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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

[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

$$\eta_{cy} = P_y. \tag{6}$$

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
>
> $$\eta_{c_f y} = \frac{dc_f}{dy} \cdot \frac{y}{c_f} = \frac{dc_f}{dy_{Pf}} \cdot \frac{dy_{Pf}}{dy} \cdot \frac{y}{y_{Pf}} \cdot \frac{y_{Pf}}{c_f} = \frac{dc_f}{dy_{Pf}} \cdot \frac{_{Pf}}{c_f} \cdot \frac{dy_{Pf}}{dy} \cdot \frac{y}{y_{Pf}}, \tag{8}$$ [13]
>
> [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 $y_{Pf} = y_P$]
>
> $$\eta_{y_{Pf} y} = \frac{dy_{Pf}}{dy} \cdot \frac{y}{y_{Pf}} = \frac{1}{k} \frac{dc_P}{dy} \cdot \frac{ky}{c_P} = \frac{dc_P}{dy} \cdot \frac{y}{c_P} = \eta_{c_P y}$$
>
> so that
>
> $$\eta_{c_f y} = \eta_{c_i y_{Pf}} \cdot \eta_{c_P y}.$$ [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

[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 th 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

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

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 equalibrium 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]

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.

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

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

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

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

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) $c(t) = a_{00}\alpha + a_{01}\alpha y(t) + (1-\alpha) c(t-1) + u_0(t) - (1-\alpha) u_0(t-1)$;

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

(18) $q_m(t) = a_{20}\alpha + a_{22}\alpha y(t) + (1-\alpha) q_m(t-1) + a_{21} p_m(t) - a_{21}(1-\alpha) p_m(t-1) + u_2(t) - (1-\alpha) u_2(t-1)$.[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) $q_f(t) = \left(a_{10} - \frac{a_{12}a_{00}}{a_{01}}\right) + \frac{a_{12}}{a_{01}} c(t) + a_{11} p_f + u_1(t) - \frac{u_0(t)}{a_{01}}$,

(20) $q_m(t) = \left(a_{20} - \frac{a_{22}a_{00}}{a_{01}}\right) + \frac{a_{22}}{a_{01}} c(t) + a_{21} p_m(t) + u_2(t) - \frac{u_0(t)}{a_{01}}$.[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) $c(t)-c(t-1)=\gamma_c[c_P(t)-c(t-1)],$

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

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

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

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

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

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

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

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

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	0. 726	0. 217	0. 219	0. 350	0. 421
	(. 056)	(. 057)	(. 031)	(. 028)	(. 071)	(. 056)
$c(t-1)$	. 099	. 209				
	(. 077)	(. 064)				
$q_f(t-1)$			. 151	. 237		
			(. 139)	(. 106)		
$q_m(t-1)$					. 248	. 371
					(. 127)	(. 111)
$p_f(t)$			—. 155	—. 142		
			(. 042)	(. 036)		
$p_m(t)$					—. 478	—. 429
					(. 076)	(. 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.

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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).