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Engel's Law and Saving

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Abstract

It is well known that poor people spend a larger portion of their budget on food than rich people do. It has also been frequently observed that poor people allocate their consumption expenditure over time differently than rich people do. Kuznets, for instance, points out that saving rates are lower in poor countries than in rich countries and that savings rates increase over time as a country grows from the early stages to the late stages of development. In this paper, we ask the question: Under what conditions will the differences in saving behavior between rich and poor consumers be systematically related to the non-homotheticity of consumers' intratemporal demand for food? We find simple relationships between consumers' intratemporal expenditure elasticities of demand for food and the growth rate of their total consumption expenditure. We find that poor consumers low saving rates are related to their high expenditure elasticity of demand for food.

It has frequently been observed that poor people save less proportionally than rich people do. Kuznets, for instance, points out that saving rates are lower in poor countries than in rich countries and that savings rates increase over time as a country grows from the early stages to the late stages of development.[1] More recently, saving rates have been observed to increase with development in Japan, Taiwan, and Korea.[2] Bhalla [1980] and Paxson [1988] among others have found that saving rates rise with permanent income in cross sectional data for individuals. It has also been frequently observed that intratemporal demand is not homothetic. Engel's Law is simply the observation that food budget shares decrease with increases in income. In this paper, we take an empirical approach to the question of whether the differences in the saving behavior of poor and rich consumers may be related to the non-homotheticicities we observe in intratemporal demand. We find simple conditions under which the impact of the non-homotheticity of demand for food on saving behavior can be measured in panel data. Our initial review of the evidence indicates that, empirically, the fact that poor consumers save less proportionally than rich consumers do may be explained as stemming from non-homotheticicities in consumers' intratemporal demand.

Our central result is derived from the simple observation that food consumption growth between any two periods is approximately equal to total consumption expenditure growth between those two periods times the

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[1] Kuznets[1960, 1961].

[2] See Hayashi [1989a] for a discussion of the Japanese saving rate. See page 20 of the *Economist* magazine July 20, 1990 for saving data for Taiwan and Korea.

expenditure elasticity of demand for food. Thus, if food consumption is observed to grow at the same rate for all consumers who face the same interest rates and relative prices, then the ratio of any two consumers' total consumption expenditure growth rates is approximately equal to the reciprocal of the ratio of those consumers' intratemporal expenditure elasticities of demand for food.[3] An empirical measure of the impact of the non-homotheticities of intratemporal demand on saving behavior can thus be derived from panel data by checking first whether food consumption grows at roughly the same rate for poor and rich people[4] and then checking whether the expenditure elasticity of demand for food systematically differs across poor and rich consumers. Our review of the evidence on consumer demand indicates that the expenditure elasticity of demand for food does indeed vary systematically across poor and rich consumers.

Our survey of the literature on consumer demand indicates that poor consumers have a substantially higher expenditure elasticity of demand for food than rich consumers do. It appears for instance that the expenditure elasticity of demand for food in countries where the budget share spent on food is over 60 percent (India for example) is approximately twice that in countries where the budget share spent on food is under 25 percent (the

[3]More generally, if some function of food consumption (such as food consumption in excess of some subsistence level of food consumption) grows at the same rate for all consumers who face the same interest rate and relative prices, then the ratio of any two consumers' total consumption expenditure growth rates is approximately equal to the reciprocal of the ratio of those consumers' intratemporal expenditure elasticities of demand for that function of food consumption.

[4]It is important to measure food consumption growth rates for consumers who face similar market opportunities. Differences in consumption growth rates can be generated by market imperfections as well as by non-homotheticites in preferences.

United States for example). If food consumption were to grow at the same rate in these two countries when they faced the same relative prices and interest rates, then total consumption expenditure would grow in India at only half the rate it did in the United States.

Our work has direct application to Euler equation type estimation of the intertemporal elasticity of substitution or the coefficient of relative risk aversion from consumption data for poor and rich consumers or poor and rich countries. Many economists employ the constant relative risk aversion utility function assumption that utility is additively separable across time and states of nature and that the marginal utility of total consumption expenditure at any date or in any state of nature is simply the total consumption expenditure at that date or in that state of nature raised to a power. This assumption is convenient in that it implies that all consumers have the same intertemporal elasticity of substitution or coefficient of relative risk aversion, regardless of their total consumption expenditure level. When this type of utility function is assumed, the result that all consumers should have the same growth rate of total consumption expenditure when they face the same interest rates and relative prices is immediate. Of course, it is always possible to locally approximate the marginal utility of consumption expenditure for any consumer at any date or in any state of nature as a power function of that consumer's total consumption expenditure, but there is no reason to believe that the power coefficient estimated in thisapproximation would be invariant across different expenditure levels. We show in this paper that there is reason to believe that the coefficient used to approximate marginal utility as a power function of total consumption expenditure is in fact substantially higher for poor consumers than it is for rich consumers. Specifically, we show that the power coefficient used in approximating the marginal utility of total consumption expenditure at any date or in any state of nature is directly proportional to the expenditure elasticity of demand for food (or some function of food expenditure) when food consumption (or some function of food consumption) enters intratemporal utility additively separably as a power function[5]. This result implies that poor consumers should have a higher coefficient of relative risk aversion and a lower intertemporal elasticity of substitution than rich consumers do, with these differences among consumers being proportional to the differences in their expenditure elasticities of demand for food (or the above mentioned function of food consumption).

Our results also have immediate implications for explaining the differences in saving behavior of rich and poor countries. Abstracting from differences in the marginal product of capital across countries, these results indicate that national saving rates in growing economies should be substantially lower in poor countries than in rich countries. We present simulations of simple growth models in which consumers have non-homothetic intratemporal utility and in which saving rates follow a rising S shaped pattern as the economy grows. Our simulations qualitatively match the observations of Kuznets [1961] and Chenery and Syrquin [1975, pp.108-109] among others that savings rates tend to follow an S curve as economies develop: savings rates are low and rise only slowly (or are stable) in the early stages of development, they rise rapidly as the economy grows, and

[5]If food consumption, or some function of food consumption, enters intratemporal utility additively separably as a power function, then food consumption, or that function of food consumption, grows at the same rate for all consumers who face the same interest rate and relative prices.

then they become stable at a higher level in the late stages of development.[6] Our simulations also qualitatively match the observations of Bhalla [1980] that saving rates follow an S curve as the permanent income rises in an Indian panel data. We derive this qualitative behavior of saving rates simply from use of non-homothetic utility functions commonly employed in demand studies.

We anticipate several applications of our results to questions in international economics and development economics. Our results are applicable in particular to the question of how permanent changes in the terms of trade affect the current account and the question of how agricultural pricing policies affect the saving of individuals in the agricultural sector in developing countries. The answers to both of these questions turns on the effects of permanent changes in intratemporal relative prices on saving. Our results can be used to determine the direction and magnitude of these effects.

We refer the reader to recent surveys by Gersovitz (1988), Deaton (1989a), and Kotlikoff (1989, the Introduction) for the empirical and theoretical literature on saving. Some authors have studied the effect of subsistence levels of consumption on saving. For example, Lluch, Powell, and Williams (1977) used Lluch's (1973) extended linear expenditure system (ELES) to provide a unified framework to explain intratemporal and

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[6] It should be noted that Kuznets [1961] found that saving rates were stable in early stages of development in several countries even when the economy was growing rapidly. This finding should be distinguished from the finding that less developed countries with low growth rates have low and stable saving rates, which, of course, is much less surprising. In particular, Kuznets found that in the nineteenth century, Norway, Sweden, Canada, Australia, and Japan had relatively rapid growth rates and low and stable saving rates.

intertemporal expenditures patterns. Christino's (1989) model of saving can be considered as a one good version of the linear expenditure system. We consider the linear expenditure system as a special case of our analysis. We show that the linear expenditure system can explain substantial differences in the saving behavior of rich and poor consumers, but we observe that the linear expenditure system has the counterfactual implication that the expenditure elasticity of demand for food rises, not falls, as total consumption expenditure rises and the budget share spent on food falls. Related to this literature are the dual economy model of Lewis (1954) with an assumption that saving is undertaken only from profit income (see, e.g., Dixit [1973] for a survey) and Gersovitz's (1983) model of saving that emphasizes the probability of survival.

Some authors have used a model in which some (typically poor) consumers follow a rule of thumb to spend all of or a fixed portion of their income on consumption goods because of liquidity constraints to explain the differences in the saving behavior of rich and poor consumers. (See, e.g., Bhalla [1979]. Also see Hayashi [1985] for a survey). Deaton (1989b) provides a model of this type starting from preferences and technologies with liquidity constraints. Though poor households may very well be liquidity constrained (see, e.g., Zeldes [1989]), we argue that poor consumers would save less proportionally than rich consumers even if there were a complete set of markets. Our work complements this other work on saving.

