Research Review

Global Modeling After Its First Decade

By Donella H. Meadows*

Global models are computer models that address social problems of global scope To date, seven global models have been constructed by different groups of people in different countries who ask different questions and use different methods

Among the social problems addressed by these models are the following resource depletion, poverty and hunger, inequities in international trade, environmental degradation, and rapid population growth

Among the methods used are the following simultaneous econometric equations, simulation, optimization, input-output, and systems dynamics

Not surprisingly, global modelers at the Sixth Global Modeling Conference of the International Institute of Applied Systems Analysis found themselves in fundamental disagreement over several points Here are some of the most important ones

1 Should models be built to answer a single, well-defined problem or to represent many aspects of a system and serve diverse purposes?
2 Should models be made in direct response to pressing issues of public policy or should the goal be general improvement in understanding?
3 Should models be normative or descriptive?
4 How far into the future can one see with a model?
5 What is the best method to use for global modeling?
6 Should models be large or small?
7 Should the procedure for developing the model be top down or bottom up?
8 What should be done when data about a crucial system relation are not available?
9 How should actors, technology, prices, population, and other factors be represented?
10 How should a model be tested?
11 What is the appropriate audience for global modeling? When and how should results be communicated to this audience?

Despite these differences, one can draw from the seven global models some common, general messages both about the modeling process and about the state of the world and its future The fact that global modelers with such disparate backgrounds can agree on anything is noteworthy The areas of methodological agreement are the following

1 It is better to state your biases, insofar as you are able, than to pretend you don't have any
2 Computer models of social systems should not be expected to produce precise predictions
3 Inexact, qualitative understanding can be derived from computer models and can be useful
4 Methods should be selected to fit problems (or systems), problems should not be distorted to fit methods
5 The most important forces shaping the future are social and political, and these forces are thus far the least well represented in the models
6 In long-term global models, environmental and resource considerations have been too much ignored
7 Models should be tested much more thoroughly—for agreement with the real world, for sensitivity to uncertainties, and over the full range of possible policies
8 A substantial fraction of modeling resources should go to documentation
9 Part of the model documentation should be so technically complete that any other modeling group can run and explore the model and duplicate all the published results
10 Part of the documentation should be so clear and free from jargon that a nontechnical audience can understand all the model's assumptions and how these assumptions lead to the model's conclusions
11. Modelers should identify their data sources clearly and share their data as much as possible
12 Model users, if there are any clearly identifiable ones, should be involved in the modeling process as directly and frequently as possible
13 An international clearinghouse for presenting, storing, comparing, criticizing, and publishing global models is necessary

The most important points of agreement on the state of the world and its possible future are the following

1 There is no known physical or technical reason why basic needs cannot be supplied for all the world's people in the foreseeable future These needs are not being met now because of social

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and political structures, values, norms, and world views, not because of absolute physical scarcities
2 Population and physical (material) capital cannot grow forever on a finite planet
3 There is no reliable and complete information about the degree to which the earth's physical environment can absorb and meet the needs of further growth in population and capital There is a great deal of partial information, which optimists read optimistically and pessimists read pessimistically
4 Continuing "business-as-usual" policies through the next few decades will not lead to a desirable future—or even to meeting basic human needs, it will result in an increasing gap between the rich and the poor, problems with resource availability and environmental destruction, and worsening economic conditions for most people
5 Because of these difficulties, the continuation of current trends is not a likely future course Over the next three decades, the world's socioeconomic system will be in a period of transition to some state that will be, not only quantitatively, but also qualitatively, different from the present
6 The exact nature of this future state, and whether it will be better or worse than the present, is not predetermined, but is a function of decisions and changes being made now
7 Because of the momentum in the world's physical and social processes, policy changes made soon are likely to have more impact with less effort than the same set of changes made later By the time a problem is obvious to everyone, it is often too late to solve it
8 Although technical changes are expected and needed, no set of purely technical changes tested in any of the models was sufficient in itself to bring about a desirable future Restructuring social, economic, and political systems was much more effective
9 The interdependencies among peoples and nations over time and space are greater than commonly imagined Actions taken at one time and in one area of the globe have far reaching consequences that are impossible to predict intuitively and probably also impossible to predict (totally, precisely, or maybe at all) with computer models
10 Because of these interdependencies, single, simple measures intended to reach narrowly defined goals are likely to be counterproductive Decisions should be made within the broadest possible context—across space, time, and areas of knowledge
11 Cooperative approaches to achieving individual or national goals often turn out to be more beneficial in the long run to all parties than do competitive approaches
12 Many plans, programs, and agreements, particularly complex international ones, are based on assumptions about the world that are either mutually inconsistent or inconsistent with physical reality Much time and effort is spent designing and debating policies that are, in fact, impossible

Surely, one reason for the extensive areas of agreement on procedures and findings is the robustness of the conclusions We tend to arrive at the same answer no matter what direction we take But there is another possible and worrisome reason Numerous assumptions underlying all the models are seldom questioned and are held as an act of faith Among the assumptions that regularly appear in global models are the following

