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Contributors

ROBERT H. MASUCCI, a past contributor to our Book Reviews, is head of the Farm Income Research and Development Section of the Farm Income Branch, AMS. Formerly assigned to the development of production expense estimates, he is currently responsible for analyses relating to farm income and its distribution and agricultural industrial relationships.

RANDOLPH BARKER is an Agricultural Economist with the Agricultural Adjustments Research Branch of the Farm Economics Research Division, ARS. He is stationed at Ithaca, N.Y., where he is cooperating with Cornell University in analyzing profitable adjustments on dairy farms.

MARGUERITE C. BURK since 1944 has been in charge of the work on food consumption, first with the former Bureau of Agricultural Economics, now with Agricultural Marketing Service. Her interest in motivation research grew out of her search for explanations of changes in U.S. food consumption not explained by variations in income and urbanization.

HYMAN WEINGARTEN, an Analytic Statistician in the Agricultural Economics Division, AMS, has been studying various methods of applying econometric techniques to the electronic computer.

GLENN L. JOHNSON is Professor of Agricultural Economics at Michigan State University. Formerly with the Bureau of Agricultural Economics, he is well known for his original studies of supply response in agriculture. During the past year he has been serving as Simon Visiting Professor in the Department of Agricultural Economics at the University of Manchester.

KARL GERTEL is an Agricultural Economist with the Farm Economics Research Division, Agricultural Research Service, where he is concerned with problems of water utilization.

DWIGHT HAIR, Forest Economist, Division of Forest Economics Research, Forest Service, U.S. Department of Agriculture, during the last 12 years has particpiated in a variety of studies relating to the production and marketing of timber products.

ALLEN B. PAUL, Agricultural Economist, Marketing Economics Division, AMS, is mainly concerned with analysis of the changing structure and practice in food manufacturing and distribution.

MARTIN J. GERRA carries on econometric studies in the Statistical and Historical Research Branch, AMS.

DANIEL W. BURCH, Analytical Statistician in the Agricultural Economics Division, AMS works on the current analysis of the general economy as it relates to agriculture, and prepares the *Demand and Price Situation* for the Outlook and Situation Board.

HAROLD F. BREIMYER, formerly head of the Livestock, Fats and Oils Section, Statistical and Historical Research Branch, AMS, recently joined the staff of the Council of Economic Advisers.

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Regional Differences in Per Capita Farm and Nonfarm Income

By Robert H. Masucci

Establishment of parity prices by way of the unit of purchasing power approach—the concept on which the parity formula is now based—may not adequately reflect parity of incomes and living standards for farmers. This is true especially if the norm or base period is far back in the past, and if radical changes have occurred in the demand for, and the cost structures of, many farm commodities. Recognition of such limitations has led to a second general approach to the measurement of parity—a formula that involves parity income, with prices derived from this formula. The income approach received Congressional recognition, and resulted in a definition of parity income in the Soil Conservation and Domestic Allotment Act of 1936, revised in the Agricultural Act of 1938. Later, it was replaced with a definition in the Agricultural Act of 1948 that was substantially different. This parity concept centers generally on the relation between the incomes of farm people and those of nonfarm people. In the measurement of such parity two basic approaches have been used. One involves the maintenance of a historical income ratio that would provide farmers with incomes and living standards proportionate to those of nonfarmers; the other would establish the standard of equal incomes or living standards as between farmers and nonfarmers. In the first approach, the ratio of farm to nonfarm income in recent years has been at parity or above, compared with the historical base of 1910–14. The second approach, on the other hand, yields a very substantial differential as between farm and nonfarm incomes, although differences in the purchasing power of the farm dollar versus the nonfarm dollar would probably narrow the gap appreciably. This paper bears on the second of these approaches, that is, the comparison of income differences, especially with respect to the regional variations between the incomes of farm-operator families and those of the nonfarm population.

INCOME COMPARISONS between the total farm population, which includes hired workers, and the nonfarm population, are usually based on U.S. totals regularly published by the Farm Income Branch of the Agricultural Marketing Service in the July issue of the *Farm Income Situation.* Only for 1949 have comparisons been made of the per capita income of persons in farm-operator households only, with income of the nonfarm population. However, the Survey of Farmers' Expenditures in 1955 provided data on which estimates of the per capita income of farm-operator households for a more recent year could be developed, not only for the United States but also for the major geographical regions.

Regional data for 1955 shed considerable light upon the variability in income differences among regions. They permit analysis of the influences of the individual regional differences upon the average difference for the United States as a whole, and they open to question the adequacy of the measurement of the difference between farm and nonfarm per capita incomes when only data for the United States as a whole are employed

TABLE 1.—*Regional distribution of farm-nonfarm income differences, 1955*

Region	Income per capita		Difference	Population of operator households	Total "gap" col. (3) × col. (4)
	Nonfarm	Farm			
	Dollars	*Dollars*	*Dollars*	*Thousands*	*Thousand dollars*
Northeast	2, 175	1, 218	957	1, 420	1, 359
East North Central	2, 182	1, 082	1, 100	3, 003	3, 303
West North Central	1, 861	957	904	3, 301	2, 984
South Atlantic	1, 521	879	642	3, 533	2, 268
East South Central	1, 366	751	615	3, 105	1, 910
West South Central	1, 577	1, 121	456	2, 318	1, 057
Mountain	1, 726	1, 353	373	725	271
Pacific	2, 215	2, 575	−360	840	−302
United States			[1] 704	18, 245	12, 850

[1] Computed by dividing U.S. total gap by total population of farm-operator households.

Sources: Estimates of nonfarm income, per capita, consist of estimated total personal income of the entire population, both farm and nonfarm, as shown in the *Survey of Current Business*, August 1958, U.S. Dept. of Commerce, less estimated farm-operator family income, divided by the Bureau of the Census estimate of total population July 1, 1955 (excluding armed forces overseas) less estimated population in farm-operator households.

Per capita income of farm-operator households consists of (1) the net income of farm operators from farming, as reported in the *Farm Income Situation*, FIS–175, September 1959, plus (2) the off-farm income of farm-operator families, based on data reported in the *Survey of Farmers' Expenditures 1955*, December 1956, U.S. Department of Agriculture, and U.S. Department of Commerce, divided by the estimated population of farm-operators' households, as reported in the *Survey of Farmers' Expenditures, 1955.*

in deriving such a measurement.

The greatest difference between per capita farm and nonfarm incomes in 1955 was in the East North Central Region; farm income per capita in that region fell short of nonfarm income by $1,100 (table 1). In sharp contrast, farm-operator families in the Pacific Region had a per capita income that actually exceeded nonfarm income by $360. For the most part, this reflected the comparatively large-scale farm operations and the relatively small farm population in that region.

The income differential or gap was largest in the North, and smallest in the West; the gap in the South was in between. The fact that the gap was largest in the northern regions reflects for the most part the relatively high degree of industrialization there and the consequent higher level of nonfarm income compared with the other regions, with the exception, of course, of the Pacific Region. In that area, not only was per capita income of nonfarm persons highest; the per capita income of farm-operator households was also the highest by far.

TABLE 2.—*Relationship between income from farming and off-farm sources of farm population, 1955, by regions*

Region	Total net farm income	Income from off-farm sources	Total income	Column (2) ÷ column (3)	Population of farm-operator households	Total net farm income per capita	Off-farm income per capita
	Million dollars	*Million dollars*	*Million dollars*		*Thousands*	*Dollars*	*Dollars*
Northeast	826. 7	902. 7	1, 729. 4	0. 522	1, 419. 9	582	636
East North Central	1, 987. 4	1, 261. 4	3, 248. 8	. 388	3, 003. 0	662	420
West North Central	2, 357. 2	802. 8	3, 160. 0	. 254	3, 300. 6	714	243
South Atlantic	1, 814. 6	1, 290. 2	3, 104. 8	. 416	3, 532. 7	514	365
East South Central	1, 331. 3	999. 3	2, 330. 6	. 429	3, 105. 0	429	322
West South Central	1, 417. 2	1, 182. 0	2, 599. 2	. 455	2, 317. 7	611	510
Mountain	666. 0	315. 9	981. 9	. 322	725. 5	918	435
Pacific	1, 367. 0	796. 3	2, 163. 3	. 368	840. 1	1, 627	948
United States	11, 767. 4	7, 550. 6	19, 318. 0	. 391	18, 244. 5	645	414

Note: See table 1 for sources of data.

Industrialization Provides Off-Farm Income Supplements

Another aspect of the regional differences in the farm-nonfarm income gap is the extent to which farm families in the various regions have been supplementing their incomes from farming with income from off-farm sources (table 2).

Where per capita income from farming is low, dependence upon nonfarm sources of income generally is high, as can be seen in table 2. Per capita income from farming in the Northeast was low and income from off-farm sources accounted for 52 percent of the total per capita income of farm-operator households. In the South Atlantic and East South Central Regions, per capita farm income was also low and income from off-farm sources accounted for 42 and 43 percent, respectively, of total income. In the Pacific, Mountain, and West North Central Regions, on the other hand, per capita farm incomes were relatively high, and in these regions income from off-farm sources was relatively low.

While there appears to be an inverse correlation between the level of farm income and the percentage of total income obtained from off-farm sources, the extent to which farm families in the various regions were able to supplement their incomes from nonfarm sources depended largely upon the availability of job opportunities. In the Pacific and Northeast Regions, for example, industry is heavily concentrated. Farm families' income from nonfarm sources in these regions was greater than farm family income from such sources in any other region. On the other hand, the relatively low level of industrialization in the West North Central, South Atlantic, and East South Central Regions limited the ability of farm families to supplement their incomes from farming.

Use of U.S. Aggregates Biases Gap Measurement

With respect to the influences of regional differences upon the average difference for the United States as a whole, regional data also point up the biases contained in estimates of the farm-nonfarm income gap for the United States as a whole derived from aggregative figures. Because of the lack of detailed geographical estimates of income differences, the farm-nonfarm gap for the United

TABLE 3.—*Comparison of farm and nonfarm income per capita in 1955 using aggregative data for the United States*

Item	Total income	Total population	Income per capita
	Million dollars	*Thousand*	*Dollars*
Nonfarm	287, 280	146, 058	1, 967
Farm	19, 318	18, 245	1, 059
Difference			908

See table 1 for sources of data.

States is usually measured as shown in table 3. This method involves using aggregative figures for the United States. For 1955, the gap is seen to be $908 per capita, indicating that an additional $16.6 billion would have been required in 1955 to provide the 18.2 million persons in farm-operator households the same average income as nonfarm persons.

Computation of the average gap for the United States using detailed geographical data, however, points up the upward bias contained in the average derived by use of United States figures—a bias introduced by the variability in the size of the farm population relative to the nonfarm population in each region.

As table 1 shows, the total deficiency for the United States, was (1) $12,850 million when estimated by using regional data, compared with (2) an estimated deficiency of $16,566 million when computed by using United States totals—a difference of about $3.7 billion.

Why the difference? If breakdowns or comparisons by States or counties were available, would the estimated deficiency be reduced even more?

Source of Bias Hidden in Population Weights

In attempting to find some answers let us investigate the makeup of these measurements of gap. The computation of a simple average gap from aggregative figures, whether for a region (an aggregation of States or counties) or for the United States (an aggregation of regions, States, or counties) implies the summation of the nonfarm incomes for each geographical component divided by the summation of the nonfarm population, from which is subtracted the sum of farm incomes divided by the summation of farm population for each geographical component.

In symbols, this is

$$I_{U.S.}=\frac{\sum_{i=1}^{n} Yi}{\sum_{i=1}^{n} Pi}-\frac{\sum_{i=1}^{n} Xi}{\sum_{i=1}^{n} bi}, \text{ where}$$

$I_{U.S.}$ = U.S. average gap computed by use of U.S. totals.

Yi = Total nonfarm income of the ith geographical component;

Pi = Total nonfarm population of the ith geographical component;

Xi = Total income of farm-operator households of the ith geographical component; and

bi = Total population of farm-operator households of the ith geographical component.

Assuming three geographical subdivisions this may be written as

$$(2) \qquad I_{U.S.}=\frac{Y_1+Y_2+Y_3}{P_1+P_2+P_3}-\frac{X_1+X_2+X_3}{b_1+b_2+b_3},$$

The right hand member is equivalent to

$$(3) \quad \left[\frac{Y_1}{P_1+P_2+P_3}-\frac{X_1}{b_1+b_2+b_3}\right] + \left[\frac{Y_2}{P_1+P_2+P_3}-\frac{X_2}{b_1+b_2+b_3}\right] + \left[\frac{Y_3}{P_1+P_2+P_3}-\frac{X_3}{b_1+b_2+b_3}\right]$$

Now let us look at the component for any one region, say, the first. This may be written as

$$(4) \quad \left[\frac{Y_1}{P_1}\right]\left[\frac{P_1}{P_1+P_2+P_3}\right]-\left[\frac{X_1}{b_1}\right]\left[\frac{b_1}{b_1+b_2+b_3}\right].$$

This indicates that a region's contribution to a simple average for all regions combined depends on (1) the per capita nonfarm income in that region, (2) the ratio of that region's nonfarm population to the total nonfarm population for all regions combined, (3) the per capita farm family income in that region, and (4) the ratio of that region's farm population to the total farm population for all regions combined.

Turning now to the United States average difference computed by use of the regional data, we have

$$(5) \bar{I}_{U.S.}=\frac{\left[\frac{Y_1}{P_1}-\frac{X_1}{b_1}\right]b_1+\left[\frac{Y_2}{P_2}-\frac{X_2}{b_2}\right]b_2+\left[\frac{Y_3}{P_3}-\frac{X_3}{b_3}\right]b_3}{b_1+b_2+b_3}$$

This in essence is an average of regional differences weighted by the proportion of total farm population residing in each region. Its meaning is straightforward. It is an average per capita difference, which, when multiplied by the total population will yield an estimate of the total dollar deficiency consistent with the existing variations in the gap among regions. In other words, it measures the total amount of *additional income* needed to equalize farm and nonfarm dollar incomes in *each region.*

Again taking a component of this United States average for the first region we get from (5) above.

$$(6) \qquad \left[\frac{Y_1}{P_1}-\frac{X_1}{b_1}\right]\frac{b_1}{b_1+b_2+b_3}$$

$$=\left[\frac{Y_1}{P_1}\right]\left[\frac{b_1}{b_1+b_2+b_3}\right]-\left[\frac{X_1}{b_1}\right]\left[\frac{b_1}{b_1+b_2+b_3}\right]$$

Subtracting this from (4) above, yields

$$(7) \qquad \left[\frac{Y_1}{P_1}\right]\left[\frac{P_1}{P_1+P_2+P_3}-\frac{b_1}{b_1+b_2+b_3}\right]$$

Here we have the source of the differences in the measurement of the United States average gap between per capita income of nonfarm persons and that of farmers arising from the use of the aggregative data, on the one hand, and regional data, on the other. It lies in the weighting of the nonfarm per capita income for each region in computing the U.S. average.

