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The Implications of Friedman's Permanent Income Hypothesis for Demand Analysis

A Review by Marc Nerlove

The measurement of income elasticities of demand for farm products, both individually and as an aggregate, is a fundamental problem which has concerned a considerable number of agricultural economists. Professor Milton Friedman's recent study, A Theory of the Consumption Function *(3)*,[1] *investigates the relation between aggregate consumption and aggregate income. Though addressed to the general economist, it is of special interest to economists and statisticians engaged in the study of factors affecting the consumption and prices of farm products. Friedman presents a fundamentally new view of the consumption function, which he terms "the permanent income hypothesis." Central to this hypothesis is a sharp distinction between* measured *income, or that which is recorded for a particular short period of time, and* permanent *income, a longer term concept. His analysis, if correct, suggests that current methods for measuring income elasticities of demand are generally inadequate. This paper contains a summary of Friedman's position; an appraisal of its implications for the analysis of demand for individual commodities; the formulation of an alternative to the permanent income hypothesis; and a test of their relative merits. It is hoped that this presentation will make the permanent income hypothesis more widely known and will stimulate further investigations in this area by agricultural economists.*

The permanent income hypothesis can be summarized in a system of three simple equations (*3, p. 222*). Let c_P and y_P be undefined magnitudes which are called "permanent consumption" and "permanent income," respectively; let c and y be measured consumption and measured income; and let c_T and y_T be the difference between the measured and permanent magnitudes—what Friedman calls the "transitory" components of consumption and income—then:

(1) $c_P = k\ (i, w, u)\ y_P,$

(2) $y = y_P + y_T,$

(3) $c = c_P + c_T.$

[1] Italic numbers in parentheses refer to Literature Cited, page 13.

Implications of the pure theory of consumer behavior.—Equation (1) is Friedman's consumption function; it asserts that planned or permanent consumption (c_P) is a fraction (k) of permanent income (y_P) that does not depend on the size of permanent income but does depend on other variables, e. g., the interest rate (i), the ratio of nonhuman wealth (material wealth) to income (w), and other factors affecting consumer tastes for current consumption versus accumulation of assets (u).[2] Friedman derives equation (1) from

[2] One of the more important of these may be the *variability* of income. For example, farmers and small businessmen tend to save a larger proportion of their incomes than do civil servants.

the pure theory of consumer behavior as stated in its simplest form, (*3, Chapter II, pp. 7–19*). This is a decided advantage as compared with most theories of the aggregate consumption function.[3] The other two equations are definitional.

Permanent and transitory components of income and consumption.—The real interest in the permanent income hypothesis lies, not in Friedman's formulation of the pure theory of consumer behavior that leads to equation (1), but rather in his treatment of the relation between the unobservable variables, c_P and y_P, and the variables c and y, which are the consumption and income we actually measure. Friedman treats this relation in a chapter entitled "The Permanent Income Hypothesis" (*3, chapter III, pp. 20–37*). As its title indicates, this chapter is the key to Friedman's monograph. Friedman states the central theme as follows:

> The magnitudes termed "permanent income" and "permanent consumption" that play such a critical role in the theoretical analysis cannot be observed directly for any individual consumer unit. The most that can be observed are actual receipts and expenditures during some finite period, together, perhaps, with some verbal statements about expectations for the future. The theoretical constructs are *ex ante* magnitudes; the empirical data are *ex post*. Yet in order to use the theoretical analysis to interpret empirical data, a correspondence must be established between the theoretical constructs and the observed magnitudes (*3, p. 20*).

The usual way of establishing such a correspondence has been simply to treat current consumption expenditures and current income as if they *were* the theoretical constructs. Friedman's approach is different.

As equations (2) and (3) indicate, Friedman proposes the division of the measured magnitudes into two parts: the permanent component (y_P or c_P) and the transitory component (y_T or c_T).[4, 5]

Essentially, what Friedman has done is to suppose that although "consumption" is related to "income", both variables are subject to error. This is an old problem in statistics,[6] but Friedman has given it a surprising, and fruitful, new twist by giving the distinction between error and "true" value an economic interpretation in terms of consumer behavior.

The interpretation of the permanent and transitory components of either income or consumption is slightly different, depending on whether we think primarily in terms of (1) budget studies (cross-section analysis) or (2) time-series analysis of the aggregate consumption function. Friedman gives the following interpretation:

> The permanent component [of income] is to be interpreted as reflecting the effect of those factors that determine the consumer unit's capital value or wealth. . . . It is analogous to the "expected" value of a probability distribution. The transitory component is to be interpreted as reflecting all "other" factors, factors that are likely to be treated by the unit affected as "accidental" or "chance" occurrences, though they may, from another point of view, be the predictable effect of specifiable forces . . . (*3, pp. 21–22*).

On this interpretation the concept of "permanent" is closely related to that of "expected normal" which I have used in several other connections (*10, 1*).[7] Indeed, the latter was preceded and definitely suggested by the former.

Two types of forces produce the transitory component: The first is that *specific* to an individual consumer unit. The second is not specific to an individual but affects all or part of the *group* of consumers under consideration. For the

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[3] An exception is the Modigliani-Brumberg formulation, (*7, pp. 383–436*).

[4] As Friedman points out (*3, p. 22*), this division is arbitrary. At one point, Friedman generalizes his assumption so that the observed magnitudes are divided into an arbitrary number (n) of components (*3, p., 186*). The choice of *two* components was made primarily on grounds of simplicity.

[5] The system of equations, (1)–(3), is not perhaps the most reasonable form of the permanent income hypothesis. On several grounds a logarithmic form seems preferable. Friedman gives this as

(1′) $\log c_P = \log k + \log y_P,$

(2′) $\log y = \log y_P + \log y_T,$

(3′) $\log c = \log c_P + \log c_T.$

In his theoretical development, Friedman switches frequently from the linear to the logarithmic form and back, but usually in his empirical applications he uses the logarithmic form.

[6] See D. V. Lindley (*4, pp. 218–44*) for an excellent analysis of the problem of regression when both dependent and independent variables are subject to error.

[7] Also Marc Nerlove, ESTIMATES OF THE ELASTICITIES OF SUPPLY OF CORN, COTTON, AND WHEAT. Unpublished Ph. D. thesis. The Johns Hopkins University, Baltimore. 1956.

group as a whole, the transitory factors that affect *specific* consumer units may tend to cancel out by the law of large numbers, so that the average transitory component, if caused by factors of the first type, generally tends toward zero. On the other hand, transitory factors that affect all or a large number of the members of the group do not tend to cancel one another. These are likely to be important in time-series analysis and their importance depends on the nature of the period covered. Factors specific to individual consumer units are of importance primarily in the analysis of budget data, and they depend on the nature of the group being studied.

Assumptions on the relation of permanent and transitory.—In the general form stated in equations (1) to (3) (see p. 1) or (1′) to (3′) (see p. 2), the permanent income hypothesis is empty: two additional equations have been specified but so have two additional variables. No empirical data could contradict the hypothesis as it stands. Additional assumptions are therefore necessary. The particular assumptions that Friedman makes are as follows:

Assumption I: The transitory components of income and consumption are uncorrelated with one another and with the corresponding permanent components.

Assumption II: The average transitory components of consumption and income are both zero.[8]

Friedman warns us not to interpret the permanent components as corresponding to average lifetime values:

> It is tempting to interpret the permanent components as corresponding to average lifetime values, and transitory components as the difference between such lifetime averages and the measured values in a specific time period. Such an interpretation is not, however, appropriate, and this for two reasons. In the first place, the experience of one unit is itself but a small sample from a more extensive hypothetical universe, so there is no reason to suppose that transitory components average out to zero over the unit's lifetime. In the second place, and more important, it seems neither necessary nor desirable to decide in advance the precise meaning to be attached to "permanent". The distinction between permanent and transitory is intended to interpret actual behavior: we . . . treat consumer units *as if* they regarded their income and their consumption as the sum of two such components, and *as if* the relation between the permanent components is the one suggested by our theoretical analysis. This general approach is suggested by theoretical considerations, but the precise line to be drawn between permanent and transitory components is best left to be determined by the data themselves, to be whatever seems to correspond to consumer behavior (*3, p. 23*).

Thus permanent income is that expected by a consumer unit as his normal income, where his expectations hold only for a finite period of the future. The length of this period may be called the economic horizon for the particular consumer. The concept of "permanent" is related to the length of this horizon; if the horizon is short, a large part of any given income change will be considered permanent.

When the hypothesis is interpreted in logarithmic form [see equations (1′) to (3′)], assumptions I and II should, of course, be construed in logarithmic terms as well.

The relation between measured consumption and measured income.—Equations (1) to (3), plus assumptions I and II, enable Friedman to interpret the nature of the usual statistical relationship between measured consumption and measured income, for either time-series or cross-section data. Suppose we compute the least-squares regression of c on y, where both c and y refer to an observation for either (1) the same consumer unit or (2) the same time period, depending on the nature of our data:

$$c=a+by. \tag{4}$$

a and b are the estimated coefficients.

Friedman shows that the least-squares regression coefficient b may be interpreted as

$$b=kP_y, \tag{5}$$

where P_y is the fraction of the total variance of income in the group (or over the period if we are dealing with time series) contributed by the permanent component of income.[9] As Friedman states,

> The regression coefficient b measures the difference in consumption associated, on the average, with a one dollar difference . . . in measured income. On our permanent income hypothesis, the size of this difference in consumption depends on two things:

[8] Assumption II is clearly unjustified for time-series data. Its chief justification for cross-section data is that it enables Friedman to explain, interpret, and *predict* a wide variety of empirical phenomena (*3, p. 30*).

[9] To simplify the notation, the variables of which k is a function have been dropped.

first, how much of the difference in measured income is also a difference in permanent income, since only differences in permanent income are regarded as affecting consumption systematically; second, how much of permanent income is devoted to consumption. P_y measures the first; k, the second; so their product equals b. If P_y is unity, transient factors are either entirely absent or affect the incomes of all members of the group by the same amount; a one dollar difference in measured income means a one dollar difference in permanent income and so produces a difference of k in consumption; b is therefore equal to k. If P_y is zero, there are no differences in permanent income; a one dollar difference in measured income means a one dollar difference in the transitory component of income, which is taken to be uncorrelated with consumption (by Assumption I); in consequence, this difference in measured income is associated with no systematic difference in consumption; b is therefore zero (*3, p. 32*).

If assumption II holds and if permanent consumption is proportional to income, as is continually assumed in the permanent income hypothesis, (5) yields an extremely simple interpretation of the regression of consumption on income. Let η_{cy} be the elasticity of measured consumption on measured income as computed at the mean values of measured consumption and measured income for the linear case, or as the coefficient of log y in the logarithmic case. Friedman shows that

$$(6) \qquad \eta_{cy}=P_y.$$

That is, the income elasticity of aggregate consumption, as measured from budget data, measures not the elasticity of permanent consumption to permanent income (the theoretically relevant variables) but the proportion of the variance of measured income in the sample contributed by variation in the permanent component! On Friedman's interpretation, therefore, the regression of measured consumption on measured income tells us nothing about the relation of consumption to income but rather something about the relation between the distributions of wealth and of measured income in the sample under consideration.

It should now be clear why, in dealing with cross-section data, assumption II is an integral part of the theory, although not a necessary part. If the mean transitory components of consumption and income equal zero for the sample under consideration, then the ratio of the average consumption for the group to the average income for the group measures k. The elasticity of measured consumption on measured income measures P_y. Both parameters can be identified. If assumption II does not hold, neither P_y nor k can be measured separately; only their product can be measured.

A similar situation arises in the application of the permanent income hypothesis to time-series data. As I have indicated, assumption II is unreasonable when applied to aggregate consumption and income over time. If assumption I only is made, the regression of measured aggregate consumption on measured aggregate income over a period of time tells us something about the product of k with P_y, where P_y measures the contribution of the permanent component to the total variance of income over the period in question; it tells us nothing about k and P_y separately. An additional assumption or assumptions must therefore be introduced.

A method for finding the "true" consumption function from time-series data.—In his chapter, "Consistency of the Hypothesis with Existing Evidence on the Relation between Consumption and Income: Time Series Data," (*3, pp. 115–56*), Friedman specifies additional assumptions appropriate in the context of time-series analysis. Based on an examination of existing time-series studies of the relation between income and consumption, Friedman concludes that permanent income could be represented by a weighted average of incomes for current and past years. The transitory component of consumption is taken to be a purely random error term; that is, no systematic relationship between the transitory components of different time periods exists and the transitory components have mean zero.[10]

The particular model which Friedman constructs to represent the relation between what people consider the permanent component to be and past-measured income is closely related to Hicks' definition of the elasticity of expectations (*1*). Friedman assumes that permanent income,

[10] In a later section (p. 7), it is suggested that the transitory component of consumption expenditure cannot be so treated.

$y_P(t)$, is an exponentially weighted moving average of past measured incomes, $y(t)$, for time t:

$$y_P(t)=\alpha\int_{-\infty}^{t} e^{-\alpha(t-\lambda)}y(\lambda)\,d\lambda, \tag{7}$$

where α is the elasticity of expectations.[11, 12]

Implications of Friedman's Hypothesis

Of the many implications of Friedman's permanent income hypothesis for the analysis of demand for individual commodities, we can examine only a few: (1) The effect of the type of group covered by the sample on income elasticities derived from cross-section data; (2) the effect of the length and type of period covered on income elasticities derived from time-series data; and (3) the valid way to combine income elasticities derived from cross-section data with other time-series data in a demand analysis.

Measurement of income elasticities from cross-section data.—Consider the planned expenditures on, or the planned quantity to be consumed of, an individual item of consumption such as food. We may expect this quantity to be related, via consumer tastes and preferences, to the prices (current and/or expected) of food and other items, and to the income the family expects to receive, or the permanent component of income. If current and expected prices are the same, we may suppose, without loss of generality, that each consumer unit in a cross-section faces approximately the same prices [current and/or expected].

Friedman describes the situation as follows:

> [A consumer unit's] . . . measured expenditures on food differ from its planned expenditures because of a transitory component of food expenditures, and its measured income differs from its permanent income because of a transitory component of income. When the regression of measured expenditures on measured income is computed from budget data for a group of families—the regression that has come to be called an "Engel curve"—the transitory component of food expenditures tends to average out, but the transitory component of income does not. . . . In consequence, the elasticity of measured expenditures with respect to measured income reflects not only . . . [consumers'] tastes and preferences but also the transitory components of income.

Let c_f stand for the mean observed consumption on food of families with a given measured income, and assume that the transitory component of food expenditures is uncorrelated with the permanent or transitory component of income and averages zero for the group as a whole, so that c_f can be regarded as the mean permanent component of food expenditures. The elasticity of c_f with respect to measured income then is

$$\eta_{c_f y}=\frac{dc_f}{dy}\cdot\frac{y}{c_f}=\frac{dc_f}{dy_{Pf}}\cdot\frac{dy_{Pf}}{dy}\cdot\frac{y}{y_{Pf}}\cdot\frac{y_{Pf}}{c_f}=\frac{dc_f}{dy_{Pf}}\cdot\frac{{}_{Pf}}{c_f}\cdot\frac{dy_{Pf}}{dy}\cdot\frac{y}{y_{Pf}},\text{[13]} \tag{8}$$

[where y_{Pf} represents the permanent component of income based on an economic horizon peculiar to food expenditures].[14]

But, on our hypothesis, $y_P=\frac{1}{k}c_P$ which means that

[if $y_{Pf}=y_P$]

$$\eta_{y_{Pf}y}=\frac{dy_{P}}{dy}\cdot\frac{y}{y_{Pf}}=\frac{1}{k}\frac{dc_P}{dy}\cdot\frac{ky}{c_P}=\frac{dc_P}{dy}\cdot\frac{y}{c_P}=\eta_{c_P y}$$

so that

$$\eta_{c_f y}=\eta_{c_f y_{Pf}}\cdot\eta_{c_P y}.\text{[15]}$$

The first elasticity on the right-hand side, between permanent food expenditures and permanent income, reflects the influence of tastes and preferences proper; the second, the influence of transitory factors affecting income.