We realize that some of the international difference in saving rates that we discussed in the Introduction may be explained by the life cycle model of Modigliani and Brumberg [1954] and Ando and Modigliani [1963] (with a finite horizon) from the difference in the growth rate of per capita income or dependency variables (see Gersovitz [1988, Section 3.5] for a survey). However, results in Ram [1982] and Hayashi [1986, 1989b] suggest that we need a model of saving that poor consumers save less proportionately even after taking into account of effects implied by the life cycle model. Though we will analyze a model with an infinite horizon (essentially Barro's [1974] model), it is also possible to analyze effects of nonhomothetic preferences on saving in the life cycle model.

Our paper is organized as follows. In Section I, we demonstrate our central result relating expenditure growth rates to expenditure elasticities of demand for food. We also present the result that the power coefficient on total consumption expenditure used to approximate a consumer's marginal utility of that total consumption expenditure at any date or in any state of nature is directly proportional to the consumer's intratemporal expenditure elasticity of demand for any function of food consumption which enters utility additively separably as a power function. In Section II, we present some commonly used utility functions as examples. To justify the application of these utility functions to aggregate data, we then present the necessary aggregation results in Section III. Section IV examines the literature of budget studies to ascertain whether or not the expenditure elasticity for food differs substantially and systematically between poor and rich people. Then, Section V presents simulation results from simple growth models in which consumers have non-homothetic utility and demonstrate the rising S shaped pattern of saving rates that appears in these models. In Section VI, we discuss the application of these simulation results to explaining the different trends in saving rates observed in cross sectional and long run United States time series data. Section VII contains our concluding remarks.

I. Food Consumption and Total Consumption Expenditure Growth

In this section we demonstrate the result that if some function of food consumption always grows at the same rate in equilibrium for all consumers who face the same interest rate and relative prices, then the ratio of total consumption expenditure growth rates for any two consumers is approximately equal to the reciprocal of the ratio of those consumers' intratemporal expenditure elasticities of demand for that function of food consumption.

A. Total Expenditure Growth and the Expenditure Elasticity forFood

Consider a consumer who allocates expenditure within a period over N goods and across T time periods. Let $C(t)=(C_1(t),...,C_N(t))$ indicate the consumer's consumption of the N goods in period t and let good 1 denote food. Let $P(t)=(P_1(t),...,P_N(t))$ be the intratemporal prices over the N goods and $E(t)$ be the total expenditure allocated to consumption at time t. For convenience, normalize $P_1(t)=1$ for all t and use $R(t)$ to denote the interest rate between periods t and $t+1$ in terms of good 1. Assume that the consumer has well defined intratemporal Marshallian demand functions for food of the form $C_1(P(t),E(t))$.[7]

Our initial result is based on the following identity. For any variable $x(t)$, denote its growth rate by $\hat{x}(t) = log(x(t+1))-log(x(t))$. Denote the expenditure elasticity of the demand for food by $\mu(P,E) = \partial log(C_1(P,E))/\partial log(E)$. Using a first order approximation to the log of the

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[7]This will be the case, for instance, if utility is additively separable across time.

consumer's demand function for food, we get the approximate relation that $\hat{E}(t) \cong \mu(P(t),E(t))^{-1}\hat{C}_1(t)$.

Consider now an economy with $h=1,2,\ldots,H$ consumers each with identical Marshallian demand functions for food but with different initial endowments of the N goods and the various factors of production. Let $C_1^h(t)=C_1(P(t),E^h(t))$ denote the intratemporal demand for food of consumer h given his total consumption expenditure for the period t of $E^h(t)$. Assume that there exists a function F of food consumption such that in equilibrium, $F(C_1^h(t))$ grows at the same rate for all consumers facing the same interest rate $R(t)$ and pairs of relative price vectors $P(t)$, $P(t+1)$. We denote that common growth rate by

$$\hat{F}(C_1(t))=log(F(C_1^h(t+1)))-log(F(C_1^h(t)))$$

Using the same logic as above, we can argue that for each individual the relationship $\hat{E}^h(t) \cong \mu_F(P(t),E^h(t))^{-1}\hat{F}(C_1(t))$ approximately holds, with the elasticity of demand for the function F of food consumption denoted by $\mu_F=\partial log(F(C_1(P(t),E^h(t)))/\partial log(E^h(t))$. Under the assumption that the growth rate of $F(C_1(t))$ is the same for all individuals, these simple definitions give us our result that when some function of food demand grows at the same rate for all consumers who face the same interest rate and relative prices, then the total consumption expenditure growth for any individual consumer is inversely proportional to that consumer's expenditure elasticity of that function of his demand for food.

B. *Food Consumption and the Marginal Utility of Total Consumption Expenditure*

In modeling business cycles, asset markets, and growth, many economists employ the assumption that utility is additively separable across time and across states of nature and that the marginal utility of total consumption expenditure at any date or in any state of nature is a power function of total expenditure at that date or in that state of nature. These assumptions have the useful implications that the coefficient of relative risk aversion (which is given in this case by the negative of the power coefficient on total consumption expenditure) and the intertemporal elasticity of substitution (which is given by the reciprocal of the coefficient of relative risk aversion) are constant over all expenditure levels. The assumption that there are no systematic differences in these numbers across rich and poor consumers is maintained in light of the fact that there is little direct evidence on the magnitude of the differences in risk aversion or attitudes towards saving among consumers. In this section, we argue that there are in fact systematic differences in these numbers across rich and poor consumers and that the magnitude of these differences can be fixed from the magnitude of the differences in the expenditure elasticity of demand for food for poor and rich consumers. We do this by showing that the power coefficient that is used to approximate the marginal utility of total consumption expenditure in the standard constant relative risk aversion utility function framework is proportional to the expenditure elasticity of demand for any function $F(C_1)$ of food consumption which enters intratemporal utility additively separably as a power function. Since we can test whether any function $F(C_1)$ enters intratemporal utility additively separably as a power function by testing whether this function of food consumption grows at the same rate for all consumers, the empirical implementation of this result would be the same as that for the results above. We demonstrate this result as follows.

Consider again a consumer who allocates expenditure within a period over N goods and across an arbitrary number of time periods. Let the consumer have time separable utility with an intratemporal utility function $u(C_1(t),\ldots,C_N(t))$ and let β denote the consumer's discount factor. Let $P(t)=(P_1(t),\ldots,P_N(t))$ be the intratemporal prices and $E(t)$ be the total expenditure allocated to consumption at time t. We normalize $P_1(t)=1$ for all dates t and write the interest rate in terms of good 1 as $R(t)$. We write the consumer's intratemporal indirect utility function $v(P(t),E(t))$. We note that the consumer's intertemporal first order conditions include

$$\frac{v_E(P(t),E(t))}{v_E(P(t+1),E(t+1))} = \beta R(t)$$

where $v_E(P,E)$ is the partial derivative of the indirect utility function with respect to total consumption expenditure. The common utility function assumptions which we referred to above are that $v_E(P,E)$ is of the form AE^{ξ}.

The consumer's marginal indirect utility of total consumption expenditure, $v_E(P,E)$, may also be written in terms of the direct utility function as $U_1(C(P,E))$, where $C(P,E)$ is the consumer's Marshallian demand function over the N goods. If $F(C_1)$ enters intratemporal utility additively separably as a power function, then we can write $U_1(C(P,E))$ as $A(F(C_1(P,E)))^{\lambda}$, where the parameters A and λ are common to all consumers. For fixed relative prices P, the function $F(C_1(P,E))$ is a function of a single variable E. We show in lemma 1 in the Appendix that we can approximate this function as a power function of total expenditure of the form BE^{ψ} where B and ψ are chosen so that $F(C_1(P,E)) = BE^{\psi}$ and $\partial F(C_1(P,E))/\partial E = \psi BE^{(\psi-1)}$. In this case, the power coefficient ξ used in the approximation of the indirect marginal utility of total consumption expenditure is equal to $\lambda\psi$. Our result on the differences between poor and rich consumers in the power coefficient estimated as the coefficient of relative risk aversion or the inverse of the intertemporal elasticity of substitution is derived from the fact that ψ is approximately equal to μ_F, the expenditure elasticity of demand for the function $F(C_1)$ of food consumption. Since the coefficient λ is assumed to be common to all consumers, then the ratio of ξ for any two consumers is approximately equal to the ratio of μ_F for those two consumers.

Our results in this section do not hinge upon assumptions about the completeness of markets. Our results instead are about the shape of consumers' utility functions. If consumers face different interest rates and relative prices, then their saving behavior will naturally differ. Our results depend upon the assumption that if consumers were to face the same interest rates and relative prices, then their food consumption would grow at the same rate. In testing this assumption, it is important to distinguish between differences in food consumption growth rates that arise because of differences in the market opportunities of different consumers and those differences in food consumption growth rates that arise as a consequence of the shape of consumer preferences.

