 2/3) at-home equivalent person. Similarly, if the seven away-from-home meals are either breakfasts or dinners instead of lunches, the number of at-home equivalent persons is unchanged. Consequently, if the average nutrient intake varies substantially by the type of meal eaten and if the away-from-home meals tend to be more of one type

Table 1—Recommended Dietary Allowance (RDA) and equivalent nutrition units

Household member	RDA[1]		Equivalent nutrition units	
	Food energy	Calcium	Food energy	Calcium
	Kcal	*Mg*		
Male, age 25	2,700	800	1.00	1.00
Female, age 25	2,000	800	.74	1.00
Male, age 9	2,550	950	.94	1.19
Female, age 2	1,200	725	.44	.91

[1] Based on 1974 RDA.

Table 2—Adjusted meals and equivalent nutrition units

Persons served	Meals during week			Equivalent nutrition units[1]		Adjusted meals times nutrition units	
	At home	Away	Adjusted[2] at home	Food energy	Calcium	Food energy	Calcium
Household meals:	*Number*						
Male, age 25	14	7	14.00	1.00	1.00	14.00	14.00
Female, age 25	17	2	18.79	.74	1.00	13.90	18.79
Male, age 9	19	3	18.14	.94	1.19	17.05	21.59
Female, age 2	21	0	21.00	.44	.91	9.24	19.11
Guest meals:							
Female, age 75	1	n.a.	1.00	.67	1.00	.67	1.00
Weekly total	n.a.	n.a.	72.93	n.a.	n.a.	54.86	74.49

n.a. = Not applicable.

[1] The 1974 Recommended Dietary Allowances are used for illustration because they are used in the 1977-78 Nationwide Food Consumption Survey.
[2] The proportion of meals at home times 21.

than another—so that the nutritive effects of different meal types do not average out—then the 21-MNEP concept may systematically over- or under-estimate actual nutrient usage. The direction of this bias would depend on the percentage of morning, noon, and evening meals obtained from home supplies and the relative nutritive contents of each meal type.

To examine the validity of the above assumption, we use data from the individual intake portion of the 1977-78 NFCS low-income supplementary sample. Nutrient information obtained in the 1-day recall portion of this survey is averaged by type of meal and age and sex of the individual. Only information on members of housekeeping households is used to compute these averages, and skipped meals are excluded.[4] The meal types are defined as follows:

- Breakfast — Meals classified as breakfast by the respondent.
- Lunch — Meals classified as either lunch or brunch and meals classified as dinner but eaten at or before 3 p.m.
- Supper — Meals classified as supper or dinner eaten after 3 p.m.
- Snacks — Meals classified as coffee or beverage break, snack, or "other" meal.

Individuals not reporting one of the above names for a meal were excluded from the analysis. We tabulated the average nutritive content for meal types by 21 age-sex groupings.[5]

Analysis revealed that the nutritive values vary considerably across meal types, nutrients, and age-sex groups. Let us use the adult male 23-50 years of age as an example. The average breakfast (433 Kcal) contains less than half the calories of the average supper (965 Kcal), and an average lunch (759 Kcal) contains less than 80 percent of the calories of a supper.[6] Conversely, the average breakfast and lunch, respectively, contribute 78 percent and 91 percent of calcium as does the average supper. Similarly, for boys 9-11 years of age, the average breakfast (307 Kcal) contributes about 43 percent of the calories of a typical supper (707 Kcal), and lunch (703 Kcal) contributes about the same as supper. This evidence suggests that one cannot scale the nutritive values of a breakfast or lunch as a constant percentage of a dinner for all nutrients of a given age-sex group or even for a given nutrient across all age-sex groups. Thus, it is fallacious to assume that all meals contribute equally to dietary intake.

Table 3 reports the average percentages of those meals obtained from home and nonhome supplies by the 21 RDA age-sex groups. Lunches are by far the meal most frequently eaten away from home, especially for school-age individuals. For individuals of all ages, almost 26 percent of all lunches are eaten from nonhome supplies. This figure compares with 41-53 percent for school-age individuals. Morning and evening meals are more likely to be eaten from home food supplies. Only about 4-6 percent of these meals are eaten from nonhome supplies. Because the nutritive values of lunches are generally between those of breakfasts and suppers, the equal weighting given to these meal types by the 21-MNEP may produce average nutritive values closely approximating those obtained from lunches eaten from nonhome supplies. However, this hypothesis deserves closer analysis.

The second assumption we address is whether or not the average nutritive content of each meal type varies depending on the source—at home or away from home. The validity of this assumption has recently been addressed by Kennedy and others (*4*). Their findings for this particular issue are summarized in table 4. The table contains the average percentage of nutrients obtained from each meal type and source of food. An examination of table 4 lends support to the statistical analysis of Kennedy and others which reveals that the average nutritive contents of at-home and away-from-home meals are statistically different, but are of little substantive significance. Thus, it seems reasonable, at least for the nutrients examined by Kennedy and others, that the average nutritive contents of particular meal types consumed from home supplies are equivalent to those consumed from nonhome supplies.

The third assumption made in the 21-MNEP scaling concept requires that individuals obtain nutrients in proportion to their dietary needs. Dietary needs

[4] A housekeeping household is defined as one in which at least one member had 10 or more meals from home food supplies during the 7 days preceding the interview.

[5] These tables are available on request from the authors.

[6] A kilocalorie (Kcal) is the amount of heat necessary to raise 1 kilogram of water from 15 to 16 degrees Centigrade.