It follows that the differences among groups of families in the observed income elasticity of particular categories of consumption cannot be interpreted as reflecting solely the influence of differences in tastes or of differences in prices or similar factors affecting opportunities [such as income, *sic!*]; they may [also] reflect a third set of forces, namely, differences in a particular characteristic of the income

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[11] Friedman allows for the expectation of a time trend in permanent income. But this refinement need not concern us here.

[12] Equation (7) may be derived from the differential equation

$$\frac{dy_P}{dt}=\alpha(y-y_P).$$

In fitting his model, Friedman uses a discrete approximation to equation (7), whereas, in a later section (p. 7), I use a discrete form of this differential equation. Either approach introduces an error, the magnitude of which is likely to be small.

[13] The notation in (8) is altered slightly so as to correspond with that used elsewhere in this review.

[14] The rationale for distinguishing between permanent components appropriate to various categories of consumption and that appropriate to total consumption is given below. Although Friedman explicitly assumes that the same horizon applies equally to total consumption and its individual categories, he is in some doubt as to its validity. As we shall see, differences in the apparent horizons appropriate to various categories of consumption is one of the key reasons for doubting the adequacy of Friedman's permanent income hypothesis.

[15] The notation is altered from that in Friedman.

distribution, the importance of transitory components of income (*3, pp. 206–207*).[16]

If the elasticity of measured food expenditures, or, for that matter, expenditures on any particular category of consumption, with respect to measured income depends partly on the contribution of the permanent component to the variance of measured income, it follows that the income elasticity obtained from a budget study depends crucially on the group of households covered by the sample.

For example, consider two groups, one of which typically has highly variable incomes and the other of which typically has stable incomes (for example, farmers versus civil servants). On the basis of the permanent income hypothesis, we would expect the income elasticity for a particular consumption good to be lower for the first group than for the second, *even if the distribution of tastes, income, and the like were the same for the two groups.* The reason for this is simply that, for the group whose incomes are typically highly variable, the permanent component varies much less than measured incomes; whereas, for the group whose incomes are quite stable, the variation of the measured income within the group is accounted for almost entirely by the variation of the permanent component. Thus we would expect both $\eta_{y_P y}$ and P_y to be smaller for the first group than for the second.

Similarly, if we compare the elasticities of expenditure on particular categories of consumption with respect to measured income for two representative samples, one of the urban population of the United States and the other of the total population of the United States, we might expect to find the former higher than the latter, as a sample of the urban population excludes the farm population and the incomes of this population might be expected to vary more than those of the urban group. In general, we may suppose that the more typically stable a group's incomes the more nearly will an elasticity of measured consumption expenditures (for total consumption or for an individual category of consumption) on measured income tend to approximate the elasticity with respect to the permanent component of income *appropriate to that group.*

Measurement of income elasticities from time-series data.—For cross-section data, the characteristics of the group sampled are of crucial importance in the interpretation of income elasticities; for income elasticities computed from time-series data, the characteristics of the period considered, particularly its length, are most important. Friedman makes this point in reference to total consumption:

> The length of the period is important because, other things the same . . . [the contribution of the permanent component to the variance of measured income], and so the observed income elasticity can be expected to be larger, the longer the period covered, provided that the society in question is undergoing a systematic secular change in income. The total variance of [measured] income equals the variance contributed by the transitory component plus the variance contributed by the permanent component, given our assumption that the two components are uncorrelated. The variance contributed by the transitory component is not systematically affected by lengthening the period: by definition, the transitory components are largely random and short-lived. True, the variance may be larger at one time than another—this is why the historical characteristics of the period are important—but there is no reason why it should be systematically larger or smaller for a long than for a short period. The variance contributed by the permanent component, on the other hand, tends to be systematically larger, the longer the period covered, for the more widely separated two dates are, the larger will tend to be the secular difference in income between them. . . . the ratio of the variance contributed by the permanent component to the total variance [of measured income], will therefore tend to be higher, the longer the period, and to approach unity as the period is indefinitely lengthened. If secular change were the only source of variation in the permanent component the lower limit of . . . [the ratio of the variance contributed by the permanent component to total variance] would be zero and this limit would tend to be approached as the length of the period covered approached zero. Since there are other sources of variation in the permanent component [over time], all one can say is that . . . a lower limit greater than zero [will tend to be approached] as the length of the period approaches zero (*3, pp. 125–27*).

Friedman finds that this expectation is well fulfilled by the elasticities computed from regressions of measured total consumption on measured

[16] This statement in qualitative form follows directly from (10). If we wish to express it in usable form

$$\eta_{c,y} = \eta_{c,y_P} \cdot P_y$$

we must assume, in addition to $y_{Pf} = y_P$, that the mean transitory components of food consumption and total consumption equal zero. Both assumptions are questionable. The test of Friedman's hypothesis, in the section of this article beginning on page 9, appears to indicate that we cannot take the fundamental step $y_{Pf} = y_P$.

income for periods of different lengths: the elasticities are systematically lower for the shorter periods. With certain qualifications, this implication of the permanent income hypothesis may be extended to individual categories of consumption: If we are willing to accept the assumptions underlying equation (10), then the elasticity of demand for food with respect to measured income, obtained from time-series data, tends to be[17] the product of (1) the elasticity with respect to permanent income and (2) the proportion of the variance of measured income contributed by the permanent component. Thus, for example, the income elasticity computed for the period between World Wars I and II should be lower than the elasticity computed for a period including both the interwar and postwar periods.[18]

A reservation is that the assumptions on which (10) is based may not be fulfilled when we deal with elasticities estimated from time-series. The following reasons are involved: (1) The permanent component appropriate to the particular category of consumption under consideration may not be the same as that appropriate to total consumption. Thus, if the permanent component appropriate to, say, food is *all* of measured income, the income elasticity computed for the interwar period might be greater than, less than, or equal to the elasticity computed for both interwar and postwar periods. (2) Systematic transitory components in the expenditure devoted to the particular category may occur; in general, however, this might be expected to strengthen the qualitative conclusions based on the permanent income hypothesis but the quantitative relationship, (10), would no longer hold.

Combining income elasticities from cross-section data with other time-series data.—The length of most economic time series is limited; whereas, given sufficient funds for surveys, cross-section data are almost unlimited. It is of some interest, therefore, to develop methods for combining cross-section and time series data.[19] Several recent studies of the demand for individual commodities have attempted such combination.[20] The procedure is generally to obtain an income elasticity from a cross-section sample and to assume that this elasticity applies, with or without certain minor adjustments, to the aggregates over time. The income elasticity so obtained is inserted into the demand function and the remaining parameters are estimated from time-series data. It is clear that this procedure is inconsistent with the permanent income hypothesis.

Based on equation (10), Friedman suggests a way to combine cross-section and time-series data which is consistent with the permanent income hypothesis: Simply divide the income elasticity for a particular commodity by the income elasticity of total consumption expenditures, both estimated from the same budget study. In this way, we obtain an estimate of the elasticity of expenditures on, or demand for, the particular commodity with respect to permanent income. This estimate is a valid one on two assumptions only: (1) The same concept of permanent income appropriate to the particular commodity is appropriate to total consumption; and (2) the average transitory components of expenditure on, or consumption of, the commodity and of total consumption are zero. An estimate of aggregate permanent income over time may be constructed by the procedure which Friedman uses to estimate the consumption function from time-series data. The resulting series and the estimated elasticity with respect to permanent incomes may be combined with other time-series data to obtain estimates of the other parameters which appear in the demand function for the particular commodity.

An Alternative Hypothesis

A possible source of difficulty in the permanent income hypothesis.—In the application of the permanent income hypothesis to individual categories of consumption, the most important assumption is that permanent income means the same thing for different categories of consump-

[17] "Tends to be" rather than "is," since the correlation between prices and measured income is not taken into account.

[18] This in fact is true for meat; see Elmer J. Working (*14*) and Marc Nerlove. THE PREDICTIVE TEST AS A TOOL FOR RESEARCH: THE DEMAND FOR MEAT IN THE UNITED STATES. Unpublished M. A. thesis, the Johns Hopkins University, Baltimore. 1955.

[19] For further discussion of the nature of this problem and a brief survey of the literature bearing on it, see Richard J. Foote and Marc Nerlove (*12*).

[20] See, for example, Richard Stone (*11*), James Tobin (*12*), and Herman Wold and Lars Jureen (*13*).

tion and for consumption as a whole. The exact meaning of permanent income may be interpreted, as has been indicated, in terms of the horizon of the consumer unit. Friedman believes that there is no reason why the horizon should be the same for all individual categories of consumption and some why it should differ systematically (e. g., housing expenditures may be planned in terms of a longer horizon than food expenditures). If this is true, the concept of permanent income applicable to total consumption must be interpreted as an average of the concepts applicable to each category (*3, pp. 207, 208*).

If both consumption and income are properly defined, it does not seem reasonable that the horizons for different categories of consumption should differ greatly from one another. Only if indivisibilities, difficulties of short-run substitution, or various institutional factors are introduced would the concept of differing horizons appear to be useful, but, as I have indicated elsewhere, it may be useful to treat this type of rigidity differently from expectational rigidity in consumer behavior (*8, 9*). We thus think of expenditures for housing in terms of rental (or rental value) rather than in terms of purchase price; were it not for imperfections in the capital and housing markets, an individual consumer who experienced a rise in his income which he considered to be permanent would immediately adjust his housing expenditure, along with that for other categories. Even if we accept Friedman's view that the concept of permanet income might differ for different categories of consumption, it is plausible that it would not differ greatly for similar commodities. In any case, the attractive simplicity of Friedman's permanent income hypothesis is greatly reduced if one must assume different concepts of permanent income for different categories of consumption.

Short- and long-run elasticities of demand.—Long ago Marshall distinguished between the short-run and the long-run elasticities of demand:

> * * * time is required to enable a rise in the price of a commodity to exert its full influence on consumption. Time is required for consumers to become familiar with substitutes that can be used instead of it, and perhaps for producers to get into the habit of producing them in sufficient quantities. Time may be be also wanted for the growth of habits of familiarity with the new commodities and the discovery of methods of economizing them (*5, p. 110*).

As Marshall phrases the distinction, it has to do with the price elasticity of demand, but it is clear that it also applies to income. Thus, for the reasons Marshall suggests, a change in income will exert its full effects on consumption only after some time has elapsed. In this case, we say that consumption is a function of income (and also possibly price) taken with a distributed lag (*9*).

Friedman's additional assumptions in the case of time series analysis (see equation (7)) show clearly that he thinks of aggregate consumption in relation to income taken with a distributed lag. He derives this distributed lag on the basis of economic considerations related to the nature of the transitory component of income: Any *change* in income may be thought of as divided into two components (just as any given income is itself divided into two components). The elasticity of expectations is a measure of the proportion of the change that is considered to be permanent. An expression of this in difference equation form is

$$(11)\quad y_P(t)-y_P(t-1)=\alpha[y(t)-y_P(t-1)],\ 0<\alpha\leqq 1,$$

where α is the proportion of the change that is considered to be permanent and all variables are logarithms of actual values.[21] He thus concentrates on the nature of the income variable and neglects the possibilities inherent in his division of the consumption variable into two components: Friedman always treats the transitory component of consumption as though it is purely random and has no economic interpretation. Marshall's distinction between the short and long runs, however, suggests that this component may have an interpretation.

Suppose that permanent consumption, c_P, can be interpreted as long-run equilibrium consumption, that is, the level of consumption that would eventually be reached if income remained constant at the current level. The transitory component of consumption, c_T, whether it be for an individual category or for aggregate consumption, may then be interpreted as a result of those forces that prevent consumers from reaching a long-run equilib-

[21] Equation (11), or rather the general species of such equations, is discussed more fully in Nerlove (*8*) and in Arrow and Nerlove (*1*).

rium position, for example, the difficulties of finding substitutes, the existence of stocks of durable consumption goods, etc.[22] A simple dynamic model can be formulated which expresses the way consumers move toward their long-run equilibrium or permanent consumption:

$$(12)\quad c(t)-c(t-1)=\gamma[c_P(t)-c(t-1)],\ 0<\gamma\leq 1,$$

where γ is the elasticity of adjustment and all variables are expressed in logarithms.[23]

The interesting thing about this model, based directly on Marshall's distinction between the short and the long runs, is that, qualitatively, it can explain eveything that the permanent income hypothesis explains without introducing any distinction between measured and permanent income.[24] The implications for demand analysis, however, are quite different.

If the income elasticities of demand for individual items are small in the short run and larger in the long run, the income elasticity of aggregate consumption is smaller in the short than in the long run. We have no reason to suppose, however, that the relation between the short- and long-run income elasticities are the same for every category of consumption. Hence, the distribution of lag for income need not be the same for every category of consumption. The distribution of lag appropriate to aggregate consumption is simply an average of those that apply to the individual categories.

Tests of the Permanent Income Hypothesis

First test.—If Friedman's hypothesis is to provide a useful tool for the analysis of the demand for individual commodities, the distribution of lag should be the same for each commodity and for total consumption, or, at least, for similar commodities or groups of commodities. If we assume the distribution of lag to be generated by a model such as (11), the distribution of lag can be summarized by the value of a single parameter, the elasticity of expectations, α. Thus α should be the same for each commodity and for total consumption.

In addition to total consumption, the demand for all food and for meat are investigated. Meat and all food are similar commodities as compared, say, with housing or clothing, and we would *not*, therefore, expect the "horizons" appropriate to these two commodities to differ greatly, although we might allow some difference between food and meat, on the one hand, and total consumption on the other.

Let $y(t)$ = log of observed income during period t,
$y_P(t)$ = log of permanent or "expected normal" income,
$c(t)$ = log of observed aggregate consumption,
$q_f(t)$ = log of the consumption of all food,
$q_m(t)$ = log of the consumption of meat,
$p_f(t)$ = log of the price of food,
$p_m(t)$ = log of the price of meat.[25]

[22] For a fuller discussion see Nerlove (*8*).

[23] For a derivation of equation (12), see Nerlove (*9*).

[24] I have not attempted to compare quantitatively this alternative hypothesis with Friedman's for all the data he considers. I have no doubt, however, that it would prove adequate.

[25] For statistical purposes, these variables except for $y_P(t)$, are defined as the logarithms of:

for $y(t)$, Per capita disposable personal income (Commerce definition) deflated by the BLS consumer price index (1947–49=100);
$c(t)$, Per capita personal consumption expenditures (Commerce definition) deflated by the CPI;
$q_f(t)$, The Agricultural Marketing Service index of per capita civilian food consumption at retail (not expenditure);
$q_m(t)$, Total civilian meat consumption per capita, in pounds, excluding lard;
$p_f(t)$, The Bureau of Labor Statistics index of food prices at retail deflated by the CPI;
$p_m(t)$, An Agricultural Marketing Service index of the retail prices of all meat excluding lard, deflated by the CPI.

The data on observed total consumption and income are not entirely appropriate for this test: the Commerce definition of consumption includes many items that are properly savings, and the Commerce definition of disposable income excludes many items that might properly be considered as income (for example, social security taxes). Friedman has constructed series on consumption and income more appropriate for work of this kind, but these, at the time of writing, were unavailable to the author of this paper. The computational difficulty of constructing such series precluded their use in the simple test presented here.

The basic equations to be estimated are the consumption function, a demand function for all food, and a demand function for meat:

$$(13) \quad c(t)=a_{00}+a_{01}y_P(t)+u_0(t),$$

$$(14) \quad q_f(t)=a_{10}+a_{11}p_f(t)+a_{12}y_P(t)+u_1(t),$$

$$(15) \quad q_m(t)=a_{20}+a_{21}p_m(t)+a_{22}y_P(t)+u_2(t),$$

where $u_0(t)$, $u_1(t)$, and $u_2(t)$ are residual terms.