In those regions where the proportion of the nonfarm population to the total nonfarm population for all regions is high relative to the proportion of the farm population to the total farm population for all regions, the per capita nonfarm income will receive a heavier weight in the United States average when it is computed by the aggregative method. Where the reverse is true the weight will be lighter. And where they are equal there will be no difference in weight as between the two methods.

As can be seen from (7), these differences will be greater, the higher the absolute level of nonfarm income per capita in a given region.

TABLE 4.—*Comparison of regional contributions to computed United States average difference between per capita nonfarm and farm income, using two methods of computation*

Region	Ratio of regional nonfarm population to U.S. nonfarm population	Ratio of regional population of farm households to U.S. population of farm households	Per capita income		Contribution to estimated United States average gap		Estimated bias in aggregative U.S. average
			Nonfarm	Farm	Using aggregative method	Using regional differences	
	Percent	*Percent*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Northeast	0. 3037	0. 0778	2, 175	1, 218	566	74	+492
East North Central	. 2101	. 1646	2, 182	1, 082	280	181	+99
West North Central	. 0792	. 1809	1, 861	957	−26	164	−190
South Atlantic	. 1091	. 1936	1, 521	879	−4	124	−128
East South Central	. 0580	. 1702	1, 366	751	−49	105	−154
West South Central	. 0914	. 1270	1, 577	1, 121	2	58	−56
Mountain	. 0359	. 0398	1, 726	1, 353	8	15	−7
Pacific	. 1126	. 0461	2, 215	2, 575	131	−17	+148
United States	100. 0000	100. 0000			908	704	+204

Regional Distribution of Bias

Table 4 reveals the extent of biases and their distribution by region, when the computation of the United States average differences or gap in per capita nonfarm and farm income is made by use of United States totals only. Some explanation of the data in some of the columns may be in order, at this point, to make the meaning of the table clearer.

Columns (1) and (2) are simply the proportions of total United States nonfarm and farm populations, respectively, in each region. Columns (3) and (4) are the per capita incomes for each region. Columns (5) and (6) under "Contributions to United States average gap," show the estimated dollars per capita contributed by each region to the United States average computed by the aggregative and regional difference methods. Thus, in column (5), we have expression (4) above computed for each region. That is, each entry for a region is (1) the per capita nonfarm income multiplied by the ratio of nonfarm population in that region to total United States nonfarm population, less (2) the per capita income of farm-operator households multiplied by the ratio of the farm population in that region to the total United States farm population. The sum of these computations yields the United States average gap, as computed by use of aggregative United States figures. These are the regional contributions implied by the aggregative method.

In column (6) we have expression (6) above computed for each region. It consists of nonfarm income per capita less the farm income per capita, multiplied by the farm population ratios for each region.

Column (7) which is the difference between columns (5) and (6) shows the estimated "bias" in the United States average gap resulting from the computation of the United States average by use of United States totals. The differences shown in column (7) could also have been obtained by substitution in expression (7) above, which we have found is the difference for each region implied by the two methods. Thus, for the Northeast Region we find that the substantial density of nonfarm population in that area relative to the farm population, combined with the high dollar level of nonfarm income per capita results in an extreme upward bias in that region's contribution to the U.S. average computed by use of aggregative figures. Upward biases are also reflected for the Pacific and East North Central Regions for the same reasons. In all other regions, downward biases are the rule primarily because of the relatively higher density of farm populations in those regions.

Regional Data Would Minimize Bias

One clear implication of these results is the necessity for greater geographical detail in per capita income data in order to properly gage the magnitude of the disparity in income between farm operators and persons in nonfarm occupations for the country as a whole. As a minimum goal, estimates at a regional level on a current year basis should be aimed at. Of course, biases may be present even in regional measures because such estimates are themselves aggregates of State estimates. However, tests with limited data available for 1955 indicate that if a comparison were made on a State-by-State basis rather than on a regional basis, the U.S. average gap estimated by use of aggregate figures for the U.S. would be reduced by about the same amount as that indicated by the regional data. Considering the additional cost of collecting and analyzing State data, therefore, regional data appear to be quite adequate to measure the average gap between the income of persons on farms and those not on farms for the U.S. as a whole.

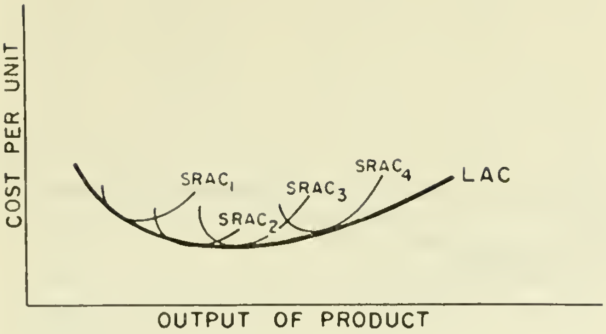
A Derivation of Average Cost Curves by Linear Programming

By Randolph Barker

This paper presents a further modification of linear programming technique which provides the basis for the calculation of average cost curves. The procedure followed is similar to variable resource programming. Returns are maximized with respect to the output of a particular product as output is varied over the desired range. This provides information on variable costs which when combined with fixed-cost data permits the plotting of average cost curves. The author is indebted to Walter R. Butcher and Earl O. Heady for their constructive criticism.

SEVERAL MODIFICATIONS of linear programming procedure that have been developed have greatly increased the flexibility of programming as a research tool. This paper presents a variation of the simplex solution that permits calculation of average cost curves. Although this method is similar to the variable resource and variable pricing techniques developed earlier, it is based on the continuous variation of a product over the relevant output range.

The procedure for calculating average cost curves is developed in detail. An empirical example is taken from a 1957 investigation of "loose housing" systems on Iowa dairy farms. Synthetic farm models for central Iowa conditions were constructed to permit comparison of the conventional stanchion barn with the following loose-housing milking systems: (1) A 4-abreast stanchion parlor, (2) an elevated side-entry 3-stall parlor, (3) an elevated side-entry 6-stall parlor, and (4) a 6-on-a-side herringbone parlor. Short-run and long-run average cost curves were developed for these systems.



The Nature of the Cost Curves

In the hypothetical diagram presented, a family of short-run firm cost curves (SRAC) and a long-run average cost curve (LAC) are shown. Underlying each of the short-run curves is a unique production function related to a particular technique and a fixed plant. Innovations that involve different techniques can be either cost-reducing or output-increasing, or both. An innovation that causes an upward shift in the production function is frequently characterized by a subsequent shift of the cost curve downward and to the right.

The long-run average cost curve, which is often referred to as the planning curve, is formed by fitting an envelope curve to a series of short-run firm cost curves. The long-run average cost curve indicates a minimum-cost route of expansion in volume of output and herd size and provides information on economies of large-scale production. Theoretically, in the long run, the entrepreneur may alter the quantities of all inputs and the form in which they are used. In an instance of this kind, resources are not normally increased in the same proportions. Therefore, the empiricaly derived long-run average cost curve is not the result solely of adding inputs in fixed proportions. In the words of Chamberlin, "The long-run average cost curve must be interpreted as the joint result of the proportions of factors employed in their aggregate amounts."[1] For a time, the short-run firm curves that are tangent to or circumscribed by the curve have successively lower minimums. Hence they define a downward course for the latter until a minimum is reached. This may be attributed to (1) increased specialization and (2) qualitatively different and technologically more efficient units of factors, particularly machinery.[2] Technology, therefore, forms an essential part of a planning curve as used here.

Method of Analysis

The basic method used in computing cost curves was that of "variable resource programming." Under this method, a single resource is allowed to vary continuously throughout the specified range. For example, by varying the quantity of capital, optimum farm plans could be computed for a given set of enterprises and resource restrictions. The plans designated would be those representing "corner points" in resource use. A corner point indicates an optimum plan limited by the scarcity of some resource other than capital. Corner points and the linear segments connecting them represent the maximum return (or the minimum total cost) for varying levels of capital.

Two assumptions of linear programming have particular importance with respect to the derivation of average cost curves: (1) constant returns to scale within an enterprise, and (2) independence among enterprises. For most farming situations in which the free competitive market operates, these assumptions are relevant. In general, changes in prices and costs are affected very little by changes in scale. However, this does not prevent us from calculating an upswing in the cost curves based on the limited supply of resources, or on limited plant facilities.[3]

For purposes of the study reported, the quantity of milk rather than the quantity of some resource was allowed to vary. At each programming iteration, a new plan was developed indicating the optimum organization of resources for a particular level of milk output and a particular milking system. This procedure was continued for each short-run cost curve until it was no longer possible to increase milk production. (This is indicated by the absence of negative coefficients in the milk-output row of the matrix.)

[1] Chamberlin, E. H., *The Theory of Monopolistic Competition*, Harvard University Press, Cambridge, 1950, p. 230.

[2] Ibid. p. 235.

[3] For a discussion of average cost curves with reference to plant capacity, see Kenneth E. Boulding, *Economic Analysis*, Harper and Brothers, New York. 1955. Pp. 570–571.

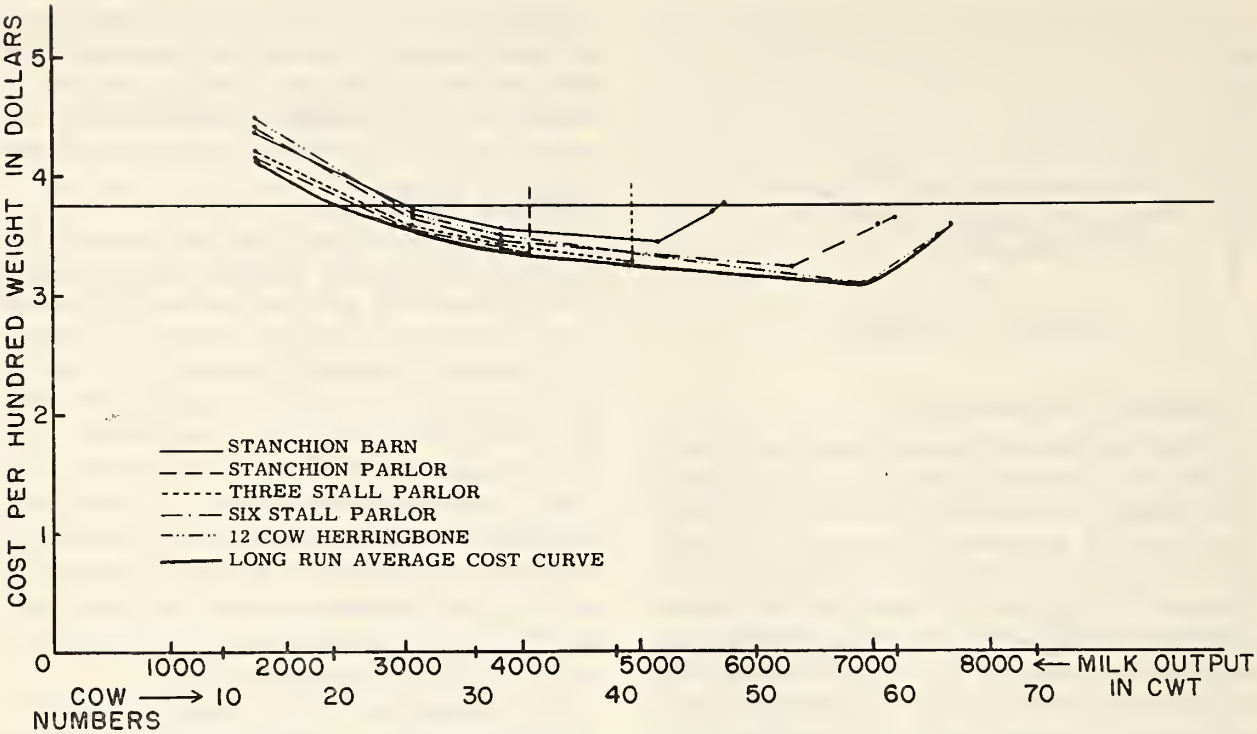


Figure 1.—Short-run average cost curves showing cost per hundredweight of milk for five dairy-cash grain farms in central Iowa with a long-run average cost curve for dairy farming.

The costs for the dairy enterprise under linear programming were analyzed at each iteration as follows. First, the entire farm was initially programmed, and dairy costs were segregated in order to determine the cost per hundredweight of milk.[4] Cash grain for sale represented a second opportunity for the use of farm resources. Farm labor was limited to two full-time men and one summer hand. A minimum return to capital of 5 percent was required. Land was not limiting. Costs included a 5-percent charge for fixed capital, a 7-percent charge for variable capital, and a $2,500 charge per man-year of labor. The cost per unit thus represented a charge for all items except management.

Five average cost "curves," one for each of the dairy systems analyzed, are presented in figure 1. Cost per hundredweight of milk was determined for each of the corner points under a given milking system. As shown in figure 1, these points are connected by line segments. Curved lines could have been used to conform with the orthodox presentation of costs. However, this has not been done because under the finite possibilities offered by the programming solution, the path of optimum farm plans is correctly defined by line segments.

As the volume of production or herd size is increased, all cost curves behave similarly, declining at first rapidly and then more gradually. This decline is due to the spreading of fixed costs over a larger herd size. The upswing of the curves is caused by labor restrictions. The curves for the 3-stall and stanchion parlors rise vertically from the minimum cost point at 4,095 and 4,959 hundredweight, respectively, under the labor restrictions.[5] For the other three systems, a point is

[4] The problem of allocating costs between enterprises is difficult and always open to dispute. Of necessity, many of the decisions are arbitrary.

[5] See footnote 4.

reached at which greater output of milk can be achieved only by a considerable sacrifice in production of cash grain. More labor is required in the dairy enterprise. The quantity of land operated is reduced and directed into forage-intensive rotations. This loss in revenue from the cash grain enterprise, charged as an opportunity cost to the dairy, causes the cost curves to rise. In fact, most Corn Belt dairy farmers combine a sizable cash grain enterprise or other livestock enterprise with the dairy. Therefore, incorporation of this opportunity cost is felt to be a realistic procedure.

Because of the discontinuous nature of the short-run average cost curves, the long-run average cost curve has been fitted by hand. Only three of the short-run curves—the stanchion parlor, the 3-stall parlor, and the herringbone—have points lying on the long-run curves. This is because the stanchion barn and the 6-stall systems do not have lowest cost per unit for any point in the output range of the analysis.

The lowest point on the long-run curve is at 6,946 hundredweight, with a price of $3.10 per hundredweight, the minimum price for the short-run curve associated with the herringbone parlor. The long-run average cost curve might continue to fall up to some point at which the economies associated with proportionality and the spreading of fixed costs are almost completely exhausted. Beyond this point, the slope of the curve cannot be determined accurately. In the traditional concept of the long-run, it is assumed that all resources are variable. This would mean that the labor supply, as well as land and capital, could be increased. Under these circumstances, the long-run average cost curve would extend horizontally until management became restricting. Although land, labor, and capital can be combined in very large units, the coordinating ability of management is limited; it cannot be increased indefinitely along with other resources. Once the capacity of the operator for efficient management is exhausted, the long-run cost curve will turn upward.