Table 3—Percentage of meals eaten from home and nonhome supplies, by age-sex group and meal[1]

Age and sex	Meal and source					
	Morning		Noon		Evening	
	At home	Other	At home	Other	At home	Other
	Percent					
Children:						
0-.5 years	99.3	0.7	98.3	1.7	98.4	1.6
.6-.9 years	98.3	1.7	95.5	4.5	97.2	2.8
1-2 years	97.4	2.6	91.3	8.7	96.3	3.7
3-5 years	93.5	6.5	80.2	19.8	95.8	4.2
6-8 years	90.1	9.9	46.8	53.2	97.7	2.3
Adult males:						
9-11 years	87.9	12.1	51.8	48.2	97.5	2.5
12-14 years	91.9	8.1	47.5	52.5	98.3	1.7
15-18 years	95.0	5.0	58.6	41.4	94.4	5.6
19-22 years	88.8	11.2	71.7	28.3	87.9	12.1
23-50 years	92.1	7.9	79.1	20.9	91.1	8.9
51-64 years	90.1	9.9	82.9	17.1	96.8	3.2
65-74 years	96.9	3.1	92.2	7.8	95.7	4.3
75 years and over	98.9	1.1	96.0	4.0	97.9	2.1
Adult females:[2]						
9-11 years	88.7	11.3	47.6	52.4	97.8	2.2
12-14 years	92.8	7.2	53.1	46.9	96.6	3.4
15-18 years	94.6	5.4	56.7	43.3	97.1	2.9
19-23 years	94.4	5.6	80.9	19.1	92.5	7.5
23-50 years	97.6	2.4	89.0	11.0	95.7	4.3
51-64 years	98.1	1.9	94.1	5.9	97.0	3.0
65-74 years	98.8	1.2	95.0	5.0	95.7	4.3
75 years and over	99.4	.6	94.4	5.6	95.7	4.3
All	94.2	5.8	74.2	25.8	95.5	4.5

[1] 1977-78 USDA Nationwide Food Consumption Survey, Low-Income Household Sample, 7-day recall of foods used from home supplies.
[2] Excludes pregnant and nursing women.

are assumed to be proportional to the RDA's established in 1974. A potential problem with the RDA scaling is that, except for food energy, it is constructed to exceed the requirements of most healthy individuals and thereby insure that the needs of nearly all members of the population are met.[7] Consequently, the scale may be inappropriate for a population subgroup such as the one represented by the 1977-78 NFCS supplementary low-income sample in which some households may be at nutritional risk.

[7] See (*5*, *6*).

The validity of the above assumption is examined with data obtained from the individual intake portion of the low-income survey. If the assumption that consumption is proportional to one's RDA is correct, then one would expect that the ratio of nutrient intake to the RDA for each nutrient would be identical. However, it is not necessary for the ratio to be equal across nutrient groups or to equal 1 because the underlying assumption requires only that the nutritive values of consumption be proportional to the RDA's, not equal to them.

Table 4—Percentage of daily nutrient intake provided by specific meals consumed from home supplies and from nonhome supplies (weekdays)[1]

Meal and source	Food energy or nutrient group					
	Energy	Protein	Calcium	Iron	Vitamin A	Vitamin C
	Percent					
Breakfast:						
Home	22.1	19.4	30.7	26.3	28.8	32.1
Nonhome	24.4	22.3	28.2	24.6	24.0	24.0
Lunch:						
Home	31.5	31.8	30.8	29.3	26.0	3.2
Nonhome	30.8	33.0	31.4	29.8	27.8	26.0
Dinner:						
Home	46.0	52.2	37.9	47.3	48.0	45.4
Nonhome	47.0	51.8	37.8	47.3	44.0	42.6
Other:						
Home	17.3	11.3	19.2	12.3	13.1	15.0
Nonhome	15.5	8.5	13.1	10.7	7.8	9.0

[1] The percentage of daily nutrient intake provided by specific meals is based only on those individuals reporting that meal. Skipped meals are not included because there is no objective means of allocating that meal between at-home and away-from-home sources. Consequently, the sum of percentages across all meals will not add to 100 unless there are no skipped meals.

Source: (*4*).

Table 5 reports nutrient intakes per RDA for each nutrient and age-sex group. The nutrient intake values are computed from the 3-day averages reported in the low-income sample, and RDA's are based on 1974 standards. This table reveals that actual nutrient intake varies considerably from the dietary needs established by the RDA's. As noted earlier, this variation suggests that the RDA's do not represent an appropriate scale for adjusting actual nutritional intake, at least not for a population subgroup such as the one represented in the low-income sample.

We do not examine the fourth assumption, namely, that nutrients lost or gained from skipped meals or extra meals are exactly offset by the other meals eaten. This assumption is no less important than the others; however, it is far more difficult and time consuming to verify. One way to measure the potential size of this problem would be to examine the number of household members who report fewer than or more than 21 meals during the survey week.

The evidence suggests that two of the three assumptions examined deviate substantially from what actual food intake data indicate. A fourth assumption is not addressed because it would require substantial additional research. Whether or not the discrepencies in these assumptions create a systematic error in actual use is unknown. Some errors may cancel each other out.

Meal-Adjusted Household Nutrition Scale: Methodology

We propose an alternative to the 21-MNEP which we call the meal-adjusted household nutrition scale (MAHNS). Unlike the 21-MNEP, which measures the number of away-from-home meals in terms of a

Table 5—Average nutritive values of diets per 1974 Recommended Dietary Allowance, by age-sex group[1]

Age and sex	Food energy or nutrient group												
	Food energy	Protein	Calcium	Iron	Magnesium	Phosphorous	Vitamin A	Thiamine	Riboflavin	Niacin	Vitamin B_6	Vitamin B_{12}	Vitamin C
	Proportion												
Children:													
0-.5 years	0.60	0.94	1.18	1.77	0.87	1.23	1.23	1.93	2.22	1.29	0.82	2.81	1.88
.6-.9 years	.80	1.53	1.32	.96	1.28	1.75	1.95	1.57	2.23	1.10	1.22	5.15	1.89
1-2 years	.95	2.16	.86	.59	1.09	1.10	1.69	1.40	1.82	1.29	1.66	3.26	1.48
3-5 years	.87	2.06	.89	.83	.97	1.16	1.57	1.32	1.57	1.20	1.43	2.98	1.75
6-8 years	.77	1.94	1.10	1.08	.90	1.42	1.50	1.14	1.56	1.02	1.18	2.42	1.96
Adult males:													
9-11 years	.76	1.94	1.09	1.09	.86	1.41	1.72	1.14	1.68	1.03	1.14	3.09	2.18
12-14 years	.73	1.87	.83	.76	.74	1.14	1.08	1.09	1.41	1.05	.97	1.58	1.87
15-18 years	.72	1.64	.84	.82	.68	1.20	1.30	1.13	1.26	1.02	.82	1.95	1.82
19-22 years	.64	1.50	.91	1.35	.67	1.52	1.15	.89	.97	.98	.72	1.79	1.68
23-50 years	.81	1.69	.94	1.52	.83	1.68	1.02	1.06	1.14	1.23	.77	1.71	1.52
51-64 years	.82	1.47	.78	1.43	.78	1.51	1.08	1.18	1.11	1.29	.72	1.76	1.52
65-74 years	.76	1.41	.86	1.31	.74	1.45	1.20	1.07	1.07	1.15	.66	1.36	1.46
75 years and over	.63	1.20	.72	1.16	.59	1.22	1.29	.91	1.00	.94	.53	2.18	1.23
Adult females:[2]													
9-11 years	.78	1.90	1.00	1.04	.86	1.35	1.30	1.18	1.55	1.03	1.03	1.78	1.93
12-14 years	.77	1.68	.71	.67	.76	1.00	1.19	1.17	1.40	1.03	.82	1.34	1.77
15-18 years	.80	1.38	.61	.58	.65	.88	1.08	1.07	1.14	1.05	.57	1.56	1.44
19-22 years	.76	1.44	.73	.60	.64	1.19	.94	1.07	.98	1.13	.57	1.15	1.71
23-40 years	.72	1.30	.62	.56	.64	1.09	1.16	1.01	1.03	1.14	.51	1.44	1.37
51-64 years	.77	1.34	.61	1.02	.66	1.09	1.40	1.01	1.15	1.26	.53	1.55	1.52
65-74 years	.72	1.25	.69	.98	.67	1.11	1.50	.96	1.15	1.14	.53	1.39	1.50
75 years and over	.69	1.17	.63	.98	.65	1.03	1.55	.95	1.21	1.18	.51	1.65	1.47
All	.77	1.60	.81	.93	.77	1.24	1.29	1.11	1.29	1.13	.83	1.93	1.63