1 Technology is a crucial factor in global development
2 The poor nations of the world are developing in the same pattern as the Western industrialized nations, but after a time lag
3 Political leaders are above the global system, outside it, making the important decisions affecting it, and not affected by it
4 The most important phenomena in the world are economic and can be described in terms of monetary units
5 Nation-states are the basic actors in the world, and they interrelate primarily through flows of commodities and money
6 A good indicator of the welfare of a population is the annual flow of market-exchanged goods and services (measured by monetary value) produced by that population
7 The questions that interest political leaders are indeed the critical questions that need to be answered
8 The questions that interest political leaders are narrow and self-serving and not the important ones at all

Perhaps all these statements are true—or none of them is But should any of them be accepted unquestioningly as the basis for our global models? Assumptions like these are conceptual walls and interfere with our seeing the world as it really is Modelers must feel free to put forward creative new hypotheses even if they affront conventional wisdom

Monthly Food Price Forecasts

By Paul C. Westcott*

Retail food prices in the seventies rose at an 8 0-percent annual rate, or 1 2 percentage points faster than nonfood prices Double-digit increases in retail food prices occurred in 4 of the past 10 years These developments have spurred public interest in food prices and in the factors which cause them to change

My purpose here is to discuss a two-equation linear model that was developed to make monthly food price forecasts The model provides estimates of price movements of the two major food price components of the CPI—food at home (representing prices in grocery stores) and food away from home (representing prices in restaurants, cafeterias, and fast-food estabishments)

The Model

Much empirical work using price equations has been based on markup models Popkin suggests a form of the markup model in which prices are examined by their stage of processing "as an approximation to the type of study that could be conducted in an input-output framework" (*7*, p 486)[1] In this approach the price of any product is represented as a function of prices for inputs used in its production, including prices of raw materials and costs of marketing The price markup from one stage of processing to the next is also affected by excess demand variables, such as the unemployment rate and capacity utilization

Heien (*5*) uses this approach in a dynamic monthly model of the food price determination process to examine the farm-to-retail lags for 23 foods He divides the farm-to-retail marketing process into two stages of processing—farm-to-wholesale and wholesale-to-retail—and estimates markup equations for each stage Heien's study illustrates that the dynamic nature of the food marketing process is important in food price determination models In each processing stage, changes in input prices and marketing costs are only partly transmitted to successive stages in the same period, with an additional time period required for all effects to be passed through to retail

The model used in this article draws on Popkin's idea that product price is a function of input prices, and it draws on Heien's idea that the dynamic nature of the food marketing process is important The equations use distributed lags and explain retail food prices as functions of prices for domestic foodstuffs, prices for imported foodstuffs, and costs of food marketing

Estimation Results and Implications

Two major components of retail food prices that interest policymakers and the public are prices for food in grocery stores and prices for food consumed away from home Because food prepared in restaurants is more highly processed than food purchased in grocery stores, the dynamic properties of the price markup process for the two categories differ Therefore, two separate price forecasting equations were estimated

The CPI for food at home and the CPI for food away from home are used as dependent variables The index of prices received by farmers for foodstuffs (PRF),[2] the Producer Price Index (PPI) for raw sugar, and the food marketing cost index (MCI) are independent variables PRF approximates the domestic farm value of retail food[3] Sugar is a major imported food that is domestically consumed Therefore, the model uses the PPI for raw sugar to represent prices for imported foodstuffs[4] MCI represents the major inputs used in processing, distributing, and retailing food[5] Monthly data from 1971 through 1979 with all variables expressed as percentage changes from the previous month were used to estimate each equation The 12 months of 1980 were saved for beyond-sample validation

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

[2]The PRF index is an aggregate of 37 farm-level commodity prices It is similar to the index of prices received by farmers for all farm commodities, but nonfood items have been removed For example, cotton and tobacco prices (which are included in the price index for all farm products) are not included in the PRF The remaining foodstuffs components are aggregated by use of new relative weights derived from appropriate adjustment of the original set of weights This index and the weights used in its construction are discussed in (*10*)

[3]The PRF index is used rather than USDA's farm value of the market basket data because it is published earlier Therefore, retail food price forecasts can be provided to policymakers and the public almost 1 month in advance of the release of the CPI

[4]Coffee prices were initially included, but they did not add significantly to the model in the estimation stage

[5]The food marketing cost index is a price measure representing 40 major inputs used in processing, distributing, and retailing food For a further discussion, see (*3*)

In the food-at-home equation, two binary variables, C_1 and C_2, were included for August and September 1973—months at the end of the Nixon administration's price freeze Large price changes for food at home occurred in these months (a 7 4-percent increase in August and a 1 4-percent decrease in September), caused largely by policy considerations outside normal food marketing operations [6] C_1 is equal to 1 for August 1973, and to zero otherwise C_2 is equal to 1 for September 1973, and to zero otherwise Monthly dummy variables (D_i) were also included to represent seasonal effects D_i equals 1 in the ith month of each year, and zero elsewhere The equation was fit by ordinary least squares