It can be shown that equations (13) to (15) with the addition of an equation such as (11), which relates permanent or expected normal income to measured income, leads to the following system of equations:

$$(16) \quad c(t)=a_{00}a+a_{01}ay(t)+(1-a)c(t-1)+ u_0(t)-(1-a)u_0(t-1);$$

$$(17) \quad q_f(t)=a_{10}a+a_{12}ay(t)+(1-a)q_f(t-1)+ a_{11}p_f(t)-a_{11}(1-a)p_f(t-1)+ u_1(t)-(1-a)u_1(t-1);$$

$$(18) \quad q_m(t)=a_{20}a+a_{22}ay(t)+(1-a)q_m(t-1)+ a_{21}p_m(t)-a_{21}(1-a)p_m(t-1)+ u_2(t)-(1-a)u_2(t-1).$$[26]

Equations such as (16) to (18) are called the reduced equations for the system (13) to (15).[27] In contrast to equations (13) to (15), they involve only observable magnitudes and may therefore be estimated statistically.

Another method, which is not generally recommended, is available for obtaining reduced equations for the system (13) to (15): Simply solve (13) for $y_P(t)$ and substitute the result in (14) and (15); thus

$$(19) \quad q_f(t)=\left(a_{10}-\frac{a_{12}a_{00}}{a_{01}}\right)+\frac{a_{12}}{a_{01}}c(t)+a_{11}p_f+u_1(t)-\frac{u_0(t)}{a_{01}},$$

$$(20) \quad q_m(t)=\left(a_{20}-\frac{a_{22}a_{00}}{a_{01}}\right)+\frac{a_{22}}{a_{01}}c(t)+a_{21}p_m(t)+u_2(t)-\frac{u_0(t)}{a_{01}}.$$[28]

Regressions based on equations (16) to (20) are presented in table 1. In addition to the estimated regression coefficients, table 1 gives the square of the multiple correlation coefficient, the number of observations, the Durbin-Watson statistic, the estimated or assumed elasticity of expectations, and the estimated elasticity of total consumption or demand with respect to permanent (or expected normal) income. Each regression was run for two periods: the interwar years, 1920–41, and the combined interwar and postwar years, 1920–41 and 1948–55.

The regressions based on equation (16) indicate that the elasticity of total consumption expenditures with respect to income is not one as suggested by the permanent income hypothesis. If $a_{01}=1$, as required by the permanent income hypothesis, the sum of the coefficients of $y(t)$ and $c(t-1)$, in the regressions based on (16), should equal one. Thus we can test the significance of the difference between the two relevant elasticities from one by testing the significance of the difference of the sum of the coefficients of $y(t)$ and $c(t-1)$ from one. A likelihood ratio test may be derived to test the null hypothesis that the sum of the coefficients of $y(t)$ and $c(t—1)$ is one. The logarithm of the likelihood ratio for the period 1920–41 is 43. For the periods 1920–41 and 1948–55, it is 12. As the value of Chi-square for one degree of freedom is 11 at the 0.001 probability level, we reject the null hypothesis and conclude that the estimated elasticities of total consumption with respect to permanent income differ significantly from one. This result, however, should be interpreted with care for these reasons: (1) The use of more-or-less inappropriate data on consumption and income may have led to the inconsistency. (2) The fact that the estimated elasticities rise when a longer period is used is consistent with the permanent income hypothesis and suggests that some transitory component of income may be affecting the regression. (3) Although the Durbin-Watson statistic does not indicate the presence of positive serial correlation, it is low enough to warrant caution.[29]

[26] The derivation of equations such as (16) to (18) from equations such as (11) and (13) to (15) is given in the subsection on "An indirect method for obtaining reduced equations," of Nerlove (8).

[27] The reader should avoid confusing these with the reduced form equations arising in the theory of estimation of simultaneous equations.

[28] The reason why this procedure is not generally recommended may be seen by examining the residual terms in (19) and (20): since $u_0(t)$ enters both residuals and since $c(t)$ appears as an independent variable, one of the independent variables is correlated with the residual in both (19) and (20). In this particular instance, however, it is plausible that such correlation is small; hence, the procedure, although it is not generally recommended, may be applicable to this particular instance. See Nerlove (8).

[29] If positive serial correlation in residuals of (16) is present, estimates of the coefficients are statistically biased, as $c(t—1)$ enters as an independent variable.

TABLE 1.—*Demand for aggregate consumption, food, and meat based on the permanent income hypothesis: Least-squares regressions and related statistical data* [1]

Item	Aggregate consumption, equation (16)		Food, based on equation— (17)		Food, based on equation— (19)		Meat, based on equation— (18)		Meat, based on equation— (20)	
	1920–41	1920–41 and 1948–55	1920–41	1920–41 and 1948–55	1920–41	1920–41 and 1948–55	1920–41	1920–41 and 1948–55	1920–41	1920–41 and 1948–55
Regression coefficient for specified independent variable:										
$y(t)$	0.729 (.056)	0.726 (.057)	0.199 (.030)	0.210 (.029)	--------	--------	0.351 (.074)	0.387 (.060)	--------	--------
$c(t)$	--------	--------	--------	--------	0.291 (.028)	0.296 (.016)	--------	--------	0.422 (.101)	0.554 (.063)
$c(t-1)$	.099 (.077)	.209 (.064)	--------	--------	--------	--------	--------	--------	--------	--------
$q_f(t-1)$	--------	--------	.182 (.128)	.266 (.108)	--------	--------	--------	--------	--------	--------
$q_m(t-1)$	--------	--------	--------	--------	--------	--------	.231 (.161)	.432 (.117)	--------	--------
$p_f(t)$	--------	--------	−.065 (.058)	−.088 (.058)	−.133 (.045)	−.137 (.038)	--------	--------	--------	--------
$p_m(t)$	--------	--------	--------	--------	--------	--------	−.470 (.088)	−.485 (.076)	−.475 (.086)	−.458 (.072)
$p_f(t-1)$	--------	--------	−.094 (.045)	−.052 (.045)	--------	--------	--------	--------	--------	--------
$p_m(t-1)$	--------	--------	--------	--------	--------	--------	−.015 (.085)	.093 (.067)	--------	--------
Constant term	.315	.122	1.545	1.323	1.681	1.682	1.774	1.134	2.120	1.855
R^2	.97	.99	.92	.97	.85	.96	.74	.83	.62	.76
Number of observations	22	30	22	30	22	30	22	30	22	30
Durbin-Watson statistic, d	1.56	1.48	1.86	1.89	1.52	[2] 1.42	2.13	2.21	[2] 1.08	[3] .92
Estimate of—										
α	.90 (.08)	.79 (.06)	.82 (.13)	.73 (.11)	[4] .90	[4] .79	.77 (.16)	.57 (.12)	[4] .90	[4] .79
The elasticity of the dependent variable with respect to permanent income	.81	.92	.24	.29	.29	.30	.46	.68	.42	.55

[1] Numbers in parentheses beneath the coefficients are their respective standard errors.
[2] Durbin-Watson test inconclusive at the 5-percent probability level.
[3] Significant positive serial correlation.
[4] Assumed.

The most interesting row of table 1 is the second from last, in which the estimates of the elasticities of expectations based on the various regressions are presented. Although the elasticities derived from the different equations differ, depending on the length of the period, the differences are more marked as between commodities, especially between total consumption and food, on the one hand, and meat, on the other. In addition, when consumption rather than income, is used in the regressions for food and meat, the multiple correlations are markedly lower for the interwar period, and this is true also for the interwar plus postwar period in the case of meat. The only significant or inconclusive Durbin-Watson tests are also found for these regressions.

Are these differences in the elasticities of expectations among commodities and total consumption significant? If they are, we have reason to doubt the adequacy and/or utility of Friedman's permanent income hypothesis as applied to individual categories of consumption. An F-test, based on (*6, pp. 100–102*), was used to test the significance of the differences between the coefficients of $c(t—1)$, $q_f(t—1)$, and $q_m(t—1)$ in the regressions based on equations (16)–(18). A significant

F-ratio indicates a significant difference among the coefficients, and, hence, among the elasticities of expectations for total consumption, all food, and meat. The F-ratio for the regression using data for the period 1920–41 is 20, with 2 and 53 degrees of freedom; the F-ratio for the combined periods 1920–41 and 1948–55 is 261, with 2 and 77 degrees of freedom. Each ratio is highly significant.

We cannot, of course, conclude definitely on the basis of the simple, and perhaps crude, test that the permanent income hypothesis is false; all we can say is that it does not appear to be useful when it is applied to individual categories of consumption.[30]

Second test.—A simpler alternative hypothesis, based on considerations suggested by Marshall, is outlined in the previous section. If the type of factor suggested by Marshall is the sole cause of rigidities in consumer behavior, the type of equation suggested by (12) appears to be adequate to express the relation of measured consumption for any particular category to permanent or long-run equilibrium consumption. In this case, we have distributed lags in both prices and income, but within any equation the distribution of lag is the same for both price and income. In place of equation (11), we have three equations of the same form as equation (12):

$$(21)\quad c(t)-c(t-1)=\gamma_c[c_P(t)-c(t-1)],$$

$$(22)\quad q_f(t)-q_f(t-1)=\gamma_f[q_{Pf}(t)-q_f(t-1)],$$

$$(23)\quad q_m(t)-q_m(t-1)=\gamma_m[q_{Pm}(t)-q_m(t-1)],$$

where $c_P(t)$, $q_{Pf}(t)$, and $q_{Pm}(t)$ are the long-run equilibrium values of total consumption and the quantities demanded, and γ_c, γ_f and γ_m are the parameters that determine the distributions of lag. Our basic demand equations are:

$$(24)\quad c_P(t)=a_{00}+a_{01}y(t)+u_0(t),$$

$$(25)\quad q_{Pf}(t)=a_{10}+a_{11}p_f(t)+a_{12}y(t)+u_1(t),$$

$$(26)\quad q_{Pm}(t)=a_{20}+a_{21}p_m(t)+a_{22}y(t)+u_2(t).$$

The long-run equilibrium values of aggregate consumption and the quantities of total food and meat demanded cannot be observed, so equations (24) to (26) cannot be estimated. If, however, the long-run equilibrium variables, as given by (24) to (26), are substituted in (21) to (23), we have equations that contain only observable variables:

$$(27)\quad c(t)=a_{00}\gamma_c+a_{01}\gamma_c y(t)+(1-\gamma_c)c(t-1)+\gamma_c u_0(t)$$

$$(28)\quad q_f(t)=a_{10}\gamma_f+a_{11}\gamma_f p_f(t)+a_{12}\gamma_f y(t)+(1-\gamma_f)q_f(t-1)+\gamma_f u_1(t)$$

$$(29)\quad q_m(t)=a_{20}\gamma_m+a_{21}\gamma_m p_m(t)+a_{22}\gamma_m y(t)+(1-\gamma_m)q_m(t-1)+\gamma_m u_2(t)$$

Equation (27) suggests a regression of exactly the same form as is suggested by (16), but equations (28) and (29) suggest regressions that differ somewhat from those under the permanent income hypothesis. Comparing (28) with (17) and (29) with (18), we see that $p_f(t-1)$ does not enter a regression based on (28) and $p_m(t-1)$ does not enter a regression based on (29). The fact that the coefficients of these variables in the regressions presented in table 1 do not differ significantly from zero or are of the wrong sign suggests that the alternative hypothesis may have some merit. The coefficients of $c(t-1)$, $q_f(t-1)$ and $q_m(t-1)$, of course, need not be the same. Regressions based on equations (27) to (29) are presented in table 2 for the years 1920–41 and the combined periods 1920–41 and 1948–55. As can be seen, the results compare favorably with those presented in table 1.

Conclusions

Friedman's recent monograph, *A Theory of the Consumption Function*, deals with the interpretation of the statistical relation between measured total consumption expenditures and measured income. Even though the explanation of total consumption expenditures is the object of Friedman's inquiry, his approach has significant implications for the estimation of income elasticities of demand for individual commodities. Only a few of these implications have been explored in this

[30] A possible difficulty with the test described above is that consumers may not react to current price, just as, according to Friedman, they do not react to current income. Models based on the assumption that consumers react to expected normal price, a concept analogous to permanent income, may be developed. Statistical analyses based on such models, however, indicate little improvement over the analyses presented above.

It is also possible that, in the case of individual categories of consumption, consumers react to current price and income as well as to expected normal price and permanent income. Models that incorporate this assumption are possible, and statistical analyses based on such models are currently underway in the Department of Agriculture.

TABLE 2.—*Demand for aggregate consumption, food, and meat based on an alternative to the permanent income hypothesis: Least-squares regressions and related statistical data* [1]

Item	Aggregate consumption, equation (27)		Food, equation (28)		Meat, equation (29)	
	1920–41	1920–41 and 1948–55	1920–41	1920–41 and 1948–55	1920–41	1920–41 and 1948–55
Regression coefficient for specified independent variable:						
$y(t)$	0.729 (.056)	0.726 (.057)	0.217 (.031)	0.219 (.028)	0.350 (.071)	0.421 (.056)
$c(t-1)$	.099 (.077)	.209 (.064)	----------	----------	----------	----------
$q_f(t-1)$	----------	----------	.151 (.139)	.237 (.106)	----------	----------
$q_m(t-1)$	----------	----------	----------	----------	.248 (.127)	.371 (.111)
$p_f(t)$	----------	----------	−.155 (.042)	−.142 (.036)	----------	----------
$p_m(t)$	----------	----------	----------	----------	−.478 (.076)	−.429 (.065)
Constant term	.315	.122	1.563	1.366	1.730	1.263
R^2	.97	.99	.89	.97	.73	.82
Number of observations	22	30	22	30	22	30
Durbin-Watson statistic, d	1.56	1.48	1.91	1.89	2.16	2.04
Estimate of—						
γ	.901	.791	.849	.763	.752	.629
Long-run elasticity with respect to—						
Income	.81	.92	.26	.29	.47	.67
Price	----------	----------	−.183	−.186	−.636	−.682

[1] Numbers in parentheses beneath the coefficients are their respective standard errors.

review; many more await the reader of Friedman's book.

Although Friedman's permanent income hypothesis apparently explains many things that have puzzled demand analysts, it does not appear to be a highly useful tool in analyzing demand for individual commodities. The crude test presented here suggests that in order to apply Friedman's hypothesis we must assume that the consumer horizons appropriate to different categories of consumption differ greatly, even for such similar categories as all food and meat.

The permanent income hypothesis has not been shown to be false. What has been shown is that the transitory component of consumption is subject to economic interpretation. Models based on this interpretation are more useful in the analysis of demand for individual commodities than the permanent income hypothesis, even though they completely neglect the transitory component of income.

In essence, then, Friedman presents an exaggerated view of his hypothesis because he neglects to give the transitory component of consumption as much weight as he does the transitory component of income. The permanent income hypothesis is a valuable contribution to demand analysis, but it will need to be supplemented in order to be utilized effectively. This kind of thing is at once the despair and the delight of applied research workers: no theoretical analysis can remain unchanged as it is applied to more and more data; of necessity, applied workers must play a fundamental role in the building of theory. Professor Friedman is to be commended for giving us such a fine place from which to continue his work.

Literature Cited

(*1*) ARROW, KENNETH J., AND NERLOVE, MARC.
1958. A NOTE ON EXPECTATIONS AND STABILITY. Econometrica. April 1958. (In press.)

(*2*) FOOTE, RICHARD J., AND NERLOVE, MARC.
1957. WHY APPLIED RESEARCH WORKERS ARE INTERESTED IN PROBLEMS OF AGGREGATION. U. S. Agr. Marketing Serv. (Processed.)

(*3*) FRIEDMAN, MILTON.
1957. A THEORY OF THE CONSUMPTION FUNCTION. 243 pp. Princeton, Princeton University Press.