[1] Dietary intake levels are 3-day average, 1977-78 USDA Nationwide Food Consumption Survey, Supplemental Low-Income Sample individual intake portion.
[2] Excludes pregnant and nursing women.

nutritionally standardized person, the MAHNS was developed to expand nutrients used from home food supplies to nutrients in all foods used by household members. The MAHNS assumes that the nutritive values of food obtained from nonhousehold supplies are proportional to those obtained from household supplies for similar meal types. The relative nutritive contributions of each meal type are assumed to vary by the age and sex of the individual. The RDA's are not used in the MAHNS as a scale of dietary intake; this information is developed instead from actual dietary intake data.

The MAHNS for each nutrient, j, has four parts: (1) the nutritive values of meals consumed from home supplies by household members, NVH^j; (2) the nutritive values of meals consumed from home supplies by guests, NVG^j; (3) the nutritive values of meals consumed from nonhome supplies by household members, NVA^j; and (4) the nutritive values of foods used from home food supplies, N^j. The first three components can be calculated from reported survey information on the types of meals (that is, morning, noon, and evening meals) consumed at home and away from home by household members and guests and from a set of nutritive values reflecting the average nutritive content of meal types by age and sex of the individual. For our analysis, the nutritive values are constructed from the individual intake portion (1-day recall data) of the 1977-78 NFCS, Supplemental Low-Income Sample.

Formally, the MAHNS for each nutrient, j, and household, i, is constructed as follows:

$$MAHNS_i^j = N_i^j \cdot \left[\frac{NVH_i^j}{NVH_i^j + NVG_i^j} \right] \circ \left[\frac{NVH_i^j + NVA_i^j}{NVH_i^j} \right]$$

$$i = 1, 2, \ldots, n$$
$$j = 1, 2, \ldots, 13$$

where:

$$NVG_i^j = \sum_{g=1}^{G_i} \sum_{m=1}^{M} w_{m,g} X_{m,g}^h$$

$$NVH_i^j = \sum_{f=1}^{F_i} \sum_{m=1}^{M} w_{m,f} X_{m,f}^h$$

$$NVA_i^j = \sum_{f=1}^{F_i} \sum_{m=1}^{M} w_{m,f} X_{m,f}^a$$

Symbols not previously defined are as follows: G_i denotes the number of guests who eat meals in the ith household; $w_{m,g}$ is the average nutritive value of meal type, m, for the age and sex class of the gth guest; $X_{m,g}^h$ denotes the number of meal types, m, eaten by the gth guest from household supplies, h; M denotes the number of differentiated meal types (that is, morning, noon, evening, snack, and refreshment); F_i denotes the number of household members in the ith household; $w_{m,f}$ is the average nutritive content of the mth meal type for the fth household member's age-sex group; and $X_{m,f}^h$ and $X_{m,f}^a$ denote the number of meals of type, m, for family member, f, eaten from home supplies, h, and nonhome supplies, a, respectively.

The expression in the first set of parentheses adjusts the nutritive content of all foods used from home supplies, N_i^j, for meals eaten by guests. This adjustment proportions out guest meals based on the number and average nutritive values of meals eaten at home by household members and guests. The expression in the second set of parentheses is a similar type of adjustment for meals eaten from nonhome supplies by household members.

The average nutritive values of meal types by age and sex of individuals used in the computation of the MAHNS are a new and critical element. For this study, these values are taken from the 1-day recall data obtained in the individual intake portion of the 1977-78 NFCS Supplementary Low-Income Sample. A major advantage of using these 1-day recall data is that they are obtained from the same sample of households and at the same time as the 7-day recall information on foods used from home supplies.[8] Thus, it is reasonable to assume that the relative nutritive values of meals for each age-sex group are comparable to those expected in the household portion of the survey.

[8] Of course, all 3 days of the intake diary could be used to obtain the average nutritional content of meals by age and sex.

A major problem in developing the nutritive value scales is matching meal types reported in the individual intake survey (that is, breakfast, brunch, lunch, dinner, supper, and snack) with those reported in the household survey (that is, morning, noon, and evening). It is assumed that the morning, noon, and evening meals correspond directly with the definitions for breakfast, lunch, and supper presented earlier. Furthermore, because snack meals by household members are not reported separately, the nutritive values of snack meals are distributed equally to morning, noon, and evening meals. This assignation does not apply to household guests because their meals, snacks, and refreshments are reported separately. Guest snacks and refreshments are assumed to be equivalent to 1/2 and 1/4 of the average nutritive values obtained from all snacks eaten daily by household members of the same age and sex group. The next section applies the MAHNS to the 1977-78 NFCS Supplementary Low-Income Sample and compares the MAHNS with the 21-MNEP.

