HOUSEHOLD SAVING: MICRO THEORIES AND MICRO FACTS

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1. INTRODUCTION

Why do people save? Keynes (1936) lists eight motives which we reproduce here with one addition¹:

1. "To build up a reserve against unforeseen contingencies" (the precautionary motive);

2. "To provide for an anticipated future relationship between the income and the needs of the individual..." (the life-cycle motive);

3. "To enjoy interest and appreciation..." (the intertemporal substitution motive);

4. "To enjoy a gradually increasing expenditure..." (the improvement motive);

5. "To enjoy a sense of independence and the power to do things, though without a clear idea or definite intention of specific action" (the independence motive);

6. "To secure a masse de manoeuvre to carry out speculative or business projects" (the enterprise motive);

7. "To bequeath a fortune" (the bequest motive);

8. "To satisfy pure miserliness, i.e. unreasonable but insistent inhibitions against acts of expenditure as such" (the avarice motive).

9. To accumulate deposits to buy houses, cars and other durables (the downpayment motive).

A number of features of this list bear remark. First, it seems complete. Interpreting the motives broadly, it seems that since 1936 only the downpayment motive has been added to the list. This is not to deny, of course, that we have made considerable strides in formalising many of the motives in the past sixty years. Second, there is recognition here of a considerable heterogeneity in the motive for saving. It is unlikely that a single explanation will suffice for all members of a population at any given time or even for the same person over a long stretch of time. In particular, there is a widespread feeling that the wealthy have different motives to save than the less wealthy. Third, many of the motives are complementary. For example,
households that save for retirement (the life-cycle motive) will also build up financial reserves that can be used to buffer pre-retirement income or consumption shocks (the precautionary motive). Finally, there are some motives that will lead to behaviour that will be difficult to rationalise with traditional economic models. For example, the motives of avarice (and its opposite, extravagance) and independence lend themselves more to psychological explanation.

We begin our survey with a long theory section. This is necessary since the past decade has seen theoretical developments which are likely to change radically our intuitions about saving behaviour. One seemingly trivial problem we have encountered in discussing the theory is that of terminology. As an example, for many researchers the term 'life-cycle model' refers specifically to a Modigliani style model with no bequests and fairly simple environments. For others the term is taken to refer to any model in which agents solve forward looking intertemporal consumption problems that may allow for, say, bequests, habits and liquidity constraints. Similar ambiguity attaches to the term 'permanent income hypothesis' which is usually (but not invariably) attached to a model that is different from that of Friedman (1957). Rather than further muddying the waters we shall avoid the terms 'life-cycle model' and 'permanent income model' as far as possible and refer instead to models that assume optimisation as standard saving models. Within this we discuss various specific cases that have been important. We also discuss models that imply behaviour that may be inconsistent with the standard model (see section 7).

The principal innovation in the theory in the past decade has been to allow for the precautionary motive. Although this was discussed in earlier papers it is only recently that we have come to realise that intuitions derived from models without a precautionary motive can be seriously misleading, even if the amount of uncertainty is small. Thus it is often claimed, for example, that the life-cycle model implies that the path of consumption over the life-cycle should be independent of the path of income. This is a prediction of what we term the certainty-equivalence model (CEQ model, see section 2.1 for a definition) but it is by no means an implication of more general models that allow for a precautionary motive. The move to a
more general model that allows explicitly for a precautionary motive brings with it both benefits and costs. We shall deal with these at length in section 2 but the principal benefit is that we can accommodate a much wider range of behaviour in the precautionary model. One of the costs is simply the converse of this: we have far less sharp predictions from the more general model. The other principal cost is in tractability: we cannot typically derive closed form expressions for savings and consumption functions and we cannot reproduce many of the manipulations that are possible on the CEQ model.