In this analysis, it has been assumed that the farm labor supply is limited. This assumption appears to be realistic for the immediate future. If this labor limitation holds in the long run, then the long-run cost curve will rise, as in figure 1, touching the corner points on the short-run average cost curve for the herringbone parlor. This means that labor instead of management would be the long-run limiting factor.

Programming Procedure

This section describes in detail the programming procedure for those who are interested in the mechanics of the linear programming technique.[6] The maximum profit solution was employed in order to derive the opportunity costs associated with removing labor from production of cash grain. There was also interest in knowing net returns for various levels of output. Normally, orthodox cost curves alone can be derived more efficiently if a minimum cost solution is employed.

In order to derive an average cost curve, we first solved for the optimum plan by the usual simplex procedure.[7] This optimum solution corresponds to the point of maximum net revenue and of optimum output (though usually not minimum cost).

The second step in deriving a short-run curve might be posed in question form as follows: "What procedure may we employ to determine the minimum cost per unit at every level of output?" In moving from the optimum to the first and subsequent suboptimum positions, we must decide how to readjust our plan so that we will lose the smallest amount of money per unit increase or decrease in milk output. In each instance, the smallest of these coefficients will determine the activity that will be introduced to alter the optimum plan.

If prices are held fixed, the solutions that define the firm cost curves will be a series of suboptimum plans with respect to the maximum profit solution. As with all curves developed by linear programming, the average cost curves are formed by line segments. The length and slope of these segments are determined by the availability and cost of resources.

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[6] Symbols and techniques are those used in *Linear Programming Methods*, by E. O. Heady and W. Candler, 597 pp., Ames, Iowa, State College Press, 1958.

[7] It is not necessary to begin in this way. One can start by solving for any predetermined level of milk output, for example, the zero level. The starting point will depend on the information desired and the computing facilities available.

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TABLE 1.—*Plan for optimum output for 6-stall parlor*

Resource		P_0	May labor P_{41}	June labor P_{42}	September labor P_{45}	Summer labor P_{46}	Hired man P_{47}	COMMM P_4	Cows (D^2) P_{13}
CCOM	$-78.44\ P_1$	67. 54	0. 4357	0. 0882	0. 0767	0. 1603	0. 2163	0. 3335	0
Corn selling	$1.32\ P_{21}$	7, 154. 00	34. 3800	1. 2400	−13. 1900	2. 2600	17. 8900	3. 3200	16. 9400
Corn silage	$-1.04\ P_5$	41. 32	. 0100	−. 0349	. 1716	. 0637	. 1171	−. 0001	. 0002
Field hay	$-7.98\ P_8$	55. 82	−. 0405	. 0553	. 1239	. 1011	. 1108	. 0002	−. 0001
Cows (D_4)	$-77.04\ P_{18}$	13. 38	−. 0480	. 0862	−. 0464	. 1565	−. 0069	. 0001	0
COMM	$-56.25\ P_3$	43. 93	−. 3033	. 1763	. 1533	. 3208	. 0209	1. 6670	. 0001
Straw	$-2.30\ P_9$	42. 30	−. 0308	. 0421	. 0939	. 0766	. 0840	−. 0001	. 0002
Cows (D_1)	$-308.26\ P_{10}$	9. 98	0	0	0	0	0	0	0
Summer labor	$-600.00\ P_{23}$	1. 00	0	0	0	0	0	0	0
Oats selling	$.64\ P_{22}$	1, 277. 00	7. 9700	. 0600	−3. 8500	. 0700	3. 3320	13. 7000	−34. 3300
Cows (D_3)	$-87.81\ P_{14}$	29. 47	. 0095	−. 0333	. 1638	−. 0608	. 1117	0	0
Grass silage	$-6.45\ P_7$	20. 22	−. 0724	. 1300	−. 0700	. 2362	−. 0103	. 0003	0
July labor	P_{43}	17. 46	−. 5810	−. 2992	−. 4848	1. 2765	−. 2904	−. 5075	. 0004
Hired man	$-2{,}500.00\ P_{24}$	1. 00	0	0	0	0	. 0044	0	0
Milk selling	$3.75\ P_{19}$	6, 346. 00	−4. 6250	6. 3250	14. 0850	11. 5050	12. 5950	0	. 0050
$Z_i - C_i$		15, 778. 04	9. 6911	8. 2314	7. 8406	8. 6607	9. 0357	. 5657	. 1981
ΔP_i		----------	−2. 10	1. 30	. 56	. 75	. 72	---------	39. 62

Table 1, an abbreviated matrix, presents the maximum-profit solution for the 6-stall parlor system. The coefficients in the milk-selling row (other than in column P_o) indicate the per hundredweight change in amount of milk for each unit of the corresponding activity introduced into the plan. Positive coefficients signify a decrease in milk supply, negative coefficients an increase. Introducing one unit of P_{41} will increase milk output by 4.625 hundredweight. The profit, or $Z_j - C_j$ row, indicates the marginal change in net income forthcoming with the introduction of a unit of the j^{th} activity. In the optimum plan, all $Z_j - C_j$ values are positive or zero, indicating that for the given restrictions, profit is at a maximum. It is therefore apparent that the introduction of any activity will result in a suboptimum position. If the coefficients of the $Z_j - C_j$ row are divided by the corresponding coefficients of the milk-selling row, the solution will signify the change in profit per unit change in milk for each unit of the activity produced. The smallest of these numbers indicates the column vector to be removed. The smallest negative number will locate a point of higher milk output, the smallest positive number a point of lower output. Mathematically, we may formulate:

$$\Delta P_j = \frac{Z_j - C_j}{\pm m_j}$$

in which: ΔP_j is the change in profit per unit change in milk as added or subtracted by the j^{th} column

$Z_j - C_j$ is the marginal return in the j^{th} column

m_j is the milk coefficient of the j^{th} column

The minimum negative and positive ΔP_j's indicate the activities to be introduced into the plan.[8] The outgoing row is then determined in the normal way, by selecting the smallest R value when R is the number obtained by dividing the positive coefficients of the outgoing row into the corresponding coefficient of the P_o or resource column. The smallest R indicates the resource that will become restricting. The new profit equation may be written as follows:

$$\Pi^* = \Pi + \min_{i} R(Z_j - C_j)$$

[8] Those who have worked closely with linear programming will note immediately the similarity between the above procedure and that of variable pricing, for if we allow the price to vary, the ΔP_j would be the change in price necessary to bring about a new optimum or locate another point on the step supply function. See W. Candler, A Modified Simplex Solution for Linear Programming with Variable Prices, Jour. Farm Econ. 39: 2, May 1957.

TABLE 2.—*First iteration for output greater than optimum*

Resource		P_0	May labor P_{41}	COMMM P_4	Cows (D_2) P_{13}
May labor	P_{41}	155. 01	1	0. 7654	0
Corn selling	1.32 P_{21}	1, 824. 59	0	29. 6355	16. 9400
Corn silage	−1.04 P_5	39. 77	0	. 0076	. 0002
Field hay	−7.98 P_8	62. 10	0	−. 0308	−. 0001
Cows (D_4)	−77.04 P_{18}	20. 82	0	−. 0366	0
COMM	−56.25 P_3	90. 95	0	1. 4348	. 0001
Straw	−2.30 P_9	47. 07	0	−. 0237	. 0002
Cows (D_1)	−308.26 P_{10}	9. 98	0	0	. 0001
Summer labor	−600.00 P_{23}	1. 00	0	0	0
Oats selling	.64 P_{22}	41. 53	0	19. 8005	−34. 3300
Cows (D_3)	−87.81 P_{14}	28. 00	0	. 0073	1. 0001
Grass silage	−6.45 P_7	31. 44	0	−. 0551	0
July labor	P_{43}	107. 52	0	−. 9522	. 0004
Hired man	−2,500.00 P_{24}	1. 00	0	0	0
Milk selling	3.75 P_{19}	7, 062. 94	0	−3. 5401	. 0050
Z_j-C_j		12, 718. 07	0	7. 9836	. 1981
ΔP_i		----------	----------	−. 44	----------

n which Π* is the new profit

Π is the old profit

R is the ratio of the P_0 value to the corresponding positive coefficient of the j^{th} column

Z_j-C_j is the marginal return of the j^{th} column

Once this iteration has been completed, at least one of the coefficients of the Z_j-C_j row is negative. This identifies a suboptimum position for the given resources.[9] But the suboptimum represents an optimum for the particular level of milk output. That is to say, if the output of milk were fixed, the programming solution would locate a point that lies somewhere on our curve.

Tables 2 and 3 represent steps that have been worked from the data in table 1. These are the first points to the right and left of the optimum for the 6-stall parlor. Little explanation is needed. In table 1, P_{41} contains the only negative ΔP_j. It was selected as the outgoing column and replaced row P_1. The new solution shows a decrease in return of $3,060 ($15,778 minus $12,718) and an increase in milk output of 717 hundredweight (7,063 minus 6,346). Again in table 1, the minimum positive ΔP_j indicates that P_{45} is the outgoing column. Income is lowered by $3,326 ($15,778 minus $12,432), and milk output is decreased by 2,534 hundredweight (6,346 minus 3,812).

The procedure outlined above can be continued over the range of output desired, either until the cost curve intersects the Y axis (at which point milk production becomes zero), or, at the other extreme, until the slope of the average cost curve becomes vertical. This will occur when all negative values have been removed from the milk-selling row, or when the output of milk has been maximized for the given resources.

It may happen that the point of maximum production will coincide with that of maximum profit. For example, this is the situation under the 3-stall and stanchion parlor (fig. 1). In this instance, the plant is producing at capacity, and fixed resources limit further expansion. The average cost curve rises to infinity from the minimum point. Profit and milk-selling rows will contain only positive values.

As the number of activities is often limited by necessity, this would not be an uncommon programming solution. In reality, however, the farmer is seldom confronted with a cost curve that has such sharp kinks. The number of opportunities for the adjustment of resources and output is infinite, and the cost curve is perhaps better described by a smooth curve. For example, cattle rations and fertilizer inputs can be altered by minute quantities. Nevertheless, linear program-

[9] At this point, the procedure departs from that of variable pricing. Under variable pricing, the Z_j-C_j is recomputed to eliminate all negative values and maintain an optimum plan for the new price.

Table 3.—*First iteration for output less than optimum*

Resource		P_0	June labor P_{42}	Sept. labor P_{45}	Summer labor P_{46}	Hired man P_{47}
CCOM	$-78.44\ P_1$	81.34	0.1038	0	0.1888	0.2686
Corn selling	$1.32\ P_{21}$	9,527.07	−1.4415	0	−2.6359	26.8847
Corn silage	$-1.04\ P_5$	10.45	0	0	0	.0001
Field hay	$-7.98\ P_8$	33.53	.0805	0	.1471	.0263
Cows (D_4)	$-77.04\ P_{18}$	21.73	.0768	0	.1393	.0247
COMM	$-56.25\ P_3$	16.35	.2075	0	.3777	−.0836
Straw	$-2.30\ P_9$	25.41	.0612	0	.1114	.0200
Cows (D_1)	$-308.26\ P_{10}$	9.98	0	0	0	0
Summer labor	$-600.00\ P_{23}$	1.00	0	0	.0100	0
Oats selling	$.64\ P_{22}$	1,969.67	−.7227	0	−1.3590	5.9574
Sept. labor	P_{45}	179.91	−.2033	1	−.3712	.6819
Grass silage	$-6.45\ P_7$	32.81	.1158	0	.2102	.0374
July labor	P_{43}	104.68	−.3978	0	1.0965	.0402
Hired man	$-2{,}500.00\ P_{24}$	1.00	0	0	0	.0044
Milk selling	$3.75\ P_{19}$	3,811.90	9.1885	0	16.7331	2.9900
Z_j-C_j		12,431.93	9.8254	0	11.5710	3.6890
ΔP_j		--------------	1.0693	--------------	.6915	1.2338

ming offers an approximation of this curve that can prove of value to the decision maker.

Once the desired number of iterations have been carried out, the information necessary for plotting the average cost curves is easily obtained. Fixed costs should be added to the programming results. Variable costs are obtained by multiplying the unit cost (shown by the figure with negative signs to the left of the P_o) by the corresponding number of units in the plan (shown in the P_o column). The only remaining task is to separate costs for the dairy enterprise from all other costs and to divide the total at each iteration by the milk output to obtain the cost per hundredweight of milk. This establishes the points that are connected to form the cost curves as shown in figure 1.

Finally, it should be pointed out that figure 1 represents only one way in which the information obtained from this programming procedure can be presented. Curves could be developed that indicate costs for the whole farm rather than for a particular enterprise. In this case, it would be necessary to change the vertical axis to measure costs in terms of dollars of gross return. Also, instead of making cost comparisons, it would be possible to develop revenue curves. For example, the net return at each iteration (as indicated in the Z_j-C_j of the P_o column) could be simply plotted against herd size. The particular method of presentation will depend on the nature of the problem at hand.

Some Contributions to the Study of Marketing Behavior

By Marguerite C. Burk

What makes consumers buy, or what causes them not to buy, has long been the subject of research, and today it is a well worn topic of conversation. Agricultural economists are professionally concerned with consumers' demand for food and the motivation of their choices. Through the years, fashions in this area of research have changed, as have the phrases used to describe it. Twenty years ago the key phrase was "food habits," later abandoned for "consumer preferences." More recently, it has become "motivation research." No matter what the name, agriculture has a stake in the results. The editors offered Miss Burk the opportunity to review some of the recent contributions to the subject, and what began as a review of several books developed into the discussion that follows.

THE OBJECTIVES of this article are threefold. Basically, the purpose is to review four recent books that deal with motivation research and marketing behavior. But other contributions besides these books are surveyed to indicate the significance of research in this field to agricultural economists. The third objective is to describe some of the unfulfilled needs of food consumption analysts for basic research by social scientists other than economists.

The four books reviewed are: *Motivation and Market Behavior* by Robert Ferber and Hugh G. Wales, (*7*)[1] *Motivation Research and Marketing Management* by Joseph W. Newman, (*10*) *Marketing Behavior and Executive Action* by Wroe Alderson, (*1*) and *Consumer Behavior: Research on Consumer Reactions* edited by Lincoln H. Clark. (*4*)

Motivation and Market Behavior (*7*) by Ferber and Wales is a compilation of readings on motivation research sponsored by the American Marketing Association. Its aim is to provide a wide range of ideas on the subject for the benefit of specialists in marketing and business research by presenting: (1) Different interpretations and attitudes toward the study of motivation and (2) various approaches to solving problems in human motivation.