Comparison of MAHNS and 21-MNEP

The MAHNS and 21-MNEP are alternative techniques for adjusting or otherwise standardizing the nutritive values of foods used from home supplies for meals eaten from nonhome supplies and for guest meals. The assumptions implied by each technique differ. The reference base, to which these techniques adjust nutritive values, also differ. The MAHNS adjusts the household nutritive values upward to that of total food usage by household members. The 21-MNEP is a scaling measure of meals eaten from home supplies in terms of the relative nutritional requirements of those eating the meals. To compare the two measures, one must adjust both to the same units by combining the actual nutrient content of foods used from home food supplies with each scaling technique and then by dividing the quotient by the dietary requirements (1974 RDA's) corresponding to the units of each technique.

Table 6—Nutritive value of diets per nutrition unit: Comparison of the 21-MNEP and the MAHNS[1]

Nutrient	Food Stamp Program status					
	All		Participants		Nonparticipants	
	21-MNEP	MAHNS	21-MNEP	MAHNS	21-MNEP	MAHNS
	Proportion					
Food energy	1.380	1.372	1.475	1.449	1.321	1.325
Protein	2.297	2.296	2.515	2.494	2.161	2.173
Calcium	1.239	1.236	1.249	1.241	1.233	1.233
Iron	1.678	1.669	1.716	1.689	1.655	1.657
Magnesium	1.337	1.323	1.414	1.387	1.289	1.284
Phosphorous	2.182	2.160	2.276	2.242	2.122	2.108
Vitamin A	2.188	2.158	2.458	2.398	2.020	2.008
Thiamine	1.825	1.787	1.968	1.903	1.736	1.714
Riboflavin	2.080	2.066	2.220	2.193	1.993	1.987
Niacin	1.955	1.928	2.110	2.057	1.859	1.848
Vitamin B_6	1.262	1.250	1.407	1.385	1.172	1.166
Vitamin B_{12}	2.592	2.566	2.779	2.743	2.475	2.456
Vitamin C	2.986	2.941	3.420	3.358	2.716	2.682

[1] 1977-78 USDA Nationwide Food Consumption Survey, Supplementary Low-Income Sample, household portion. Dietary requirements are those established in 1974 as the Recommended Dietary Allowance.

Table 6 compares average nutrients per dietary requirement for the two measures. The nutritive values ($W_{m,g}$ and $W_{m,f}$) used for this analysis are available from the authors. Averages are reported for both Food Stamp Program (FSP) participants and eligible nonparticipants. Nonhousekeeping households and FSP ineligible households are excluded from the tabulations. The two alternative measures yield almost identical averages for each nutrient group. A small discrepency can be found in the third significant digit. The closeness of these measures was not expected.

Examination of only mean values can be misleading because large disparities may exist for each household, yet cancel out in the average. To avoid this potential problem, we computed the correlation between the two measures over each household. We also analyzed the differences between the two measures. Table 7 reports correlations between the 21-MNEP and the MAHNS. In the low-income sample, the correlations between the two measures are extremely high for all nutrient groups. The lowest correlation, 0.969, is for iron. The highest correlation, 0.993, is for vitamin A. These correlations reveal that the 21-MNEP and the MAHNS are almost identical measures.

Table 7 shows the disparities between the two measures. The mean difference between the two measures is small for all nutrient groups. On average, the 21-MNEP scale yields slightly larger nutritive values per dietary requirement than the MAHNS. The standard errors of the distributions of the differences also appear in the table. However, examining selected percentiles is perhaps more informative for an unknown distribution. Table 7 shows the distribution of the differences for selected percentage points. The distribution of the differences is narrow. Between the 5th and 95th percentiles—into which 90 percent of the households fall—the discrepency is less than ±0.23. Thus, the two measures yield nutritive values of diets which are relatively close for each household. We also conducted regression analysis to examine for systematic differences between the two measures. These results support the other analyses in that no substantive differences were found.

Table 7—Comparison of nutritive values of diets per nutrition unit implied by the 21-MNEP and the MAHNS[1]

Nutrient group	Correlation	Difference between MAHNS and 21-MNEP						
		Mean	Standard deviation	Percentiles of the distribution				
				5	10	50	90	95
						Percent		
Food energy	0.981	-0.008	0.121	-0.115	-0.066	0.005	0.072	0.109
Protein	.978	-.001	.209	-.236	-.130	.019	.150	.218
Calcium	.978	-.003	.131	-.086	-.043	.003	.087	.132
Iron	.973	-.010	.211	-.185	-.109	[2]	.113	.185
Magnesium	.974	-.013	.137	-.096	-.055	.003	.059	.094
Phosphorous	.982	-.022	.191	-.208	-.126	[2]	.100	.166
Vitamin A	.993	-.031	.229	-.259	-.153	-.002	.094	.185
Thiamine	.979	-.038	.178	-.175	-.111	-.009	.053	.098
Riboflavin	.971	-.014	.237	-.140	-.075	.008	.114	.187
Niacin	.977	-.027	.205	-.208	-.127	.001	.075	.131
Vitamin B_6	.969	-.012	.147	-.141	-.078	.001	.078	.122
Vitamin B_{12}	.996	-.028	.284	-.231	-.120	[2]	.123	.214
Vitamin C	.991	-.042	.296	-.168	-.085	[2]	.084	.159

[1] 1977-78 USDA Nationwide Food Consumption Survey, Supplemental Low-Income Sample. Excludes nonhousekeeping households and those classified as ineligible for the Food Stamp Program.
[2] Less than 0.001.

Conclusion

We have discussed the assumptions underlying the 21-MNEP concept and presented a less restrictive alternative termed the MAHNS. The 21-MNEP is a household size adjustment based on recommended daily nutrient requirements and the number of meals eaten at home. The MAHNS is a nutrient adjustment factor based on observed nutrient intake patterns with consideration given to meal types and age and sex characteristics.

A priori one would expect the MAHNS adjustment to be superior to the 21-MNEP based on their respective assumptions. However, for the 1977-78 NFCS Supplementary Low-Income Sample, the measures were almost identical. In retrospect, two related factors may account for this similarity. First, the characteristics of the sample selected for comparison may have caused this observed similarity. Second, and possibly related to sample selection, is the fact that lunches (the meal most often eaten away from home) had values of nutrients close to the mean nutrient levels for breakfasts and dinners combined.

It is a welcome finding that we can sometimes do as well with a simple scaling adjustment as with a complex one. Perhaps researchers can now place greater confidence in the use of the 21-MNEP. However, one should be cautious and not summarily dismiss the MAHNS process based on evidence from one sample. Applications of the MAHNS adjustment to the complete 1977-78 NFCS might provide additional insight into differences between the two methodologies.