After the theory section we present some facts (section 3) concerning saving by U.S. households. As far as possible we try not to draw inferences from these - that will the task of the next three sections. Section 4 deals with one specific phenomenon: the apparent decline in the U.S. saving rate in the recent past. In this section we also discuss some of the possible explanations for the decline in a relatively ad hoc way. This ad hocery is imposed on us by the relative ignorance that still surrounds the reasons why households save. Many attempts have been made to dispel this ignorance. In sections 5 and 6 we consider some of the evidence for and against various theories of saving. Section 5 concentrates on the short run allocation of funds over time (particularly Euler equation studies of consumption) whilst section 6 is concerned with the longer run. Finally, we have a section on behavioural models of saving that largely eschew the standard optimising framework.

We shall not be dealing with a number of topics that readers might expect to see treated in a survey on saving (see King (1985) and Deaton (1992) for excellent surveys of saving behaviour). We ignore almost entirely the voluminous literature that uses aggregate time series data. Although the profession has learnt a great deal about the modeling of intertemporal allocation from empirical work on aggregate time series data it is our belief that we have learnt almost nothing useful about individual behaviour itself from this work. We also restrict attention mainly to U.S. data. Thus we do not have much discussion of international comparisons. This is not because we do not think that such comparisons are useful but simply because we must draw the line somewhere: this survey is already very long. Interested readers are referred to the volume edited by Poterba that compares savings rates in the G7.
countries (Poterba (1994)).

Another large topic that we largely ignore is intergenerational transfer behaviour generally and bequest behaviour in particular; see Gale and Scholz (1994a) for a discussion and references. We also have very little to say about portfolio choice; this is largely because there is relatively little work on this that uses micro data directly. Closely related to this is the accumulation of assets for households by firms (in the form of retained earnings) and government (in the form of pensions); we shall not treat the determination of these assets directly although we do allow for the impact of their accumulation in the determination of household savings.

2. MODELS OF SAVING AND CONSUMPTION

2.1 The Certainty-Equivalence Model

The usual model for discussing the intertemporal allocation of money and time is the life cycle model. This takes its inspiration from Modigliani and Brumberg (1954), and Friedman (1957) but in its modern form it is a good deal more general than either of the two variants these authors present. The central tenet of the modern view is that agents attempt to keep the marginal utility of expenditure (mue) constant over time. We refer to this as the standard savings model. A formal derivation is given below but the entirely plausible informal argument is that rational forward looking agents will not want expenditure to worth more (in discounted utility terms) in one period than in any other. This principle governs both short run (business cycle/high frequency) allocation and long run (life cycle/low frequency) allocation. Thus agents seek to equalise the marginal utility of money from one period to the next and between now and the distant future. It is the simultaneous consideration of the short run and the long run that gives the standard savings model its power and also puts it at most risk of being rejected by the data.

It is important to emphasise that the modern view that agents seek to equalise the mue over time is consistent with the existence of imperfections in the capital market and with habits or satiation. Thus liquidity constraints
may cause the m̄e to fall over time (as consumption grows over time) in an expected way. This is consistent with the standard savings model: agents would prefer to have more consumption in the early periods but capital market imperfections prevent this. Indeed the most general model that allows for capital market imperfections and non-additive preferences over time does not seem to impose any restrictions on the time path of consumption and asset prices. It is only when we impose restrictions on preferences and budgets that we can derive testable implications. Thus the modern standard model in its most general form is better thought of as a framework than as a direct source of testable propositions. We now consider the sets of restrictions sometimes used.

One collection of assumptions has been widely used; we refer to the model that uses these assumptions as the certainty-equivalence model\(^4\) (CEQ model):

*Assumptions for the CEQ model.* Agents have intertemporally additive utility functions with a constant discount factor and face perfect capital markets. Either there is perfect certainty or agents maximise expected utility; form rational expectations and have quadratic utility functions.