II. Some Common Utility Functions

In this section we discuss as an example the relationship between total expenditure growth and intratemporal expenditure elasticities of demand when utility is additively separable across time and intratemporal preferences are given by a commonly used utility function. Let consumers' preferences be given by the function $U = \sum \beta^t u(C_1(t), C_2(t))$ where

$$u(C_1,C_2) = \frac{\theta_1}{1-\alpha_1}[(C_1-\gamma_1)^{(1-\alpha_1)}-1] + \frac{\theta_2}{1-\alpha_2}[(C_2-\gamma_2)^{(1-\alpha_2)}-1]$$

Here C_1 is food consumption, C_2 is consumption of all other goods, γ_1 and γ_2 are subsistence levels of consumption of the two goods, and $\alpha_1,\alpha_2>0$. This utility function contains as special cases two utility functions commonly used in demand studies. If $\alpha_1=\alpha_2$, then this utility function yields the linear expenditure system in that the intratemporal demand functions for consumption of each good in excess of subsistence consumption $(\tilde{C}_n=C_n-\gamma_n)$ are linear in expenditure in excess of subsistence expenditure $(\tilde{E}=E-\gamma_1-P\gamma_2)$. If $\gamma_1=\gamma_2=0$, then this utility function is the addilog utility function used by Houthakker and Engel's Law is captured by specifying that $\alpha_1>\alpha_2>0$.

We observe from the consumer's intertemporal first order condition

$$\frac{u_1(C_1(t),C_2(t))}{u_2(C_1(t+1),C_2(t+1))} = \frac{(C_1(t)-\gamma_1)^{-\alpha_1}}{(C_1(t+1)-\gamma_1)^{-\alpha_1}} = \beta R(t)$$

that the function of food consumption given by $F(C_1) = (C_1-\gamma_1)$ grows at the same rate for all consumers facing the same relative prices and interest rates. Thus the ratio of any two consumers' total expenditure growth rates is given by the reciprocal of the ratio of their expenditure elasticities for this function F of food consumption (denoted $\mu_F=\partial \log F(C_1(P,E))/\partial \log(E))$).[8]

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[8]It is not necessary that $F(C_1)$ enter utility additively separably to get the result that $F(C_1)$ grows at the same rate for all consumers. For instance, if intratemporal utility is of the form

$$U(C(t)) = \frac{1}{1-\alpha}\left((\prod_n (C_n(t)-\gamma_n)^{\beta_n})^{(1-\alpha)}-1\right)$$

then $(C_1-\gamma_1)$ grows at the same rate for all consumers.

It can be shown for the utility function above that the expenditure elasticity of demand for the function F of food consumption (food consumption in excess of subsistence consumption) where expenditure is measured in excess of subsistence expenditure ($\tilde{\mu} = \partial log(\tilde{C}_1)/\partial log(\tilde{E})$) is given by the expression

$$\tilde{\mu} = \left(\frac{\tilde{c}_1}{\tilde{E}} + \frac{\alpha_1 \, p \, \tilde{c}_2}{\alpha_2 \, \tilde{E}} \right)^{-1}$$

With $\alpha_1 > \alpha_2$, $\tilde{\mu}$ declines from 1 to α_2/α_1 as $\tilde{E}$ rises from zero to infinity. The expenditure elasticity of demand for the function F of food consumption is given by $\mu_F = \tilde{\mu}\ (E/\tilde{E})$. This expenditure elasticity of demand for F, the critical elasticity for assessing differences in total expenditure growth rates across consumers, declines from infinity to α_2/α_1 as $\tilde{E}$ rises from zero to infinity when $\alpha_1 > \alpha_2 > 0$ and subsistence expenditure is positive.[9] The consumer's standard expenditure elasticity of demand for food is given by $\mu = \partial log(C_1(P,E))/\partial log(E) = \mu_F(\tilde{C}_1/C_1)$. This expenditure elasticity of demand for food can vary arbitrarily with expenditure, depending upon the values of γ_n chosen. When subsistence food consumption γ_1 is positive, the term $(\tilde{C}_1/C_1)$ increases from zero to one as expenditure rises, so that the change in the expenditure elasticity of demand for food depends upon the relative rates of change of the term $(\tilde{C}_1/C_1)$ and μ_F as expenditure rises. Note, though, that since $\mu_F = \mu(C_1/\tilde{C}_1)$, μ_F is higher for poor consumers than for rich consumers if μ is observed to be higher for poor consumers and if subsistence food consumption is observed to be positive.

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[9] If the subsistence expenditure level is negative, then μ_F rises from zero to α_1/α_2 as expenditure E rises from zero to infinity.

Some discussion of the special cases of the addilog utility function and the linear expenditure system is in order. Under the linear expenditure system ($\alpha_1 = \alpha_2$), the term $\tilde{\mu}$ is always one. The term μ_F falls from infinity to one as expenditure rises if and only if subsistence expenditure is positive.[10] Thus, under the linear expenditure system, consumers who are close to subsistence expenditure have arbitrarily small growth rates of total expenditure. This result arises simply because poor consumers cannot substitute subsistence consumption between periods. Lastly the term μ can have an arbitrary sign on its derivative with respect to total expenditure E depending upon the values of subsistence expenditure γ_1 and $P\gamma_2$. But, since equilibrium $\tilde{C}_1$ is linear in $\tilde{E}$, the elasticity of the demand for food in the linear expenditure system is given simply by $\mu = b(E/C_1)$, where b is a positive constant and (E/C_1) is the reciprocal of the food budget share. Since the budget share spent on food should be falling in E for reasonable values of the parameters of the linear expenditure system, this demand system has the implication that the elasticity of demand for food is rising, not falling with expenditure. We will see in our review of demand studies that this implication contradicts the data.

Under the addilog utility function ($\gamma_1 = \gamma_2 = 0$), the terms $\tilde{\mu}$, μ_F, and μ are all the same and given by the formula of the budget shares given for $\tilde{\mu}$. These expenditure elasticities fall from 1 to α_2/α_1 as expenditure rises and the food budget share falls. The ratio of rich and poor consumers' total expenditure growth rates is then bounded by the ratio α_1/α_2. Ogaki [1988,

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[10] If subsistence expenditure is negative, then the term μ_F rises from zero to one as expenditure rises. In this case, poor consumers have higher total expenditure growth rates than rich consumers.

1989], Ogaki and Park [1990], and Ogaki and Atkeson [1990] have developed a method for estimating the parameters α_i for the addilog utility function from time series and paneldata. In Ogaki and Atkeson [1990] we estimate these parameters in various data sets using these methods.

III. Aggregation of Preferences

The utility function given above has the convenient property that the aggregate consumption data from a competitive equilibrium in a model with production and multiple consumers behaves as if chosen by a single representative consumer who has the same parameters α_n and γ_n in his utility that the individual agents have. This feature of this utility function implies that one can model the evolution of the aggregate consumption expenditure growth by observing aggregate food consumption and total consumption expenditure data and using parameter estimates for $\alpha_1, \alpha_2, \gamma_1,$ and γ_2 obtained either from individual or aggregated panel data. One does not have to observe the evolution of the entire distribution of consumption and expenditure in the population to measure the changes in aggregate saving behavior over time.

The aggregation result may be stated as follows. Consider an economy with H consumers numbered $h=1,\ldots,H$ each of whom have some endowment of the consumption goods and the various factors of production. Assume that all of the consumers have identical time additively separable preferences with intratemporal utility function over food and all other goods given by

$$u(C_1^h, C_2^h) = \frac{\theta_1}{1-\alpha_1}\left[(C_1^h-\gamma_1)^{(1-\alpha_1)}-1\right] + \frac{\theta_2}{1-\alpha_2}\left[(C_2^h-\gamma_2)^{(1-\alpha_2)}-1\right]$$

where C_i^h indicates the consumption of good i by individual h. Furthermore, assume that aggregate production possibilities are described by some set Y

of feasible aggregate consumption vectors. Our aggregation result is that, if this economy has a competitive equilibrium, then there exists a parameter D for which the equilibrium prices and the aggregate consumption vector are a competitive equilibrium for an economy with the same production possibility set Y and a single representative consumer who has time separable preferences with an intratemporal utility function given by

$$u(C_1^*,C_2^*) = \frac{\theta_1}{1-\alpha_1}\,[(C_1^*-\gamma_1)^{(1-\alpha_1)}-1] + \frac{\theta_2 D}{1-\alpha_2}\,[(C_2^*-\gamma_2)^{(1-\alpha_2)}-1]$$

where $C_i^*=\sum C_i^h/H$. Before we prove this result, it is worthwhile to discuss its implications. This representative consumer has utility with the same parameters α_1,α_2, γ_1, and γ_2 as the individual consumers. Knowledge of these parameters together with aggregate data on food consumption, and total consumption expenditure is sufficient to calculate the various parameters $\tilde{\mu}$, μ_F, and μ for the representative consumer. The parameter D will be shown to reflect the distribution of initial wealth in society, and would thus in principle be difficult to measure directly. But, because the individual and the representative consumer share common values of $\alpha_1,\alpha_2,\gamma_1$, and γ_2, the impact of this parameter D on the evolution of aggregate saving behavior over time is completely summarized in the aggregate equilibrium food consumption and total consumption expenditure data.