References

(1) Adrian, John, and Raymond Daniel. "Impact of Socioeconomic Factors on Consumption of Nutrients in the United States," *American Journal of Agricultural Economics*, Vol. 58, No. 1, Feb. 1976, pp. 31-38.

(2) Allen, Joyce E., and Kenneth E. Gadson. *Nutrient Consumption Patterns of Low-Income Households*. TB-1685. U.S. Dept. Agr., Econ. Res. Serv., June 1983.

(3) Johnson, Stanley R., James A. Burt, and Karen J. Morgan. "The Food Stamp Program: Participation, Food Costs, and Diet Quality for Low-income Households," *Food Technology*, Oct. 1981, pp. 58, 61-66, 68-70.

(4) Kennedy, E., M. Harrell, and B. Frazio. "Distribution of Nutrient Intake Across Meals in the U.S. Population," *Ecology of Food and Nutrition*, Vol. 11, 1982, pp. 217-24.

(5) National Academy of Sciences, National Research Council. *Recommended Dietary Allowances*. 8th ed. Washington, D.C., 1974.

(6) ————. *Recommended Dietary Allowances*. 9th ed. Washington, D.C., 1980.

(7) U.S. Department of Agriculture, Agricultural Research Service. *Dietary Levels of Households in the United States, Spring 1965*. Household Food Consumption Survey, 1965-66, Report No. 6. 1969.

Research Review

Prospects for Soviet Agriculture in the 1980's

D. Gale Johnson and Karen McConnell Brooks. Bloomington: Indiana University Press, 1983, 214 pp., $17.50 (cloth), $8.95 (paper).

Reviewed by Jim Cole*

Prospects for Soviet Agriculture in the 1980's is a concise and thorough study of the agricultural sector in the USSR, a sector whose growth has tapered in the past decade and has thereby strained development in other sectors of the economy by channeling investment rubles and hard-currency reserves to agriculture. As the authors point out, total investment in the agro-industrial complex represents about a third of all investment in the Soviet economy. Johnson and Brooks conclude, however, that these resources are poorly spent because of the high degree of centralized planning and management, the lack of effective incentives, and pricing policies that fail to guide resources into productive spheres. They do not, however, provide supporting evidence for their views on the last point.

Johnson and Brooks present no new Soviet data. Instead, they analyze existing data through the seventies, and they trace Soviet agricultural performance from the early fifties and sixties, when growth was almost 4 percent per year, into the seventies, when growth slowed to just over 1 percent per year. The lack of new information is disappointing.

What makes the book interesting and worthwhile is its treatment of climatically similar areas of the USSR, the United States, and Canada. In part I of this two-part book, Johnson concludes that grain yields in the Soviet Union have been increasing over the past 30 years at "essentially the same rate" as in areas of the world that are climatically similar. To illustrate his point, Johnson divides the USSR into 24 crop regions, using data from 1955 to 1979[1] and production and area estimates at oblast levels;[2] he concludes that annual yield increases for the USSR amount to 0.3 centners (66 pounds) per hectare per year. According to Johnson, this annual increase in yields is the same as in analogous areas of Canada and the United States, after fallow area and some data inconsistencies have been taken into account.[3]

Johnson concludes that agricultural problems in the USSR will continue into the next decade and will burden the economy. The Soviet Union will probably continue to have a high degree of centralized planning and poor price and incentive policies. While noting that climate plays a twofold role in determining agricultural production (through long-term trend and short-term variability), he predicts that grain production could reach 226 million tons in 1985 and 245 million tons in 1990. Keeping meat production goals would force the Soviet Union to import as much as 40 million tons of grain annually through the end of the eighties. If meat production targets are relaxed somewhat, Johnson still envisions grain imports of 25-30 million tons in 1986-90.

Compared with the research of the Economic Research Service (see "U.S.-USSR Grain Trade" in the U.S. Congress, Joint Economic Committee compendium, *Soviet Economy in the 1980s: Problems and Prospects*, Dec. 31, 1982), Johnson's production projections seem reasonable, but are high for imports. His high import figure seems to be based on a continuation of Soviet feeding inefficiencies, an assumption that may produce unrealistic grain-for-feed requirements. The Soviet Union is certainly aware that it is an inefficient feeder of grain and is taking steps to correct this problem.

Brooks compares productivity in the Soviet Union with that in the United States and Canada in part 2. Because agricultural input and output data were available only at the State level for the United States, the Province level for Canada, and the Republic level for the USSR, the detail Johnson used earlier had to be abandoned. Brooks concludes that agriculture in similar areas of the United States

*The reviewer is an economist with the International Economics Division, ERS.

[1] The Soviet Union has failed to publish yield or production data for grains for 1981 and 1982.

[2] An oblast is the political subdivision of a Soviet Republic.

[3] For example, the Soviet Union reports grain production in terms of "bunker weight." Therefore, one must deduct 10-15 percent (to remove excess moisture and nongrain material), thus leaving usable grain supplies as a residual.

and Canada is twice as productive as it is in the Soviet Union. Most differences, as she points out, lie in the productivity of labor. Output-to-land ratios, about 10 times greater in Canada and the United States, were generally inconclusive. Horsepower-per-cultivated-hectare ratios were about 2-3 times higher in the non-Soviet areas. Brooks discusses the historical difficulties associated with Soviet labor productivity, including wages and tariffs on collective and state farms (with interesting, but not new, information on the labor organization on both collective and state farms), problems of wages versus productivity growth differentials, and the movement of labor out of agriculture into other economic sectors.

Farms in Transition

David E. Brewster, Wayne D. Rasmussen, and Garth Youngberg (eds.). Ames: Iowa State University Press, 1983, 169 pp. $9.75.

Reviewed by Kenneth R. Farrell*

Farms in Transition is an interdisciplinary potpourri of 11 papers originally presented at a symposium on farm structure and rural policy in late 1980 at Iowa State University. As is frequently the case with conference proceedings, the papers reprinted in this volume are largely stand-alone contributions with little integration of subject matter by either authors or editors. If there is a unifying theme, it is that "big is bad" and that "small," if not "beautiful," is to be preferred for numerous reasons, ranging from less environmental degradation to more vigorous rural communities.