For the away-from-home equation, polynomial distributed lags were estimated from the generalized Almon procedure which uses the Lagrangian interpolation formula to estimate the polynomial function The lag lengths used were 6 months on PRF and 4 months on MCI Because significant autocorrelation was present in the initial estimate (the Durbin-Watson statistic is 0 91), the Cochrane-Orcutt autocorrelation adjustment procedure was used

The estimated equations for food at home (1) and food away from home (2) are as follows

$$\begin{aligned} & -\underset{(127)}{188} + \underset{(023)}{048}\,F_t + \underset{(023)}{147}\,F_{t-1} + \underset{(016)}{061}\,F_{t-2} \\ & + \underset{(129)}{510}\,M_t + \underset{(005)}{012}\,S_t + \underset{(765)}{5\,897}\,C_1 - \underset{(825)}{4\,448}\,C_2 \\ & + \underset{(234)}{385}\,D_1 + \underset{(219)}{666}\,D_2 + \underset{(211)}{865}\,D_6 + \underset{(209)}{427}\,D_7 + \underset{(215)}{750}\,D_{12} \\ & R^2 = 756 \quad d = 1\,77 \quad \Sigma f_i = 256 \quad \overline{f} = 1\,048 \end{aligned} \tag{1}$$

$$\begin{aligned} & \underset{(108)}{043} + \underset{(005)}{001}\,F_t + \underset{(004)}{019}\,F_{t-1} + \underset{(005)}{028}\,F_{t-2} \\ & + \underset{(005)}{029}\,F_{t-3} + \underset{(005)}{025}\,F_{t-4} + \underset{(004)}{018}\,F_{t-5} \\ & + \underset{(003)}{008}\,F_{t-6} + \underset{(038)}{191}\,M_t + \underset{(040)}{163}\,M_{t-1} \\ & + \underset{(035)}{146}\,M_{t-2} + \underset{(036)}{125}\,M_{t-3} + \underset{(036)}{082}\,M_{t-4} \\ & R^2 = 710 \quad \varrho = 566 \quad \Sigma f_i = 129 \quad \overline{f} = 3\,131 \\ & \Sigma m_i = 707 \quad \overline{m} = 1.639 \end{aligned} \tag{2}$$

[6]Price ceilings on pork ended in July 1973, resulting in sharp hog and pork price increases in August "The announcement in July that beef price ceilings would be lifted in September and the observed jump in hog prices when ceilings were lifted on pork encouraged cattle feeders to hold back cattle nearing market weights for expected higher prices in September" (*11*, p 5) This not only pushed up meat prices in August, but also caused large cattle marketings and a price decline in September

where

F = PRF, or prices received by farmers for domestic foodstuffs,
M = MCI, or food marketing cost index,
S = Producer Price Index for raw sugar,
C = Dummy variables, end of price freeze, 1973, and
D = Seasonal dummy variables

The standard errors are shown in parentheses, d is the Durbin-Watson statistic, ϱ is the autocorrelation adjustment parameter, Σf_i is the sum of the farm value lag coefficients, $\overline{f}$ is the mean farm value lag (in months), Σm_i is the sum of the marketing cost lag coefficients, $\overline{m}$ is the mean marketing cost lag (in months) The subscripts of F, M, and S denote time periods

Using Theil's explanatory set reduction strategy (*9*), I omitted insignificant variables from the final specification Most of the sugar price variables were not statistically significant and were dropped from the equations Only the current sugar price in the food-at-home equation was included All lagged marketing cost variables were dropped from the food-at-home equation, as were six of the monthly dummy variables All dummy variables were omitted from the food-away-from-home equation

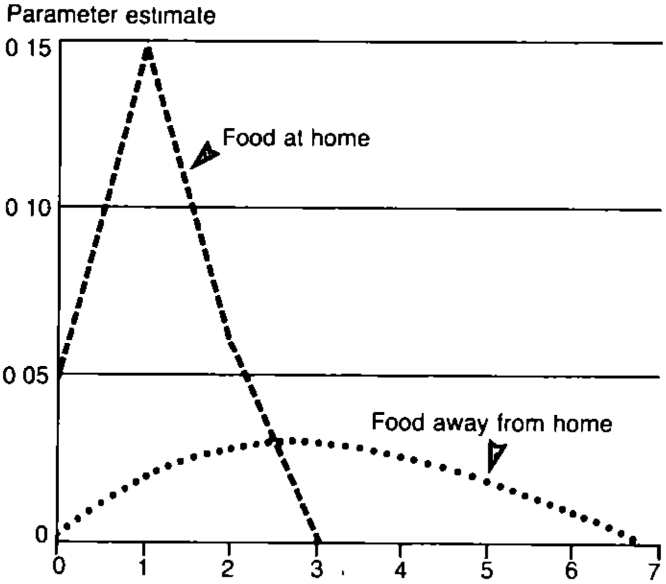
Most of the estimated structural parameters are of the expected sign (positive), and most of the estimates are statistically significant The negative constant term in the food-at-home equation is not statistically different from zero