To prove this aggregation result, begin with the assumption that there exists a competitive equilibrium for the original economy with H consumers. Denote individual consumption in period t by $C_i^h(t)$, $i=1,2$, $h=1,2,\ldots,H$, and aggregate consumption per capita by $C_i^*(t)$, $i=1,2$. Individual consumption satisfies the following first order conditions in equilibrium

$$\left(\frac{C_i^h(t)-\gamma_i}{C_i^h(t+1)-\gamma_i}\right)^{-\alpha_i} = \beta R(t)\frac{P_i(t)}{P_i(t+1)} \qquad i=1,2$$

$$\frac{\theta_1}{\theta_2}\,\frac{(C_1^h(t)-\gamma_1)^{-\alpha_1}}{(C_2^h(t)-\gamma_2)^{-\alpha_2}} = \frac{P_1(t)}{P_2(t)}$$

The first condition governs the consumer's intertemporal allocation of consumption while the second governs the consumer's intratemporal allocation of consumption. To show that the equilibrium prices and the aggregate consumption vector are also a competitive equilibrium in this economy with a representative consumer, we must find a value for the parameter D such that the aggregate consumption per capita vector satisfies the corresponding first order conditions for the representative consumer

$$\left(\frac{C_i^*(t)-\gamma_i}{C_i^*(t+1)-\gamma_i}\right)^{-\alpha_i} = \beta R(t)\frac{P_i(t)}{P_i(t+1)} \qquad i=1,2$$

$$\frac{\theta_1}{D\,\theta_2}\,\frac{(C_1^*(t)-\gamma_1)^{-\alpha_1}}{(C_2^*(t)-\gamma_2)^{-\alpha_2}} = \frac{P_1(t)}{P_2(t)}$$

We find the appropriate value of D as follows. The intertemporal first order conditions for the individual consumers indicate that consumption of each good in excess of subsistence consumption of that good grows at the same rate for all consumers in equilibrium.[11] Note that these intertemporal first order conditions will be satisfied by the representative consumer at the equilibrium prices and the aggregate consumption per capita vector

[11] Note that total expenditure growth need not be the same for all consumers since consumption of the two different goods may grow at different rates and consumers can spend different fractions of total expenditure on the two goods.

regardless of the value of the parameter D. These intertemporal first order conditions also imply that each consumer's food consumption in excess of subsistence food consumption is a constant fraction over time of aggregate food consumption per capita in excess of the individual's subsistence consumption level. We can index the distribution of initial wealth in equilibrium by indexing consumer's by the fraction δ_h defined by $\delta_h = (C_1^h(t)-\gamma_1)/(H(C_1^*-\gamma_1))$ where $C_1^* = \sum_h C_1^h/H$.

The individual consumer's intratemporal first order condition implies that

$$(C_2^h(t)-\gamma_2)^{\alpha_2} = \frac{P_1(t)}{P_2(t)} \frac{\theta_2}{\theta_1} (C_1^h(t)-\gamma_1)^{\alpha_1}$$

Substituting $(C_1^h(t)-\gamma_1) = \delta^h H(C_1^*(t)-\gamma_1)$ into the expression above and summing across consumers we get the condition that in the aggregate

$$H^{\alpha_2} (C_2^*(t)-\gamma_2)^{\alpha_2} = \frac{P_1(t)\ \theta_2}{P_2(t)\ \theta_1} (\sum_h (\delta^h)^{\alpha_1/\alpha_2})^{\alpha_2} H^{\alpha_1} (C_1^*(t)-\gamma_1)^{\alpha_1}$$

From this expression we can see that the representative consumer's intertemporal and intratemporal first order conditions are satisfied at the equilibrium prices and the equilibrium aggregate consumption vector when D = $(\sum_h \delta_h^{\alpha_1/\alpha_2})^{\alpha_2} H^{(\alpha_1-\alpha_2)}$. This parameter $D=1$ if $\alpha_1=\alpha_2$. Thus, when preferences are given by the linear expenditure system, they aggregate in the sense of Gorman. When $\alpha_1>\alpha_2$, then the utility function of the representative consumer depends upon the distribution of initial wealth in society. But, as we mentioned earlier, the impact of this distribution of wealth in society on the evolution in aggregate expenditure growth is completely summarized in the evolution of aggregate consumption data over time.

IV. Review of Studies Measuring the Expenditure Elasticity of Demand for Food

This section provides evidence for a stylized fact that the expenditure elasticity for food declines as total expenditure rises and the budget share for food declines by reviewing studies measuring expenditure elasticities. Table 1 lists budget shares for food and expenditure elasticities for food from various studies. Most of the expenditure elasticities reported in Table 1 were estimated from cross-sectional budget surveys in each country with the double-logarithmic function. Two exceptions are the estimates by Henri Theil and Frederick E. Suhm (1981) and the estimates by Michael R. Haines (1989). Theil and Suhm estimated elasticities from a cross-country data by Irving B. Kravis, Alan Heston, and Robert Summers (1978), using Holbrook Working's model (1943). Haines's estimates are based on the Almost Ideal Demand System.

Table 2 reports means of expenditure elasticities in Table 1 for different budget shares for food. Table 2 shows marked tendency for the expenditure elasticity for food to rise as the budget share for food increases. It should also be noted that when the population in a survey is divided into groups, the group with higher budget share for food exhibits higher expenditure elasticity for food. Manual workers have higher expenditure elasticity for food than clerical workers and government officials in the 1927-28 survey in Germany; manual workers in the Netherlands have a higher expenditure elasticity of demand for food than do white collar workers in the 1951 survey in Netherlands; working class consumers have a higher expenditure elasticity of demand for food than do middle class consumers in the 1937-39 survey in the United Kingdom; and unskilled workers have a higher expenditure elasticity of demand for food than do skilled workers in the 1875 survey in the United States. It is also possible to see a tendency for the expenditure elasticity for food to decline over time in each country as the economy grows. However, different estimates are not always comparable because the populations of surveys are different. For example, the 1787-93 survey in Great Britain were for poor agricultural workers, while Theil and Suhm's estimate for the U.K. is for the entire country in 1970.

In table 2, we present a summary of these studies in a single table. We divide the studies up into categories determined by the aggregate budget share spent on food in each study. We then take the mean of the estimates of the expediture elasticity of demand for food for studies in any particular category. We report these means in table 2. This table shows that there is a substantial drop in the expenditure elasticity of demand for food as the food budget share falls.

V. The Evolution of Aggregate Expenditure Growth

The result that the preferences specified above aggregate implies that, if food consumption in excess of subsistence consumption grows at the same rate for all individuals facing the same interest rates and relative prices, then, abstracting from interest rate and relative price changes, aggregate consumption expenditure growth differs across countries and changes over time within a country as the expenditure elasticity of demand for food consumption in excess of subsistence consumption varies across countries or within a country across time. In this section, we simulate the evolution of individual and aggregate saving rates in a growth model with consumers with non-homothetic intratemporal utility.

We demonstrate in our simulation that, for growing economies with a constant marginal product of capital and constant relative prices and consumers with utility functions in the class specified above, the saving rate is strictly increasing as the economy grows if the subsistence expenditure level is non-negative. We observe that the model can produce substantial systematic differences in the saving behavior of rich and poor consumers. The model can also produce qualitatively the S shaped pattern of saving rates described by Kuznets and Chenery and Syrquin as typical of developing countries. We need to do considerably more empirical work estimating the parameters of this utility function to attempt to match the data quantitatively.

The growth model is defined as follows. Production is given by a linear technology. The capital stock at time t is denoted $K(t)$ and can used to produce food $C_1(t)$ or other consumption goods $C_2(t)$ or tomorrows capital stock $K(t+1)$ according to the production function

$$AK(t) = \delta_1 C_1(t)+\delta_2 C_2(t)+K(t+1)$$

This linear production function sets the interest rate at A and the prices of food and all other goods at δ_1 and δ_2 respectively. Assume that all the consumers in this economy have identical utility and that they differ only in their initial endowment of capital. Denote the initial aggregate capital stock $K(0)$ and the initial endowment of capital for the individual by $K^h(0)$. Because of the linear production structure, the equilibrium income and consumption for any individual consumer can be solved for as if the individual were the sole consumer in his own autarkic growth economy. Alternatively, we may interpret A, δ_1, and δ_2 as defining interest rates and prices which the individual consumer faces in equilibrium and K as the individual consumer's stock of assets.