The authors view motivation study as the search for the *whys* of human behavior, both of individuals and of large groups of people. They stress the fact that research into motivations involves the use of all sorts of techniques from many disciplines—statistics, psychology, economics, sociology, and other social sciences. The existence of different levels of motivation and knowledge of when and how to carry out an analysis on each level, must be recognized as indispensable to a sound understanding of the subject. The authors are critical of the fact that motivation studies have rarely "held other factors constant."

Part I of the Ferber and Wales book provides a general discussion of the meaning and nature of so-called motivation research based on writings of proponents and opponents of the narrow view of the subject—the one that equates the psychological approach with motivation research. The other three parts of the book present illustrations of alternative approaches that are used to explain market behavior. Part II describes and discusses the principal psychological techniques used in motivation research,[2] showing the strong and weak points of each. Part III gives a rundown of nonprojective survey techniques,[3] and part IV pre-

[1] Numbers in italics in parentheses refer to Literature Cited, p. 19.

[2] Such as depth interviewing, focused group interviewing, projective techniques of word association, sentence completion, Rorschach Test, Thematic Aperception Test.

[3] Such as use of informed opinion, measurement of consumer attitudes toward products, brand preference studies, regression analysis.

sents some interesting material on the techniques of aggregative analysis.

The flavor of the book and of the controversies it describes can be illustrated with a few quotations. On page 11 is this conclusion of Charles Cannell, "Techniques are measurement devices only; they are not theory. Theory is essential to understanding the consumer, and techniques in themselves are useless without theory and without hypotheses derived from theory. . . ." Some examples of the findings of motivation researchers on the personality and social status aspects of the demand for automobiles are scattered through the book. The comment of Wroe Alderson is particularly pertinent to an evaluation of the results of such motivation research. He writes, "The very fact that a symbol might be recognized by others may make it less acceptable to the subject as an outlet for secret yearnings . . . (*7, p. 17*)." One of the readings in the book is the paper by Pierre D. Martineau, "A Case Study: What Automobiles Mean to Americans." By now, most Americans are aware of the fact that motivation researchers have stressed the symbolism of automobiles in the modern American culture and that doubts have arisen about their conclusions.

Alfred Politz has been one of the critics of motivation research as narrowly interpreted. His article, "Motivation Research—Opportunity or Dilemma," is an indictment of the validity of psychological methods as sometimes applied to marketing research. He emphasizes the need for quantification and restricts the use of motivation research to the development of hypotheses. In contrast, Ernest Dichter maintains that such techniques are sufficient in themselves. Politz writes, ". . . The problem of the researcher is not to find causes but to find controllable causes . . . (*7, p. 52.*)." He argues that consumer research is a multiphase process.[4]

L. Edward Scriven points out in his paper, "Rationality and Irrationality in Motivation Research," that nose-counting has the function of determining how many people do what. The next problem is to determine why. He believes that the psychological approach to marketing offers "a starting point from which the statistical researcher may determine the relative importance of various motives and attitudes . . . (*7, p. 65*)."

The article by Warren J. Bilkey, "A Sociopsychological Approach to Consumer Behavior," is a good example of the approach of Kurt Lewin—"which teaches that people's actions are survival oriented, their behavior being motivated by their wants and satisfactions in relation to the social environment in which they live (*7, p. 233*)." According to Bilkey, Lewin in his analysis of consumer behavior for the National Research Council during World War II "employed the concept that consumer purchasing in its essence involves a psychic conflict between the person's desire for the item in question and his resistance against the undesirable considerations which the purchase entails, such as money cost and buying time involved. . . ."

Lewin worked on food habits, but Bilkey points out that he failed to relate these findings to the interviewees' actual purchasing behavior. The article by Bilkey describes his small-scale study in which he attempted to quantify people's stated psychic tensions regarding the purchase of certain items and their expenditures for those items. Bilkey believed that he found certain quantitative relationships and that psychic tensions for food were related to the standard of living, the level of uncommitted cash balances, and food price changes.

In the introduction to the last part of their book, Ferber and Wales point out that analysis of the end-result of human behavior can yield, at times, more reliable information regarding the psychological bases for this behavior than can actual interviews, and invariably at considerably lower cost. The contribution of Ruth P. Mack, "Why Consumer Purchases Change Over Time," utilizes a method for prediction of such purposes based on an analysis of aggregates. Her working hypotheses are derived from considerations of individual behavior. Mrs. Mack uses shoes as her example and develops four dimensions in buying: (1) which needs are filled, (2) choice of article to satisfy want, (3) when to buy, (4) relative price.

The contribution that Ferber and Wales make lies in their measured presentation of a broad range of conflicting ideas, and evaluations and ordering of those ideas through introductory notes to each part, and headnotes to each reading.

[4] Robert J. Williams of Alfred Politz Research, Inc., presented a useful short critique of motivation research in his article, "Is It True What They Say About Motivation Research?" (*11*).

Business Use of Motivation Research

Newman's book, *Motivation Research and Marketing Management* (*10*), was written for business executives. It is based on an extensive review of the actual application of the findings of motivation research by research firms, marketing agencies, and business firms for which the motivation studies were made. The purposes of the book are, first, to provide an improved basis for thinking about the nature and significance of motivation research, and, second, to contribute to an understanding of management problems related to its use in marketing.

The key ideas are set forth in the preface. Three in number, they are: (1) Products and services have as their paramount purpose the satisfaction of the wants of the people who buy and use them. (2) Progress consists of evolving better conceptual schemes, that is, more meaningful ways of looking at our world. (3) Buying and consumption should be recognized as human acts serving human purposes.

Newman's definition of motivation research differs markedly from the limited view often presented. He describes motivation research as the attempt to apply systematically the accumulated knowledge of human behavior and the analytical concepts and research methods of such behavioral sciences as psychology, sociology, and social anthropology to the buying behavior of individuals and of groups. This description raises, in the mind of this reviewer, the question of what role the economist is supposed to play in the analysis of consumption and of consumer buying.

The book has three parts. The first covers the concepts of buying behavior and their development, the second provides selected cases of motivation research as examples of its potential, and the third takes up the meaning of motivation research for marketing knowledge and administration.

Marketing people, according to Newman, have thought about buying and consumption in terms of sales data, economic theory, and lists of buying motives without measurement of their relative importance in particular instances. He discusses the common use of introspection, quickie market research, and the compilation of basic marketing facts without exploration of their *whys*. All too often, emphasis has been on techniques and procedures.

Following this up, Newman argues that progress in marketing depends upon developing better concepts of the nature of the people and things with which it deals. To support his argument, he quotes James B. Conant: "The revolutionary advances in science are made in terms of new conceptual schemes (interlocked with controlled experiments), not in terms of improved methods, and not in terms of amassing data."[5] Newman believes that motivation research is contributing to the ongoing process of conceptual development. He points out that the newer research is developing both the concepts relating to the consumer, such as self-image, basic needs, and the influences of the cultural and social milieu, and concepts relating to the product, such as brand image.

Although all aspects of the examples presented are interesting, this reviewer found Newman's discussion of their objectives and of executives' reactions to them particularly thought-provoking. He stresses the two phases in research effort—the formulation of hypotheses and their testing. This book, as well as the one by Ferber and Wales, describes some of the motivation research carried on by automobile manufacturers. Toward the end the author emphasizes contributions of behavioral scientists to idea getting or hypothesis formulation. "An adequate explanation of consumer behavior will be developed only when the psychological aspects are treated together wih the cultural, interpersonal, situational, economic, and material which determine how man's needs finally are handled (*10, pp. 392–393*)."

Newman's book provides agricultural economists with (1) some valuable stimuli to rethinking our bases for analysis of economic data on consumption, (2) a highly readable summary and appraisal of research on motivation, and (3) still another goad to cooperative research with other social scientists.

From a Sociological Viewpoint

Wroe Alderson's *Marketing Behavior and Executive Action* is in effect an antidote for an overdose of claims for motivation research. The basic premise of this book is that marketing behavior is

[5] Page 46 of Newman. (*10*) Quotation from "Science and the Practical Arts," *Harvard Business Review*, Volume XXV, 4A (Autumn 1947), p. 550.

essentially group behavior. "Consumption, which is the end and aim of marketing activity, is a highly socialized activity . . . (*1, p. 15*)." The objective of the book is to present a functionalist approach to marketing theory. The author takes a *very* broad view of the field of marketing; he concerns himself with the development of a *general science* of human behavior. "Functionalism is that approach to science which begins by identifying some system of action, and then tries to determine how and why it works as it does (*1, p. 16*)." Throughout the book, Alderson stresses the whole system or Gestalt approach of starting with the whole and then proceeding to examine the parts. This is akin to the process of disaggregation used in macroeconomics.

Alderson stresses a sociological interpretation of marketing. For example: "The main body of contemporary economists are functionalists in the sense of concerning themselves with systems of action and how they operate to achieve the objectives of their participants. Marketing theory differs from received economic theory mainly in visualizing a more flexible functionalism which is concerned with a variety of systems involved in the movement of goods and services (*1, p. 25*)." This heavy dose of sociology is indeed surprising, coming as it does from one of the successful professional market researchers for business.

Part I, headed "Marketing and the Behavioral Sciences," draws on a number of social science fields for elements of a theory of group behavior. Early in part II, in a discussion of the theory of market behavior, is this statement ". . . Economics starts with certain assumptions as to market organization, while marketing in a sense starts further back with attempts to organize the market or to establish the process of orderly marketing which economics for some purposes takes for granted . . . (*1, p. 99*)."

The chapter in part II on motivation in consumer buying is enlightening and stimulating. ". . . Consuming units such as households are organized behavior systems, but they are systems with a dual aspect . . ." as buyers and as users of goods (*1, p. 163*). Alderson identifies rational problem-solving as a key aspect of consumer behavior. He reviews the development of ideas on consumer behavior by referring to Bentham's pleasure-pain principle of human conduct, the explanations of marginal utility exponents, the habit and impulse ideas of behavioristic psychologists, and the more recent emphasis on instinctive drives by the Freudian psychologists. He stresses the idea that consuming habits are part of the pattern of living, but buying habits are only derived from this pattern. He argues that the consumer purchaser is trying to resolve problems created by his desire for a high standard of living amid uncertainties arising from outside influences.

Alderson makes this significant point, ". . . The concept of demand in economic analysis is concerned primarily with the consumer buyer making a choice in the presence of scarcity. To analyze demand for its own sake would be to explore the problems of choice which affect consumers in the midst of abundance (*1, p. 285*)." Those who agree with Galbraith that many Americans have reached this state of affluence will recognize the urgent need for research in this area.

Part III deals with executive action in marketing. As these chapters are written primarily for executives and management, they are passed over here except for the note that chapter 13 on the solution of marketing problems is based on the idea that problems should determine methods and not vice versa.

Compendium on Consumer Behavior

Lincoln H. Clark has assembled in *Consumer Behavior: Resarch on Consumer Reactions* (*4*) two sets of conference papers. Those in part I were presented to the 1955 meeting of the Committee for Research on Consumer Attitudes and Behavior. Part II contains selected papers prepared for the Conference on Consumption and Economic Development at Princeton University in 1955.

The items in part I that are likely to be of particular interest to researchers in agricultural marketing are: "Consumer Reaction to Product Innovation" by Wroe Alderson, "Consumer Product Acceptance Rates" by A. C. Nielsen, Jr., "Product Changes and Consumer Reactions" by Alfred Politz, and James Morgan's article with an extensive bibliography, "A Review of Recent Research on Consumer Behavior." Much of the bibliography is annotated.

Another article with a bibliography, "International Comparisons of Patterns of Family

Consumption" by the late Faith Williams, is in part II. This bibliography covers sample surveys of consumer expenditures in the postwar period; the author urges workers in this field to give greater attention to achieving more comparability in the collection, summarization, and analysis of the data.

Eleanor M. Snyder's paper, "Impact of Long-Term Structural Changes on Family Expenditures, 1888–1950," should stimulate research by agricultural economists. Her purpose was to examine secular changes in consumption functions derived from eight cross-section surveys of urban families. Herculean efforts were obviously required to adjust data to comparable bases of price, income, and definitions of consumption categories. The data used were in published and unpublished tabulations for 1888–1890, 1901, 1909, 1918–19, 1935–36, 1941, 1944, and 1950. But no amount of patient research in the 1950's can make these surveys comparable in sample coverage and methods used in data collection.[6] Therefore, Miss Snyder's hypothesis that secular changes in the level of urban family food expenditures are a stable function of variations over time in family size, income, and retail food prices cannot be definitively proved or disproved, in this reviewer's opinion. This hypothesis is important to projections of the demand for food and for food marketing services, but the extent of this review precludes further consideration.

Of even more direct interest to many agricultural economists is the Snyder assumption of secular stability in the relationship between total family food expenditures and expenditures for two subgroups—(1) meat, poultry, and fish and (2) sweets and beverages together. For this section of the analysis, Miss Snyder used spring data for 1935–36, 1942, 1945, and 1948. Perhaps a 13-year period is rather short to establish "secular stability." It includes less than two cattle cycles. Also, this reviewer remains dubious of conclusions drawn partly from the disparate samples of nonrelief families in 1935–36. Before accepting this hypothesis about a stable share for meat, poultry, and fish in total food expenditures (including alcoholic beverages), most agricultural economists will want to study prices and quantities consumed in the survey periods in relation to cattle and hog cycles and to changing marketing costs.

Other Contributions to *Why* Research

In the preceding sections, the main points covered by four recent books in the field of motivation research have been considered. Let us now turn to a number of other contributions made in this area. Here emphasis is placed upon the interest of agricultural economists in *why* research, taking a broad view of motivation research. Newman wrote, "Developing better concepts and conceptual schemes is important to marketing because progress consists of the evolution of new mental images of what things are or should be; more meaningful ways of looking at things . . . (*10, p. 394*)."

A contribution to the development of conceptual schemes in the area of motivation research has been made by James A. Bayton in his article, "Motivation, Cognition, Learning—Basic Factors in Consumer Behavior." (*2*) [7] The article gives a comprehensive application of contemporary psychological theories to the analysis of consumer behavior. It calls attention to important psychological ideas necessary to understanding the behavior of consumers. "Human behavior can be grouped into three categories—motivation, cognition, and learning. Motivation refers to the drives, urges, wishes, or desires which initiate the sequence of events known as 'behavior.' Cognition is the area in which all of the mental phenomena (perception, memory, judging, thinking, etc.) are grouped. Learning refers to those changes in behavior which occur through time relative to external stimulus conditions. Each broad area is pertinent to particular problems of consumer behavior. All three together are pertinent to a comprehensive understanding of consumer behavior (*2, p. 282*)."

Perhaps most significant to agricultural economics research is Bayton's statement about competition that goes on within our mental processes. In many instances, he states, cognitive competition occurs between two or more generic categories before it occurs between goal-objects within a generic

[6] For example, the 1935–36 Consumer Purchases Study excluded all persons receiving any relief. Also, the extent to which expenditures by urban clerical workers and wage earners are representative of those by all urban families probably changed considerably in the 62-year period.

[7] The article received special recognition by the American Marketing Association.