(*4*) LINDLEY, D. C.
1947. REGRESSION LINES AND THE LINEAR FUNCTIONAL RELATIONSHIP. Jour. Royal Statis. Soc. Supp. 9: 218–244.

(5) Marshall, Alfred.
1936. principles of economics. Ed. 8, 871 pp. New York, The Macmillan Co.

(6) Meinken, Kenneth W.
1953. the demand and price structure for oats, barley and sorghum grains. U. S. Dept. Agr. Tech. Bull. 1080, 102 pp.

(7) Modigliani, Franco, and Brumberg, Richard.
1954. "utility analysis and the consumption function" in post-keynesian economics. Kenneth K. Kurihara, ed. 442, pp. New Brunswick, Rutgers University Press.

(8) Nerlove, Marc.
1957. using distributed lags in the analysis of demand for agricultural and other commodities. AMS Report. (In process.)

(9) Nerlove, Marc.
1958. distributed lags and the estimation of long-run supply and demand elasticities. Jour. Farm Econ. May 1958. (In press.)

(10) Nerlove, Marc.
1956. estimates of the elasticities of supply of selected agricultural commodities. Jour. Farm Econ. 38: 496–509.

(11) Stone, Richard.
1954. the measurement of consumers' expenditure and behavior in the united kingdom, 1920–38. Vol. I, 447 pp. Cambridge, Cambridge University Press.

(12) Tobin, James.
1950. a statistical demand function for food in the u. s. a. Jour. Royal Statis. Soc. Series A. 113: 113–40.

(13) Wold, Herman, and Jureen, Lars.
1953. demand analysis: a study in econometrics. 358 pp. New York, John Wiley and Sons.

(14) Working, Elmer.
1954. demand for meat. 136 pp. Chicago, Institute of Meat Packing.

Cross-Sectional Pricing in the Market for Irrigated Land

By Edward F. Renshaw

This investigation of price-determining influences in the market for irrigated land was motivated originally by a presumption that one way to evaluate land-investment alternatives, such as public expenditures for irrigation, would be to compare the present price of nonirrigated land in the market with an "expected" market price after investments are made. The models were developed to aid in estimating a current market value for land that is comparable, in the value sense, to the price of such land after capital investment. In an attempt to test variants of the theory that a certain proportion of the expected gross receipts is capitalized into land values, that is, that land values can be estimated on the basis of gross farm income, the author has constructed both time-series and cross-sectional models. The time-series portion of the analysis was published in the May 1957 issue of the Journal of Farm Economics *(4)*,[1] "*Are Land Prices Too High: A Note on Behavior in the Land Market.*" *The cross-sectional models dealing with this problem are presented here with a unique approach and interesting methodology.*

The approach used in this study to isolate determinants of land price is built on the premise that land value represents a capitalization of expected net income. While net income to land cannot be observed or measured easily owing to joint ownership of agricultural factors of production, gross income, a variable that is closely correlated with net income, can either be measured directly or estimated from acreage response. The models given here are concerned essentially with carrying the weighting principles that underlie expectation models[2] a few additional steps along the road to empirical application.

Model 1

Model 1 can be classified as a conventional expectation model; estimated land and water value per acre is related directly to expected crop value per acre, when expected crop value is a weighted function of estimated gross crop value in the 10 preceding years.

[1] Numbers in italics in parenthesis refer to Literature Cited, page 19.

[2] For a more theoretical discussion of the mathematics underlying expectation models readers are referred to a recent article by Marc Nerlove in the *Journal of Farm Economics* (3).

The variables and the estimating equation for model 1 are as follows:

X_1=the per acre value of irrigated land without buildings + the present value per acre of repayment contracts assessed against project construction costs, 34 Bureau of Reclamation projects, 1956.

X_2=expected crop value per acre, 1955.

$$(1.1) \qquad X_1=117.6+1.885X_2 \qquad R^2=0.59$$
$$(.28)$$

The data on project land values were obtained by mailing a return post card to the officers in charge of all irrigation districts having water repayment contracts with the Bureau of Reclamation.[3] The present value per acre was derived by discounting to a 1956 present value the exact or an approximate repayment stream and then dividing by the acreage to which the Bureau was prepared to supply water in 1952. The interest rate used to discount all future repayment streams was 4½ percent, the farm mortgage rate.

Estimated growth crop value per acre in the preceding 10 years[4] is assigned these weights:

$X_{1t-1}=0.2052$, $X_{1t-2}=0.1631$, $X_{1t-3}=0.1296$, $X_{1t-4}=0.1030$, $X_{1t-5}=0.0819$, $X_{1t-6}=0.0651$, $X_{1t-7}=0.0517$, $X_{1t-8}=0.0411$, $X_{1t-9}=0.0327$, $X_{1t-10}=0.0260$.

[3] A distinction should be made between two kinds of sampling error present in the land-value data: (1) Districts reporting may not be representative of the whole project. (2) Errors of enumeration may be present either because project managers have a poor knowledge of land values, or their subjective weighting of productivity differences within the project is incorrect. The 17 included projects with 100 percent of the districts reporting have as a rule only one or two districts, while the 17 projects with only a sampling of districts reporting may have up to 10 or 15 districts reporting. An averaging out of second-class errors could conceivably counterbalance errors of the first kind.

As actual market values that exist during the construction and early development of a given project are likely to be affected by uncertainty as to crop yields after water is applied, by uncertainty as to the repayment responsibility of the water users, and by antispeculation rules adopted by the Bureau in recent years, only projects established before 1950 are used in this paper to estimate functional relations in the irrigated land market.

[4] Source of data: Bureau of Reclamation, *Crop Summary and Related Data, Federal Reclamation Projects* (9) for 1945–54. Crop summary data have not yet been made available for crop year 1955. Ideally, if expected crop value is to represent a refined test of theory, land values also should be those for 1955.

The comparatively low R^2 in equation (1.1) is to be expected in view of the sampling techniques used to obtain both the independent and the dependent data, the broad geographical area over which aggregation takes place (the 34 included projects are rather widely distributed through the 17 Western States), the rather large differences in irrigation enterprises classified by commodity types, the variability in the marginal cost of water to irrigators, and other institutional and technical factors that affect the proportion of total crop income allocated to land and to repayment of irrigation facilities.

From the standpoint of estimating irrigation benefits in terms of increases in land and water values, Model 1 has two serious defects. Crop summary data are not only limited, they also are subject to bias, owing to the fact that the variable repayment contracts that exist between the Bureau and some irrigation districts make water repayment a function of realized crop receipts. Empirical evidence exists[5] to substantiate a belief that these contracts lead to an underreporting of crop yields which in turn causes a downward bias in estimates of crop values. A second defect of model 1 is that it does not permit one to predict land values without information on historical crop returns or a reliable system with which to forecast expected crop values.

For comparison, two additional cross-section models methodologically related to model 1 but not exclusively limited to the pricing of irrigated land have been developed.

Model 1a

X_A=value of land and buildings per acre, March 1954, by States and for the United States as a whole. Source: *Current Development in the Farm Real Estate Market* (6).

X_B=same as X_A (Delaware and New England excluded).

[5] A comparison of crop summary data for the North Platte Irrigation Project, 1935–45, with Nebraska Agricultural Statistics for Scotts Bluff County (relatively the most important county within the project) indicates consistently lower yields reported to the Bureau than to the USDA crop reported. Although a comparison of this kind is not conclusive evidence of underreporting associated with variable repayment contracts, nevertheless the magnitudes of the differences are suggestive.

X_C = expected cash receipts from farming + value of home consumption, 1954, where "expected" refers to a weighted function of gross income in the preceding 10 years—divided by the acreage in farms in 1950. Source of data: *Agricultural Statistics* (*10*).

(1a.1) $X_A = 25.8 + 1.884 X_C$ $\quad R^2 = 0.83$
$\quad\quad (.12)$

(1a.2) $X_B = -1.4 + 3.085 X_C$ $\quad R^2 = 0.89$
$\quad\quad (.17)$

Model 1b

X_D = value of land and buildings per acre, 1955, 19 different commercial family-operated farms. Source: *Farm Costs and Returns* (*2*).

X_E = same as X_D (Corn Belt cash grain farm and the wheat pea farm excluded).

X_F = expected gross farm income per acre, 1956, where expected income is a function of income in the preceding 10 years.

(1a.3) $X_D = 15.2 + 2.657 X_F$ $\quad R^2 = 0.60$
$\quad\quad (.53)$

(1a.4) $X_E = 10.5 + 2.376 X_F$ $\quad R^2 = 0.82$
$\quad\quad (.12)$

Model 1b is a severe test of the theory that a constant proportion of expected gross receipts is capitalized into land values by the market. It may be noted that by excluding "cash grain" in the Corn Belt and "wheat pea" in the winter wheat area, two of the most naturally productive agricultural areas in the United States, the coefficient of gross correlation is increased from 0.60 to 0.82. Perhaps equally significant is the tendency for the residuals by type of enterprise to have the same sign. Hope exists for a more perfect aggregation across commodities and regions by weighting expected gross receipts on the basis of differences in climate, soil, markets, and enterprises.

Index of Gross Crop Value

The development of the second major model in this article involves the crop-index approach to estimation of land values developed in part by H. E. Selby (*5*).[6] From the standpoint of predicting changes in land values, the index of gross crop value has two rather attractive properties. First, to the extent that crop summary data are subject to errors in yields reported, a crop-value index may be superior to other estimates of expected crop value in predicting land values, in that random errors in yields reported can be expected to average out because of the effect of the large samples. Further, neither a constant nor a proportional bias in the reporting of yields would affect the ability of the index to predict land values, provided the relative returns expected from different crops are substantially unaffected. Second, the crop-value index itself is a funciton of cropping response which perhaps can be estimated independently in the case of proposed land improvement more accurately than changes in expected income.

One could build an estimate of expected gross crop returns per acre, commodity by commodity, weighting in some way individual crop values for a period of past years. Provided the differences

[6] By adjusting 1940 census data in a manner similar to the way the 1950 census data are treated here, Selby constructed what he called an index of intensity by arbitrarily assigning the weight of 1.00 to orchards, vineyards, planted nut trees, and vegetables, the weight of 0.50 to semi-intensive crops such as sugar beets, cotton, potatoes and beans, and the weight of zero to all other irrigated acreages. No theoretical justification was given for the weights chosen. It should be noted that these weights bear a fairly close relation to the weights obtained from the 1950 crop summary data of the Bureau. Assuming that relative prices have remained roughly the same for most agricultural crops, the similarity in weights perhaps explains the remarkable coefficient of gross correlation of (0.785), which he established between the intensity index and the value of irrigated land without buildings in 199 counties.

By adding alfalfa yield, farm size, and the cost of water, he obtained a multiple correlation coefficient of 0.826. The cost of water had the wrong sign (+), perhaps because of the use of total cost per acre, per year, which may have turned the variable into a productivity index of sorts, if we assume not too great a variance in per unit cost of water.

The Department of Agriculture has developed a productivity index. It is the product of a crop-intensity index, which is a measure of the relative proportion of various kinds of crops grown, and a crop-yield index, which is a measure of relative yields. The chief difference between the USDA productivity index and my crop-value index is the way in which weights are selected and used in constructing the indices. As to the best of my knowledge, the Department of Agriculture has not constructed a productivity index for a cross-section of Bureau projects, no test can be made of the relation between land values and the productivity index. A discussion of the productivity index may be found in the following citations: (*1*), (*8*).

in receipts by crops are not so large as to affect materially the accuracy of prediction, commodities can be grouped together. If expected receipts per acre by commodity group do not vary unduly among farms, communities, or projects, higher order averages can be substituted for more local averages—the extreme case being to weight local acreage according to expected national crop-value averages. I shall call this an index of gross crop values per acre.

In order to establish a severe test of the aggregation hypothesis underlying the crop-value index, acreages of various crops grown under irrigation were grouped into the following categories and assigned weights derived from crop summary data on Federal reclamation projects:

1. Cereals	17.5
2. Seeds	37.3
4. Miscellaneous	49.8
4. Vegetables and truck	66.5
5. Hay and forage	9.4
6. Fruits and nuts	100.0

Weights were calculated for each group on the basis of a 3-year average weighted crop value per acre devoted to each commodity group for all reclamation projects. The group (fruit and nuts) with the highest 3-year average crop value per acre was arbitrarily assigned the weight of 100 and the other groups were indexed accordingly.

Individual project, country, or district acreages of commodity groups were multiplied by the group weights derived from the crop summary data, summed, and divided by the total area irrigated to get an index value for each observation. As duplicate acreage (resulting when more than one crop is grown on the same ground) is excluded only from the total area irrigated, in theory the index values could range from 9.4 to something over 100.

A direct test of the aggregation hypothesis underlying the crop-value index can be made by correlating the index directly with expected crop value (variable X_2, model 1). As one would suspect, the resulting correlation coefficient is higher than either of the coefficients associated with correlating directly and separately the two independent measures of gross crop value with land and water value.

Model 2

Preliminary results of the test of the hypothesis that the crop-value index is a good measure of land value are summarized in the equations of model 2.

X_3=postal survey estimate of the value of irrigated land without buildings 5 years ago, plus the present value of water-repayment contracts, 30 Bureau of Reclamation projects.[7]

X_4=estimated value of irrigated land without buildings, 46 counties in which the proportion of irrigated land within wholly irrigated farms was 50 percent or more, 1950 census.[8]

X_5=value of irrigated land, 37 irrigation enterprise organizations, 1946 (all enterprises having a substantial acreage of cotton and citrus excluded). Data were taken from the original questionnaires of a survey study of irrigation-enterprise organizations conducted by the former Bureau of Agricultural Economics and the Soil Conservation Service in 1946.

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[7] Four projects—Carlsbad, Balmorhea, Austin, and Rio Grande, all in the Southern Plains—were excluded because cotton, a principal crop in the miscellaneous category, was inappropriately indexed. As cotton is listed in the crop summary tables under lint and seed, cotton acreage was given inadvertently a double weight. Further, nonprice rationing of water on some projects makes the yield variablity between projects excessive.

[8] The 1950 Census of Irrigation (7) has sample estimates of the value of land and buildings per acre by counties for farms classified as wholly irrigated. (Wholly irrigated farms are farms that reported 1 acre or more of cropland harvested in 1949 and on which all of the cropland harvested was irrigated. All, part, or none of the other land in the farm may have been irrigated.) A difficulty associated with using these estimates arises in subtracting out the value of nonirrigated land within farms classed as wholly irrigated. The value of nonirrigated land in wholly irrigated farms does not appear to bear a simple relation to the value of nonirrigated land in farms classified as nonirrigated. (Nonirrigated farms include all farms with less than 1 acre irrigated in 1949.) Places containing 3 or more acres that produced agricultural products valued at $150 or more in 1949, and places containing less than 3 acres with sales of agricultural products of $150 or more in 1949 are counted as farms.

To some extent, bias in census estimates of irrigated land values can be minimized by selecting counties with a high proportion of irrigated land within wholly irrigated farms. Unfortunately, the number of reclamation projects located in counties in which the proportion of irrigated land in wholly irrigated farms exceeds, say, 50 percent, is very small.

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X_6=crop-value index described above (based on acreage weights for commodity groups taken from the crop summary data of the Bureau of Reclamation 1948–50).

X_7=crop-value index. Not comparable to X_6 for these reasons: Citrus is an important crop in a number of census counties and is of only negligible importance on projects of the Bureau from which the acreage weights were taken. No acreage duplication exists as weighted crop acreage was divided by the sum of unweighted crop acreage. The index assumed that all vegetables were grown on farms classified as wholly irrigated (and that none were grown on farms classified as partially irrigated). These three factors tend to make crop-value index parameter estimate much larger in equation (2.2).