The intertemporal first order conditions for each consumer indicate that individual and aggregate consumption of the two goods evolves according to $C_1(t)-\gamma_1 = (A\beta)^{1/\alpha_1} (C_1(t-1)-\gamma_1)$ and $C_2(t)-\gamma_2 = (A\beta)^{1/\alpha_2} (C_2(t-1)-\gamma_2)$. The individual's wealth and the aggregate capital stock both evolve according to the difference equation

$$K(t+1) = AK(t)-\delta_1\gamma_1-\delta_2\gamma_2-\delta_1(A\beta)^{t/\alpha_1} (C_1(0)-\gamma_1)-\delta_2(A\beta)^{t/\alpha_2} (C_2(0)-\gamma_2)$$

We solve the model by choosing the highest value of time zero expenditure $E(0)$ such that with $C_i(0)=C_i(\delta_1,\delta_2,E(0))$ $i=1,2$, the sequence of capital stocks above is bounded above zero. It is clear from this difference equation that if $(A\beta)=1$, then the saving of rich and poor consumers is the same regardless of the parameters used in the utility function.

We define the saving rate as $(K(t+1)-K(t))/AK(t)$. We simulate the model to examine how the saving rate, the food budget share, and the expenditure elasticity of demand for food all evolve as the model economy grows. We assume that consumers have preferences described by the addilog utility function. We set $\alpha_1= 1.5$, $\alpha_2= 0.5$, and $\gamma_1=\gamma_2=0$. In this simulation, the rise in the saving rate rises over time and the expenditure elasticity of demand for food falls as the model economy grows and the budget share spent on food falls. The saving rate in this simulation shows the rising S pattern over time described by Kuznets and Chenery and Sryquin as a feature of the data. The simulated data from the model do not match their data quantitatively because the simulated data show low and stable saving rates in a region in which the food budget share is over 70 percent. This budget share for food is too high for any but the poorest consumers. The results from this simulation are shown in figures 1-5. We used the following parameter values: $\beta=.95$, $A\beta=1.03$, $\theta_1=\theta_2=1$, and

$\delta_1 = \delta_2 = 1$.

The predicted saving rate at any point in time for any individual consumer in this model (including the representative consumer) can be found on the figures 1 through 5 by indexing consumers either by their food budget share or their expenditure elasticity of demand for food and then reading off the saving rate that corresponds to such an individual. The evolution over time of any consumer's saving rate and budget share for food is described by the curves presented in these figures.

VI. Cross-Section and Time Series Estimates of the Marginal Propensity to Save

In his study of consumption function, Friedman (1957) applied his permanent income hypothesis to explaining the fact that cross sectional estimates of consumers' marginal propensity to save were higher than their average propensity to save, so that saving rates show a tendency to rise in cross sectional data. He observed, as have many others, that these cross sectional results seem paradoxical in light of the observation that saving rates are very stable in long term time series data for the United States, so that estimates of the marginal propensity to save are on the order of the average propensity to save when long term time series data is used. Friedman resolves that paradox by noting that variations in temporary income will produce high estmiates of the marginal propensity to save in cross section data. The life cycle model reolves the paradox in a similar way. Our simulation results offer an alternative to the permanent income hypothesis and the life cycle model as an explanation of these seemingly paradoxical findings. Our results indicate that one would obtain the same results even when saving rates were computed as fractions of permanent income. Our alternative explanation is based on the non-linear evolution of the saving rate depicted in our simulations.

We observe in figures 1-5 for the simulation of the growth model with consumers with addilog utility that our model predicts dramatically rising saving rates as consumers move from spending 70 percent of their budget on food to 5 percent of their budget on food. The rate of increase in the saving rate, though, becomes quite small once the food budget share drops below 30 percent. We observe that aggregate food expenditure shares in the United States have been below 30 percent since about 1914,[12] so we predict that estimates of the marginal propensity to save should be about the same as estimates of the average propensity to save when one uses aggregate time series data for the United States. On the other hand, if one uses cross sectional data including poor consumers who are spending up to 50 percent of the total expenditure on food (e.g., food budget shares range from less than 20 percent to more than 56 percent in Ogburn's [1918-19, Table 1] survey), one should observe a marked tendency for saving rates to rise with income and thus one should estimate a marginal propensity to save substantially higher than the average propensity to save. We also predict that time series estimates of the marginal propensity to save for countries such as Taiwan, Japan, of Korea, should also pick up the rising trend in the aggregate saving rate and thus produce high estimates of the marginal propensity to save. If consumers have utility given by the addilog utility function, this tendency toward rising saving rates should taper off as food expenditure shares approach 25 percent or so in these rapidly developing

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[12] See Kuznets [1962] Appendix Table 6.

countries.

VII. Conclusions

In this paper we present a simple approximation for the relationship between the non-homotheticity of consumers' demand for food and the differences in the saving behavior of rich and poor. We show that when food consumption, or some function of food consumption, grows at the same rate for all consumers, then the ratio of any two consumer's total expenditure growth is approximately equal to the reciprocal of the ratio of those consumers' expenditure elasticity of demand for that function of food. We review studies of intratemporal demand for food which indicate that poor consumers have a substantially higher expenditure elasticity of demand for food than rich people do.

We put forward as an example a class of utility functions which included the linear expenditure system and the addilog utility function. We went on to show that this class of utility functions aggregates to justify the application of these ideas to aggregate data. We presented three simulations of a growth model with consumers with non-homothetic intratemporal utility functions in our example class of utility functions.

Our simulation results indicate that, since poor consumers (countries) have a substantially higher intratemporal expenditure elasticity of demand for food than rich consumers (countries) do, poor consumers (countries) should have a substantially lower saving rate than rich consumers if food consumption grows at the same rate for all consumers (countries). The differences in saving rates of poor and rich consumers are even greater if there is a positive level of subsistence food consumption and food consumption in excess of subsistence food consumption grows at the same rate for all consumers.

Our simulation results also indicate that this tendency for saving rates to rise as an economy grows tapers off eventually, either as the budget share spent on food gets small or the subsistence level of expenditure gets small. We used this result to offer an alternative explanation to the permanent income hypothesis of why estimates of the marginal propensity to save are lower in United States long term time series data than they are in cross sectional data.

We anticipate application of our results to reexamining the effects of permanent changes in the terms of trade on the current account and of agricultural pricing policies on agricultural sector saving rates in developing countries. The answers to both of these questions turn on the effects of changes in intratemporal relative prices on saving behavior. Our results indicate that, in general, if the expenditure elasticity of demand for food rises with a change in intratemporal prices, then savings will fall at any given interest rate. On the other hand, if the expenditure elasticity of demand for food falls with a change in relative prices, then saving will rise.

As Bhalla (1980) and Jones and Manuelli (1990), among others, emphasized, the standard permanent income model of consumption has an implication that income redistribution does not affect the competitive equilibrium and hence the growth of the economy. In contrast, income redistribution does affect the growth of the economy in our model since the saving behavior of the representative consumer depends upon the initial distribution of wealth in society. We intend to analyze the predictions of this type of model for the evolution of the distribution of total consumption expenditure in a growing economy. We also intend to analyze the impact of various policies, such as policies affecting the price of food and all other goods, on saving behavior in this model.

Our future research will include econometric work. We were not able to find studies bearing on the question of whether some function of food consumption would grow at the same rate for all consumers facing the same prices and interest rates.[13] In further research, we will look at some of the evidence for ourselves. We also will work on estimating utility functions that capture both intratemporal and intertemporal behavior. In a companion paper, Ogaki and Atkeson [1990], we have begun some of this work, utilizing econometric procedures developed in Ogaki (1988) and Ogaki and Park (1989).

APPENDIX

The result that a strictly increasing or decreasing function mapping the positive real line to the positive real line can be approximated by a power function which takes on the original function's value and slope at a point is presented here in Lemma 1.

Lemma 1: Let $y=f(x)$ be a differentiable function mapping positive x into positive y. Assume that $f'(x)\neq 0$. Then for any $\hat{x}>0$, we can find parameters A and μ such that $A\hat{x}^{\mu} = f(\hat{x})$ and $A\mu\hat{x}^{(\mu-1)} = f'(\hat{x})$.