The signs on the binary variables in the food at-home equation are as expected The price-freeze dummy variables reflect events in the livestock sector at that time (see fn 6) The positive sign on the December dummy variable reflects increased holiday demand Similarly, the estimated coefficients on the June and July dummy variables probably reflect increased demand for food at home for summer barbeques and picnics [7] The signs on the January and February dummy variables probably reflect seasonal supply disruptions due to weather

The difference between the two equations regarding price transmission lags for PRF is interesting For food at home, the largest impact is in the first lag period, with smaller impacts in the preceding and following months (see figure) The mean lag is 1 048 months, indicating that price changes for foodstuffs are passed through to retail prices quickly, averaging about 1 month

[7]Dummy variables for November and August were not statistically significant Because the CPI survey throughout most of the estimation period was conducted during the first week of each month, retail food prices in the November CPI probably did not reflect increased holiday demand The shift of some demand to the away-from-home market in August—when many people take vacations—probably offset higher summer demand for food at home

Estimated Coefficients for Current and Lagged Domestic Foodstuffs Price Variables



For food away from home, the impacts increase each month through the third lagged period, before diminishing through the sixth lagged month The mean lag is 3 131 months, indicating a slower retail price response to price changes for foodstuffs than in the at-home market The coefficient on current PRF in the food-away-from-home equation is not statistically different from zero, implying a lag before any effects of domestic foodstuff price changes are reflected in food-away from-home prices These results are likely caused by delays in menu pricing adjustments and by future contracting for food supplies in that market

Changes in food marketing costs also affect retail prices faster in the at-home market In the food-at-home equation, only current marketing costs are statistically significant, indicating that the pass through to retail generally occurs in the same month In the food-away-from-home equation, the largest impact is in the current period with smaller effects occurring through the fourth lagged month The mean lag of 1 639 months again indicates a slower retail price response to changes in marketing costs

The role of farm value changes and of marketing cost changes is another important result The sum of the lag coefficients of PRF in the at-home equation, an estimate of the longrun effect of a 1 0 percent change in prices for foodstuffs, is 0 256, whereas in the away-from-home equation the sum is 0 129 This implies that foodstuff price changes are more important to the at-home market than to the away-from-home market Conversely, marketing cost changes play a larger role in the away-from-home market, reflecting the larger amount of processing required The marketing cost coefficient in the at-home equation is 0 510, whereas the sum of lagged marketing cost coefficients in the away-from-home equation is 0 707

Validation

To validate the model, I performed a deterministic simulation of the model to generate estimated time series for the endogenous variables I compared these to the actual endogenous values and calculated summary validation statistics For both equations, I made within-sample (1971-79) and beyond sample (1980) comparisons Because the exogenous data are available prior to the release of the CPI and because this model is primarily intended for forecasts 1 month ahead, I used actual exogenous data in all simulations

The table shows summary validation statistics for both the within-sample and beyond-sample simulations The food-away-from-home equation performs very well as a forecasting tool The Theil inequality coefficients are well below unity and the mean absolute errors are relatively small However, a less satisfactory performance is indicated for the food-at-home equation Although the Theil inequality coefficients are well below unity, the mean absolute errors are relatively large

Summary validation statistics

Consumer Price Index category	Within sample		Beyond sample	
	Mean absolute error	Theil inequality coefficient	Mean absolute error	Theil inequality coefficient
Food at home	0 40	0 42	0 40	0 54
Food away from home	14	24	14	22

These results are a consequence of the larger variation in food-at-home prices, reflecting the structures of each market regarding both its lag pattern and the relative importance of prices for foodstuffs and marketing costs Prices for foodstuffs are more volatile than are food marketing costs, largely because of the seasonal nature of agricultural production and the weather's important role in determining supplies As prices for foodstuffs are more important in determining at home prices, prices in grocery stores reflect this variation more than away-from-home prices Furthermore, the longer lag structure in the away-from-home market distributes changes in prices of foodstuffs over more months, thereby reducing the volatility of impacts at the retail level

Conclusions

I have estimated a distributed lag model with equations for the CPI for food at home and for food away from home to forecast the two major aggregate components of the food CPI Validation statistics from simulations for the within-sample period and for a 12-month beyond-sample period indicate that reasonably good forecasts 1 month ahead can be made for the food-away-from home CPI, with less satisfactory forecasts obtained for the more volatile food-at-home CPI

The model estimates are consistent with U S Department of Agriculture marketing bill data, which indicate agricultural commodity price changes are a larger part of the price determination process in the at-home market than in the away-from-home market The estimated coefficients of prices for foodstuffs and prices for marketing costs also indicate that the price transmission lags characterizing the pricing of foods in grocery stores are shorter than those depicting price changes for food away from home

The Economic Research Service (ERS) makes monthly forecasts of retail food prices. The two equations discussed here draw on exogenous data on prices for domestic and imported foodstuffs and on marketing costs that are available at the time the price forecasts are needed These equations have proven useful in meeting the demands on ERS for shortrun food price forecasts

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In Earlier Issues

Many people who observe day to-day prices in commodity markets believe that prices follow certain patterns of movement, or that their fluctuations can be traced to various causal factors An attempt to discover such patterns was unsuccessful Because the problem is important, the negative findings are set forth