(2.1) $X_3=24.9+\underset{(0.11)}{0.805}X_6$ $R^2=0.66$

(2.2) $X_4=-104.9+\underset{(0.15)}{1.901}X_7$ $R^2=0.74$

(2.3) $X_5=28.7+\underset{(0.082)}{1.197}X_6$ $R^2=0.86$

In analyzing the results of model 2, the crudity of the crop-value index actually constructed should be emphasized. In it, such pairs of commodities as corn and rye, apples and peaches, alfalfa and straw, and cotton and dry beans were given equal weights when, in fact, the expected crop value per acre of the first is often twice that of the second. Our theory would suggest that the ability of the index of crop value to predict could be improved by refining the crop weights in such a way that aggregation takes place across fewer commodities. In addition to refining crop weights, the variance explained, particularly in equation (2.1) and (2.2), might be increased with better estimates of irrigated land values. Better data could easily be acquired by altering the census questionnaire or by including questions on land values in the crop summary questionnaire of the Bureau of Reclamation.

With respect to the individual regressions, it should be pointed out that the assumptions underlying equation (2.1) and (2.3) are most comparable. The higher R^2 in equation (2.3) may be deceptive in part owing to a larger range in data. For example, if the four California and Arizona projects (Yuma, All American Canal, Gila, and Salt River) are left out of the equation (2.1), resulting R^2 is lowered to 0.36. However, it may be indicative of better dependent variable data and a loss of important information through aggregation over irrigation districts to the project level. The high R^2 must surely indicate considerable stability in relative agricultural prices between 1946, the date of the land-value estimates, and 1950, the year for which our acreage weights are assumed to have the greatest relevance.

Having arrived in a somewhat devious way at the hypothesis that land and water value is, in effect, some weighted function of the proportion of total acreage devoted to various crops, the natural suggestion would be to run a direct multiple correlation between land value and crop percentages. The chief advantage of this correlation is that, knowing only the acreage distribution of various crops, one can obtain acreage weights directly from the data. One need not know a great deal about actual gross crop values. Aggregation across commodities should of course be improved by knowledge of relative crop values per acre.

As a preliminary test of the hypothesis that acreage response is a good predictor of land value, I have developed a simplified equation using the basic data from which equation (2.3) was obtained. The results are summarized in model 3.

Model 3

X_8=the percentage of total irrigated acreage devoted to cereals.

X_9=the percentage of total irrigated acreage devoted to seeds, miscellaneous, and vegetables and truck.

X_{10}=the percentage of total irrigated acreage devoted to fruits and nuts.

(3.1)
$X_5=101+\underset{(1.01)}{0.459}X_8+\underset{(1.32)}{2.611}X_9+\underset{(0.92)}{10.41}X_{10}$ $R^2=0.88$

The commodity group that was left out of model 3 in order to obtain parameter estimates is hay and forage. Despite additional aggregation across commodity groups (three commodity groups—seeds, miscellaneous, and vegetables and truck—were collapsed into variable X_9) the coefficient of gross correlation is slightly higher for equation (3.1) than for equation (2.3).

A limitation to the technique suggested in model 3 is the fact that computing effort is a rapidly increasing function of the number of crop percentages included in the model. The problem of too many independent variables can be overcome to some extent by a high degree of aggregation, as I have done in model 3, or by classifying data according to enterprise, regional, or other differences and running separate regressions containing fewer variables.

One might, on other grounds, wish to classify the basic data and run separate regressions in order to test the stability of parameter estimates and to catch the effects of other factors believed to influence cross-sectional land values. In the case of irrigated land, it would seem desirable to classify the data according to climatic regions and water-right differences in the hope of isolating the effects of nonprice rationing of water and variability yield. A classification according to enterprise differences might be justified in order to catch differences among enterprise types with respect to the allocation of factor income. Any differences between crops in the proportion of per acre crop value that is net income to land will of course be picked up directly in the regression on individual crop percentages.

Evaluation of the Crop-Value Index as a Predictor of Land Value

For the principle of the crop-value index to be a success as a predictor of land value, the cropping pattern must be directly related to those economic, technological, and physical factors that govern the marginal product of land. It would be a fallacy to presuppose that cropping pattern itself determined land value, as the obvious conclusion would be to put all irrigated land into fruits and nuts. To the extent that the underlying factors governing productivity, such as type of soil, climate, topography, distance from market, local demand, water rights, and the expected cost of water, are directly related to, or impose restraints on, a rational cropping pattern, many variables that influence land value can be collapsed into statistics on the acreage devoted to various crops. Essentially, all that a crop-value index can do is to measure the effect on land value of substitutions to crops yielding higher opportunity returns per acre. It will be of little use as a predictor of land value if the real factors that affect land value either are not, or cannot easily be made, a function of cropping pattern by defining crops appropriately in such a way as to pick up differences in income-yielding potentiality.

Literature Cited

(*1*) Fuhriman, W. U.
1947. Farm organization and income on irrigated farms in 1944, Vale-Owyhee project, Oregon. 46 pp., illus. Bur. Agr. Econ. in Cooperation with Oreg. State Col., Bur. Reclam., and Farm Security Admin, Washington, D. C. (Mimeographed.)

(*2*) Goodsell, W. D., Brown, W. H., Fowler, H. C., and others.
1956. Farm costs and returns, 1955 (with comparisons) commercial family-operated farms, by type and location, U. S. Dept. Agr. Agr. Inform. Bul. 158, 62 pp., illus.

(*3*) Nerlove, Marc.
1956. Estimates of the elasticities of supply of selected agricultural commodities. Jour. Farm Econ. 38: 496–509.

(*4*) Renshaw, Edward F.
1957. Are land prices too high: a note on behavior in the land market. Jour. Farm Econ. 39 (2): 505–510.

(*5*) Selby, H. E.
1945. Factors affecting value of land and water in irrigated areas. Jour. Land and Pub. Util. Econ. 31: 250–2, 8.

(*6*) U. S. Agricultural Research Service.
1954. Current developments in the farm real estate market, March 1954.

(*7*) U. S. Bureau of the Census.
1952. United States census of irrigation: 1950, V, 3, irrigation of agricultural lands.

(*8*) U. S. Bureau of Reclamation.
1945. Columbia Basin joint investigation: allocation of repayment charges by class of land, problem 13. 155 pp. Washington, D. C.

(*9*) U. S. Bureau of Reclamation.
1945–54. Crop summary and related data, federal reclamation projects. Annual. Washington, D. C.

(*10*) U. S. Department of Agriculture.
1936–56. Agricultural statistics. Annual. Washington, D. C., U. S. Govt. Print. Off.

Alternative Methods for Estimating Changes in Production From Data on Acreage and Condition

By Richard J. Foote and Hyman Weingarten

Reports on prospective plantings are designed to aid farmers in deciding among alternative crops before the planting season. In this connection, they are a useful guide only insofar as they assist the farmer in forecasting probable levels of, or changes in, relative prices. Prices during the ensuing marketing year for each of the crops that a farmer can grow depend on the particular supply and demand conditions that affect them. Two assumptions usually are made implicity with respect to factors of demand: (1) That possible changes in demand will affect the several alternative crops about the same and in such a way that they will affect the ratio of one price to another very little, and (2) that any differential effects of changes in demand can be forecast by economic analysis. Changes in production, however, frequently have important effects on relative prices and, in general, cannot be forecast by economic analysis. Hence, a survey of farmers' intentions is used instead. As farmers cannot forecast probable yields before planting, the survey is confined to intentions with respect to acreage. This article explores alternative ways of translating the acreage intentions data into the more meaningful decision-making variable, prospective changes in production for specified crops and, as a byproduct, indicates how useful the data are for this purpose. If a majority of farmers change their minds with respect to plantings after the report is issued, then the data regarding intentions to plant would give a poor forecast of production. But these analyses indicate that, on the average, for many crops data on intentions to plant are a useful guide to forthcoming production. Included also are analyses of the usefulness in forecasting production of data on acreage seeded to winter wheat and rye published before harvest in December, of data on acreage of cotton in cultivation in July, and of data on condition of specified crops.

IN MARCH, the Crop Reporting Board issues annually a report on farmers' planting intentions as of March 1 for most field crops.[1] In addition to tabular data on indicated planted acreages by States, text statements for the more important crops are given with respect to the total production in the United States that would result if yields per planted acre should equal a specified average and the acreage planted equals that indicated by farmers as of March 1.

A cautionary statement is included in each report; the statement in the 1957 report (page 5) is as follows:

> The purpose of this report is to present information on planting prospects at an early date for use by growers and others in advance of final planting decisions. Commodity comments which follow mention many factors for the different crops which may result in changes, thus stressing the fact that many of the plantings referred to are still to be accomplished. Production computations in comments generally involving 5-year average yields are offered as convenient added information and not as true estimates of probable production. Actual production forecasts will be made by the Crop Reporting Board after determination of acreage for harvest and accumulation of evidence on per acre yields.

Despite the fact that the data on intentions to plant are in a different category from the regular production reports issued by the Crop Reporting Board, they do have forecasting implications. Thus, it is desirable to explore the extent to which the information provided in the prospective plantings report can be used as a guide to probable changes in production. Similar analyses are given for certain indications of acreage and for estimates of condition as a percentage of normal, which are published for some crops before the first forecast of production.

In the early years of crop reporting, reports on acreage intentions were not issued uniformly as they are now. Since 1938, these intention figures

[1] Crop forecasts appear in *Crop Production*, a monthly publication issued by the Crop Reporting Board, U. S. Department of Agriculture, Washington, D. C.

have been reported consistently on a planted acreage basis for most crops. Planted acreages also are reported in December for these crops. To insure valid conclusions, analyses that involve data on acreage intentions begin with 1938 wherever possible. Of necessity, however, shorter periods are studied for some crops, because of a lack of data. All of the studies discussed here refer to national aggregates, as such data provide the most important single figure for each crop from either a price-forecasting or a national policy standpoint. As data are given in the published reports by States, similar analyses on a State basis appear to be desirable.

Alternative Methods

We first list several alternative ways by which information on farmers' intentions to plant or other available information might be used to forecast changes in production. Emphasis is placed on year-to-year changes in production rather than the absolute level, because most outlook statements on either prices or supply are given in these terms. A comparison is made with the estimate of production issued in the December following harvest, rather than the final figure, because the latter is based partly on information regarding marketings or other check data in addition to that on acreage and yields *per se*. We show first the results of applying these methods to three crops—corn, flaxseed, and spring wheat. A summary is then given of the results for all field crops.

The three crops were chosen for special attention for the following reasons: (1) Changes in acreage on a percentage basis for corn normally are small, whereas percentage variations in yield frequently are 25 percent or more. Thus corn is one of several crops for which, on the average, the acreage-intentions report may be of little value in indicating probable changes in production. (2) For spring wheat, changes in acreage frequently have decided effects on total production. Winter wheat, of course, is not included in the intentions-to-plant report because by March it is already growing. (3) Flaxseed is an item for which variation in yield is relatively small in percentage terms, and the variation in acreage is frequently large. The latter reflects (a) weather conditions that may affect the acreage planted to spring wheat, the principal alternative crop to flaxseed and one which normally must be planted in advance of flaxseed, or (b) changes in the prospective price of flaxseed relative to that for spring wheat, which in some years have been substantial. Thus, spring wheat and flaxseed are among those crops for which the acreage intentions report might be of considerable value, on the average, as an indication of prospective changes in production.

The following alternative methods of obtaining an indicated change in production are considered:

1. Direct use of the indicated change in intentions to plant from the planted acreage of the preceding year, in percentage terms, as an indication of the prospective percentage change in production. A more sophisticated way of doing this statistically is to use the indicated change in acreage as the independent variable in a regression analysis for which the change in production is the dependent variable, and this is the method used. If the constant term in the regression analysis does not differ significantly from zero and the regression coefficient does not differ significantly from one, the direct method and that based on the regression analysis are identical for practical purposes.

2. Use of the change in intentions to plant from the harvested acreage of the preceding year as the independent variable in a regression analysis for which the change in production is the dependent variable. Contrary to what might be expected on first thought, use of the harvested acreage for the previous year for some crops provides a more reliable guide than does use of the planted acreage for the preceding year. (See table 3.)

3. Use of (a) the figure given in the text or (b) its approximate equivalent based on multiplying the intentions to plant by an average yield per planted acre as an indication of prospective production. The years used in computing the average yield in the latter case were those specified in the text. To be consistent with the other analyses, the indicated change in production from the preceding year based on this figure is used as the independent variable in a regresssion analysis for which the actual change in production is the dependent variable.

4. Use of an average production for the same years as those used in computing the average yield in method (3b) as an indication of prospective production. This indication is used in the same way as those from methods (3a) and (3b).

5. Obtaining an indication of prospective production by multiplying an average yield per planted acre by the acreage planted in the preceding year as shown in the December crop report. This is similar to method (4) except that acreage in the preceding year is used instead of, in effect, an average acreage.

6. Use of a mechanical projection of a moving average of yield times either (a) last year's acreage or (b) intended acreage as an indication of production. The mechanical projection is similar to that used by the Bureau of the Census in its method of measuring shifts over time in normal seasonal variation as programmed for UNIVAC.

Methods (4), (5), and (6a) are designed to measure how closely changes in production can be forecast by using information available prior to the acreage-intentions report and thus to indicate how much additional information is obtained from that report. Methods (1), (2), (3a), (6a), and (6b) were applied also to winter wheat and rye, with the data on seeded acreage as published in December used in the same way as the intentions-to-plant data for other crops.

Results for the Three Crops

Corn.—The qualified estimates given in the text turn out to be more closely correlated with production than were the estimates obtained by any other method tested. For 1943–54, 63 percent of the year-to-year variation in production was associated with the estimate published in March. From 50 to 52 percent of the variation, however, was associated with estimates based on an average or projected yield multiplied by the acreage planted in the preceding year. Thus, the explained variation was increased by 11 to 13 percentage points by making use of data obtained from the acreage-intentions report.

Spring wheat.—As for corn, the best results are obtained by using the qualified estimate given in the text, although for this item the percentage of associated variation is only 49 percent for 1945–54. But for spring wheat, only 13 percent of the variation is associated with estimates in which the intentions data are not used. For Durum and other spring wheat, no estimates are given in the text. The best method of forecasting for Durum is a projected yield multiplied by the acreage intentions; this was associated with 32 percent of the variation in production. For "other" spring wheat, the best method was an average yield times the intended acreage; here the associated variation was 61 percent. For each of these classes, substantial improvement is obtained by making use of the data on intentions. As discussed later (see table 2), further improvements in accuracy are obtained by making use of the condition figures published in June.

TABLE 1.—*Alternative methods of forecasting production from past yields and indicated acreage: Method that gives the highest percentage of variation associated with actual production, this percentage, and related data, specified crops, 1938–54* [1]

Crop	Method that gives the highest percentage		Difference between highest percentage and that for—	
	Method	Percentage	Best method that does not use indicated acreage	Qualified estimate in text
Included in intentions report:		*Percent*	*Percent*	*Percent*
Corn	3a	63	11	0
Spring wheat:				
Durum	6b	32	30	-------
Other	3b	61	22	-------
All	3a	49	22	0
Oats	3a	71	20	0
Barley	3a	88	38	0
Flaxseed	3a	82	49	0
Rice	6b	88	88	33
Sorghums	1	69	35	28
Potatoes	3a	68	36	0
Sweetpotatoes	1	70	52	17
Beans, dry edible	4	46	0	42
Peas, dry field	2	59	48	37
Soybeans	3a	51	17	0
Peanuts	2	59	30	25
Hay, all	6b	45	18	18
Sugar beets	6b	94	76	44
Tobacco:				
Flue-cured	3a	76	48	0
Fire-cured	3b	69	29	-------
Burley	3b	83	46	-------
Maryland	6b	78	23	-------
Dark air-cured	3b	79	38	-------
Cigar—				
Filler	6b	69	39	-------
Binder	2	47	37	-------
Wrapper	6b	49	18	-------
Based on acreage estimates as of preceding December:				
Winter wheat	2	45	25	2
Rye	6b	70	44	-------

[1] For some analyses, fewer years were used. Details are shown in table 3.