Still the book succeeds in making some useful, if conventional, points. Farm and rural policy has become increasingly pluralistic and complex (Guither). Past policies have been anything but neutral in effect regarding farm structure (Heady, Soth). There are important, possibly growing, social class divisions among farmers over issues such as farm structure (Coughenour and Christenson). Agricultural groups need allies in the policy process more than ever, but potential allies are fewer than ever (Meier and Browne). The policy instruments which might be employed to modify current farm and rural community structures are not likely to be politically acceptable in the eighties (Buttel).

The book has the familiar ring of themes popular in the late seventies. Lee proclaims the imminence of a new era for agriculture—a transition from conditions of excess resources and chronic surpluses to one of limits. Heady believes that "The agricultural public and society at large must decide soon whether to let the trend to super farms continue, or whether to introduce measures to limit farms to an efficient and modest size." In what is easily the most lucid of the 11 papers, Berry calls for a holistic, "organic" solution to agriculture's problems—one which will be "ecologically, agriculturally, and culturally healthful."

Soth is not optimistic that political action will slow down the "cannibalization" of farms, but sees the possibility that two economic forces could have restraining effects: (1) rising energy costs and pressures on the natural resources base and (2) deterioration of environmental quality from overcropping and excessive use of chemicals. Benbrook, Fulton, Korsching, and Nowak generally agree with Soth's hypotheses.

The book and, I suspect, the symposium could have been made more appealing by the inclusion of contrary viewpoints on the structure issue. There is a strong flavor of populist agricultural fundamentalism and, occasionally, euphoric recollection of small-town, small-farm America. Editors Brewster, Rasmussen, and Youngberg contend that the book focuses on subject matter not usually emphasized in discussions of farm structure. But no author makes the case for concentration and large farms, although some must surely believe in such market phenomena, given the trends of recent years. Nor does the book provide a rigorous examination of the tradeoffs, economic or political, which an explicit farm structure policy would require. To its credit, it does raise classical issues of efficiency versus equity and illustrates the many, frequently conflicting, dimensions of contemporary agricultural and rural policy. However, more definitive evidence of the "PERTs" and "PESTs" are needed to advance the structural issue from its recent rhetorical plane.[1]

The structure issue is by no means a new element in agricultural policy; it was evident in much of the New Deal legislation. Nor is the quiescent nature of the issue in late 1983 evidence of its demise in future public policy debate. *Farms in Transition* will be a useful, if not seminal, reference.

*The reviewer is director of the Food and Agricultural Policy Program of Resources for the Future, Washington, D.C.

[1] Gordon C. Rausser, "Political Economic Markets: PERTs and PESTs in Food and Agriculture," *American Journal of Agricultural Economics*, Vol. 64, No. 5, 1982, pp. 821-33.

New Directions in Econometric Modeling and Forecasting in U.S. Agriculture

Gordon C. Rausser, ed. New York: Elsevier Science Publishing Co., Inc., 1982, 830 pp., $85.

Reviewed by David Torgerson*

This collection of 22 papers is a selection presented at four conferences sponsored by ERS from 1976 to 1980 to acquaint U.S. Department of Agriculture (USDA) modelers with promising state-of-the art techniques and concepts in econometric modeling. The usefulness of this collection goes far beyond the original target audience. To paraphrase Samuelson, "quantitative economics is too good to be left for quantitative economists." The Rausser collection contains some good, a few excellent, expositions of economic ideas that had been fermenting in the late sixties to the late seventies. A few important topics, however, were absent or not covered in depth. But this book does introduce the reader to tools required for understanding the current literature and to associated debates on econometric modeling issues.

Despite the wide set of topics covered, the articles *implicitly* address five questions: (1) What is the nature of dynamic economic decisionmaking? (2) What are the appropriate variables from outside agriculture which are needed for a credible model of U.S. agriculture? (3) How do policy interventions affect individual behavior and market outcomes? (4) What is (are) the appropriate or convenient representation(s) of producer and consumer resource allocation decisions? (5) What should the role of econometric modeling in policy formation and analysis be, and how should it be implemented? The chief strengths of this collection comes from its attempt to deal with such a broad range of concerns. Its chief weakness stems from its failure to provide a clear presentation of the connections among economic ideas.

This collection deserves better editing and organization and needs an index. The table in the next column may partly fill this gap.

The articles are divided into six parts and consider developments in: (1) supply and demand analysis, (2) expectation formation, (3) qualitative analysis applied to markets, (4) agricultural trade analysis, (5) Government policy analysis, and (6) forecasting techniques, evaluation, and model management. Part 1 is the deepest and clearest. In fact, it could have been a useful monograph applying modern producer and consumer theory. It sets a high standard that the rest of the book rarely meets. The first three chapters of part 5 serve as a useful primer on techniques of grain reserve modeling. For those without first-hand knowledge of large-scale model-building efforts, the final chapter of the book (which examines the institutionalization of a large-scale econometric model in *Agriculture Canada*), provides a sense of the political econometric realities of modeling.

Aggregate index

Topic	Chapters
Bayesian analysis	19, 21, 22, 23
Commodity modeling	5, 8, 9, 11, 12, 13, 14, 15, 16, 17, 20, 21, 22
Disequilibrium modeling	10, 11, 13
Dynamics	3, 8, 14, 15, 16
Forecasting	19, 20, 21, 22, 23
Functional form issues	16, 19, 21, 22
Information	4, 5, 9, 19, 20, 21, 22, 23
Model evaluation and inference (calibration, estimation, testing)	8, 14, 16, 19, 20, 21, 22, 23
Modern demand and producer theory (quality, properties of demand functions)	3, 4, 5, 6
Open agricultural systems (macro, international linkages)	11, 12, 13, 17, 22
Qualitative economics (Lancaster)	2, 3, 4
Qualitative econometrics (McFadden)	3, 10, 11, 19
Rational expectations	7, 9
Risk and uncertainty	3, 4, 6, 7, 8, 14, 16, 18, 19
Varying parameter estimation	20
Welfare economics (consumer surplus, Government behavior)	3, 11, 14, 15, 16, 17, 18, 19, 22, 23

*The reviewer is an agricultural economist with the National Economics Division, ERS.

Ladd (part 3, ch. 2) reviews several generalizations of Lancaster's economics of product characteristics that treat product characteristics, and not products, as the objects of consumer choice. Such useful topics as constant quality indexes and behavorial price functions are examined from this framework. (There is an obvious typographical error in formula (15)). Other applications and potential extensions are listed. After an article by USDA's Waugh in 1928, the approach was virtually dormant until the late sixties, when the work reviewed here emerged.