Proof: Case 1. Assume $f'(\hat{x})>0$. Then we must have $\mu>0$. We can solve for A and μ from equations

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[13] It is important to distinguish between situations where consumers' food consumption grows at different rates because of market failures such as liquidity effects and situations where consumer's food consumption grows at different rates because of non-separabilities in the utility function.

$$\log(A) + \mu \log(\hat{x}) = \log(f(\hat{x}))$$

$$\log(a) + \log(\mu) + (\mu-1) \log(\hat{x}) = \log(f'(\hat{x}))$$

The first equation gives

$$\mu = \frac{\log(f(\hat{x})) - \log(A)}{\log(\hat{x})}$$

Since $\mu>0$, we can use this expression and the second equation to derive a single equation in μ

$$\log(\mu)+\log(f(\hat{x}))-\log(\hat{x})-\log(f'(\hat{x}))=0$$

Thus this equation has a unique solution in A and μ. Case 2, when $f'(\hat{x})<0$ and $\mu<0$, can be handled in the same fashion by solving for $-\mu$ using $-f'(\hat{x})$.

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TABLE 1

FOOD BUDGET SHARES AND EXPENDITURE ELASTICITIES

	Food Budget Share	Expend. Elas.	s.e.
Australia, Queensland 1939-40[a]	30.0	0.390[m]	0.037
Austria 1954-55[b]	53.0	0.554	0.019
Belgium 1853[a]	64.0	0.849	0.010
Belgium 1970[c]	25.8	0.430	. . .
Brazil 1953[a]	49.0	0.795	0.028
Burma, Rangoon, Hindustani 1927[a]	54.0	0.826	0.024
Burma, Rangoon, Tamils, etc. 1927[a]	61.0	0.847	0.036
Burma, Rangoon, Chittagonians 1927[a]	60.0	0.703	0.024
Canada 1947-48[b]	31.0	0.647	0.008
Ceylon 1953[a]	65.0	0.810	0.051
China, Peiping 1927[a]	47.0	0.591	0.011
China, Shanghai 1927-30[a]	54.0	0.617	0.065
Colombia 1970[c]	39.6	0.670	. . .
Cuba 1953[a]	46.0	0.704[m]	0.020
Finland 1950-51[b]	50.0	0.621	0.026
France 1951[b]	49.0	0.483	0.020
France 1970[c]	26.5	0.450	. . .

TABLE 1 - *Continued*

	Food Budget Share	Expend. Elas.	s.e.
Germany 1889-1890[d]	52.2	1.064	. . .
Germany 1907[b]	45.0	0.537	0.018
Germany 1927-28, Manual Workers[b]	42.0	0.598	0.035
Germany 1927-28, Clerical Workers[b]	33.0	0.501	0.030
Germany 1927-28, Gorvernment Officials[b]	33.0	0.385	0.027
Germany 1927-28, all three groups[b]	37.0	0.473	0.020
Germany 1951[a]	42.0	0.526	0.034
Germany 1970[c]	22.6	0.450	. . .
Ghana, Accra 1954[a]	59.0	0.840	0.024
Ghana, Kumasi 1955[a]	58.0	0.818	0.032
Ghana, Secondi-Takoradi 1955[a]	59.0	0.654	0.037
Ghana, Akuse 1954[a]	60.0	0.791	0.037
Guatemala, Guatemal City 1947[a]	52.0	0.508	0.036
Hungary 1970[c]	35.6	0.530	. . .
India, Bombay, Single Workers 1921[a]	56.0	0.709	0.049
India, Bombay, Workers' families 1921[a]	58.0	0.837	0.015
India, Bhopal City 1951[a]	61.0	0.821	0.013
India, Punjab 1950[a]	73.0	0.811	0.027
India 1970[c]	66.7	0.750	. . .
Iran 1970[c]	46.7	0.670	. . .
Ireland 1951-52[b]	40.0	0.597	0.019
Italy 1952-53[b]	46.0	0.602	0.096
Italy 1970[c]	37.5	0.530	. . .

TABLE 1 - *Continued*

	Food Budget Share	Expend. Elas.	s.e.
Japan 1953[a]	50.0	0.563	0.017
Japan 1955[b]	45.0	0.556	0.025
Japan 1970[c]	32.3	0.520	. . .
Latvia 1936-37[b]	34.0	0.430	0.030
Libya 1950[a]	70.0	0.805	0.073
Malaysia 1970[c]	41.0	0.680	. . .
Mexico, Mexico City 1931[b]	40.0	0.657	0.017
Netherlands 1951, Manual Workers[b]	39.0	0.714	0.050
Netherlands 1951, White Collar[b]	29.0	0.490	0.025
Netherlands 1951, Both Groups[b]	33.0	0.502	0.022
Netherlands 1970[c]	25.7	0.460	. . .
Northern Rhodesia 1951[a]	24.0	0.514	0.109
Norway 1952[b]	37.0	0.515	0.048
Panama, Panama City 1952[a]	38.0	0.717	0.055
Philippines, Manila 1954[a]	50.0	0.757	0.028
Philippines 1970[c]	56.5	0.700	. . .
Poland 1927[b]	64.0	0.731	0.030
Portugal, Porto 1950-51[a]	58.0	0.623	0.047
Puerto Rico, Whole Territory 1952[a]	53.0	0.812[m]	0.031
South Korea 1970[c]	55.9	0.710	. . .
Sweden 1955[b]	37.0	0.631	0.048
Swizerland 1919[b]	46.0	0.460	0.036

TABLE 1 - *Continued*

	Food Budget Share	Expend. Elas.	s.e.
U.K. 1787-93, Agricultural Workers in Great Britain[g]	72.2	0.876	0.138
U.K. 1794, English Working Families[h]	74.2	1.003	0.043
U.K. 1889-90[d]	50.7	0.845	. . .
U.K. 1937-39, Working Class[b]	37.0	0.594	0.021
U.K. 1937-39, Middle Class[b]	25.0	0.344	0.019
U.K. 1937-39, Both Groups[b]	35.0	0.519	0.027
U.K. 1970[c]	29.5	0.460	. . .
U.S. 1875, Massachusetts, Industrial Workers[e]	55.5	0.607	0.027
U.S. 1875, Massachusetts, Skilled Workers[e]	52.0	0.570	0.069
U.S. 1875, Massachusetts, Unskilled Workers[e]	60.0	0.730	0.038
U.S. 1889-90[d]	45.7	0.810	. . .
U.S. 1901[b]	44.0	0.712	0.017
U.S. 1916, Washington, D.C.[f]	40.0	0.670	. . .
U.S. 1950, Large Cities, North[b]	32.0	0.693	0.017

TABLE 1 - *Continued*

	Food Budget Share	Expend. Elas.	s.e.
U.S. 1950, Suburbs, North[b]	30.0	0.664	0.029
U.S. 1950, Small Cities, North[b]	31.0	0.653	0.029
U.S. 1950, Large Cities, South[b]	31.0	0.685	0.015
U.S. 1950, Suburbs, South[b]	30.0	0.698	0.037
U.S. 1950, Small Cities, South[b]	32.0	0.687	0.031
U.S. 1950, Large Cities, West[b]	30.0	0.682	0.023
U.S. 1950, Suburbs, West[b]	29.0	0.709	0.031
U.S. 1950, Small Cities, West[b]	31.0	0.645	0.029
U.S. 1950, All Classes of Cities[b]	31.0	0.692	0.002
U.S. 1960-61[i]	25.2	0.513	0.008
U.S. 1970[c]	17.4	0.280	. . .

NOTE: Food budget shares are percentages based on current prices.

[a]Houthakker (1957). His estimates of expenditure elasiticities are from Table III. Unless otherwise note, estimates adjusted for family size are reported. Standard errors are for unadjusted estimates.

[b]Houthakker (1957). His estimates of expenditure elasticities are from Table II.

[c]Theil and Suhm (1981). Their estimates of expenditure elasticities are from Table 4.1.

[d]Haines (1989).

[e]Williamson (1967).

[f]The budget share is from Ogburn (1918-19) and the estimate of expendituer elasticity is from Stigler (1954).

[g]The budget share is from Stigler (1954). The estimate of the expenditure elasticity is from Crafts (1985).

[h]The budget share is the mean of the budget shares of agricultural and nonagricultural workers reported in Stigler (1954, Table 2). The estimate of the expenditure elasticity is from Crafts (1985).

[i]Houthakker and Taylor (1970)

[m]Unadjusted for family size

TABLE 2

MEANS OF ESTIMATES OF EXPENDITURE ELASTICITIES

Budget Share for Food (w)	Mean of Estimates	The Number of Estimates
w≤25%	0.397	4
25%<w≤30%	0.540	11
30%<w≤35%	0.581	13
35%<w≤40%	0.608	12
40%<w≤45%	0.602	6
45%<w≤50%	0.641	11
50%<w≤55%	0.725	8
55%<w≤60%	0.727	12
60%<w≤65%	0.812	5
w>65%	0.849	5

NOTE: The results were calculated from Table 1.