The implications of these assumptions\(^5\) for consumption and saving have been thoroughly investigated over the past forty years and were well understood by the mid 1980's. Very broadly, the implications for consumption are (see Deaton (1992) for a very clear account): the shape of the lifetime path of consumption is independent of the shape of the expected path of income; the marginal propensities to consume out of current and future expected income are much the same; the marginal propensity to consume out of future income is independent of the riskiness of this income; the elderly should run down assets; anticipated changes in income have no effect on consumption and consumption changes are orthogonal to past information. Of course, most of these implications are highly interrelated and all are ultimately derived from the proposition that agents seek to keep the m̄e constant and the latter is linear in consumption for quadratic utility functions.

Many of these implications implicitly employ supplementary assumptions.
For example, the conclusion that consumption and expected income paths are independent implicitly assumes that consumption and labour supply are additively separable. If they are not, then consumption and expected income may be correlated. For example, many people anticipate retirement a long way ahead. If consumption and labour supply are complementary (perhaps because of the costs of going to work) then on retirement both income and consumption fall. Even though the fall in income is anticipated, behaviour of this sort does not invalidate the CEQ model. As another example, the orthogonality between consumption changes and past information only holds under special circumstances. For example, if parents pay for child care during the day when children are of pre-school age these costs can be a sizable share of total consumption. Typically these costs fall or even disappear when children start school. The latter event is anticipated some time ahead so that we can predict the change in consumption using past information. Thus the orthogonality implication is once again dependent on the implicit assumption that the marginal utility of expenditure does not depend on (predictable) events.

Although tractable, the CEQ is restrictive. Less restrictive alternatives are available. For example, we can retain the quadratic utility assumption and drop one (or more) of the other CEQ assumptions. Generalisations include allowing for imperfections in the capital market; VN utility functions that are not time additive; non-constant discount factors and preferences that do not satisfy the expected utility axioms. Another line of investigation drops the assumption that utility functions are quadratic; this leads to a model which has been the focus of a great deal of theoretical work in the past decade.

2.2 The standard additive model.

In this sub-section we discuss the model without the assumption that utility is quadratic (or that there is perfect certainty). We retain the assumptions of additivity over time for the utility function and of perfect capital markets. Since the latter implies that budgets are additive over time we call this less restrictive model the standard additive model.
Assumptions for the standard additive model. Agents have intertemporally additive utility functions with a constant discount factor and face perfect capital markets. Agents maximise expected utility and form rational expectations.

The major difference between this model and the CEQ model is, of course, the allowance for non-quadratic preferences. This may not seem like much of a radical difference but it turns out that it is.

One of the principal lessons that we have learned in the past decade is that the intuitions derived from the CEQ model can be highly misleading in the presence of even a small amount of uncertainty if agents display prudence (that is, the third derivative of the utility function is positive, see Kimball (1990)). To illustrate how misleading the CEQ model can be, consider the following simple two period model. Assume that the agent maximises expected utility with life-time preferences over the certain consumption path \((C_1, C_2)\) represented by the VN utility function:

\[
U(C_1, C_2) = \ln C_1 + \ln \epsilon
\]

Let \(Y_1\) be cash-in-hand (first period earnings plus any starting wealth) in period 1. Earnings in period 2 are stochastic; specifically, let second period earnings be zero with probability \(\epsilon\) and \(Y_2/(1-\epsilon)\) with probability \((1-\epsilon)\). Thus an increase in \(\epsilon\) represents a mean preserving spread in future earnings risk. Finally, we assume that the real rate of interest is zero.

In Table 2.1 we present some calculations for three different scenarios: perfect certainty (\(\epsilon = 0\)) with low first period cash-in-hand and then uncertainty with high and low first period cash-in-hand respectively. We calculate first period consumption, the savings rate from first period income, the marginal propensities to consume (mpc) out of first and second period income, the effective discount rate used to discount future expected earnings (the discount rate for future expected earnings which would give the associated first period consumption if the agent had quadratic preferences) and the variance of second period log consumption. The latter term will be discussed in the next sub-section.