Hanemann (ch. 3) formally develops characteristic demand theory by using tools of modern demand analysis such as duality and Cournot aggregation. He compares and constrasts the generalized Lancaster (GL) and Houthakker-Theil (HT) models of choice of product qualities. The HT model assumes continuous choice of one quality for each good. By contrast, the GL model assumes discrete choice with the possibility of more than one quality for each good. The HT model precludes consideration of the set of quality levels offered, whereas the GL model always assumes an interior solution to the optimization problem—that is, the consumer buys some of each product. A stochastic generalization of the GL model is developed to deal with corner solutions. The presentation shows the merger of qualitative economics in Lancaster's style with the qualitative econometrics associated with McFadden (probit, tobit, and logit). For an alternative view that bases qualitative demand on the theory of household production, see (*6*).[1]

Berek and Rausser (ch. 4) neatly bridge demand and supply. The demand for product characteristics by consumers is the wedge for the exercise of monopoly power by monopolistically competitive firms. As reflected by the new literature, monopolistic competition is seen as Pareto optimal (or a Pareto improvement over perfect competition). Consumers value diversity; monopolistically competitive firms supply it. Unfortunately, demand uncertainty and myopic price search behavior make a firm's market share indeterminate. Although conceptually and analytically interesting, this article will not stimulate much change in the way empirical margin research is carried out.

[1] Italicized numbers in parentheses refer to items in the References at the of this article.

Using duality theory, Weaver (ch. 5) cogently develops a multiple output-input production system for estimation. The empirical part was published in (*13*). One should not take the empirical results presented in this version seriously because of the large size of estimated fertilizer and capital service price elasticities. Clearly, these problems arise from identification bias. Nevertheless, the presentation of duality is excellent. Hallam, Just, and Pope (part I, ch. 6) use duality theory to extract some empirically testable propositions from the expected utility maximization hypothesis. They present a reasonable motivation for this attempt and the limitation of current approaches. They derive the effect of output on price risk. The analysis explicitly ignores output uncertainty, a major concern of farmers.

It is disappointing that the authors of part 2 did not do a better job of presenting rational expectations. This failure is especially ironic because the pathbreaking article in rational expectations was an agricultural commodity model developed by Muth (*9*). Readers seeking an overview of rational expectations ideas can consult (*5*) or (*11*) or more technical treatments in (*2*) or (*7*). A reasonable example of empirical rational expectations modeling appears in (*8*).

Part 3 on market analysis and qualitative econometrics begins with a good overview by Chambers and Just titled "Qualitative Econometric Analysis in Agriculture." The major point is that the techniques of qualitative econometrics (logit, probit, and switching regression) are useful in modeling market disequilibrium. To pursue these techniques further, the reader should consult the excellent review of qualitative econometrics in (*1*). Much of the early market disequilibrium literature was characterized as *ad hoc* and unmotivated. Chambers and Just's article and those it reviews attempt to motivate price rigidity reasonably and to formulate estimable models of this type.

Further refinement of the dynamics in these models will likely lead to richer empirical estimation. Rausser and Riboud (ch. 11) and Chambers, Just, Moffitt, and Schmitz (part 4, ch. 13) are interesting empirical applications of those techniques when market clearance is lacking because of Government intervention. The market for junk feed (corn gluten feed and dried distillers grains) in the European Community is a nearly perfect case for applying these methods. This set of approaches shows how policy interventions affect market behavior both in terms of the outcomes and the final societal benefits and costs (measured as consumer or producer surplus).

Thompson and Abbott (part 4, ch. 12) and Freebairn, Rausser, and de Gorter (part 5, ch. 17) together do a reasonable job of presenting the major trade and macroeconomic agricultural linkages in models of the late seventies. Events both in the profession and in the world have largely overtaken their views.

One promising approach that uses the market nonclearance hypothesis was begun by neo-Keynesians such as Okun (*10*). Perhaps blending qualitative econometrics with this approach will yield fruitful modeling that links open macroeconomies to U.S. agriculture.

The first three articles in part 5 on Government policy analysis address the desirability of Government intervention in agriculture. Burt, Koo, and Dudley present a dynamic programming model showing that wheat farmers are the gainers and consumers are the losers from a Government wheat storage program. These authors provide a fairly clear exposition on the use of dynamic programming and sensitivity analysis. Further extensions of this work would involve a sensitivity analysis based on alternative objective functions. For a reasonable technical treatment of dynamic programming from and economist's perspective, see (*3*) and (*4*).

Gardner (ch. 15) examines the change in private and foreign government behavior induced by a government's holding grain stocks. In Gardner's model, the net cost (based on market value of carryover stock) of price stabilization rises if some interactions of private stock behavior are taken into account. Once other countries are brought in, the possibilities of free riders and strategic interaction abound. The point that private and other country stockholding behavior should be considered in modeling public stockholding mechanisms is well taken both in theory and in practice.

Just and Hollam (ch. 16) examine price-stabilizing and destabilizing policies from several theoretical and technical perspectives. A producer surplus concept based on a mean-variance expected utility objective function is developed as a function of expected quasi-rents per acre. An empirical model of the U.S. wheat economy is used to carry out the calculations of surplus. Domestic producers are large gainers and foreign concerns are losers from price stabilization, assuming producers are not taxed for storage and administrative costs. Domestic producers and consumers gain if the source of instability is domestic supply. This is a good example of modern applied welfare economies incorporating risk.

Rausser, Lichtenberg, and Latimore (ch. 18) review some of the literature in endogenous government behavior. Although interesting (but perhaps redundant) to political scientists, this article has little operational significance. Policymakers make too few key decisions during their term in office to allow an econometrician to estimate an objective function representing those decisions.

Part 6 contains the pearl of this collection, Zellner's article on what he calls SEMTSA (structural-econometric model time series analysis). It is an original, insightful, and provocative article. Economists became interested in time series analysis when univariate time series models outforecasted large econometric models for a large number of important variables. Some suggest this situation arose from specification errors, inappropriate structures, inflexible functional forms, and incorrect assumptions about error structure and exogeneity of variables. Therefore, Zellner presents SEMTSA. From this synthesis he clarifies the logic of some empirical Bayesian results and clarifies the interconnections of forecasting, structural estimators, and control within the Bayesian framework. He outlines the type of problems this approach revealed about SEM (structural-econometric models) and sketches some areas for future research. His article presents a model which unites time series and econometric modeling.