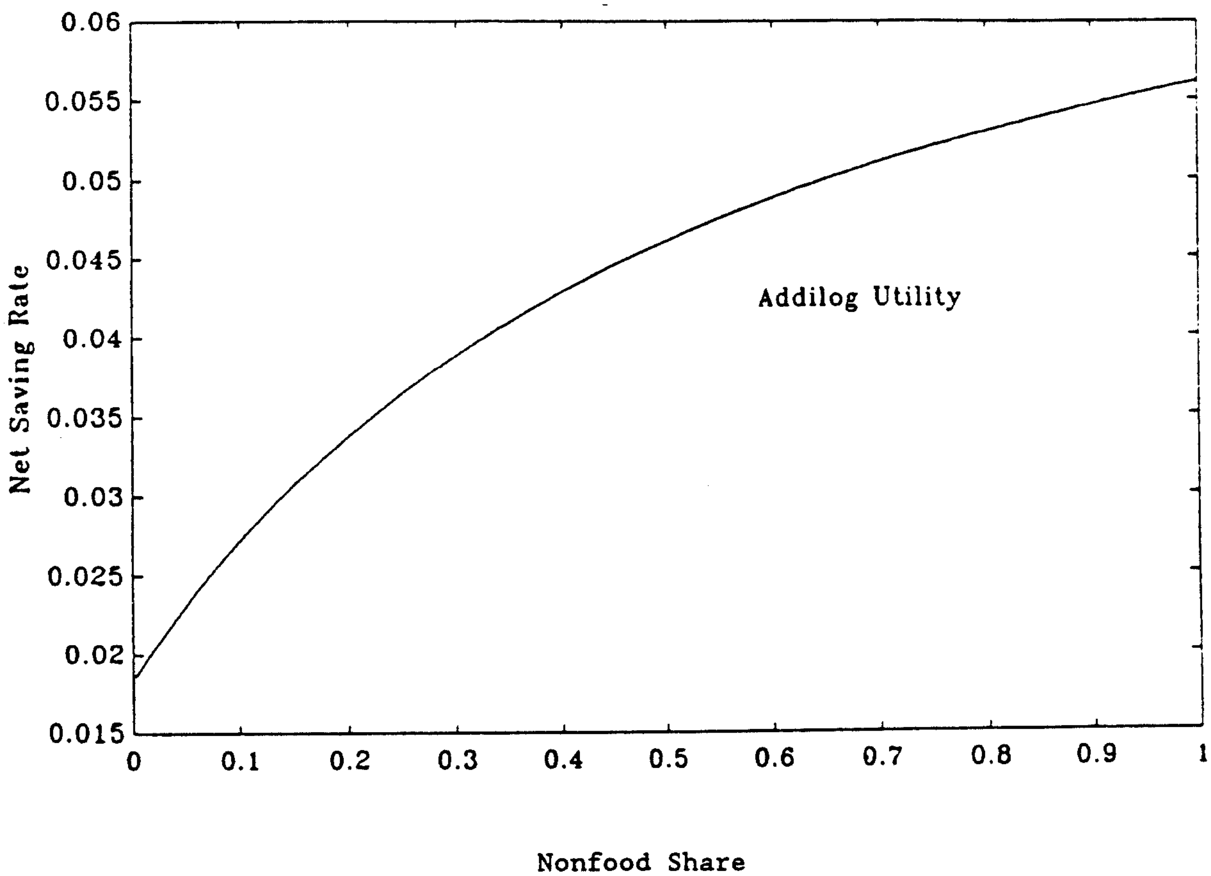

Fig. 1. Net Saving vs. the budget share for nonfood consumption

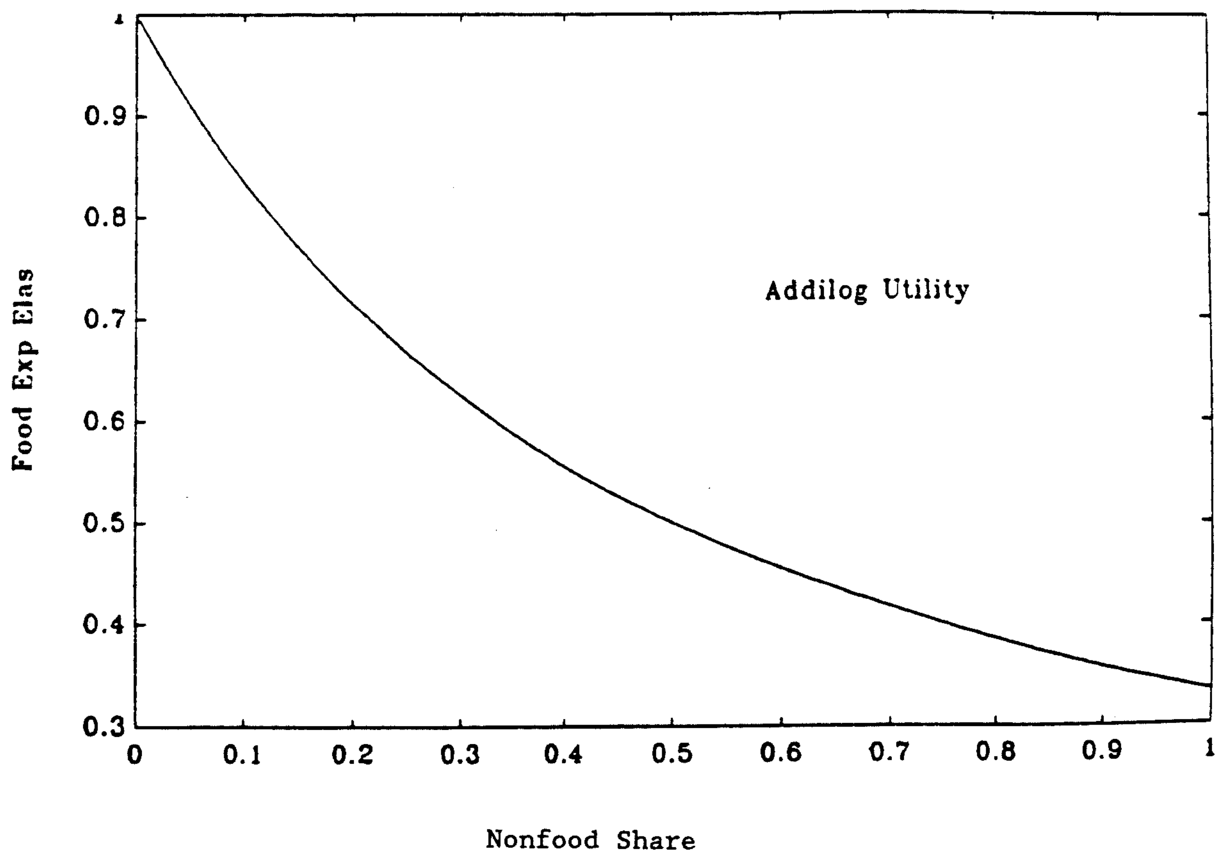

Fig. 2. Food expenditure elasiticity vs. the budget share for nonfood consumption