Flaxseed.—A similar situation holds for flaxseed, except that the percentage of associated variation is considerably higher than for either of the other test crops. Here the qualified estimate given in the text is associated with 82 percent of the variation in production, and figures of 78 percent or above are given for three other methods. Methods in which the intentions data are not used at best are associated with only 33 percent of the actual production.

A Summary of the Usefulness of Acreage Data in Forecasting Production

Detailed figures on the results that relate to acreage are given in table 3; significant aspects are summarized in table 1.

For all the crops except one, methods that utilize the indicated acreage data explain a higher percentage of the variation in production than do those that do not utilize this information; the exception is dry edible beans. For this crop, the use of average production yields the best estimate for 1944–54. Differences between the highest figure that utilizes this information and the highest figure that does not utilize it for the other crops range from 11 percent for corn to 88 percent for rice. For 16 of the 27 items, the improvement equals or exceeds 30 percentage points. Thus the intentions-to-plant data appear definitely to be useful in making forecasts of future production.

Naturally, estimates based on the acreage information, combined with an average or projected yield, are not perfect forecasters of future production. Percentages of variation associated with actual production for the best method range from 32 percent for Durum wheat to 94 percent for sugar beets. For 20 of the 27 items, the percentage equals 50 percent or better, and for 11 items, the percentage is 70 percent or better. For a few crops, the best estimate based on acreage data is closer on the average to actual production than is the first or even later production forecasts isued by the Crop Reporting Board.

Of the crops for which a qualified estimate is given in the text, the percentage of variation associated with actual production, based on this figure, ranges from 4 percent for dry edible beans to 88 percent for barley, with 10 of 17 items equal to or exceeding 50 percent. For approximately half of the items for which a qualified estimate is given, this is the best estimate; for the other half, one of the other methods tested is an improvement.

It appears to be desirable to examine carefully the items for which a method other than the qualified estimate in the text gives the best forecasts.

TABLE 2.—*Alternative methods of forecasting production when use is made of data on condition: Percentage of variation associated with year-to-year changes in actual production, specified crops, 1938–54*

Result for—	Crop			
	Spring wheat [1]		All hay [2]	Rye
	Durum	Other		
Best method based only on indicated acreage and past yields	*Percent* 32	*Percent* 61	*Percent* 45	*Percent* 70
Seeded acreage times condition when condition relates to—				
December	------	------	------	(3)
April	------	------	------	(3)
Average yield times indicated acreage times condition when condition relates to—				
May	------	------	(3)	------
June	38	66	16	------
Logarithmic multiple regression for seeded acreage and condition when condition relates to—				
December and seeded acreage is related to preceding—				
Planted acreage	------	------	------	39
Harvested acreage	------	------	------	49
April and seeded acreage is related to preceding—				
Planted acreage	------	------	------	28
Harvested acreage	------	------	------	43
Logarithmic multiple regression for average yield, indicated acreage and condition when condition relates to—				
May and indicated acreage is related to preceding harvested acreage	------	------	25	------
June and indicated acreage is related to preceding—				
Planted acreage	78	58	------	------
Harvested acreage	74	61	38	------

[1] Based on 1946–54.
[2] Based on 1948–54.
[3] A negative correlation that does not differ from zero by a statistically significant amount was obtained.

TABLE 3.—*Alternative methods of forecasting production from past yields and indicated acreage: Percentage of variation associated with year-to-year changes in actual production, specified crops, 1938–54*

Method: Description	Number	Corn	Spring wheat: Durum	Spring wheat: Other	Spring wheat: All	Oats	Barley	Flaxseed	Rice	Sorghums	Potatoes	Sweet potatoes	Beans, dry edible	Peas, dry field	Soybeans
		Indicated acreage based on intentions to plant													
When use is made of indicated acreage for the current year:															
Indicated acreage in relation to preceding—		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Planted acreage	1	14	13	24	21	49	57	79	[1] 75	[2] 69	64	[3] 70	35	[1] 44	37
Harvested acreage	2	20	22	38	35	25	45	78	[1] 81	[2] 64	66	[3] 69	26	[3] 59	27
Year-to-year change in—															
Qualified estimate in text	3a	[3] 63	------	------	[4] 49	[3] 71	[3] 88	[3] 82	[3] 55	[1] 41	[3] 68	[3] 53	[3] 4	[3] 22	[1] 51
Product of indicated acreage and—															
Average yield	3b	[3] 60	(4, 5)	[4] 61	[4] 48	[3] 64	[3] 70	[3] 74	[3] 48	[1] 40	[3] 54	[1] 47	[1] 5	[3] 27	[1] 44
Projected yield	6b	[3] 52	[3] 32	[3] 47	[3] 17	[3] 55	[3] 63	[3] 80	[1] 88	[3] 39	[3] 50	[3] 69	[3] 16	[1] 57	[3] 16
When use is not made of such information:															
Year-to-year change in—															
Average production	4	[3] 48	(4, 5)	[4] 39	[4] 27	[3] 51	[3] 50	[3] 33	(3, 5)	[1] 34	[3] 32	[1] 18	[1] 46	[3] 0	[1] 33
Product of acreage planted in preceding year and—															
Average yield	5	[3] 52	(4, 5)	[4] 21	[4] 13	[3] 47	(3, 5)	[3] 2	(1, 5)	[1] 21	[3] 10	[1] 7	(1, 5)	[1] 11	[1] 34
Projected yield	6a	[3] 50	[3] 2	[3] 4	(3, 5)	[3] 30	(3, 5)	(3, 5)	(1, 5)	[3] 4	[3] 21	[3] 0	(3, 5)	[1] 0	[3] 17

Method: Description	Number	Peanuts	All hay	Sugar beets	Tobacco: Flue-cured	Tobacco: Fire-cured	Tobacco: Burley	Tobacco: Maryland	Tobacco: Dark air-cured	Tobacco: Cigar: Filler	Tobacco: Cigar: Binder	Tobacco: Cigar: Wrapper	Seeded acreage: Winter wheat	Seeded acreage: Rye	In cultivation, July 1, for cotton
		Indicated acreage based on— Intentions to plant													
When use is made of indicated acreage for the current year:															
Indicated acreage in relation to preceding—		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Planted acreage	1	51	------	[2] 88	------	------	------	------	------	------	------	------	23	5	78
Harvested acreage	2	59	[3] 9	[2] 90	71	39	47	60	35	46	47	45	45	3	80

Year-to-year change in—															
Qualified estimate in text	3a	[1] 34	[3] 27	[1] 50	[1] 76	------	------	------	------	------	------	------	43	------	------
Product of indicated acreage and—															
Average yield	[1] 3b	24	11	76	74	69	83	71	79	56	43	48	------	------	------
Projected yield	6b	[3] 41	[6] 45	[3] 94	[3] 70	[3] 62	[3] 82	[3] 78	[3] 69	[3] 69	[3] 46	[3] 49	[3] 44	[3] 70	[3] 78
When use is not made of such information:															
Year-to-year change in—															
Average production	4	([1], [5])	[1] 21	[1] 18	28	[1] 34	[1] 25	[1] 55	[1] 22	[1] 6	[1] 7	[1] 10	------	------	------
Product of acreage planted in preceding year and—															
Average yield	[1] 5	12	27	5	2	40	33	53	26	40	10	31	------	------	------
Projected yield	6a	[3] 29	[6] 18	([3], [5])	([3], [5])	[3] 34	[3] 37	[3] 55	[3] 41	[3] 30	([3], [5])	[3] 25	[3] 20	[3] 26	[3] 18

[1] Based on 1944–54. [2] Based on 1942–54. [3] Based on 1943–54. [4] Based on 1945–54.
[5] A negative correlation that does not differ from zero by a statistically significant amount was obtained.
[6] Based on 1946–54.

As shown in the last column of table 1, the items that show substantial differences are rice, sorghums, sweetpotatoes, dry edible beans, dry field peas, peanuts, all hay, and sugar beets. Except for hay, all of these are rather specialized crops. Either method (1) or (2) gives the best estimates for sorghums, sweetpotatoes, peas and peanuts, with two of the four items being best for each approach. These methods assume that the change in production is a direct function of the indicated change in acreage. They tend to be of value when average yield is a poor indicator of actual yield. Method (6b) is best for rice, hay, and sugar beets. Here projected yields, based on a formula that gives heaviest weight to the later years, are used in connection with the data on intentions to plant. Method (4) is best for dry beans. This method merely states that average production over a recent period is the best indicator of forthcoming production. These methods gave best results over a relatively short period. Whether they would give better results in future than the methods currently used by the Crop Reporting Board in making their qualified estimates in the text is a matter of conjecture. The Board might well consider use of these alternative estimating procedures when conditions are such as to suggest that they might give improved results.

Similar analyses, based on the estimate of the acreage in cultivation published in the July prior to harvest, were made for cotton, using methods (1), (2), (6a) and (6b). Three of these methods, that is, all except (6a), give percentages of associated variation that range between 78 and 80 percent. As for most other crops, the acreage information contributes substantially to the accuracy of production forecasts.

Results When Information on Condition Is Used in Conjunction With That on Acreage

Table 2 shows the results from various analyses that make use of data on condition, in addition to information on indicated acreage. For purposes of comparison, the percentage of variation associated with production is shown in the first line for the best method based on information that relates only to past yields and indicated acreage.

Information on condition as a percentage of normal is given in the December and April crop reports for rye, in the May report for all hay, and in the June report for (a) Durum and (b) other spring wheat and for (a) alfalfa, (b) clover and timothy, and (c) all hay. These representations of farmers' composite opinion of the crops relate essentially to yield, and this information can be combined with information on indicated acreage to arrive at a forecast of production. It should be noted that a production forecast for all spring wheat is included in the June report. Thus the analyses discussed here for Durum and other spring wheat are chiefly of value in breaking down this total.

The following methods made use of this information:

1. Obtaining a composite indication of prospective production by use of average yield per planted acre multiplied by condition multiplied by indicated acreage.

2. Running a multiple regression analysis for which the change in actual production is the dependent variable and year-to-year changes in each of the following are used as independent variables: (a) Condition, (b) average yield, and (c) indicated acreage. As with methods (1) and (2) on acreage (see p. 21), indicated acreage can be related either to (a) planted acreage or (b) harvested acreage in the preceding year. When published data on planted acreages were available, both approaches were used. The analysis is run in logarithms, as this is believed to be a multiplicative relation.

In computing an average yield, the same years were used as those specified in the report on intentions to plant. As no such years are specified for rye, an average yield was not used. Instead, seeded acreage times condition was used as an indication of prospective production, and these two factors also were used separately as independent variables in a logarithmic multiple regression analysis.

In method (1), the composite is computed and then year-to-year changes in this are used in the analysis. In method (2), year-to-year changes in each of the components are used in the analysis. From a statistical standpoint, the two approaches are quite different.

For some items, results shown in table 2 are rather surprising. Those obtained for Durum wheat are in line with expectations; that is, analyses that make use of the information on condition yield better estimates of year-to-year changes in production than do those that do not make use of such information. Here, the best method is that based on a multiple regression analysis in which the indicated acreage is related to the planted acreage in the preceding year; this analysis, which includes an estimate of condition made in June, explains 78 percent of the year-to-year variation in production compared with only 32 percent associated with the best method that does not make use of information on condition. For "other" spring wheat, the several analyses yield similar results and little is gained from making use of the June information on condition.

For all hay and for rye, the analyses that make use of information on condition are less reliable as indicators of production than is the best analysis that does not make use of this information. For hay, this results because the best analysis is based on a projected rather than an average yield. The multiple regression analysis based on average yield, condition, and the change in indicated acreage from the harvested acreage in the preceding year was the most reliable of the several studies based on condition. It explained 38 percent of the year-to-year variation in production, compared with 27 percent for the best noncondition analysis that did *not* make use of a projected yield. A similar situation holds for rye. Here the best analysis that made use of information on condition was the multiple regression based on December condition and the seeded acreage related to harvested acreage in the preceding year. This explained 49 percent of the variation in production, compared with 5 percent for the best noncondition analysis not based on a projected yield. Apparently, information on condition of rye in April is less reliable as an indicator of production than is the information that is available in the preceding December.

Book Reviews

Economic and Technical Analysis of Fertilizer Innovations and Resource Use. Edited by E. L. Baum, Earl O. Heady, John T. Pesek, and Clifford G. Hildreth. The Iowa State College Press, Ames, Iowa. 393 pages. 1957. $4.50

THE NEXUS between research in farm management, or agricultural production economics, and research in the physical sciences has long been recognized. But the Tennessee Valley Authority and its cooperators have an outstanding record of promoting actual teamwork approaches to interdisciplinary problems. This volume, and a previous one, "Methodological Procedures in the Economic Analysis of Fertilizer Use Data" (Iowa State College Press, 1956), are indispensable references for economists, agronomists, and soil scientists who are concerned with research on fertilizers. The scope of the present work is much broader than the field of soil fertility. The book will be useful in the planning of any agronomic-economic project.

Here are 29 papers presented by agronomists, economists, and statisticians at a seminar held in Knoxville, Tenn., in 1956 under the auspices of TVA. They are grouped under the following headings:

1. Physical and economic aspects of water solubility in fertilizers.
2. An examination of liquid fertilizers and related marketing problems.
3. Methodological procedures in the study of agronomic and economic efficiency in rate of application, nutrient ratios, and farm use of fertilizer.
4. Farm planning procedures for optimum resource use.
5. Agricultural policy implications of technological change.

The early sections are devoted to specific new problems in fertilizer manufacture and use. Later sections are devoted to progressively more general problems in resource use and agricultural policy. The last two sections deal with fertilizer research only incidentally.

More attention is given in this volume to the planning of experiments than to the fitting of response functions and analytical techniques. These subjects were treated in detail in the preceding symposium. Several chapters, however, deal with the use of linear programing in connection with a variety of research problems—the manufacture of fertilizer, optimum fertilizer applications on the farm, and resource allocations in full-time and part-time farming, among others.

To aid in the planning of experiments, several papers presented deal with experimental design, selection of independent variables, and devices that will make experiments more meaningful to farmers.

Considerable attention is given to the design of experiments that will be more economical of resources than the usual factorial experiment. A corn-fertility experiment in North Carolina is reported, in which an adaptation of a design developed by G. E. P. Box and associates is used to estimate response surfaces. Fewer treatment combinations are used than would be needed with a complete factorial design.

Most production relationships from experimental data are highly specialized. This means that a vast number of relationships would have to be developed in order to analyze effectively the production possibilities of American agriculture. A paper by Clifford Hildreth shows how the number of functional relationships needed could be reduced substantially if each relationship were made more comprehensive. This might be done by putting more variables into each relationship and by including more variables in the statistical analysis. Hildreth suggests inclusion of such variables as initial fertility, rainfall, temperature, and wind. He suggests that construction of an index of weather "goodness" might be useful in handling weather as a variable in an experiment.

According to Glenn L. Johnson, designers of agronomic experiments have done a good job of duplicating farm conditions in the use of those variable inputs that a farmer can apply under controlled conditions. They have not done so well with respect to those variables that can be controlled only experimentally. As a result, a farmer tends to look on experimental results as unreal and as not applicable to him. Johnson suggests that it might be desirable to allow for more variability in experimental results, as the amount of expected variation is one of the important facts in which farmers are interested. Increased variability in experimental results should not be objectionable so long as it does not interfere with the estimation of the functions of production.

TVA test demonstration work progressed long ago from the field demonstration stage to the whole-farm demonstation. This book contains excellent treatment of farm-planing procedures, of the need for analysis of the managerial function, and of determining the data needed to reach management decisions. Special problems of low-income farming are discussed. The relationship of the whole process of economic growth to farm production and welfare and the need for studying the growth phenomenon are presented in a trenchant article by T. W. Schultz.