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category. For this reason, he suggests, perhaps not enough attention has been given to the psychological analysis of cognitive competition between generic categories. In other words, Bayton appears to argue that the preference for one food should not be studied in a vacuum, but in terms of its competition with other foods, and, likewise, that the competition between food and nonfood goods and services deserves intensive analysis.

Another contribution to *why* research is the address by C. Joseph Clawson, before the 1958 meeting of the Council on Consumer Information, "The Coming Break-Throughs in Motivation Research." (*5*) Clawson identifies seven needed break-throughs. Among these must be the uncovering of all the types of motives that affect purchase of a given product, not just the psychological or social motives. He too points out that there has been dangerous overemphasis on the social and biological motivations, with frequent disregard of economic motives.

Clawson believes that motivation research will become highly quantitative, in addition to providing qualitative insights. He makes this clear in the following statement:

"The pioneers of motivation research have made a contribution of tremendous value to the field of marketing research, but they have not gone nearly far enough. The most important of all break-throughs now needed is the quantification of findings. . . . Marketing executives have always needed and will continue to need to know how many people of what types in which regions feel what way, why, how intensely, and how much difference this makes in their behavior. The results which executives must explain, predict and control are quantitative ones, so the motives and other influences which cause these results must be expressed in quantitative terms too. Bright qualitative insights are welcome but far from sufficient for forecasting behavior and planning action to influence it (*5, p. 3*)."

Clawson joins a number of other writers already cited in emphasizing the need of motivation research for an improved framework of theoretical concepts. This framework must specify all interacting variables involved, ranging from price, income and present supply, to subconscious and concealed motivations. When the variables and their related topical areas are clearly specified for the product and its problem, the selection of research tools becomes much easier. Clawson thinks that this framework will be developed in a situation in which social scientists from different fields and even physical scientists sit down to work out a unified doctrine as well as a research plan to test and improve it. He sees the possibility, even the probability, that this development is coming in a few of the largest business firms in the country and, even more probably, in the leading universities.

Newman certainly agrees with Clawson in noting the trend toward viewing buying and consumption in the context of total human behavior of which they are a part. This current trend in marketing research for business firms is reminiscent of the approach of the Committee on Food Habits of the National Research Council during World War II. The membership of this committee, first organized in 1940, represented the fields of anthropology, psychology, sociology, home economics, physiological psychology, and public health. Curiously enough, it apparently included an economist only for a brief interim.

For this committee, Kurt Lewin made a study of food habits which was reported in a paper entitled "Forces Behind Food Habits and Methods of Change." The content of the following quotation is remarkably similar to the ideas of present day motivation researchers who take a broad view of their subject. "The question [he writes] 'why people eat what they eat' is rather complex, involving both cultural and psychological aspects (such as traditional foods and individual preferences caused by childhood experiences), as well as problems of transportation, availability of food in a particular area, and economic considerations . . . (*9, pp. 36–37*)."

A routine bibliographic search for material on food habits, consumer behavior, and consumer preferences revealed to this writer a striking shift in emphasis during the last 20 years. After World War I, interest in food habits had developed out of concern for the poor diets of certain segments of our population and led to the large-scale consumer surveys of the 1930's and early World War II period, and to the work of the Committee on Food Habits. Since the end of World War II, few writings on food habits have appeared, but the literature on consumer preferences and motivation research has snowballed.

Research Needs

The ideas of any researcher are as influenced by motivation, cognition, and learning as are those of consumers. This researcher rationalizes the presentation of her research needs in these terms: The *motivation* comes from the desire to encourage and persuade her colleagues in the U.S. Department of Agriculture who represent other social science disciplines and researchers in agricultural colleges and in food marketing agencies to help in the search for more adequate explanations of changes in food consumption. The *cognition* of the need for such research has grown out of study of data from the 1955 Survey of Household Food Consumption in connection with trends in food consumption. And this economist has *learned* from 15 years' work on analysis of food consumption that we are only on the threshold of understanding why food consumption changes or does not change.

Some of the research needs of workers in this area are:

(1) Duplication and amplification of Kurt Lewin's research as described in the paper referred to earlier, which used methods of cultural anthropology and psychology (*a*) to measure the homogeneity of food habits of households grouped according to economic and social characteristics; (*b*) to develop frames of reference for evaluating particular foods, such as expense, health, taste, and status; (*c*) to determine how groups of households put foods into these frames of reference; (*d*) to study conflicts in motivations of consumer buying.

(2) A formulation of food groupings having high "within" substitutability, but low outside competition. This would expedite the study of competition among foods. It would be based on research developed under (1).

(3) Study of competition between food and nonfood goods and services in terms of the frequencies of specified patterns and conditions under which major groups of households shop within set budgets for food, or according to quantities of individual foods desired. These would repeat and further develop the type of research undertaken by Warren J. Bilkey (*3*).

(4) Study of food habits and motivations of food consumption by high-income and well-educated households. The question here is whether such households buy all the kinds and quantities of foods they want or whether they feel restricted in choice by price or cost. Such research would provide a guide to possible future patterns of consumption when more of the population achieve these characteristics.

(5) A picture of decision-making for food comparable to that developed for durable goods by Katona and Mueller (*8*). This would help answer questions about the reaction of groups of households to short-run changes in price and supplies of major types of foods.

(6) The interrelationships and substitutions between eating at home and eating away from home. This would supply information about whether people eating a given meal out eat what they would eat at home or if they alter their meals at home to supplement meals eaten out.

In conclusion, it is suggested that interested agricultural economists in the States might form teams of researchers with other social scientists to tackle one of these problems, or even parts of one. Eventually it should be possible to coordinate small-scale case studies so as to obtain overall answers. Perhaps the recommendation of the *Manual for the Study of Food Habits* should be followed, ". . . it seems to be a definite responsibility of workers in fields like food habits, while they are exploring new problems and new methods, to build up a systematic mass of material which has been collected with impartiality and a fair degree of uniformity (*6, p. 19*)."

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Getting the Computational Job Done Electronically

By Hyman Weingarten

This account of computational procedures followed by the Agricultural Economics Division, Agricultural Marketing Service, is presented for readers interested in applications of an electronic computer to statistical and economic problems. A brief description of the machine is given to acquaint the reader with a few of the basic characteristics of this mechanical assistant. AMS machine facilities are under the direction of V. H. Nicholson, Chief of Data Processing in the Statistical Standards Division. His experienced staff of programmers and machine operators readily provide valuable assistance to those seeking machine aid. The author is one of several persons from other divisions who have learned programming techniques under Mr. Nicholson's direction.

THE CENTRAL computing unit of the Agricultural Economics Division has been plagued for years by a twofold problem—first, a lack of trained clerical personnel and, second, an ever-increasing workload. These problems are not unique. They are characteristic of many computing sections and hamper normal research functions everywhere.

Much of the statistical methodology utilized in the research activities of this division is in the area of least-squares regression analysis. Those familiar with its methodology know that a least-squares multiple regression problem is time-consuming and can become an unwelcome chore when a number of problems are presented at once. Because the research analyst is keenly aware of this situation, he often spends considerable time in an attempt to determine a priori the best statistical relationship to fit. He is hesistant to experiment—to test alternatives. In addition, the relatively recent development of computational techniques associated with the limited information method for handling simultaneous equations has added immeasurably to the workload. Problems of the latter type are generally larger and more complex.

The advent of the electronic computer has been a great factor in helping to overcome these handicaps. It has aided research personnel virtually to jump from a comparatively "primitive" era of statistical computations into a modern one of greater efficiency and practically unlimited bounds of application. The Agricultural Economics Division has been utilizing electronic equipment regularly in the recent past. First, under contract with the National Bureau of Standards, statistical computations were performed on its electronic computer, the SEAC. When Standards decided to eliminate SEAC operations, contract work was transferred to the Service Bureau Corporation. During this latter period, our personnel became familiar with computer techniques. As a result, a relatively easy transition was made when in May 1958, the Agricultural Marketing Service set up its own facilities and acquired a magnetic drum data processing type IBM 650. Since that time, the machine has provided results to economic research problems both speedily and efficiently.

The Computer and Its Language

The same battery of questions come from those who are unfamiliar with electronic computers. What is it? What does it do? How does it work? Is it actually a "brain"?

Answering the last question first, "No, it is not a brain"! A computer cannot think for itself. The machine must be told what to do every step of the way. There is nothing mysterious or superhuman about it. If a programmer fails to instruct the machine, it can go no further. It is merely a machine constructed to relieve man of burdensome computations, and this it does in a most spectacular way.

The AMS installation consists basically of three components: (*a*) The read-punch unit, (*b*) the console unit and (*c*) the power unit.

Data, previously punched on cards, are fed into the computer through the read-punch unit. Cards are read, one at a time, at a maximum rate of 200 a minute. After specified computations are performed by the computer, answers are punched by this same unit at a maximum rate of 100 cards a minute. Proper wiring of the unit's control panel permits the variation of card formats among problems, thus allowing for flexibility of input and output.

The second component of the installation, the console, contains the magnetic drum, the control and calculating units. The magnetic drum—the heart of the computer—is a cobalt-nickel-plated cylinder about 4 inches in diameter and 16 inches in length. It provides general storage, or "memory." When the unit is in operation, the drum revolves at a speed of 12,500 revolutions a minute. The control section permits access to machine storage at any time. If necessary, information can be read into general storage or memory manually through certain storage-entry switches. Stored information can be read out and ascertained from the display lights on the control unit. Lastly, the calculating units, as the name implies, perform all the mathematical operations. These occur in conjunction with registers identified as the distributor, the upper accumulator, and the lower accumulator. The accumulators are somewhat similar to those on a desk calculator. Algebraic signs are automatically controlled.

The power unit contains the power supply for all machine units. It contains also the circuitry needed to translate input from decimal form into machine code and machine code back into decimal form for output.

All processing operations are controlled by instructions consisting of numerical words of 10 digits and a plus or minus sign. A meaningful sequence of instructions leading to the solution of a problem is labeled a "program."

The 10 digits of an instruction are divided into three basic groups: The operation code, the data address, and the instruction address. As the numerical words representing the original data and instructions are read into the computer by the read-punch unit, they are stored in the console unit in locations on the surface of the drum in the form of magnetic spots. Each word is identified by a particular pattern of spots. The AMS computer can store 2,000 numerical words in storage locations, numbered 0000–1999. Each word is assigned a 4-digit address when it is first stored on the magnetic drum in order to hasten its location at a later time. Thus, in performing an operation, the machine refers to a storage location on the magnetic drum to obtain an instruction. After performing the specified operation, the machine goes to another storage address. There it obtains another instruction and acts upon it. These steps are repeated over and over.

As an illustration, suppose storage location 0101 contains the following instruction: 15 1849 0102 +, where the operation code designated is 15, the data address is 1849, and the instruction address is 0102. This means that the word in location 0101 instructs the machine through operation code 15 to add the contents of location 1849 to the lower accumulator and go to location 0102 to pick up the next instruction. Location 0102, in turn, may have the following word: 20 0147 0103 +. Now the machine is told to store the contents of the lower accumulator in location 0147 and go to location 0103 for its next instruction, and so on.

Using the Electronic Computer in a Multiple Regression Analysis

Because regression analysis is a major concern, our first objective was to secure a complete least-squares regression procedure of operation. A study of many different programs compiled by the manufacturer in his program library was made prior to the delivery of the AMS computer.[1] Five programs were selected. For any least-squares analysis, their operation provides all the data necessary with a minimum of manual computation.

In presenting a regression problem for processing, the originator submits only the observations for each variable in the problem, designating which variable is dependent. When computation is complete, the series of programs calculates

(1) Means;
(2) Standard deviations;
(3) Simple correlations coefficients;
(4) Inverse of the correlation matrix;
(5) Partial correlation coefficients;
(6) Partial regression coefficients;
(7) Standard errors of these regression coefficients;
(8) Residuals;
(9) Predicted values.

The programs do not provide for the computation of the constant term of the regression equation

[1] A "program library" is maintained as a service to those using this equipment. It is an extremely important service, as users benefit from the experiences of many programmers throughout the country. Other manufacturers have similar services.

and the multiple correlation coefficient. However, such values can be obtained easily by a short desk-calculator operation.

The five IBM library programs that make up the regression analysis series are:

1. *Correlation Analysis with Annotated Output*, *No. 290–1*, *File No. 6.0.014.*

This program computes the means, standard deviations, and simple correlations for problems with as many as 25 variables and 9,999 observations. Results from this program are obtained both in fixed and in floating decimal point form. Floating decimals are based on a code or characteristic of 50, representing an integer followed by its decimals; for example, 501478200 is the number 1.478200. Cross product terms in fixed and floating decimal form are other options that may be punched out.

2. *Double Precision Matrix Inversion*, *No. 283*, *File No. 5.2.009.*

This program can invert a matrix of any order up to a maximum of 25. Input data are the simple correlation coefficients derived from the preceding program. Elements of the inverse matrix have eight-place accuracy, that is, the symmetric elements of the matrix are identical to eight places. Input and output data are in floating decimal point form.

3. *Multiple Regression Analysis*, *Phase III–2*, *No. 299*, *File No. 6.0.001.*

Using the inverse elements and standard deviations computed by the two preceding programs, partial correlation and regression coefficients involving the dependent variable are derived. Both input and output data are in floating decimal point form.

4. *Unbiased Standard Errors of the Regression Coefficients*, *No. 297*, *File No. 6.0.008.*

This computation is based on the partial regression and partial correlation coefficients from the preceding program. Input and output data are in floating decimal point form.

5. *Multiple Regression Analysis*, *Phase IV*, *No. 299*, *File No. 6.0.001.*

This program computes either the estimated values of the dependent variable or the residual values between the computed and observed quantities based on the regression coefficients, means and the original observations of preceding programs.

Initally, this five-program series proved to be as efficient a procedure as we could get. Needless to say, efficiency could have been improved with a greater reduction in card handling. It is better, for example, to process a number of problems at one time rather than individually. Programs listed above as items 1, 2, and 4 permitted computation of any number of problems in succession without the necessity of reloading the program deck for each problem. However, this was not true in the cases of Phases III–2 and IV of Program No. 299, items 3 and 5 above. The latter require that the program deck be reloaded along with data for each new problem.

IBM programmers have been working toward the objective of developing shortcuts that will further reduce card handling. One modification recently completed, Program No. 290–3, consolidates steps 3 and 4 above. Thus partial correlation coefficients, regression coefficients, and standard errors of the regression coefficients can be obtained now by the same program. The program deck is read into memory once and then solutions for any number of problems can be derived in succession. In addition to coefficients obtained formerly, the new program also provides for the computation of the constant term of the regression equation, the multiple correlation coefficient, the standard error of estimate and computed "t" values.

To give readers some idea of the amount of time needed to obtain the coefficients for a least-squares regression analysis, estimates have been made from timing formulas for the five steps of our original program series. The economic research problems handled by the Division contain an average of approximately 20 observations. The computational time required for deriving coefficients for a typical 20-observation problem having different numbers of variables is summarized below.