A number of features emerge from these calculations. First, the degree to
which the CEQ model approximates the model with uncertainty depends on the time path of expected income. In particular, if first period cash-in-hand is low relative to second period expected earnings (that is, if there is income growth) then there can be wide divergences between the CEQ model and the additive model. In fact, in this example first period consumption can be discontinuous in $\epsilon$ at $\epsilon = 0$; this presents obvious problems for approximating consumption responses about the the CEQ predictions. Second, with low first period income the mpc to consume out of cash-in-hand can be close to unity even though there is 'not much' uncertainty. Third, with low first period income the mpc to consume out of future expected income can be close to zero. Thus the CEQ prediction that the mpc's to consume out of current and future income are the same (in a world with independently distributed incomes, as here) is wildly wrong for some agents. Finally, even a small amount of uncertainty may be sufficient to stop the agent from borrowing in the first period.

Uncertainty also causes some agents to behave as though they discount expected future earnings at a higher discount rate than the market rate of interest (see also Zeldes (1989b)). Whether or not agents do this depends critically on whether the agent would save or not in a CEQ world (which in turn depends on their current assets and the path of future income). In this example, future earnings are not discounted very much if CEQ savings would be positive (compare columns 2 and 3 of Table 2.1). This suggests that we cannot make a blanket prediction that uncertainty causes agents to discount future earnings with a rate much higher than the real rate. Rather, the (implicit) discount rate will depend on the ratio of cash-in-hand to expected future earnings. Yet another feature of this example is that the precautionary motive gives rise to behaviour that is very close to that generated by a CEQ model with a borrowing restriction; we shall discuss this further in the next subsection.

One other important feature of this example is also worth discussing at some length. The introduction of uncertainty in the final column of Table 2.1 leads to a considerable welfare loss. For this example, an agent with a certain income 8% lower than the expected value of income would be just as well off. Thus there is considerable scope for insurance here since the
actuarially fair premium would be only two-thirds of a percent of expected lifetime income. If outcomes are independent across many agents then the introduction of a social insurance scheme would lead to a considerable welfare gain for society. This is, of course, the traditional rationale for a government unemployment insurance scheme (see Baily (1978) for further discussion of the trade-off between these gains and moral hazard losses). If a social insurance scheme is introduced here it raises welfare but it also lowers saving considerably. For column three of Table 2.1, a fully insured agent will now borrow an amount equal to a little over one half of first period income rather than saving a small amount. Of course the numbers given here are rather extreme but the basic point is valid: the introduction of a precautionary motive leads to a rationale for social insurance and the introduction of the latter leads to a consequent attenuation of the precautionary motive.

In this example some agents (those with low first period cash-in-hand) have responses that are 'keynesian' even though the framework is a standard additive one (see also Barsky et al (1986)). It is important to note that there is no assumption that capital markets are imperfect in this example: the agent is free to borrow and lend at the riskless real rate of zero. Of course, in this example restrictions on borrowing are irrelevant since no agent in such a world as this would want to borrow. This very sharp result that imperfections in the capital market are irrelevant depends on their being some positive probability of zero income and this giving minus infinity utility if the agent does not have any assets (see Carroll (1992) and (1993)). If someone (family, friends or the government, for example) provides a floor to consumption even in the event of bankruptcy then agents may borrow in the first period. However, the main point carries over: the CEQ model may be a very unreliable guide to savings behaviour for agents who have a precautionary motive.