Most research workers in agricultural economics, agronomy, and soil science will find much in this book that is useful.

Orlin J. Scoville

Iowa's Water Resources—Sources, Uses, and Laws. Edited by John F. Timmons, John C. O'Byrne, and Richard K. Frevert. Iowa State College Press, Ames, Iowa. 225 pages. 1956. $3

THIRTY-SIX PAPERS given at a Water Resources seminar at Iowa State College in 1956 are made available in this volume. The seminar was sponsored by the Division of Agriculture, Iowa State College, and the Agricultural Law Center, State University of Iowa. The six parts of the book are made up of 37 chapters. Part I is a discussion of water supply in Iowa, part II deals with the economics of water use and control, part III is concerned with the multiple demands for water, part IV is devoted to water laws, part V covers the functions of governmental agencies regarding use and regulation of water, and part VI explores some of the possibilities for solution of Iowa's water problems.

The need for the seminar was premised on the conviction that Iowa, along with other humid-area States, has too little appreciation of the need for adequate water supplies in agricultural, industrial, domestic, and other uses. The editors and the authors of some of the papers stress in profound terms the obvious fact that water is essential to man's existence. The papers indicate for the most part that the authors are experts in the subject matter they treat. The water facts they present are essential to an understanding of the water situation in Iowa.

An excellent chapter by H. Garland Hershey, State geologist, deals with quantity, distribution, and future needs of groundwater. Mr. Hershey suggests a groundwater inventory as a proper and necessary step to get an answer to how much groundwater will be needed and for what purpose. The inventory, he suggests, should show the quantity of water used and for what purposes, quantities and qualities available, and where obtainable.

Earl O. Heady and John F. Timmons, Iowa State College, attempt to provide an economic framework for planning efficient use of water resources. Although this chapter contains many useful ideas, it fails to give any practical economic guidelines for water-resource planning. If their criterion of maximization of economic welfare could be developed to the point of practical application and measurement in concrete terms and something more than ideal, it might have some value to those concerned with water-rights law and the planning of water-resource projects.

L. M. Adams, attorney in the United States Department of Agriculture, contributes a succinct and well-documented explanation of water rights in the United States under riparian and appropriative doctrines. Under riparian doctrine, Mr. Adams discusses the nature and extent of riparian rights and who may exercise them; diversion and return of water; detention of water; pollution of water; and loss of right. His discussion of these topics as they apply under the appropriative doctrine is amplified with (1) an explanation of the purposes for which appropriation may be made, and (2) a discussion of the transfer of these rights.

Wendell Pendleton, chairman of the Water Rights and Drainage Law Study Committee created by the 56th General Assembly of Iowa (1955), summarizes some of the committee's preliminary findings. The committee concluded that the present water law in Iowa is both indefinite and inadequate. More basic information is needed on water supply, and although Iowa has a fairly strong program for collecting water data, the program should be accelerated. The committee agreed that the State of Iowa should adopt a water policy that would do everything practicable to conserve water for wise utilization, and that the goal should be maximum beneficial use of water in streams with a minimum of invasion of private property rights.[1]

In the final chapter on water legislation, John O'Byrne declares it imperative to begin the formulation of a coordinated statement of policy or philosophy with respect to water use and control. A job to be done immediately, he says, is to articulate present water policy from legislative acts. He recommends a forthright legislative declaration of water policy, calling for State ownership of all waters not specifically subject to riparian use; State powers to regulate, control, and limit use, and prevent use of water sources; and the holding in trust of additional rights of use such as those relating to recreation, fish and wildlife, navigation, and maintenance of flow. He also recommends establishment of a permanent State resources organization of technicians who are qualified to plan the development of water resources on a long-range basis. After making these rather far-reaching and sweeping proposals, he returns to a more realistic note, in the opinion of this reviewer, by saying that our present stage of knowledge of Iowa's water problems dictates progress that is slow and careful. He concludes with a more modest hope that Iowa can adopt a long-range water law that will be subject to regular revision, and can establish an administrative body trained to administer an Iowa Water Code.

Elco L. Greenshields

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[1] The study committee submitted its completed report to the Governor of Iowa on December 1, 1956. The committee in its report proposed a redraft of Chapter 455A, Code of Iowa, 1954, to include, in addition to flood control, specific terms relating to the conservation, development, and use of water resources. The essential recommendations of the committee were enacted into Iowa water rights law by the 57th General Assembly on April 13, 1957. The law provides that permits will be required for increasing the usage to more than above normal of water from flowing streams and underground sources.

Agricultural Cooperation. Selected Readings. Edited by Martin A. Abrahamsen and Claud L. Scroggs. University of Minnesota Press, Minneapolis. XIV, 576 pages. 1957. $7.50

COLLEGE TEACHERS and personnel trainers have received in these selected readings a more than satisfactory response to their need for help in providing their students with sources of information in the field of agricultural cooperation. The body of literature has continued to grow until even professors who teach the course must be selective in their own readings. But when a professor dips into his last annual volume of *American Cooperation*, he finds the gems interspersed with other ideas that have been better expressed before, either in this or other publications, and he longs for a single collection of the best.

These selections were made by Dr. Abrahamsen and Dr. Scroggs, a couple of keen students, who have had broad teaching and research experience with farmer cooperatives. The review of the literature involved a tremendous reading task, and the orderly arrangement called for a broad grasp of the many aspects of farmer cooperation. The major framework for assembling the readings is a division into three parts: I. The Emergence of the Cooperative Institution; II. Cooperatives in the Modern Economy; III. Evaluation and Appraisal.

The Emergence, part I, is developed with (1) a historical and statistical account; (2) a variety of statements of objectives; (3) interpretations of the sociological, spiritual, philosophical, and economic nature of cooperatives; and (4) a statement of generally accepted principles of operation.

Cooperatives in the Modern Economy, part II, includes a review of (1) the development of policy toward cooperatives in general farm organizations, in Government, and in educational institutions; (2) legislative benchmarks; (3) relations with other cooperatives, with general farm organizations, with other businesses, and with the public; and (4) the use of horizontal and vertical integration as the core of present-day cooperative growth.

Evaluation and Appraisal, part III, considers the place of farmer cooperatives, of their business performance, the growing use of cooperative research, and of the social and economic betterment they effect.

The 54 selections in the readings are by 49 authors, most of them nationally known leaders in farmer cooperation. We find such names as E. G. Nourse, Harold Hedges, Murray Lincoln, M. M. Coady, O. B. Jesness, Marvin Schaars, Lyman Hulbert, Marvin Briggs, Frank Robotka, George D. Aiken, Raymond Miller, and Joe Knapp. Most of the articles were taken from *American Cooperation*, but the editors made several selections from earlier contributions as well as other contemporaneous sources, including one unpublished statement. At the end of each of the 16 chapters is a carefully selected list of other available articles for students who wish to dig deeper.

The historical review and the chapter on business performance do not gloss over the organization struggles, business failures, economic losses, and thwarted hopes of the past—those associated with the Grange promotion of the 1870's; the Equity, the Alliance, and the Populist drives of the 1880's and 1890's; the activity of the Farmers Union during the first decade of this century; and the Sapiro and Federal Farm Board efforts of the 1920's and early 1930's. It is pointed out, however, that progress made and lessons learned through those trials constitute the foundation for the relatively strong position of farmer cooperatives in many fields today.

The future place of cooperatives is to be a fairly modest but very effective one of trail blazing; setting of standards for price, quality, and service; and individual and community satisfaction from common efforts. This is the consensus expressed in most of the selections. The publication can well constitute a milepost in cooperative education in the United States, and its publication by the Oxford University Press assures an impact on British Commonwealth nations.

James L. Robinson

Adaptive Behavior in Marketing. Proceedings of the Winter Conference of the American Marketing Association, December 1956. Edited by Robert D. Buzzell. American Marketing Association, 27 East Monroe Street, Chicago. 242 pages. 1957. $2.

DISCUSSION at the 1956 winter conference of the American Marketing Association was centered around the central theme, "Adaptive Behavior in Marketing," dealing in turn with current developments in retail trade, wholesale trade, the facilitating agencies of marketing, and the price and competitive aspects of the distributive trades.

Perhaps the various ideas in the papers brought together in this volume are all reasonably well known to some few within the marketing group. However, as marketing is a relatively new field to agricultural economists, it seems to me at least that in reviewing this material many of us will come across several new ideas or new ways of looking at several current trends in the marketing field.

The discussions were not of course confined to the marketing of food and agricultural products. But the opening paper under retail trade does deal with supermarkets, while automation in wholesale food distribution centers is discussed in the first paper in the wholesale trade section. Several of the papers also deal directly with the question of vertical integration and its relation to our agricultural system. Richard Kohls, from Purdue University, for example, discusses the by-passing of terminal marketing facilities in agricultural marketing; Richard Heflebower, from Northwestern University, considers the question as to whether mass distribution is best looked upon as a phase of bilateral oligopoly or simply as another phase of classical competition; and Robert S. Hancock from the University of Illinois considers the same subject under the title, "Implications of Quasi-Agreements and Competitive Behavior."

Several papers dealing with the future supply of marketing teachers are also of interest.

O. V. Wells

A Dictionary of Statistical Terms. By Maurice G. Kendall and William R. Buckland. Hafner Publishing Company, New York. 493 pp. 1957. $4.50.

REVIEWING A DICTIONARY is a difficult assignment because one does not ordinarily read it from cover to cover. Statistical workers who have time to read this one will find it profitable and instructive.

Work on this volume was started in 1951 at the request of the International Statistical Institute. Five years were spent on its preparation. The authors state, "We have been conscious of the fact that, had we possessed the stamina and leisure to spend another 10 years on it, a more complete and scholarly work might have . . . resulted; but it would have been 10 years behind the demand." Despite their comment, this is an amazingly complete book and their definition of the field of statistics is wide. For example, definitions of the following are included: *Aggregative model*, *almost certain*, *analogue computer*, *attack rate* (from medical statistics), *axonometric chart*—to mention a few that I would not have expected.

The authors say, "The function of a dictionary, in our view, is to provide an explanation of terms in current use, whether they are intrinsically desirable or not. . . . We thought it our duty to keep a tight rein on our inclination to omit expressions which are confusing or redundant, and have contented ourselves with a statement of opinion about those which we felt should be allowed to lapse into disuse." The term *best estimator* is one that I have found confusing. Their definition is unusually clear:

> The estimation of population parameters from information provided by the sample raises the question whether there is a "best" estimator. The answer depends mainly on the criteria that are laid down as to the "goodness" of an estimator. If there is a criterion which distinguishes one of two estimators as better than the other and if there

exists an estimator which is better than any other, it is said to be the best.

Various criteria have been suggested, for example those of sufficiency, minimum variance, or closeness. It is not always true that a best estimator exists.

Many authors define *unbiased*, *consistent*, and *efficient* in a way that is almost meaningless to the nonmathematician; Kendall and Buckland give definitions that undoubtedly are less precise from a mathematical standpoint but that are clear to the ordinary reader.

One of the great values of a book of this kind is to cite alternative meanings for a given term. Three meanings are given for *Monte-Carlo method*, one of which "is not to be recommended." Cross references to more precise terms are given also. For instance, in connection with an *efficient estimator* the authors state, "An estimator which tends to full efficiency for large samples is called Asymptotically Efficient." Frequently the adjective is omitted in statistical literature. Many tests, theorems, criteria, transformations, distributions, and so forth are identified by the individual who developed them. This is an exceedingly useful aspect of the dictionary.

As in any general book, an expert finds minor errors and incompleteness in some items. A casual examination reveals two such examples: (1) the *coefficient of part-correlation* is defined as a synonym of the *multiple-partial correlation coefficient* and the latter is attributed to Cowden (1952) based on a suggestion of Hotelling (1926). However, the term *part correlation* was introduced by Ezekiel in 1930 and is defined by him in a different way. (2) The definition of the terms *endogenous* and *exogenous variates* are conventional; they are based on whether the variables are an inherent part of a system of equations or "impinge on the system from outside." We are coming to believe that it is important to use a more technical definition, namely, that an *endogenous variate* is one that is believed to be correlated with the unexplained residuals in a structural equation and an *exogenous variate* is independent of these residuals. This definition is particularly valuable in helping the analyst to decide whether certain variates which he would prefer to treat as exogenous can so be treated in a statistical fit. In view of the statistical reputations of the authors and the colleagues who assisted them, it can be anticipated that such errors are few.

An interesting feature is the inclusion of glossaries in French, German, Italian, and Spanish. But definitions as such, are in English. An occasional American colloquialism has been permitted, as in the following:

> *Line-up*
>
> The American equivalent of the English meaning of the French word "que." (See Queueing Problem.)

This book is a valuable reference work to anyone even remotely connected with statistics and, the reader who has time to browse through it will discover many hitherto unknown aspects of the field.

Richard J. Foote

Agriculture and Industry—Relative Income. By J. R. Bellerby in association with G. R. Allen, A. J. Boreham, D. K. Britton, G. Gutch, H. A. Rhee, F. D. W. Raylor, and F. D. Thompson. St. Martin's Press, London, and Macmillan & Co., New York. 369 pages. 1956. $6.75.

THE MAJOR PURPOSE of this book is to provide statistics on the relative incomes of persons engaged in agriculture and persons engaged in other occupations. The author has examined and reworked a considerable body of statistical data covering the United Kingdom, Canada, United States, France, the Netherlands, and Eire. In addition, he has brought together the information available for other nations as a basis for judging the probable relative income position of agriculture in those countries.

The income ratio with which Mr. Bellerby is concerned excludes from both sides of the income comparison—farm and nonfarm—the return to property. Briefly, the income ratio involves the return per equivalent adult male from farming compared with equivalent full-time earnings in the rest of the economy. It should come as no surprise that his investigations show lower incomes for persons engaged in agriculture than for persons engaged in other pursuits. The author ranks countries according to their farm-nonfarm income ratios in 1938 as follows:

1. Ratio probably over 75 percent—Australia, New Zealand, France, China.
2. 60–75 percent—United Kingdom, Denmark, Germany, India, Burma, Hungary.
3. Between 45 and 60 percent—Sweden, Canada, Finland, Italy, Chile, Japan.
4. 35–45 percent—United States, Netherlands, Eire, Peru, Norway, Bulgaria, Portugal.
5. Under 35 percent—Egypt, Mexico, Philippines, Thailand, Turkey.

A look at these findings shows that there is no single guideline determining the income position in agriculture relative to industry. Nor are variations explained by the several stages of economic development involved for the individual countries. According to the author, the high income ratios of Australia and New Zealand reflect a condition where agriculture is the predominate occupation and where it has grown as rapidly as the rest of the economy. For China, both agriculture and industry were on a primitive level. The relatively low ratios for the United States and most of western Europe reflect a situation where industry has grown faster than agriculture.

Next Mr. Bellerby turns to an explanation of reasons for low-income ratios for agriculture. Here there appears to be nothing new. He quotes the farm surplus problem and pressure on farm prices and incomes flowing from low income-elasticity, low price-elasticity for farm products, and flexibility in expanding the supply of farm products. He states, "Agriculture is not capable of achieving a significant degree of contraction immediately or, indeed, for a considerable period of years, in the face of a shrinking market and falling prices."

He appraises next the meaning of differences in income levels as between farm and nonfarm people. Several factors are listed—differences in the cost of living on farms and in the city, the advantages of working on the land and being your own boss, security on the farms during depressions, as well as occupational, social, and personal immobilities. The difficulties of evaluating income differentials between farm and nonfarm people have been discussed elsewhere, recently in the report of the Secretary of Agriculture on "Possible Methods of Improving the Parity Formula," Senate Document 18, 85th Congress.

Perhaps the most significant point is that Mr. Bellerby's statistical investigation shows that for many countries, including Australia, New Zealand, France, the United States, and Canada, there has been little long-term change in income ratio. This indicates that although farmers' incomes are generally lower than those of other workers, the long-term tendency is for both to increase at much the same rate.