Richard J Foote
Vol. 7, No 1, Jan. 1955, p 19

Costs of Marketing Slaughter Cattle: Computerized versus Conventional Auction Systems

By Steven T. Buccola and Alice M. Chieruzzi*

Geographical dispersion of beef and dairy farms in the United States impedes not only the rapid dissemination of cattle price information, and hence cattle pricing efficiency, but also the technological efficiency of cattle transactions Electronically operated markets, employing conference call telephone, teletype, or computer, can increase the technological efficiency of cattle markets by eliminating the need for the physical proximity of buyer and seller Although under such arrangements cattle buyers cannot visually inspect animals before purchase, it has become increasingly clear that they can rely on written descriptions of cattle to adequately determine their value Remote purchases eliminate the buyers' expense of sending representatives to each purchase point Thus, buyer procurement costs may be reduced, thereby increasing the number of buyers willing to bid on cattle at each locality

The extent to which an electronic exchange reduces marketing costs is an empirical question In this article, we summarize a study in which the simulated costs of operating a computerized livestock auction market in Virginia were compared with the costs of the current, conventional auction arrangement (*1*)[1] The analysis was part of a project to set up a computer-based livestock auction system

Computerized Sales Procedures

Computerized sales of slaughter cows and lambs began in Virginia in mid-1980 (*7*) Although the volume of these sales is a small fraction of total State and regional marketings, participation is expected to increase as the industry becomes familiar with the new concept Auctions are conducted by a nonprofit organization, the Eastern Electronic Marketing Association (EEMA), through time-shared access to commercial computer facilities Livestock are assembled, weighed, and graded at participating auction markets, then descriptions of consignments are phoned to EEMA headquarters or entered on a portable terminal at the market Prior to a sale, buyers log on at terminals in their packing plants and receive printed descriptions of available livestock

Unlike electronic hog sales in Canada, which employ Dutch auctions, EEMA auctions follow English (ascending) bids Bidding for a particular lot is initiated when an EEMA representative enters an asking price at a central terminal At preset intervals, buyers receive a display of the current high bid and the number of seconds left in which to raise that bid Only the high bidder knows who has the high bid The bid is raised a preset increment when a prospective buyer pushes a key on the terminal A transaction is terminated when no buyer has raised the current high bid in the alloted time Summary information is then printed at buyer terminals indicating the description, price, and market location of the animals Buyers are responsible for arranging the transportation of these animals to their plant

We develop here the general structure of costs associated with time shared computerized auction sales, we then compare these costs, given alternative assumptions, with those of conventional sales Our characterization of handling and transportation costs specifically applies to slaughter cattle and to Virginia, although the general methods and conclusions would probably also apply to other commodities and to other States

Cost Structures

Variable costs of computerized auction sales are those that vary with the number of lots offered per week The major variable costs of a time-shared computerized sale are those associated with entering and obtaining descriptions of lots and with conducting an auction Each requires computer connect time, line printing, the user's own time, and computer processor usage[2] Fixed costs include terminal depreciation and EEMA office and management costs The table lists 17 components of cost used in the analysis, together with their 1980 values

Entering Lot Descriptions at Market and EEMA Terminals

It takes approximately 1 2 minutes for each auction market or EEMA terminal operator to log on and off the

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

[2] Some computer time-sharing enterprises charge separately for the number of lines printed We included these charges in the connect time charge

system each day, so that a total of $1\ 2\ S_wMK$ minutes are required for this purpose each week It also takes an average of 2 3 minutes to enter information on each lot offered for sale Thus, the total weekly costs of computer connect time (CC_{eL}) associated with lot entry are

$$CC_{eL} = (1\ 2S_wMK + 2\ 3A_w/A_L)C_m \quad (1)$$

and the corresponding cost of entry operator labor is $CC_{eL}SW_m/C_m$ Furthermore, it requires approximately 4 0 units of processor resource usage (SRU's), representing core use, I/O operations, and processor time, to enter each lot at each terminal[3] Total weekly cost (PC_{eL}) of processor usage for lot entry is thus

$$PC_{eL} = (4A_w/A_L)C_{sru} \quad (2)$$

Obtaining Lot Descriptions at Buyers' Terminals

It is assumed that buyers first request a short description of all lots offered that includes information on the size, average weight, average quality grade, and location of each lot They then request longer descriptions, including weight and grade ranges and weighing conditions, of the L_{Ld} number of lots that interest them It takes an average of 2 08 minutes to log on and off and to wait for descriptions Each short description requires an average of 0 06 minute, and each long description, 0 60 minute Hence, weekly costs of computer connect time (CC_d) to obtain descriptions are

$$CC_d = [(2\ 08 + 0\ 60\ L_{Ld})BT_sS_w + 0\ 06BT_s(A_w/A_L)]C_m \quad (3)$$

and the associated cost of terminal operator time is CC_dBW_m/C_m

It takes an estimated 3 0 SRU's for each buyer to log on and off the system, 0 65 SRU for each long lot description, and 0 03 SRU for each short lot description Thus, the weekly processor cost (PC_d) for obtaining lot descriptions at all buyer terminals is