Number of variables	Minutes of computation
5	11
6	12
7	13
8	14
9	15
10	17

No allowance is made for card punching, verifying, listing, or handling between programs. If such operations are considered, a rough estimate of total time required for the processing of one problem—punching of data on cards through the listing of results—would be between 1½ and 2 hours. But, as indicated before, any given time estimate will be reduced substantially if a number of problems are processed together. With the substitution of Program No. 290–3 into the AMS series, computation time is reduced even more. Although no formula is yet available, the maximum computation time for the largest problem it can accept, 25 variables, is approximately 5 minutes. Therefore, the computation times given above would be reduced substantially. One criterion developed as a result of these time calculations is that coefficients for any two, three or four-variable problem are derived by desk calculator; problems having five or more variables are processed on the computer.

Another recent addition to the AMS program series is a logarithmic subroutine, File No. 3.0.013. It has been adapted and make an integral part of the series so that regression problems may now be computed based on actual and/or logarithmic data. The desirable feature of this routine is that its output is directly acceptable as input to Program No. 290–1, the first step in the regression analysis program series.

Other Statistical Adaptations

The procedure outlined above represents only one approach used in getting solutions to some of our research problems. Many more facets of our research activity can be adapted to the machine.

For example, in some of our research, we obtain results from both the least-squares and the limited-information methods for comparison purposes. The author is currently working on a program series that will result in an eventual solution by either method and, at the same time, take advantage of computations common to both.[2] So far, a program has been designed to secure the adjusted augmented moments for as many as 28 variables. Once obtained, such factors can then be separated according to specified relationships and used either in a least-squares or limited-information solution of an equation. The program is patterned after methodology described in "Computational Methods for Handling Systems of Simultaneous Equations."[3] The method described in the publication derives coefficients from an inverse of a variance-covariance matrix. On the other hand, the methodology used in the library routines outlined here computes coefficients from an inverse of a correlation matrix. This is the essential difference between the two systems of computation.

The operation of this program produces the following data: Unadjusted augmented moments, means, scale factors, deadjustment factors, and the adjusted augmented moments in fixed and in floating decimal point form. As the program operates in fixed point form exclusively, input data have one limiting aspect. For minimum loss of information owing to rounding error, observations should not exceed four digits—three integers and a decimal. However, additional work is continuing in order to avoid such restrictions and to increase the overall flexibility of the program.

Other library programs have proved useful. For example, many of the computational steps required by the limited information method involve matrix operations. One development in particular requires a triple-product matrix of the form, $C=A\ B^{-1}\ A'$. Its solution is secured by using the inversion program outlined above, a matrix transfer program, and a program for matrix multiplication. Another area of computation deals with the determination of the roots of a characteristic equation. Heretofore, such roots were derived through an iterative method designed primarily for desk calculators. Currently, experimentation is underway to determine whether certain library programs can be adapted to our computational processes.

Because of the computer's limited drum surface and its associated storage-capacity restrictions, a complete program for the solution of simultaneous equations using the limited-information method is not feasible. Certain areas of computation have been adapted to the machine thus far. At present, the best that can be hoped for is to continue to section off various phases of computation and link them into a program series similar to the one established for least squares.

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[2] A program for the solutions of equations by the methods of limited information and least squares has been developed by IBM for a larger capacity electronic computer.

[3] Friedman, Joan and Foote, Richard J. *Computational Methods for Handling Systems of Simultaneous Equations.* U.S. Dept. Agr. Agr. Handb. 94, 109 pp., illus. Nov. 1955.

Book Reviews

The Dynamics of Supply: Estimation of Farmers' Response to Price. By Marc Nerlove. Johns Hopkins Press, Baltimore, Md. 267 pages. 1958. $5 in hard bound edition, $4 in paper bound.

IN HIS PREFACE, the author points out that when "the solution of the original problem is not as acceptable as on first thought . . . it is difficult to know how and when to commend one's work to the mercies of public discussion. Nonetheless, the benefits of such discussion far outweigh any disadvantages which may accrue to the author." This commendable statement about the value of discussion in handling difficult problems provides the viewpoint for this review article in which I shall attempt to place Nerlove's substantial effort in perspective. In doing this, Nerlove's effort is often criticized for shortcomings that are also characteristic of the profession's work. This, in turn, makes it important to say at the outset that Nerlove has done a piece of work that should find an important place in the development of methodologies and theory for measuring and studying supply responses.

The first two chapters provide the theoretical underpinning. Chapter 3 presents a quite limited review of previous empirical work on the supply of agricultural commodities. Data limitations are discussed in chapter 4, while the characteristics of the corn, cotton, and wheat sectors of the agricultural economy are discussed in the next three chapters, the last of which deals very briefly with Government programs for the same three crops. The results of the statistical analysis are presented in chapters 8 and 9.

This review encompasses three topics: (1) Theoretical considerations, (2) results obtained, and (3) the place of Nerlove's effort in the literature and work on the supply of agricultural commodities.

Theoretical Considerations

In his empirical work, Nerlove emphasizes heavily the use of observable variables (recorded prices and quantities) to estimate relationships among nonobservable variables, namely, "expected normal prices" and "long-run equilibrium output." This emphasis makes it necessary for his theory to cover (1) dynamics as well as statics and (2) what I call the "length of run problem" in economics. As he draws heavily on Hicks, Walras and Marshall, he inherits several intellectual difficulties from the profession's past. Ironically, these difficulties seem to this reviewer to be in the areas to which Nerlove has attempted to make his special contribution, namely (1) dynamics and expectations and (2) determination of relevant lengths of run.

He uses the concepts of "elasticity" and "coefficient" of expectation in dealing with actual and normal expected prices. In dealing with actual and long-run equilibrium output, he uses the corresponding concepts of "elasticity" and "coefficient" of adjustment.

Elasticity and coefficients of price expectation.—Nerlove uses a simple statistical model to explain price expectation. Basically, his model regards this year's expected normal price as last year's expected normal price plus some proportion, β, where $0<\beta\leqq 1$, of the difference between last year's actual and last year's expected normal price. As last year's price is regarded to be a similar function of the same variables for the next previous year, the model makes current expected prices a function of the average of all past prices, the most recent prices receiving the largest weight according to the size of β which is the coefficient of price expectation. When $\beta=1$, this year's expected normal price is last year's actual price, while if $\beta=0$, this year's expected price is the same as last year's expected normal price. The first of these special extreme cases has been used often by past investigators. Nerlove assumes neither extreme, but investigates the theoretical aspects of the problem of estimating β.

Elasticity and coefficients of adjustments.—The adjustment concepts used are analogous to and as simple as the price elasticity and coefficient of expectation concepts. This year's output is regarded as last year's actual output plus a proportion γ, where $0<\gamma\leqq 1$, of the difference between last year's actual output and its long-run equilibrium output. The treatment of γ is similar to the treatment of β.

Output as a function of price.—In strict accordance with the static production economic theory developed by Hicks, Walras, Marshall and others, long-run equilibrium output is treated by Nerlove as a function of normal expected price.

A major difficulty recognized by Nerlove is that his theoretical system does not permit him to distinguish estimates of β, (the coefficient of price expectation) from estimates of γ (the production adjustment coefficient). He attempts to handle this *identification* problem with an additional "identifying" variable.

Some empirical observations on the formulation of price expectations and adjustments thereto.—Work on expectations carried out by the risk and uncertainty subcommittee of the North Central Farm Management Committee (NCFMRC) indicates that the price expectation models used by farmers are much more sophisticated than the simple statistical models used by Nerlove or those previously postulated and investigated at Iowa by Schultz, Gaines and Heady; or at Illinois by Williams. Farmers have had years of experience with government programs which controlled prices and production. They have also experienced the shifts in demand which accompanied World Wars I and II and the Korean conflict. Inflations and deflations have been weathered. These experiences have been supplemented by the interpretative, educational efforts of the Extension Service and the agricultural press. The overall result is that the price expectation models of farmers are conceptually more complex than the simple primarily statistical models envisioned by Nerlove and the workers mentioned above.[1] Do we really believe that the next year's expected price is this year's expected price plus some proportion (constant from year to year) of the difference between last year's actual and last year's expected normal price regardless of wars, price-support activities, inflations, economic collapse, changing foreign demand, strikes, and institutional adjustments—all of which were important in the 1909–32 period studied by Nerlove?

Similar work on farmers' responses to price changes and the formulation of their production plans indicates far more complex adjustments than can be handled by a simple γ which does not change from year to year.[2]

Static production economic theory, lengths of run and fixed assets.—The survey work of NCFMRC is supplemented by theoretical work on the consequences of observed widespread differences between acquisition and salvage prices for producer durables. These theoretical efforts indicate major difficulties in the Marshallian, Walrasian, and Hicksian production adjustment and supply concepts used by Nerlove.

The difficulties and, hence, the need for a more adequate theory of fixed assets are outlined in the following discussion. Nerlove writes, (p. 29) "If a firm in a competitive industry produces only one output, it can be shown that the firm's supply curve for that output is identical with its marginal cost curve when marginal cost is above average variable cost, and identical with the average variable cost when marginal cost is below average variable cost." Do we really believe this standard teaching of sophomore texts? Consider a short run in which a dairy farmer regards feed and associated inputs as variable while cows, barns, and milking equipment are fixed. Do we really believe that the price of milk can fall until the present value of the anticipated future MVP's of the annual services of a dairy cow fall to zero, as would be true when MC=AVC? Of course not. We know that the meat market stands ready to buy the cow long before the capitalized value of her anticipated future MVP's falls to zero. And if our farmer starts to sell cows, it is obvious that neither his former MC nor his AVC curve is any longer relevant.

Conversely, if the price of milk were to rise until the present value of the future stream of MVP's anticipated from a dairy cow exceeded her acquisition price (market value plus buying and transportation costs), that part of the original MC above AVC would not be the firm's supply curve. Again, our farmer would treat dairy cows as variable and would move to a marginal cost

[1] Partenheimer, Earl J., *Some Expectation Models Used by Selected Groups of Midwestern Farmers.* Unpublished Ph. D. Thesis, Department of Agricultural Economics, Michigan State University, 1958. (Abstract available on request.)

[2] Boyne, D. H. and Johnson, G. L., A Partial Evaluation of Static Theory from Results of the Interstate Managerial Survey, Jour. Farm Econ., Vol. 40, May 1958.

curve which includes the cost of acquiring the services of more dairy cows. As the costs of acquiring such services exceed what can be realized in disposing of such services by selling cows, the MC curve for expanding production by adding cows is different from the MC curve for contracting production by selling cows.

A theory is needed which determines endogenously which inputs enter (along with their prices) into MC and AVC, and which enter into AFC. Such a theory would produce a partially irreversible supply function. Initial decreases in product prices following a rise in production would have little effect on output, while still larger decreases would be expected to yield a much more elastic response. Such a contraction, if followed by a price increase, would not be expected to induce an immediate expansion. However, further price increases would eventually be expected to bring forth more elastic responses.

Further difficulties appear on page 35. Here we find: "Normally factors of production will have rising supply curves to the industry . . . but will appear perfectly elastic to the individual firm." For the farm firm, the acquisition price of a durable (or of the services obtained by buying the durable) is greater than the salvage value of that durable (or the services of that durable marketed by selling it). The same is true of many expendables. Consider for instance the buying and/or transportation charges involved in acquiring and disposing of land, buildings, tiling systems, combines, cotton gins, corn cribs, hay, grain elevators, silage, tractors and fuel, all of which are involved in the production of corn, cotton, or wheat. Every farm boy knows that selling such assets or the services they produce is quite a different matter from buying them. Discontinuities are far more characteristic than perfect elasticities.

In view of the above discussion of output adjustment and supply functions for factors of production, Nerlove's coefficient of adjustment, γ, seems somewhat inadequate. A boy appears to have been sent to do a man's job. Do we really expect the difference between next year's production and this year's production to be some proportion γ, where $0<\gamma\leqq 1$, of the difference between this year's "long run equilibrium output" and this year's actual output regardless of whether product prices have just reversed, have been going up for a number of years or have been going down for a number of years? [3]

The above brief and inadequate account of what is known and suspected about the formation of price expectations and production adjustments strongly indicates that Nerlove's β and γ are oversimplifications.

Results Obtained

When Nerlove used distributed lags to estimate γ and/or β for corn, wheat and cotton, higher estimates were obtained than when one preceding year's price is treated as the long-run normal price as has usually been done in the past. These coefficients yielded, in turn, greater elasticities of production with respect to price. He points out that these larger elasticities are consistent with experiences under governmental controls and with the findings of micro-agricultural economic analysis. The estimates obtained can be interpreted as either β, the coefficient of price expectations, or as γ, the coefficient of production adjustment. Attempts to produce separate estimates of β and γ using an "identifying variable" were unsuccessful. Either the variables selected to obtain identification, or the β and γ were inappropriate.

In the first section of this review-article, questions were raised about the applicability of the price-expectation and production-adjustment models employed by Nerlove. The reasonableness of the elasticities he obtained do not detract from the relevance of these questions. Normal expected prices as estimated in regression I are averages. As such, they have the same mean as the original prices but have a much smaller range of variation. When the regression of acreage on a series of moving averages is compared with the regression of the same variable on the individual observations in the series, we expect a greater regression in the first than in the second *regardless of validity of the reasons for using the average.* The fact, then, that higher coefficients were obtained by Nerlove does not necessarily make the case for the *logic* by which they were obtained.

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[3] For some initial work on this problem see Clark Edwards, *Resource Fixity, Credit Availability and Agricultural Organization,* unpublished Ph.D. Thesis, Michigan State University, 1958. (Copies of abstract available upon request.)

Other empirical work on price expectations and production adjustment on the part of farmers, supplemented by far more dynamic theoretical work on price expectations and more realistic static theoretical work on asset fixity, length of run and supply response, suggests that the theoretical reasoning behind regressions I and II is far from adequate or complete.

The Place of Nerlove's Results in the Literature on the Supply of Agricultural Products [4]

It appears that Nerlove's theories, estimating techniques and empirical results will fit into the body of literature on supply responses about as follows:

1. His theories involving coefficients of price expectations and adjustments will persist since they are superior to past theories assuming certain values for these coefficients. As past theories have proved useful despite their shortcomings, Nerlove's concepts should prove still more useful.
2. His theories, however, are likely to prove capable of being improved by making his γ and β functions of variables other than past prices and output.
3. Attempts to make γ and β functions of additional variables may prove helpful in providing "identification" of β and γ in more advanced models still to be developed.
4. Attempts to improve price expectations and adjustment models beyond levels attained by Nerlove should include attention to:
   (a) Current work on dynamics;
   (b) current work on asset fixity and length of run and may result in the elimination of β and γ.
5. Despite its name, Nerlove's work will not become known as "*The* Dynamics of Supply." Presently, we do well to say *something* meaningful about supply dynamics.
6. Nerlove's work will prove to be an important step forward in the analysis of supply. He can be proud of it within:
   (*a*) His cautious prefatory statement quoted in the beginning of this review, and
   (*b*) in view of the following discussion of the use of his estimates which appears on p. 215: "In this section the statistical results presented in the preceding section are applied to a variety of problems. Knowledge about the elasticities of supply is useful in a large number of areas; the problems discussed in this section serve only to illustrate the uses to which such estimates may be put. Three problems are considered: (1) the accuracy of farmer's expectations of 'normal' price taken as a forecast of actual price; (2) the question of whether an equilibrium of demand and supply is stable; and (3) welfare losses under alternative price-support programs. *No definite answers are attempted in the discussion of any of these problems primarily because the results presented in the preceding section are highly tentative.*" (My italics).