Rausser, Mundalk, and Johnson (ch. 20) present a strategy, one of many recently developed, for estimating parameters which vary over time. Unfortunately, the increased complexity of this approach will likely make system estimation difficult, impossible, or meaningless. However, this article's significance lies in its focusing on a key issue—namely, that behavioral parameters, even in a reasonably specified model, are likely to shift over time. For example, no one really believes that the underlying relationships behind money demand (and the Fed's reaction function) are invariant with respect to changes in the Fed's operating rules, depository deregulation, the wide availability of computer technology, and very high nominal and real interest rates. For a presentation of a widely used alternative developed by Swamy, see (*12*).

Having read reviews of the major pieces in this collection, the reader may inquire about the book as a whole. First, in terms of the five main questions the book addresses, it gets 1 A, 3 B's, and 1 C from the viewpoint of the late seventies (recall that in graduate school, only B and better pass). Second, despite the collection's spotty performance, it has no serious competitors. This book would be useful for a seminar in policy or applied econometric methods with additional assigned readings. Practitioners catching up on new developments will also find it useful. A paperback edition would promote its sale to both these audiences.

The collection falls far short in its treatment of dynamics. The treatment of rational expectations is very weak. Third-generation investment models are not discussed. A true economics of information is at best suggested. But the reasonable quality of chapter 20 and the good presentations of disequilibrium models mitigate the book's general lack of dynamics.

The papers on policy intervention, international trade and macro linkages, and the role of econometric models in policy formation topics are adequate. Nevertheless, the collection lacks appropriate synthesis and contains severe gaffes (some of which have been alluded to), typographical errors, conjectures which have proved false, and other major limitations.

As already mentioned, the discussion of supply and demand in part 1 is excellent. The central importance of these topics in agricultural models combined with these excellent presentations raise this book to the recommended level.

References

(1) Amemiya, T. "Qualitative Response Models: A Survey," *Journal of Economic Literature*, Vol. XIX, No. 4, pp. 1483-1536.

(2) Begg, D. K. H. *The Rational Expectations Revolution in Macroeconomics: Theory and Evidence*. Baltimore: Johns Hopkins Univ. Press, 1983.

(3) Chow, G. C. *Analysis and Control of Dynamic Economic Systems*. New York: John Wiley and Sons, 1975.

(4) ________. *Econometric Analysis by Control Methods*. New York: John Wiley and Sons, 1981.

(5) Conway, R. K., and J. R. Barth. "New Developments in Macroeconomic Theory: A Prospectus and Appraisal," *Agricultural Economics Research*, Vol. 35, No. 3, July 1983, pp. 23-39.

(6) Deaton, A., and J. Muellbauer. *Economics and Consumer Behaviour*. New York: Cambridge Univ. Press, 1980.

(7) Lucas, R. E., and T. J. Sargent. "Introduction" in *Rational Expectations and Econometrics Practice*, Vol. 1 (ed. R. E. Lucas and T. J. Sargent). Minneapolis: Univ. of Minnesota Press, 1981.

(8) Mishkin, F. S. *A Rational Expectations Approach to Macroeconomics: Testing Policy Effectiveness and Efficient-Markets Models*. Chicago: Univ. of Chicago Press, 1983.

(9) Muth, J. F. "Rational Expectations and the Theory of Price Movements," *Econometrics*, Vol. 29, July 1961, pp. 315-35.

(10) Okun, A. A. *Price and Quantities: A Macroeconomic Analysis*. Washington, D.C.: Brookings Institution, 1981.

(11) Sheffrin, S. M. *Rational Expectations*. New York: Cambridge Univ. Press, 1983.

(12) Swamy, P. A. V. B. "Linear Models With Random Coefficients" in *Frontiers in Econometrics* (ed. P. Zarembka). New York: Academic Press, 1974.

(13) Weaver, R. D., "Multiple Input, Multiple Output Production Choices and Technology in the U.S. Wheat Region," *American Journal of Agricultural Economics*, Vol. 65, No. 1, Feb. 1983, pp. 45-56.

*U.S. GOVERNMENT PRINTING OFFICE : 1984 O-420-932/EMS-2034

Suggestions for Submitting Manuscripts for *Agricultural Economics Research*

Contributors can expedite reviewing and printing of their articles by doing these things:

1. SOURCE. Indicate in a memorandum how the material submitted is related to the economic research program of the U.S. Department of Agriculture and its cooperating agencies. State your own connection with the program.
2. CLEARANCE. Obtain any approval required in your own agency or institution before sending your manuscript to one of the editors of *Agricultural Economics Research.* Attach a copy of such approval to the manuscript.
3. ORIGINALITY OF MATERIAL. It is our policy to print original material. We consider alternative treatments of material published elsewhere, but such treatments need to differ substantially from the original approach. When submitting your manuscript, identify, if applicable, related material either published or submitted for publication.
4. ABSTRACT. Include an abstract and at least three keywords when you submit your article. The abstract should not exceed 100 words. It should report the major findings of your research.
5. NUMBER OF COPIES. Submit three good copies.
6. TYPING. Double space everything, including abstract, footnotes, and references.
7. FOOTNOTES. Number consecutively throughout the article.
8. REFERENCES. Check all references carefully for accuracy and completeness.
9. CHARTS AND OTHER ARTWORK. Use charts sparingly. Keep design as simple as possible. Submit all artwork in draft rather than in final form, accompanied by neatly prepared pages with essential data for replotting.

Researchers interested in a bibliography arranged alphabetically by author of materials in *Agricultural Economics Research* from the first issue in 1949 through the current issue should write Lorna Aldrich, Economist, ERS/NED, U.S. Department of Agriculture, Washington, D.C. 20250.

Readers interested in a chronological bibliography of materials in *Agricultural Economics Research* from the first issue in 1949 through the last issue in 1979 should write Lorna Aldrich, Economist, ERS/NED, U.S. Department of Agriculture, Washington, D.C. 20250.

United States
Department of Agriculture

Washington, D.C.
20250

Postage and Fees Paid
U.S. Department of Agriculture
AGR-101

U.S. MAIL

THIRD CLASS BULK RATE

ERS Abstracts

ERS Abstracts is a free service listing reports issued by USDA's Economic Research Service which are for sale by the National Technical Information Service or the U.S. Government Printing Office. To receive this newsletter, send your name and address to:

ERS Abstracts
U.S. Department of Agriculture
Room 4305-South
Washington, D.C. 20250