$$PC_d = [(3 + 0\ 65L_{Ld})BT_sS_w + 0\ 03BT_s(A_w/A_L)]C_{sru} \quad (4)$$

Conducting a Sale

Buyers are expected to log off the system after obtaining lot descriptions, then log on the system 5 minutes before a sale Because there are $M_{tL}BT_s(A_w/A_L)$ total buyer connect minutes per week during sales, the total weekly computer connect cost (CC_b) to conduct sales is

$$CC_b = [5BT_sS_w + M_{tL}BT_s(A_w/A_L)]C_m \quad (5)$$

and the weekly cost of buyers' time is CC_bBW_m/C_m

About 3 8 SRU's of processor usage are involved in a buyer's logging on and off, 0 091 SRU is consumed each time a buyer pushes the bid key, and 0 063 SRU is used each time the current high bid price is displayed at buyers' terminals Thus, the weekly cost (PC_b) of processor usage during the course of a sale is

$$PC_b = [3\ 8BT_sS_w + (0\ 063M_{tL}/SEC_{dp} + 0\ 091BD_{bt})BT_s(A_w/A_L)]C_{sru} \quad (6)$$

a function of the number of sales held each week, the total connect time of all buyers, and the total number of bids made[4]

Conventional Auction Sale Costs

The cost of conducting a conventional auction sale consists of (1) the auctioneer's fee, (2) ringmen and bookkeeper labor and facility expenses, and (3) the cost of buyers' time The first two represent a small cost when spread over normal market volumes (*5*), but the cost of buyers' time is considerable Beef packers normally obtain a portion of their auction market cattle through agents (order buyers) who charge a flat rate, currently near \$2 50 per head purchased The remainder of the cattle are bought by packers' employees (packer buyers) The fixed weekly cost of supporting a fulltime packer buyer in the East, including travel expenses, is between \$620 and \$700

Transportation and Handling Costs

The costs of transporting and handling cattle for computerized and conventional auction sales would not necessarily differ Regardless of sales arrangements, cattle must be shipped from farm to market, weighed, graded, and penned, and then transported from market to plant[5] For farmers located far from a market that participates in computerized sales, farm-to-market transport costs would generally be higher for computerized than for conventional sales Total per head costs of farm-to-market hauling were specified as $[(FC_{yr}/365) + VC_{mi}RMI]/A_{trp}$ An

[3]The processor resource usage estimates in this article are specific to the FORTRAN software package (which was developed by Computer Sciences Corporation) currently employed by EEMA and to the computer used (a Univac 1108)

[4]Besides these variable costs, weekly terminal ownership costs are \$4 40, weekly software storage costs are \$15 53, and weekly EEMA manager and office expenses are approximately \$437 50

[5]Transportation cost data were drawn from a random survey of Virginia cattle producers and dairymen (*6*) and from studies by Nor and Kuehn (*4*) and by Lin and Kuehn (*3*) In 1980 dollars, variable costs of handling were \$1 26 per head and fixed costs of handling were \$948 32 per week (weighted average of all market sizes)

average market-to-plant rate of $0 041 per head-mile was assumed, and variable and fixed costs of weighing, grading, sorting, and penning were derived from (5)[6]

Cost Results

Models of marketing costs provide a rational basis for firms' shortrun operating policies They also serve as a guideline for expansion/contraction plans of firms or firm groups and, in the present case, suggest conditions under which computerized auctions might be more efficient than conventional sales

Computerized Auction Operations

As an example of an application to shortrun operating policies, this model can be used to predict the impact of marginal changes in operating procedures or volumes on total computerized selling costs Such predictions can be used as a basis for an efficient EEMA pricing policy Costs of computerized auctions are responsive to the average number of minutes required to sell a lot (M_{tL}), the average number of head sold per lot (A_L), and the total number of head sold per week (A_w)

Summing equations (1) through (6) yields an equation for total weekly cost (Σ) Successively differentiating this sum with respect to each of the three factors and evaluating the derivatives at parameter values listed in the table will yield

[6]We obtained these figures from conversations with industry personnel and believe they are approximately correct however, they were not derived from systematic sampling

$$\partial\Sigma/\partial M_{tL} = 4\ 97/A_L \tag{7}$$

$$\partial\Sigma/\partial A_L = -16\ 2255/A_L^2 \tag{8}$$

$$\partial\Sigma/\partial A_w = -759\ 81/A_w^2 \tag{9}$$

Equation (7) shows that weekly operating costs per head decrease with the time required to sell a lot, but that the rate of decrease diminishes with increases in the average lot size For example, if an average of 20 head are sold per lot, decreasing the average time to sell a lot from 3 to 2 minutes would decrease auction costs by $0 25 per head The cost decrease would be $0 17 per head if an average of 30 head were sold per lot In equation (8), the cost economies of increasing lot size are very large at low lot sizes (5-10 head), but decrease rapidly at larger lot sizes For example, a savings of $0 16 per head is achieved by increasing lot size from 10 to 11 head, but only $0 04 per head is saved by increasing lot size from 20 to 21 head Economies with respect to weekly sales volume (equation (9)) behave similarly