This frank, highly commendable statement indicates that Nerlove is a good scientist; it should be pondered as carefully as Nerlove has written it by all who might be inclined to use distributed lags and Nerlove's models for price expectations and production adjustments.

Glenn L. Johnson

[4] Incidentally, the body of literature on this subject is much larger than that covered in Nerlove's review. Notable for the omission from Nerlove's review are three publications, all dealing with supply and all involved in Farm Economic Association annual awards: (1) Roger W. Gray, Vernon L. Sorenson and Willard W. Cochrane, *An Economic Analysis of the Impact of Goverment Programs on the Potato Industry of the U.S.*, University of Minnesota Technical Bulletin 211, 1954, (2) Dale E. Hathaway, *The Effects of the Price Support Program on the Dry Bean Industry in Michigan*, Michigan State College Technical Bulletin 250, April 1955, and (3) Glenn L. Johnson, *Burley Tobacco Control Programs*, Kentucky Agricultural Experiment Station Bulletin 580, February 1952. Other omitted work includes that of George E. Schuh, *The Supply of Fluid Milk in the Detroit Milkshed as Affected by Cost of Production*, Michigan Agricultural Experiment Station Technical Bulletin 259, April 1957. Schuh reports a short-run elasticity for milk production ranging from 0.41 to 0.57, an estimate which should have been of considerable interest to Nerlove.

Technology in American Water Development. By Edward A. Ackerman and George O. G. Löf, with the assistance of Conrad Seipp. Published for Resources for the Future, Inc., by the Johns Hopkins Press, Baltimore, Md. 709 pages, illustrated. 1959. $10.

ACKERMAN AND LÖF have given us an important work. Its rich content of facts and ideas are like those of a valuable mine or storehouse. Much can be learned by examining the contents, but these are the raw ores that must be shaped into a variety of products that will help in meeting specific water problems.

The authors review proven and emerging water technology with the purpose of classifying techniques and outlining specific technical subjects for more detailed study. Then they seek to appraise the relation between technology and administration of water resources in the United States.

Thirty-one case descriptions selected from proven and emerging technology are presented. These descriptions represent much of the water technology of agriculture, and industry upon which popular and scientific interest has centered. They are grouped under five categories of technology which economists will recognize as involving the discovery of new production functions, a more intensive use of known functions, and application of functions over a wider range.

The five categories are techniques that (1) increase demand for water, (2) decrease demand, (3) extend the services of a given unit of water supply, (4) promote economies of scale, (5) extend the physical range of water recovery.

Demand-increasing technology consists largely of new processes requiring large inputs of water. Of interest here is the discussion of the likely impact of peaceful uses of atomic energy. Demand-decreasing technology includes water-saving innovation through the substitution of capital for water in the production process. Here the account of industrial recycling will be helpful in appraising the future water requirements of industry. Another fertile field for research that is discussed is the technique of spraying the effluent from food-processing plants on agricultural lands for irrigation. Use of saline water and development of drought-resistant crops are further examples given of demand-decreasing technology.

Techniques extending the services of a given supply are modification of water supplies to a desired quality, time and place, and their subsequent allocation to various uses. The promotion of scale economies includes the improvement of machinery and techniques for construction and operation of systems for the collection and distribution of water supplies over a large area.

Most stimulating are the cases described under "Expanding the Physical Range of Water Recovery." This category is closely related to the preceding one and consists of the modification of water in the ocean, in the atmosphere, and in its discovery underground. Estimates of potential increase in precipitation through cloud seeding are given for 11 Western States.

In their consideration of administrative response to technology, the authors explicitly exclude the complex of human values and social forces that ultimately shape administrative organizations and their response to technology in water and elsewhere. Within this limitation, judgments are made of the success of administration in facilitating realization of benefits inherent in technology. The appraisal is in terms of the five categories of technology, cast into planning, development, and operational phases. The responses and potential roles are discussed for private, public, local, State, regional, and national bodies.

The conclusions are manifold, and perhaps it is in the nature of the subject that no easy summary can be given. To those acquainted with reports on water policy prepared by governmental commissions and boards, many of the conclusions will have a familiar ring. Yet something is new, primarily in perspective. There is a persistent emphasis on the role of water administration: the matching of supply and demand for water. The forces that shape the demand for water are evaluated, as is the appropriate geographic area for planning. Water development is viewed in terms of the interaction of other resources, population, and technology. In short, regional rather than project planning is stressed.

Technology in American Water Development will make its most valuable contribution as a wellspring of ideas and facts that stimulate further research. Those who read the book for clear-cut answers to specific problems are likely to be disappointed. At another level, the book can serve as a comprehensive introduction and survey of the water field. The glossary, and particularly the introductory chapters offer a broad sweep and insight into the patterns of occurrence and use of water. Helpful references appear in a topical reference list and in footnotes throughout the text.

Karl Gertel

Economics of American Forestry. By Albert C. Worrell. John Wiley and Sons, Inc., New York. 441 pages illus. 1959. $9.75.

THE ECONOMICS of forestry has been taught for a long time in forestry schools in the United States, but for many years there has been no satisfactory text for the use of students in such courses. As a professor of forest economics, now at Yale University, Professor Worrell has undoubtedly been acutely aware of the imbalance between the demand for a textbook and the supply, and has written, in his words, "a text for a college course in the economics of forestry." His objectives were "to give a clear picture of the economic environment within which forestry operates, to help the student in understanding the many economic relationships which exist in forestry and to furnish some tools of analysis which might prove useful in coping with economic problems as they arise in forestry."

In carrying out his objectives the author has devoted about three-fourths of his book to chapters on the consumer demand for forest products, the supply of forest products and services, production economics in forestry, the processing of forest products, the demand for wood as a producer's good, growing and harvesting forest products, capital in forestry production and other related topics. Upon reading this material one gets the impression that it will be useful to small businessmen such as the operators of small sawmills and pulpwood loggers as well as students.

The last quarter of the book is apparently directed to foresters who play a broader role in industry and Government. It includes chapters on the social and private costs and benefits in forestry, unpriced forest products and services, future demand for forest products and services, ownership of forestry enterprises and lands, government and forestry, and economic-policy problems in forestry.

Professor Worrell has taken elementary economic theory and illustrated it with examples from forestry. The text is written in simple language that should be readily understood by forestry students without previous training in economics. His book is therefore likely to be widely used in forestry schools, particularly where the students in forest economics have not received prior training in elementary economic theory.

On the negative side, the general coverage of the book seems to lack balance—too much of the text is devoted to supply-demand analysis of the firm and not enough to the broader economic problems of forestry. For example, scarcely any mention is made of taxation, insurance, and credit. Business cycletheory, which should be of great interest in forestry, is almost completely ignored and the field of macroeconomics is inadequately presented.

It is, of course, easy to pick flaws and say the author should have done this or that; but by any set of standards, Professor Worrell's effort represents a substantial achievement and a major contribution to the field of forest economics.

Dwight Hair

Economics of the Business Firm. By Joseph D. Coppock. McGraw-Hill Book Company, Inc., New York. 366 pages. 1959. $6.95.

ADAPTATION of relevant elements of standard economic analysis to the needs of business students is the aim of Professor Coppock's textbook. The student is not expected to have had a general course in economics, though this would help. The work is designed for a course of one quarter or one semester.

The nature, aims, and place of the business firm in economic organization and the nature and determinants of profits are covered in part 1. A chapter on "tools" discusses schedules, curves, cost functions, slope, elasticity, shifts, and so on. Part 2 considers the "Mechanisms of Profit Maximization" under different conditions of cost. Part 3 is devoted to "Determinants of Demand for the Firm's Product," covering the demands of consumer-buyers, demands of producer-buyers, demand under different conditions of "market structure" and demand manipulation. Also discussed are methods of estimating demand. Finally, "Determinants of the Cost of the Firm's Products" are dealt with in part 4, covering the technical conditions of production, the prices of inputs (under alternative "market structures") and methods of estimating costs. A short conclusion considers the applicability of the economics presented. A summary is given at the end of each chapter and each section. Questions and supplemental readings are appended.

The arrangement of subject-matter is evidently somewhat distinctive, and this commends the work to the attention of teachers. The text is readable, diagrammatic, and nonmathematical. One may wish for more liberal use of illustrations to dramatize analysis. But this would be asking Professor Coppock to write a bigger book or to delete subject matter. The latter point suggests the larger question, what subjects are important for the business student or others seeking an understanding of the economics of the business firm? For example, there is more to the economics of the business firm than cost and revenue analysis under nine alternative market structures as developed in chapters 15 and 21. Yet it may be better to drill the student on these methods of analysis, than to broaden his exposure to economics.

A few substantive comments will suffice. Included in the cost of production is the opportunity cost of capital employed. Few businessmen can afford to lose sight of this realism. But this reviewer has misgivings about the wisdom of holding money used in business as a producer or capital good (pages 44–45, 304–305). Similarly, it seems unfortunate to perpetuate the notion that production creates possession utilities (page 44), or to view the economic role of households as narrowly as discussion of the applicability of the money calculus shows (pages 22–24). Such concepts are not necessary for marginal analysis of the business unit as Professor Coppock has developed it.

Allen B. Paul

The Computer and the Brain. By John von Neumann. Yale University Press, New Haven. 82 pages. 1958. $3.00.

A COMPUTER is an often-maligned piece of machinery. All kinds of exaggerated claims are asserted about its prowess. Not the least of such claims infers that a computer thinks for itself. If it does, then obviously the line of demarcation between machine and man fades.

In this short book, which presents the 1956 Silliman Lectures at Yale University, the late John von Neumann compares computing machines with the human brain. Sadly, his wife Klara reminds the reader that these lectures represent an "unfinished and fragmentary manuscript." The burden of a fatal illness was too much for even the exceptional mind of a von Neumann to surmount in his final days.

Through a discussion of some of the principles underlying the systematics and the practice of computing machines, as well as a discussion of the human nervous system, von Neumann brings out their similarities and dissimilarities. By such means he hoped to learn how an approach toward the understanding of the nervous system ought to be made from the mathematician's point of view.

Computing machines are basically of two types: "analog" and "digital," though there are machines that embody the principles of both types. Analog computers represent each number by a physical quantity, such as the angle by which a disk has rotated or the strength of a current. Digital computers designate each number as a sequence of digits. Each digit is identified by the presence or absence of a marker, which may be in the form of a magnetized spot.

How the two basic types of computers perform the conventional basic operations of arithmetic is described in part 1. Once a procedure is established by which a computer can perform these operations, the machine must then be made to perform them according to a sequence that produces the solution of a mathematical problem. The necessity to "sequence" operations has as a consequence the need for a "memory."

The machine's memory, von Neumann points out, "must be able to 'store' a number—removing the one it may have stored previously—accepting it from some other organ to which it is at the time connected, and to 'repeat' it upon questioning: to emit it to some other organ to which it is at that (other) time connected. Such an organ is called a 'memory register,' the totality of these organs is called a 'memory,' and the number of registers in a memory is the 'capacity' of that memory."

Proceeding into part 2, the lectures discuss the human nervous system, comparing it with modern computing machines.

The brain and spinal cord together constitute the central nervous system. The basic component of the human nervous system is the nerve cell, the neuron. The neuron's function is to receive impulses and convey them to other cells. It does this by means of branches called axons and dendrons (also called dendrites). The former normally carries impulses away from the cell body while the latter carries impulses toward the cell body. The point at which the axon of one neuron and the dendrite of another seem to meet is known as the synapse. At this junction the nerve impulse jumps a tiny gap from the axon to the dendrite.

The nervous system, therefore, acts as an organ which accepts and transmits definite physical entities, the pulses. Von Neumann points out that this is the description of the functioning of an organ in a digital machine and justifies the assertion that the nervous system has a digital character.

While these lectures are not easy reading they are worthwhile for anyone who derives enjoyment from the synthesis of disciplines—constituting, in the pages of this volume, mathematics, engineering, and neurology.

Martin J. Gerra

Economic Plan and Action. By Charlton Ogburn. Harper & Brothers, New York. 287 pages. 1959. $4.75.

THE NATIONAL Planning Association, a private nonprofit organization composed of leaders of agriculture, businessmen, and labor, has made an important contribution since 1945 to the development of public and private economic policies. The author was associated with NPA for 15 years as legal counsel. His stated objective in writing this book was to summarize in one publication, with a minimum of supplementary comments, the large number of general and special studies conducted by NPA in the postwar period.

Comments in each chapter, with one exception, cover NPA reports. A number of broad economic problem areas are included, such as the Federal budget and the Full Employment Act. Most of the chapters, however, are concerned with specific problem areas, such as the export of U.S. private capital, foreign aid programs, labor and collective bargaining, and productive uses of nuclear energy and education. In each chapter, some background material on why the study was undertaken by NPA is included, along with the major findings and recommendations.

One difficulty in reading the book arises from its basic organization around the titles of NPA reports which are not tied into other studies on related subjects summarized in different parts of the book. For example, the chapters dealing with the Full Employment Act, the Federal budget, agricultural surpluses, and national defense are closely related to Federal Government budgetary policies, and these NPA reports should be analyzed as a unit if the significance of NPA contribution is to be fully realized by the reader. Findings on problems such as the export of capital, foreign aid, and business performance abroad are scattered throughout the book.

Some of the recommendations are outdated because conditions have changed since the reports were prepared. The importance of price level stabilization as a policy objective, for example, receives less emphasis here than it has in other recent discussions. Finally, the title implies that the book represents more of a direct public and private economic plan of action to achieve stated social goals than is indicated in the contents. Those economists and statisticians who are interested in a summary review of the important studies made by NPA will find this book very useful. However, prospective readers who are looking for a systematic analysis and evaluation of developments of private and Government policy formulation in the postwar period will be disappointed.

Daniel W. Burch

The Study of Economic Growth: Thirty-Ninth Annual Report of the National Bureau of Economic Research. Introduction by Solomon Fabricant. 91 pages. May 1959.

FINDING A CENTRAL THEME for the diverse research enterprises of that amazing and unique institution, the National Bureau of Economic Research, has always been difficult. Dr. Fabricant's choice around which to weave the Bureau's report of current and projected work is the study of economic growth. This fits particularly well certain areas of the Bureau's present activity, such as a historical study of the nature and rate of U.S. growth before 1870, and an over-the-shoulder appraisal of how fast the Soviet Union is now growing.