2.3 The Euler Equation for intertemporal allocation.

Most recent empirical work on saving and consumption employs the optimality condition (or Euler equation) implied by the standard additive
model as a starting point. Thus, we turn now to the derivation of this Euler equation for consumption. We denote the within period VN utility function by \( v(C,Z) \) where \( C \) is consumption and \( Z \) is a vector of modifiers for utility which we shall refer to as 'demographics'. The usual candidates for inclusion in \( Z \) are household composition, health status and labour supply but it can be anything that affects household utility. The discount factor is denoted \( \beta \); it is usually taken to be less than unity. Given the standard additive model assumptions we can derive the Euler equation for optimal allocation between periods \( t \) and \( t+1 \):

\[
v_C(C_t, Z_t) = E_t \{ \beta (1+\tilde{r}_t) v_C(C_{t+1}, Z_{t+1}) \} \tag{2.1}
\]

where \( r_t \) is the real rate between the two periods; the \( \sim \)'s denote that the variable is stochastic and \( v_C(\cdot) \) is the partial of \( v(\cdot) \) with respect to \( C \).

This Euler equation encapsulates the central insight of the standard saving model viz agents try to keep the marginal (discounted by \( \beta \)) utility of (discounted by \( r \)) expenditure (mue) constant over time.

As we shall see in section 5, the Euler equation (2.1) has been the focus of most empirical work on consumption since its use in Hall (1978). The reason for this is that to estimate the parameters of the utility function \( v(C,Z) \) we need only observe consumption in different periods, interest rates and demographics; we do not need to model agents' expectations. By 1978 the need for the latter was increasingly the stumbling block in applying life-cycle ideas to the empirical analysis of consumption and saving behaviour.

For empirical and theoretical work we typically need a parameterisation for the utility function\(^9\). Other than the quadratic form, the most widely used is the Constant Relative Risk Aversion (CRRA) or iso-elastic utility function:

\[
v(C,Z) = \frac{1}{1-\gamma(Z)} \left( \frac{C}{\alpha(Z)} \right)^{1-\gamma(Z)} \tag{2.2}
\]

The appeal of the iso-elastic form is not in its tractability (as we shall see it is not particularly easy to manipulate) but in its a priori plausibility. Both Friedman (1957) and Modigliani and Brumberg (1954) defend the assumption that intertemporal preferences over certain outcomes are homothetic; that is, a 10% increase in lifetime wealth (or permanent income) will lead to a 10%
increase in expenditure in each period. The implication of this 'proportionality' assumption is that in a perfectly certain world, consumption in any period is proportional to lifetime wealth. The actual proportion depends on discount factors, interest rates, the length of remaining life and demographics but not the wealth level itself. The other widely used assumption in the consumption literature is that utility is additive over time. Combining homotheticity with intertemporal additivity gives the iso-elastic form, hence its popularity.

The 'parameter' \( \gamma(Z) \) is the coefficient of relative risk aversion; by definition it is independent of the level of lifetime wealth but not necessarily of demographics. Concavity requires that \( \gamma \) be positive. The 'parameter' \( \alpha(Z) \) is effectively an adult equivalence scale; usually we require that the marginal utility of consumption be increasing in, say, family size.

We now derive the Euler equation for the iso-elastic utility function. To simplify notation we shall assume that \( \gamma(.) \) is independent of demographics. From the Euler equation (2.1) we have:

\[
\beta(1+r_t) \left\{ \frac{\alpha(Z_{t+1})}{\alpha(Z_t)} \right\}^{\gamma-1} \left\{ \frac{C_{t+1}}{C_t} \right\}^{-\gamma} = 1 + \epsilon_{t+1}^{e} \quad \text{with} \quad E_t(e_{t+1}) = 0 \tag{2.3}
\]

Let the variance of \( e_{t+1} \) be given by \( \sigma_{t+1}^2 \); we refer to this as the consumption shock variance. To simplify we take \( Z \) to be a scalar and parameterise \( \alpha(Z) = \exp(\alpha Z) \) where \( \alpha \) is now a parameter. Taking logs and using the usual approximation for logs\(^{10}\) we have the linearised Euler equation:

\[
\Delta \ln C_{t+1} = \tilde{\beta} + \tilde{\alpha} \Delta Z_{t+1} + \phi r_t + 0.5 \phi \sigma_{t+1}^2 + u_{t+1} \tag{2.4}
\]

where \( \phi = 1/\gamma \) (> 0), \( \tilde{\beta} = \phi \ln(\beta), \tilde{\alpha} = \alpha(\gamma-1)/\gamma \) and \( u_{t+1} = -\phi(e_{t+1} - 0.5(e_{t+1}^2 - \sigma_{t+1}^2)) \) so that \( E_t(u_{t+1}) = 0 \). Equation (2.6) is perhaps the most instructive equation in the modern consumption literature. Let us consider the right hand side term by term.