Computerized versus Conventional Costs

For purposes of designing longrun government and industry policies on electronic marketing, comparing the total costs associated with computerized and conventional cattle marketing (including selling, handling, transportation, and buyer time) is helpful We assume that a total of 4,400 head of slaughter cattle can be sold in the State each week, that in the conventional marketing system the average slaughter animal is sold 1 5 times before delivery to

Terms used in analysis of computerized auction costs

Term	Definition	Amount
A_L	Number of head per lot offered for sale	20 0
A_{trp}	Number of head hauled per farm-to-market trip	2 5
A_w	Number of head per week offered for sale	200-4200
BD_{bt}	Average number of bids per connected buyer terminal per lot	2 0
BT_s	Number of buyer terminals connected per sale	20 0
BW_m	Imputed wage of terminal bidder, in dollars per minute	$0 167
C_m	Cost of computer connect time, in dollars per minute per terminal	$0 158
C_{sru}	Cost of computer processor usage, in dollars per SRU	$0 36
FC_{yr}	Weighted average fixed costs of farm truck ownership, in dollars per year	$1,377 93
L_{Ld}	Average number of long lot descriptions requested per buyer per sale	10 0
M_{tL}	Connect time for auction bidding process, in minutes per lot per terminal	3 0
MK	Number of terminals at auction markets and EEMA entering lots for a single auction sale	11 0[1] 26 0[2]
RMI	Average round-trip distance between farm and participating auction market, in miles	62 0[1] 26 0[2]
S_w	Number of computerized auction sales held per week	5 0
SEC_{dp}	Elapsed time between displays of current high bid, in seconds	20 0
SW_m	Imputed wage of lot entry operator, in dollars per minute	$0 083
VC_{mi}	Weighted average variable costs of farm truck use, in dollars per round trip mile	$0 284

[1]9 market scenario
[2]41-market scenario

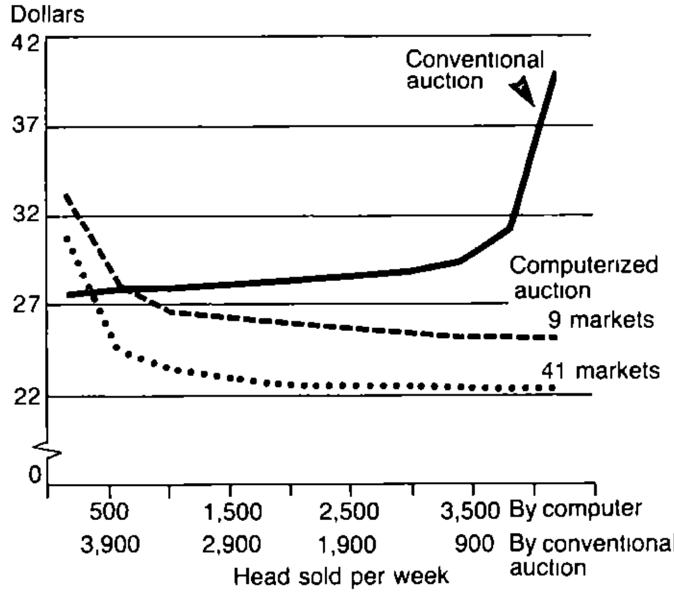
plant, and that 80 percent of packers' slaughter cattle is purchased by order buyers and 20 percent by packer buyers (see fn 6)

The figure compares the total per head costs of each system as the proportion of cattle sold through computerized sales is increased and as the proportion sold through conventional sales is decreased The upward-sloping curve indicates that total marketing costs under the conventional auction system are approximately $28 00 per head when 4,200 head per week are sold conventionally (200 head sold by computer), but costs increase to approximately $40 00 per head when only 200 head are sold conventionally (4,200 head sold by computer) The decreasing volume over which fixed packer buyer costs are spread as computerized sales are substituted for conventional sales is largely responsible for this cost increase[7]

Total per head costs of the computerized marketing system (represented by the downward sloping lines in the figure) depend on the number of auction markets that participate as information entry points and as handling, weighing, and grading stations As the number of such markets increases, costs of computer connect time and terminal ownership increase, but the average distances (and hence the per head transportation costs) from farm to market decrease This relationship is shown by the downward shift in the per head cost function as participation increases from 9 to all 41 markets in the State The negative and approximately hyperbolic slope of each of these functions results from the spreading of a larger volume of cattle over such fixed auction costs as terminal ownership, time to log on, and time to obtain long descriptions Most costs of time-shared computerized auctions vary with respect to the number of head sold

The points at which the upward-sloping line intersects downward-sloping lines indicate volumes at which computerized marketing costs equal conventional marketing costs (see figure) The intersection point varies little with the number of participating markets Total costs of marketing cattle are lower under the computerized system than under the conventional system if at least 500 head per week—that is, 11 percent of the State's volume—are sold by computer Although the height of the conventional system's cost line is sensitive to the assumed number of times a conventionally auctioned animal is resold before slaughter—1 5 times in this example—volume points at which computerized costs begin to fall below conventional costs in the 41-market scenario are little affected by the assumed number of resales