The growth idea is a less appropriate label for that part of the Bureau's program which still falls in a traditional path, and which results in rediscovery of old truths or in unrelieved frustration as often as it does in unearthing new pieces of economic knowledge. Search for natural periodicity—the pendulum principle—in economic affairs still goes on. Abramovitz, for example, finds substantiating evidence for "the notion that economic growth moves in recurrent waves of acceleration and retardation with a period of between 15 and 20 years." [1] His wondering if these are "systematic" or "episodic" is of a pattern with business-cycle research of the last half-century. Also, his "four basic chronologies—output, stock of resources, productivity, and intensity of resource utilization"—are not novel to farm economists familiar with the cattle cycle.

It is good to see that such studies, reminiscent of Mitchell, while doubtless worthwhile are overshadowed by more modern approaches. Unfortunately, some of the Bureau's growth studies bog down in the problem of identifying and measuring technology separate from capital, one made more complex by the fact that technology is an abstraction while capital is increasingly not measurable by its mass or its price but by its productivity alone. A few of the Bureau's observations on this are unconvincing. Highly gratifying is the Bureau's recognition of the human element in economic matters. Man himself is an integral part of economic society. The Bureau is studying population increase rates, consumers' buying plans, and the great field of "capital investment in human beings." Impressive, and perhaps novel for that staid agency, is an admission with respect to political action: "political decisions . . . induced by the stresses or imbalances . . . in . . . (cycli-

[1] Perhaps it is not untimely to observe that according to this life expectancy the current acceleration has only a dozen or so months to go.

cal) swings" have a "lasting import." In simpler words, public programs generated by a business recession can make a contribution to long-run growth.

The report omitted only one timely observation, that increased concern with economic growth is itself an expression of the currently existing phase of the business cycle; it is a mark of prosperity.

Harold F. Breimyer

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Colleges [1]

ANDREW, RICHARD A. A STUDY OF THE SWEET CORN INDUSTRY IN THE MIDWEST FARM ECONOMY. Minn. Agr. Expt. Sta. Tech. Bul. 232 (No. Cent. Reg. Pub. 95) 116 pp., illus. June 1959.

Presents information on economic relationships and historical developments in the sweet corn industry for the Midwest and the United States. Describes production and consumption trends, the position of sweet corn in the current setting, and the role of processors in the industry; and analyzes the demand, the Midwest supply for processing, and the competition of the Midwest with other regions.

ATKINS, S W. CHANGING SIZE OF FARMS IN TENNESSEE. Tenn Agr. Expt. Sta. Bul. 229, 15 pp., illus. August 1959. (U.S. Agr. Res. Serv. cooperating.)

From a low in the midthirties of 70 acres per farm, the average size of Tennessee farms had grown to 86 acres by 1954. At the same time, average production increased 75 percent, beef and dairy farms having the greatest increase. Among tenure groups, part owners led in expanding the acreage of their farms. Outside forces, mainly nonfarm employment, contributed to the trend by drawing a fourth of the farm operators, chiefly from the tenant group, away from farming.

BERTRAND, ALVIN L., AND OSBORNE, HAROLD W. RURAL INDUSTRIALIZATION IN A LOUISIANA COMMUNITY. Louisiana State Univ. and Agr. and Mechanical Col. Bul. 524, 40 pp., illus. June 1959. (Agr. Mktg. Serv. cooperating.)

Low-income rural areas are a potential source of employees for industry. Mostly, these employees will be unskilled, young, and willing to work for relatively low wages. Many will not travel out of their communities for outside employment unless it is necessary. Certain types of industrialization can represent a way to raise personal income and levels of living in low-income rural communities.

BRIGHT, I. DIFFERENTIALS IN WORKERS' EARNINGS IN SELECTED SEGMENTS OF FOOD MARKETING. U.S. Dept. Agr., Agr. Mktg. Serv. AMS–333, 15 pp., illus. September 1959.

Describes regional differences in hourly earnings of workers in certain segments of the food marketing industry. Hourly rates compared for the Northeast, South, West, and North Central regions. Comparisons also made of rates in food processing, wholesaling, and other parts of the industry. The study was made to provide a foundation for future work on costs of marketing.

CABLE, C. CURTIS, JR., METCALF, ALONZO, AND OTHERS. USE OF COTTON FIBER TESTS BY UNITED STATES COTTON SHIPPERS. So. Coop. Series Bul. 62, 32 pp., illus. June 1959. (Agr. Expt. Stas. of Ala., Ariz., Ark., Ga., La., Miss, Mo., N. Mex., N.C., S.C., Tenn., and Tex. and Agr. Mktg. Serv. cooperating.)

Objectives of the study were to determine (1) nature and extent of use of measures of differences in fiber fineness, fiber strength, and other fiber properties in buying and selling 1956–57 cotton by shippers, (2) influences of these measurements on prices paid and received, and (3) estimated costs of fiber tests to shippers. Data pertinent to these objectives were obtained from 164 shippers in the 13 major cotton-producing States.

CAPEL, GEORGE L. COMPARATIVE COSTS OF ALTERNATIVE METHODS FOR PERFORMING CERTAIN HANDLING OPERATIONS IN FLORIDA CITRUS PACKINGHOUSES. Fla. Agr. Expt. Sta. Bul. 609, 69 pp., illus. June 1959. (Agr. Mktg. Serv. cooperating.)

Purposes of study were to measure the physical input-output relationships in specific packinghouse operations and to use these relationships to show relative costs of alternative work methods under a range of output rates.

CLARKE, JAMES H., MYERS, MARDY, AND HUNTER, J. SCOTT. MILK VENDING—A MARKET-WIDE EVALUATION IN BERKELEY COUNTY, W. VA. W. Va. Agr. Expt. Sta. Bul. 429, 58 pp., illus. June 1959. (Agr. Mktg. Serv. cooperating.)

Sales of fluid milk through coin-operated vending machines averaged 1.5 percent of total milk sales in the market area from October 1955 to June 1957. More than 70 percent of milk vended was sold in plants and offices. Before installation of vending machines in these plants and offices, 19 percent of the employees used milk; after installation 63 percent used milk.

DIETRICH, R. A. AND WILLIAMS, W. F. MEAT DISTRIBUTION IN LOS ANGELES AREA. U.S. D.A. Mktg. Res. Rept. 347, 84 pp., illus., July 1959.

[1] State publications may be obtained from the issuing agencies of the respective States.

The structure of the Los Angeles market for livestock and meat was studied for 1 year to determine (1) geographic sources of supply, (2) types and interrelationships of firms, (3) ways of buying slaughter livestock, and (4) distribution channels.

GARLOCK, F. L., SCOFIELD, W. H., STOCKER, F. D., AND OTHERS, UNDER THE DIRECTION OF N. J. WALL. THE BALANCE SHEET OF AGRICULTURE, 1959. U.S. Dept. Agr., Agr. Inform. Bul. 214, 36 pp., illus. October 1959.

The balance sheet as presented here brings together the assets and liabilities of agriculture as though it were one large enterprise. It is the 15th in a series containing comparable annual estimates beginning in 1940.

HENDRIX, W. E. APPROACHES TO INCOME IMPROVEMENT IN AGRICULTURE. EXPERIENCES OF FAMILIES RECEIVING PRODUCTION LOANS UNDER THE FARMERS HOME ADMINISTRATION. U.S. Dept. Agr. Prod. Res. Rept. 33, 44 pp., illus. August 1959.

Conclusions are based on an evaluation of experiences of 5,555 former low-income farmers who received operating loans during the years 1947–53 from the Farmers Home Administration. Resources commanded while under the program, not those owned or used formerly, were found to be the crucial factor in the incomes and progress of families in the sample. For each $1,000 increase in credit funds advanced by FHA, over a range from $500 to $7,500, income was increased an average of about $320 per year in the South, $260 in the North, and $500 in the West.

HUNTER, E. C. ECONOMICS OF FORAGE PRODUCTION IN THE MOUNTAIN MEADOW AREAS OF COLORADO. A PROGRESS REPORT. U.S. Agr. Res. Serv. ARS 43–99, 54 pp., illus. September 1959. (Col. Agr. Expt. Sta. cooperating.)

Recent research work in the Colorado mountain meadow areas has shown that certain management practices can be used to increase the quantity or change the quality of hay produced on the average meadow. If the proper conditions exist, many ranchers can increase production economically by: (1) Applying approximately 50 pounds of nitrogen fertilizer per acre; (2) periodically seeding adapted legumes into the existing sod; or (3) combining these two practices.

JONES, A. D., JR. WOOL WAREHOUSES AND THEIR OPERATION IN THE ELEVEN WESTERN STATES. N. Mex. Agr. Expt. Sta. Bul. 440, 59 pp., illus. June 1959. (Agr. Expt. Stas. of Western States and Agr. Mktg. Serv. cooperating.)

Presents information to show (1) the type of operators, structure, and condition of wool warehouses in Western States; (2) facilities and equipment used; (3) nature and extent of the handling, preparing, and other services relating to wool at warehouses of various types and the charges or costs involved; and (4) operating practices and problems.

NELSON, PAUL E., JR., AND PAUL, ALLEN B. OWNERSHIP CHANGES BY PURCHASE AND MERGER IN SELECTED FOOD INDUSTRIES. U.S. Dept. Agr. Mktg. Res. Rpt. 369, 24 pp. October 1959.

Eight food industries representing all levels of food marketing were surveyed. Of the companies surveyed, 26 percent made acquisitions, disposals, or both during 1952–58. Within most industries the larger companies made the most acquisitions. Methods of acquisition and disposition most frequently adopted were through purchase.

PEDERSEN, JOHN R., MITCHELL, WILLIAM L., AND PRITCHARD, NORRIS T. MOVEMENT OF SHELL EGGS INTO RETAIL CHANNELS IN THE CHICAGO METROPOLITAN AREA. U.S. Agr. Mktg. Ser. AMS–338, 12 pp. Sept. 1959.

A study of Chicago egg distribution channels and the Chicago egg movement report resulted in a revised market news report on movement of eggs into retail channels that will be more useful to egg handlers than the previous report. Research on revision of similar reports in other cities is in progress.

PEIER, J. D., AND GILLILAND, C. B. CAPACITY AND PROCESSING TRENDS IN THE FATS AND OILS INDUSTRY. U.S. Dept. Agr. Mktg. Res. Rpt. 360, 43 pp., illus. September 1959.

Rapid shift in recent years to high-speed screwpress and solvent extraction in the oilseed industry has greatly increased the yield of vegetable oils. These methods yield about 30 pounds more cottonseed oil per ton than the older hydraulic method. More than four-fifths of all cottonseed and more than nine-tenths of the soybeans are processed by these improved methods.

PODANY, J. C., AND FARRIS, D. E. COSTS OF PACKING ARKANSAS PEACHES IN 1958. U.S. Dept. Agr. Mktg. Res. Rpt. 361, 16 pp., illus. August 1959. (Ark. Agr. Expt. Sta. cooperating.)

Average time required to pack a bushel of peaches was 15.5 man-minutes. Total cost (including labor, overhead, and material) averaged 72.6 cents a bushel. Overhead costs ranged from 3.7 to 20 cents per container. Costs of materials was about 48 cents a bushel.

REED, ROBERT H. ECONOMIC EFFICIENCY IN ASSEMBLY AND PROCESSING LIMA BEANS FOR FREEZING. Calif. Agr. Expt. Sta. Mimeo. Rpt. 219, 106 pp., illus. June 1959. (Agr. Mktg. Serv. cooperating.)

Major objectives of report are (1) to develop estimates of total cost of processing frozen lima beans with efficient crew and equipment organization; (2) to determine basis for integrating field and plant operations that will minimize total costs; (3) to show how costs are affected by variations in scale of operation, length of operating season, distance of field-to-plant haul, percent of manual grade-out, and proportions packed in different styles of pack; and (4) to present this information in a way to indicate which methods are most economical in producing given outputs.

RINEAR, EARL H. COMPARATIVE ACCURACY OF TWO METHODS OF PRICING TURKEYS. U. S. Dept. Agr. Mktg. Res. Rpt. 359, 15 pp., illus. Aug. 1959.

Sale of turkeys on a live, flock-run basis results usually in overestimates or underestimates of ready-to-cook yield and percentage of grade A turkeys in flocks. Comparisons of estimated yields and grades of 153 flocks of live turkeys with actual yields and grades showed overestimates and underestimates of as much as several hundred dollars for individual flocks. Sale of flocks on the basis of actual yield and grade results in a more equitable basis of pricing for both seller and buyer.

Rockwell, G. R. income and household size: their effects on food consumption. U.S. Dept. Agr. Mktg. Res. Rpt. 340, 152 pp., illus. June 1959.

This study of the influence of differences in family income, by major income classes, on food consumption at home, found that total consumption of food increases with the number of persons in the household, although consumption per person declines as household size increases. When family income increases, the quality of food consumed increases more than the quantity.

Rogers, George B., and Bardwell, Edwin T. marketing new england poultry. 2. economies of scale in chicken processing. N. H. Agr. Expt. Sta. Bul. 459, 58 pp., illus. Apr. 1959. (Agr. Mktg. Serv. cooperating.)

Economies of scale are much more pronounced for plants processing broilers than for those processing fowl. Under standard conditions, and with each of 10 sizes of model units operated at 100 percent of capacity, unit costs in processing broilers decline from 5.1 cents per pound at 150 birds per hour to 2.6 cents at 10,000 birds per hour. Unit costs in processing fowl decline from 4.0 cents at 120 birds per hour to 2.6 cents at 6,000 birds.

Stockman, L. H., and Clement, W. E. effects of coupons and special offers on sales of butter, margarine, shortening, and salad and cooking oils. U.S. Dept. Agr. Mktg. Res. Rpt. 356, 23 pp., illus. Aug. 1959.

The most apparent effect of coupons and special promotion offers in influencing the demand for butter, margarine, shortening, and salad and cooking oils was to influence some consumers temporarily to switch brands. Among families most likely to use deals were those that were white, large, in upper income level, of higher educational level than those not availing themselves of the deals, or had young homemaker.

Sutherland, J. G., Bishop, C. E., and Hannah, B. A. an economic analysis of farm and nonfarm uses of resources on small farms in the southern piedmont, north carolina. N. C. Agr. Expt. Sta. Tech. Bul. 138, 55 pp., illus. May 1959. (U.S. Agr. Res. Serv. cooperating.)

Nonfarm employment is an effective means of supplementing income of families on small farms in the North Carolina southern Piedmont. To obtain an equivalent income from full-time farming would usually require a larger additional investment than most operators of small farms would be able or willing to make. The safer means of improving income would be to organize farm and nonfarm work requiring a smaller additional capital investment in farming.

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U.S. GOVERNMENT PRINTING OFFICE: 1960

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