The first term is a discount factor; a lower \( \tilde{\beta} \) can be thought of as higher impatience which leads to higher consumption in early periods and hence lower saving and consumption growth. The second term allows for the influence of anticipated changes in demographics on consumption. Although these
demographic terms are largely ignored in the aggregate time series literature (for the good reason that that they change only very gradually in the aggregate) they are potentially important sources of variation in consumption at the micro level that we shall be primarily concerned with.

The coefficient on the interest rate, $\phi$, gives the response to anticipated changes in interest rates. Thus it is the proportional change in consumption consequent on an anticipated one percent change in the discounted price of consumption (which equals the real rate of interest). For this reason $-\phi$ is known as the \textit{interpersonal substitution elasticity} (ise). Here 'anticipated' means 'keeping the mue constant' so that this price response is a (Frisch) compensated response and can be signed from the theory: the coefficient $\phi$ should be positive. This restriction is the only integrability condition that the (one good) Euler equation has to satisfy. Note that the ise is simply the negative of the inverse of the coefficient of relative risk aversion. Thus attitudes to risk and to intertemporal substitution are intimately linked in (2.4). This is not peculiar to the iso-elastic case; it is a feature of any model that assumes expected utility maximisation and a time additive VN utility function.

The time discounting, demographic and interest rate effects are all present in the CEQ model but the fourth term on the right hand side of (2.6) is absent from that model. The term for the consumption shock variance captures the precautionary motive. If the variance of future consumption increases then agents save more for the future and (expected) consumption growth increases. This follows since the coefficient on this variance term is necessarily positive; indeed, it simply half of the ise. This close link between intertemporal substitution and prudence is accidental to the CRRA case; it follows since we have only one parameter in the utility function so this must control both prudence and risk aversion. In general there is no necessary link between risk aversion and prudence. Indeed, risk averse agents ($\nu_{CC} < 0$) can display imprudence ($\nu_{CCC} < 0$). Although Marshall found this the more compelling case, most modern authors have taken it as a given that agents are not imprudent (that is, $\nu_{CCC} \geq 0$). Kimball (1990) provides a thorough discussion of prudence and its links with risk aversion and the precautionary motive.
The variance term in (2.4) has been the focus of a great deal of recent attention. We shall return to this in the empirical section; for now we note two of the most important features of precautionary saving. The first is that it obviously depends on the uncertainty associated with future exogenous variables. For example, agents who have higher variance in future income will have higher savings. Also agents who face higher uncertainty about future demographics will change their savings behaviour. For example, if demographics include ill health (and agents do not have full medical insurance) then savings will reflect changes in the probabilities of ill health, over and above the induced changes in the distribution of future earnings. Finally, increased uncertainty about future interest rates may cause agents to adjust current consumption.

The second important feature of precautionary saving is that it depends on the level of current assets or cash-in-hand. To illustrate this, consider again the two period model developed earlier. In the last row of Table 2.1 we presented the variances of second period log consumption. The important point here is that this variance is about twenty times higher for the case in which first period cash-in-hand is low relative to expected lifetime income. Moreover, this very large difference is not being driven by differences in income risk: for both cases the coefficient of variation of second period income is the same. Thus future income variance is not, by itself, an adequate proxy for the variance term in (2.4); how this risk impacts on current consumption decisions depends on the level of current assets and income relative to expected future income.