Nathan M. Koffsky

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

AGNEW, D. B. HOW BULK ASSEMBLY CHANGES MILK MARKETING COSTS. U. S. Dept. Agr. Mktg. Res. Rept. 190, 91 pp., illus. July 1957.

Report considers advantages and disadvantages of bulk assembly of milk; changes in customary tasks, changes in ownership and control of milk collection routes, and the accompanying changes in costs. Stresses the impact of bulk milk assembly on the structure of milk marketing and milk supply.

ANDERSON, D. L., and SHAFFER, P. F. IMPROVED METHODS OF TRIMMING PRODUCE IN RETAIL FOOD STORES. U. S. Dept. Agr. Mktg. Rept. 192, 46 pp., illus. August 1957.

Improved produce trimming methods, equipment, and work places developed and installed in 2 supermarkets with weekly produce sales of $3,500 and $5,000 saved, respectively, 8½ and 16½ man-hours a week. Report studies and evaluates improved hand methods of trimming produce, using minimum time and maintaining quality of the product.

ASKEW, W. R., VOSLOH, C. J., JR., and BRENSIKE, V. J. CASE STUDY OF LABOR COSTS AND EFFICIENCIES IN WAREHOUSING FORMULA FEEDS. U. S. Dept. Agr. Mktg. Res. Rept. 205, 27 pp., illus. November 1957.

Idle or delay time consumed about 29 percent of the average worker's time in a case study of 6 feed mills having a daily volume of 100 tons per day. Report analyzes the relative efficiencies in the use of warehouse labor and how this efficiency varies among mills using three basic warehouse materials handling methods.

BOWMAN, E. K., and JOHNSTON, E. F. METHODS OF RECEIVING POTATOES IN BARRELS AT MAINE TRACKSIDE STORAGES. A cooperative publication of the Maine Agr. Expt. Sta., Univ. of Maine, Orono, and the U. S. Dept. Agr., Agr. Mktg. Serv. Maine Bul. 560, 50 pp., illus. June 1957.

At Maine trackside storages, potatoes are typically received from the field in barrels and moved into storage by 3 or 4 men. Labor comprises 75 to 85 percent of the total cost of receiving. Maintaining proper crew size, therefore, is of primary importance. Greatest single factor in determining optimum crew size is the receiving rate. Three men can be expected to receive 1,040 barrels when hoisting barrels to attic levels but 1,800 barrels when filling cellar bins. At these rates it is more efficient and economical to employ 3 men when filling cellar bins and 4 when filling ground floor bins than to employ either 3 or 4 throughout the entire operation.

BRODELL, A. P., and PHILLIPS, H. C. SILAGE FROM 1955 CROPS. HARVESTING . . . STORING . . . PRESERVING. U. S. Dept. Agr. Statis. Bul. 217, 22 pp. September 1957.

In 1955, about 73 million tons of silage was produced on more than 600,000 farms. On 60 percent of these farms, corn silage only was produced. Other farms produced corn, grass, and sorghum silage. Field forage harvesters and stationary silo fillers were commonly found on farms, but numbers of row-crop binders had declined. Of the total tonnage of grass silage produced about a third was treated with preservatives. Preservatives used were sodium metabisulfite, other chemicals, molasses, and feed grains.

CASE, B. A. FARM-MORTGAGE LOANS HELD BY LIFE INSURANCE COMPANIES. U. S. Dept. Agr., Agr. Res. Serv. ARS 43–58, 39 pp., illus. October 1957.

This publication contains basic information from 17 life-insurance companies as to farm-mortgage loans outstanding on June 30, 1956, the average amount of which was $10,800. On January 1, 1956, these companies held 87 percent of the amount of farm-mortgage loans held by such companies. It was found that life insurance companies make larger farm real estate loans than other lenders. The proportion of loans made for $25,000 or more was 15 percent in 1955-56.

FOELSCH, G. G., and COOK, H. L. AN ANALYSIS OF FEDERAL COURT DECISIONS RELATING TO THE MARKETING OF FLUID MILK. Wis. Agr. Expt. Sta. and U. S. Dept. Agr. Res. Bul. 200, 100 pp. illus. January 1957.

Report shows how Supreme Court decisions led to changes in the basic enabling legislation and sometimes to amendments in the provisions of milk orders. It indicates how essential approval and legal directions of the Court was, and is, to the attainment of orderly marketing under the milk order program.

GARLOCK, F. L. JONES, L. A., SCOFIELD, W. H., and others, under the direction of Norman J. Wall. THE BALANCE SHEET OF AGRICULTURE, 1957. U. S. Dept. Agr. Agr. Inform. Bul. 177, 30 pp., illus. October 1957.

On January 1, 1957, the value of farm assets reached a new peak of nearly $177 billion, about 5 percent more than a year earlier. The equity of farm operators and other owners of farm properties amounted to more than $157 billion at the beginning of 1957. Increases in the value of farm real estate account mainly for the increase in the value of farmers' assets.

GRAY, JAMES R., and PLATH, C. V. ECONOMICS OF ADJUSTING TO DROUGHT ON EASTERN OREGON CATTLE RANCHES. Oreg. Agr. Expt. Sta. Misc. Paper 48, 44 pp. September 1957.

The most effective of 5 drought actions taken on cattle ranches in eastern Oregon during 1955 was to increase the size of leases of both rangeland and meadowland. Adoption of new techniques could do much to accomplish the same results as increasing lease sizes, which could not be done by all ranchers. Chief among these techniques is fertilization of native meadows. Other measures carried out by ranchers included reducing the size of the breeding herd or buying more feed, the latter of which was more effective. Buying hay paid off better than buying concentrates.

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

Grubbs, V. D., Clement, W. E., and Hunter, J. S. results of a promotional campaign for lamb in sacramento, calif. U. S. Dept. Agr. Mktg. Res. Rept. 200, 92 pp., illus. October 1957.

Report evaluates the consumption of lamb in relation to promotional efforts on the part of the American Sheep Producers' Council, Inc., in Sacramento. It studies consumer reaction to lamb, consumers' likes and dislikes, and the effect of the promotional campaign on lamb consumption.

Hochstim, E. S. homemakers appraise citrus products, avocados, dates, and raisins. U. S. Dept. Agr. AMS-207, 18 pp., September 1957.

This preliminary report of an extensive study is based on more than 2,500 personal interviews with homemakers throughout the United States. Citrus fruits and other products were discussed with homemakers, their opinions presented, their attitudes tabulated.

Holman, L. E. aeration of grain in commercial storages. U. S. Dept. Agr. Mktg. Res. Rept. 178, 43 pp., illus. (Agr. Expt. Stas. of Ga., Ind., Iowa, Kans., Mich., and Tex. cooperating.) Sept. 1957.

Sixty percent of the normal costs of turning stored grain can be saved by using aeration systems developed through marketing research. This report analyzes and describes the aeration of grains, giving specific examples of savings, costs, and systems already in use. The new aeration system is bringing about significant changes in commercial grain storages.

Jeffrey, A. D. the production–consumption balance of milk in the northeast region. Dept. of Agr. Econ., Cornell Univ., Agr. Expt. Sta. Northeast Reg. Pub. 29, 97 pp., illus. June 1957.

Report gives an overall picture of the production and use of milk in the Northeastern States for the years 1947–54. Shows the quantities of milk produced on farms and its disposal by farmers in each State of the region, plant receipts and uses of milk, and prices paid by dealers.

McGrath, E. J. restaurant acceptance of dehydrofrozen peas. U. S. Dept. Agr. Mktg. Res. Rept. 198, 27 pp. October 1957.

This study indicates that dehydrofrozen peas possess excellent commercial marketing possibilities in restaurants. One hundred restaurants were supplied with the peas and, later, restaurant operators were questioned about their opinions of the peas. The operators spoke favorably of the freshness, flavor, and appearance of the dehydrofrozen peas.

Magee, A. C., Marion, P. T., Fisher, C. E., and Hughes, W. F. economics of cattle feeding systems for west texas. Tex. Agr. Expt. Sta. Bul. 880, 14 pp., illus. September 1957.

This report is intended to assist West Texas farmers to appraise the opportunities for marketing sorghum grain through cattle at a profit. It was found that they would need to add facilities costing about $4,800 in order to feed 100 cattle. This would include the cost of a silage cutter. To feed 500 head would cost about $18,000. At prices that prevailed during the fall of 1956 and the spring of 1957, cattle feeding was profitable as a way to market grain sorghum. Rations high in grain and low in roughage were most profitable with cheap grain but with high grain prices, high-forage rations are best.

Manny, E. S., and Rogers, C. E. hospitals for rural people. U. S. Dept. Agr. Farmers' Bul. 2110, 23 pp., illus. June 1957.

This bulletin reports on nationwide progress in health facilities available to rural people—types of hospitals available, how various communities build hospitals, how they finance these, other community health resources available to rural people.

March, R. W., Anderson, E. D., and Klein, J. E. analysis of short-time changes in the price of butter at chicago. U. S. Dept. Agr. Mktg. Res. Rept. 194, 67 pp., illus. August 1957.

Since World War II the price of butter has tended to fluctuate erratically when it was not being actively supported by Government purchases. It was found that relatively little of the day-to-day changes in price could be associated with published indicators of short-time changes in supply and demand. This study evaluates the fluctuations, relationship between price and demand, and analyzes factors affecting price.

Metzler, William H., and Porter, Ward F. employment and underemployment of rural people in the upper mononogahela valley, west virginia. W. Va. Agr. Expt. Sta. Bul. 404, 69 pp., illus. June 1957.

A continued slump in coal-mining employment has brought attention to the problem of inadequate work opportunities in coal-mining areas of the State, which have limited agricultural resources. Occupational adjustments must be largely along nonfarm lines.

Mullins, Troy. economic considerations in the production of short-, medium-, and long-grain rice in northeastern arkansas. Ark. Agr. Expt. Sta. Spec. Rept. 3, 16 pp. illus. October 1957.

In this area, the risk factor is greatest with long-grain rice, but a balance in production of the three grain types is desirable, particularly in periods of excess supplies. In recent years, combine harvesting and artificial drying have encouraged production of the long-grain varieties, which are better adapted to these processes. But in variety tests, the leading short- and medium-grain varieties have produced about 10 percent higher yields than the long-grain strains of Bluebonnet and about the same as Century Patna, the early-maturing long-grain variety. Differences in costs of production for the various types of grain are comparatively negligible.

Podany, J. C. marketing charges for california long white potatoes, sold in los angeles, chicago, and new york city during the 1956 season. U. S. Dept. Agr. Mktg. Res. Rept. 193, 10 pp., illus. November 1957.

Report presents the costs and margins for California Long White Potatoes marketed in 3 cities during the 1956 season. It covers packing and transportation costs, wholesale and retail margin, and return to growers.

Rinear, E. H. MARKETING MARGINS AND PRACTICES FOR TURKEYS SOLD IN THREE EASTERN MARKETS. U. S. Dept. Agr. Mktg. Res. Rept. 191, 36 pp., illus. August 1957.

Studies farm-to-retail marketing margins on ready-to-cook turkeys. Includes costs of processing turkeys, gross margins of wholesalers and jobbers. It is designed to meet, in part, a need for information on farm-to-retail price spreads on food.

Roberts, J. B., Williams, S. W., and Whitted, S. F. MERCHANDISING MILK AND DAIRY PRODUCTS IN RETAIL GROCERY STORES. Univ. of Kentucky, Cir. 551, North Central Reg. Pub. 78, 52 pp., illus.

Reports the various methods of handling and merchandising milk in 235 stores—tells about effectiveness of various displays, handling margins and store sales, income and store margins.

St. Clair, J. S., and Roberts, A. L. QUALITY AND COST OF GINNING AMERICAN-EGYPTIAN COTTON, SEASONS 1952–53 AND 1953–54. U. S. Dept. Agr. Mktg. Rept. 199, 29 pp., illus. October 1957.

This studies and compares the quality and costs of ginning services at 13 of the 21 roller gins located in central Arizona, the Trans-Pecos area of Texas, and the Mesilla Valley of New Mexico. It shows differences between the quality and cost of services performed by gins with simple, moderate, or elaborate equipment.

Stein, Fred, Mathis, A. G., and Herrmann, L. F. COSTS OF BUTTERFAT SAMPLING AND TESTING PROGRAMS. U. S. Dept. Agr. AMS–212, 19 pp., illus. October 1957.

This study estimates the relative costs of limited testing programs for finding the average monthly butterfat content of producer milk shipments. Analyzes costs of sampling and testing for butterfat, and indicates the best testing program.

Taylor, C. C., and Aull, G. H. A PRACTICAL APPROACH TO IMPROVING FARM REAL ESTATE ASSESSMENT IN SOUTH CAROLINA. S. C. (Clemson) Agr. Expt. Sta. Bul. 450, 46 pp., illus. June 1957. (Southeast Land Tenure Com. Pub. 27).

The focal weakness of present assessment procedure, as shown by this study and previous ones, lies in the fact that assessments of farm real estate are not based on a systematic evaluation of the major characteristics that contribute to the value of the property. Methods that provide for a reasonably accurate evaluation of quality of land, number and quality of buildings and other improvements, and site value attributable to location of the property, can significantly improve assessment. This bulletin includes no specific formula for general use.

U. S. Agricultural Research Service. FARM COSTS AND RETURNS, 1956 (*with comparisons*) COMMERCIAL FAMILY-OPERATED FARMS BY TYPE AND LOCATION. U. S. Dept. Agr. Agr. Inform. Bul. 176, 66 pp., illus. June 1957.

Summary results of farm operations in 1956 on 29 types of commercial farms in major farming areas in the United States are presented in this bulletin.

U. S. Department of Agriculture. MAJOR STATISTICAL SERIES OF THE U. S. DEPARTMENT OF AGRICULTURE. HOW THEY ARE CONSTRUCTED AND USED. Agr. Handb. 118, vols. 1–9.

Stauber, B. R. and Moats, R. H. AGRICULTURAL PRICES AND PARITY. Agr. Handb. 118, vol. 1, 87 pp. Aug. 1957.

Anderson, J. R., Wooten, H. H., Cooper, M. R. and Burkhead, C. E. AGRICULTURAL PRODUCTION AND EFFICIENCY. Agr. Handb. 118, vol. 2, 74 pp. Sept. 1957.

Ogren, K. E., and Parr, Kathryn. AGRICULTURAL MARKETING COST AND CHARGES. Agr. Handb. 118, vol. 4, 35 pp. 1957.

Scofield, W. H., and Holm, P. L. LAND VALUES AND FARM FINANCE. Agr. Handb. 118, vol. 6, 56 pp. Oct. 1957.

Hagood, M. J. and Bowles, G. K. FARM POPULATION, EMPLOYMENT, AND LEVELS OF LIVING. Agr. Handb. 118, vol. 7, 25 pp. Sept. 1957.

Gessner, A. L. FARMER COOPERATIVES. Agr. Handb. 118, vol. 9, 7 pp. Sept. 1957.

This series of reports is designed as a reference on statistics of the U. S. Department of Agriculture. It describes the major statistical series, discusses their uses, and compares them with related series published by the USDA or other agencies of the U. S. Government. (Volumes 3, 5, and 8 are in press.)

Statistical Compilations

U. S. Agricultural Marketing Service. AGRICULTURAL OUTLOOK CHARTS, 1958. U. S. Dept. Agr. 100 pp., illus. November 1957.

U. S. Agricultural Marketing Service. DAIRY STATISTICS. U. S. Dept. Agr. Statis. Bul. 218, 377 pp. October 1957. Supersedes Statis. Bul. 134, Dairy Statistics and Related Series.

U. S. Agricultural Marketing Service. NUMBER OF FARMS BY STATES, 1910-56, REVISED ESTIMATES. U. S. Dept. Agr. SPSY 3 (57), 11 pp., November 1957.

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