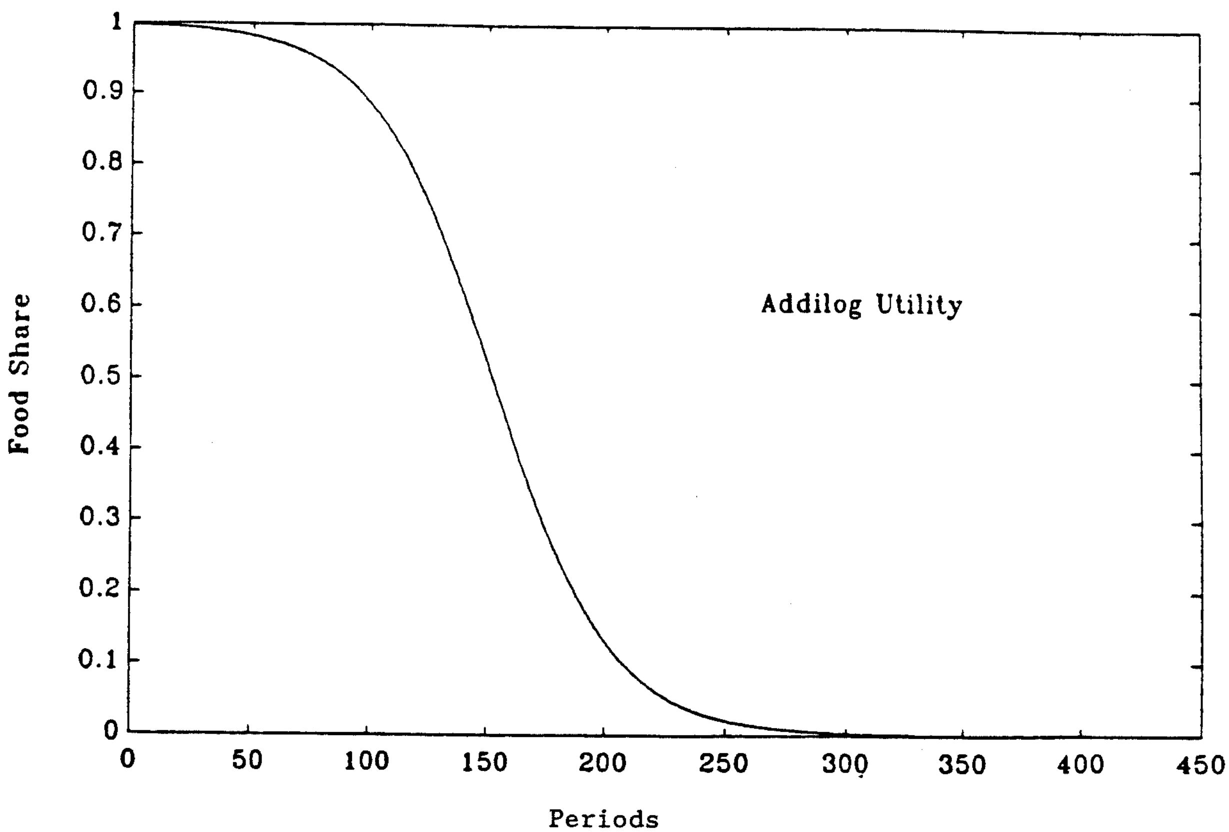

Fig. 3. Time path of the budget share for food

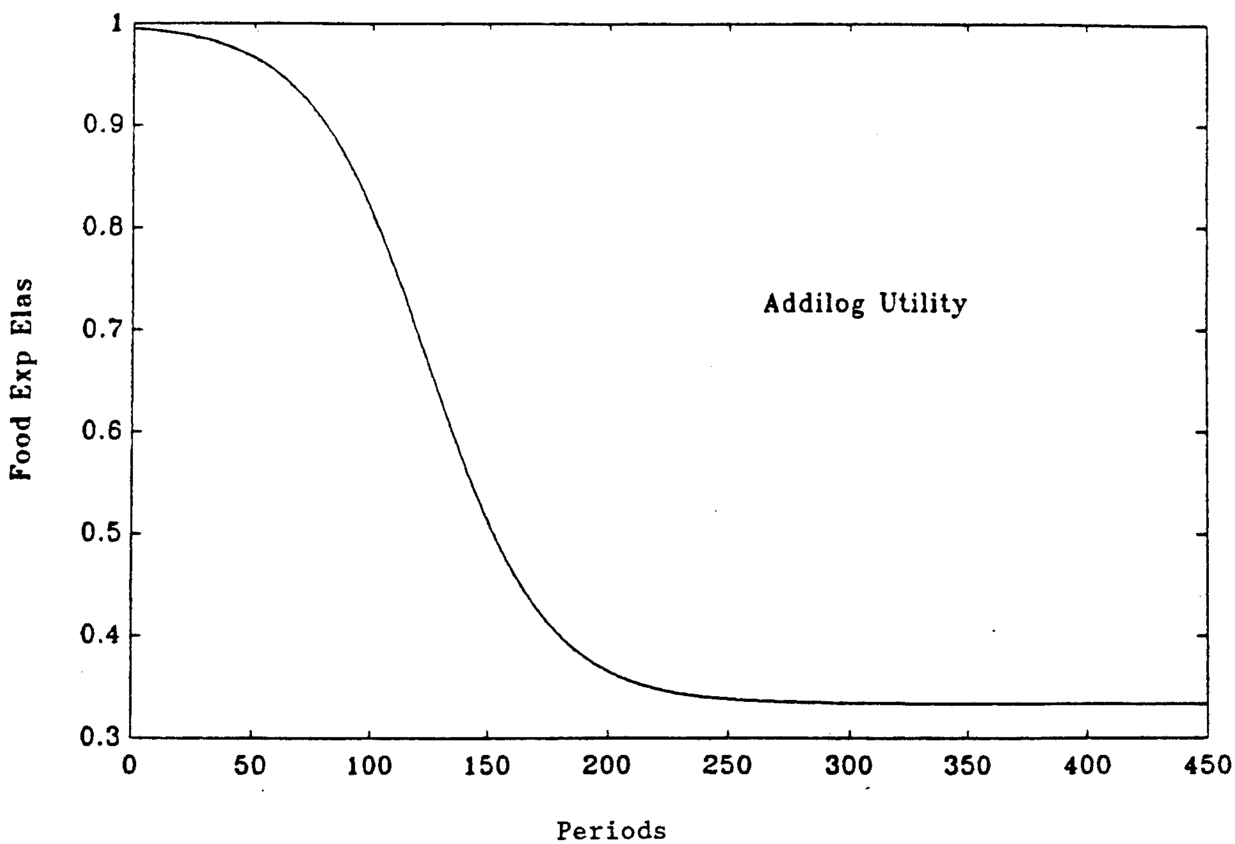

Fig. 4. Time path of the expenditure elasticity for food

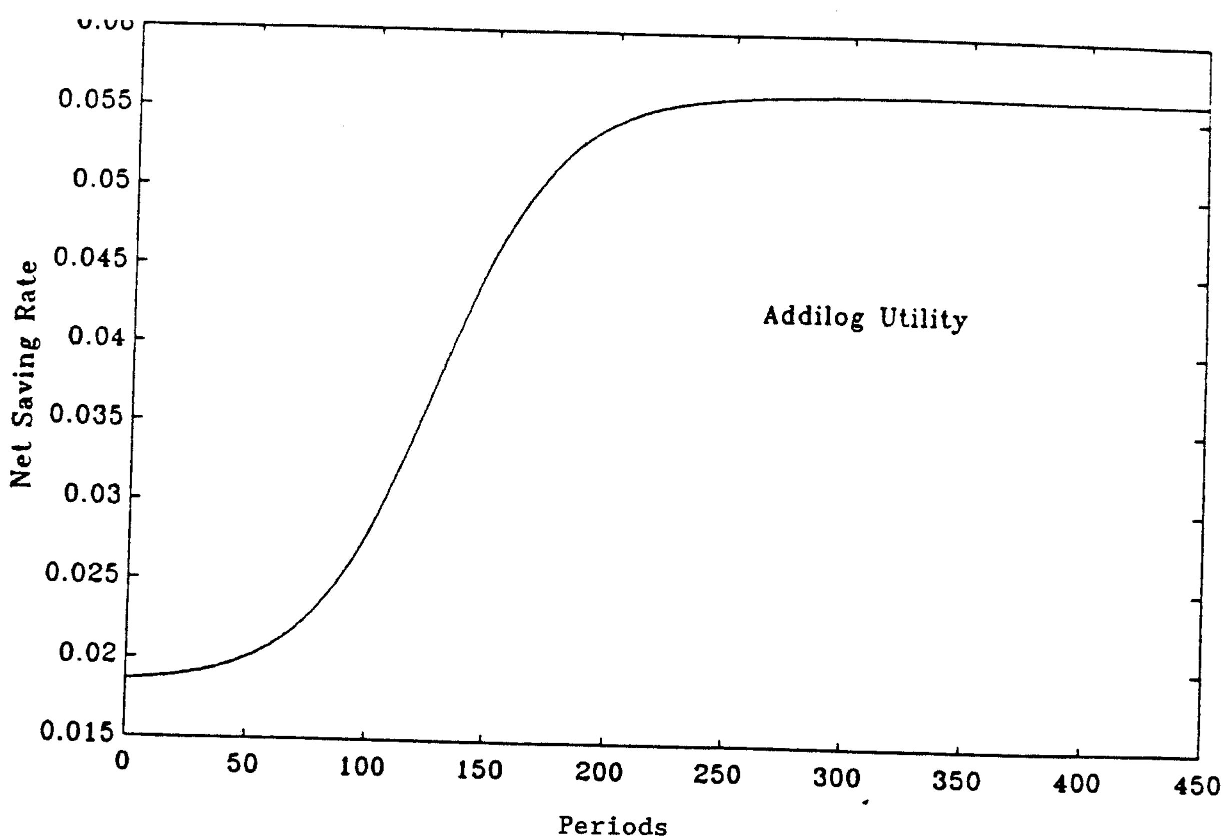

Fig. 5. Time path of the net saving rate