Costs per Head of Marketing Slaughter Cattle, Virginia, 1980*



See table for parameter assumptions

Conclusions

When all marketing costs (including handling, transportation, and buyer procurement activities as well as auctioneering) are considered, per head costs of computerized cattle sales in Virginia are less than those of conventional sales if a minimal volume is sold by computer This conclusion complements arguments made by other researchers that electronic markets encourage competition and access to market information, and thus promote pricing accuracy (2)

We do not address the important issue of the optimal, or likely, distribution of the computerized system's cost savings between producers and packers In the short run, packers will likely retain most of these savings in return for the risks they perceive as early adopters of the new technology In the longer run, as their perceived risks diminish, buyers will probably begin to pass on their cost savings in the form of higher prices paid to farmers and lower prices charged to food retailers

[7]If conventionally auctioned volume fell below 500 head per week, packers would possibly increase the proportion of cattle that they purchase through order buyers and would almost certainly limit their own buyers' activities to a part-time basis In addition, fewer sales would be held, with a view to utilizing auctioneers and bookkeepers' time more efficiently These reactions would reduce the steepness of the cost increase shown at the right end of the conventional auction line It is difficult to quantify these adjustments as the precise longrun responses to reduced conventional purchases is unknown The figure represents a shortrun situation in the sense that fixed costs are held constant throughout the entire volume range

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In Earlier Issues

Among all economic cycles that alternately bring cheer and despair to their participants and continuously challenge the ingenuity of analysts, none presents so rhythmic a pattern as does the cycle in cattle numbers

Harold F Breimyer
Vol. 7, No 1, Jan. 1955, p 1

Survival Strategies for Agricultural Cooperatives

Charles E. French, John C. Moore, Charles A. Kraenzle, and Kenneth F. Harling.
Ames, Iowa: Iowa State University Press, 1980, 278 pp., $14.25

Reviewed by Randall Torgerson*

Government, university, and farm leaders interested in the future of agricultural cooperatives are urged to examine *Survival Strategies for Agricultural Cooperatives* The central question is stated clearly in the last chapter "Will U S agricultural cooperatives survive another decade?" The authors answer affirmatively, but suggest that survival will depend on self-determination—that is, on cooperative members guiding their own destiny The authors suggest ways cooperatives can survive and expand in a food industry characterized by rapid structural change and in a dynamic economic and political environment

Research for this book began in 1974 In the preliminary chapters, the authors compare the past and present purposes of cooperatives by evaluating articles and bylaws and by examining the content of oral interviews with key cooperative leaders and academicians They identify the social and economic roles of cooperatives, their advantages and disadvantages, and issues related to their growth They also examine the competitive environment in marketing stages (from farm equipment suppliers to food distributors)

The authors suggest that cooperatives might pursue the following three general strategies (1) further integrating and coordinating, (2) collective bargaining, and (3) maintaining and improving the open market They develop these strategies on which their book is focused in part from their extensive interviews with cooperative leaders The authors strongly encourage stepped-up and comprehensive long-range planning by cooperative members to foster these growth objectives

These three general strategies are not new to readers familiar with cooperative growth and development However, the authors have added to these strategies, organizational and policy issues They emphasize planning initiatives to guide future development Readers will find the discussion on integration and coordination deficient regarding its possible impact on farm structure and regarding the alternative organizational options of producers However, the section on bargaining strategy is well written and assesses the potential problems of the cooperative community The authors recognize that improving the open-market strategy may appeal to farmers' conservative orientation, but it is "in opposition to most changes in business structure and organization occurring in recent years"

The authors allude to, but do not adequately treat, the relationship of cooperatives to general farm organizations and other types of group action Concerning the current issue of farm structure, they are strangely silent, and they fail to recognize the significance of departures from the family farm system and their implication for cooperatives

The authors conclude that the following points are essential to cooperative growth and well being Cooperatives must (1) increase product and financial commitment, (2) improve marketing as well as selling, (3) do more and better long-range planning, (4) make greater use of multi-cooperative organizations, (5) develop or improve market information systems, and (6) expand product research and development

The book is comprehensive, relevant, and timely Those interested in the economic, social, political, and technical environment faced by farm operators and their cooperatives will find the information extremely useful The authors summarize numerous studies of the competitive market environment and changing structure by the U S Department of Agriculture's Agricultural Cooperative Service This examination of current cooperative efforts in farm inputs and first-handler level marketing activities lays a solid foundation for an inquiry into cooperative alternatives and future directions

Cooperative board members, managers, policymakers, and scholars should find the reference material on marketing issues useful As a study oriented not only to survival but also to improvement, the book should be required reading for all farm leaders interested in the future economic well-being of agricultural cooperatives

*The reviewer is the administrator of the Agricultural Cooperative Service, U S Department of Agriculture