To investigate more deeply these issues we need to move beyond the Euler equation and consider consumption functions. Even consideration of the simple two period model yields the important theoretical point that the non-CEQ additive model does not imply that agents who expect high future incomes (for example, students in medical school) will necessarily borrow to finance consumption in their early years. This is the case even if agents have access to perfect capital markets. Whilst it is useful to have simple analytical counter-examples, to actually generate predictions in more realistic environments it is necessary to consider many period models.

If we wish to analyse many period models then we must have recourse
either to approximations (see, for example, Skinner (1988) or Campbell and Mankiw (1989)) or to simulations. An older example of a simulation that takes explicit account of the effect of the precautionary motive is given in Nagatani (1972). Nagatani assumes that agents are impatient (the discount rate is a good deal higher than the real interest rate) and there is consumption growth in the pre-retirement period. Even though Nagatani’s theoretical analysis now looks decidedly dated his simulations bring out many of key features that emerged in the later debate. For example, the need for high discount rates and uncertainty to reconcile the standard additive model with the observed coincidence of income and consumption in the early part of the life-cycle; the interaction between the effects of uncertainty and the ratio of human to non-human wealth and the difference between the marginal propensities to consume out of of the two types of wealth.

More recently, a number of authors have taken simulations much further (see, for example, Zeldes (1989b); Caballero (1990) and (1991); Deaton (1991), Carroll (1993), Attanasio (1994a) and Hubbard et al (1994a) and (1995)). We shall return to some of these analyses in the next section when we consider liquidity constraints but for the standard case without liquidity constraints, Carroll (1993) and Attanasio (1994a) provide insights. Carroll shows that for particular income processes, if we have a precautionary motive and 'impatience' then consumption 'tracks' income in the early part of life; effectively, it is only in later years (say, after age 45) that we observe significant saving. In the Carroll model it is the possibility of destitution in later periods that stops agents from borrowing in earlier years. This leads to what Carroll (following Deaton) calls 'buffer stock' behaviour. Agents have some (typically quite small) wealth/income ratio target. If wealth is below this then prudence dominates and the agent tries to save; above the desired ratio, impatience leads agents to run down their assets.

Attanasio (1994a) allows for demographics and shows that we can even do without impatience: the fact that children 'arrive' early in life is enough to induce a strong correlation between consumption and anticipated income in the early part of life (see also Tobin (1967)). This analysis takes the time paths of income and children as given. It would be extremely interesting to extend these studies of the standard additive model to allow for the fact that, to a
certain extent, agents choose the time profile and riskiness of income and also the time path of demographics. Thus high education agents marry later and start their families later which may be connected to their income processes.

Summing up for the model that allows for a precautionary motive, we can state that the most important conclusion that arises from recent theoretical work on consumption and saving is that this model is much less restrictive than the widely used CEQ model. It is also the case that the implications of the CEQ model may be a very misleading guide to what to expect from a precautionary savings model. This increased flexibility is both good news and bad news. The good news is that the standard additive model is a good deal less restrictive than is widely thought and is compatible with a much richer variety of short run and lifetime consumption patterns than is suggested by the CEQ model. This is cheering since the non-CEQ model is relatively easy to manipulate and hence to use in empirical work. The bad news is simply the converse of this. Even if the assumptions of the standard additive model hold, it has far less predictive power than the CEQ model so that estimation of the parameters of the model assumes a greater importance. All of this assumes, of course, that the standard additive model is valid for all agents; this is by no means universally accepted since the assumptions that underpin it are questionable. We turn now to a consideration of relaxing some of these assumptions.

2.4 Liquidity constraints and habits.

Of all of the assumptions of the standard additive model, the one that has been most questioned is the the existence of perfect capital markets (see Hayashi (1987) and Deaton (1992)). It is palpably the case that borrowing rates typically exceed lending rates and that people often ask for credit and are refused. To allow us to capture the essence of the effects of liquidity constraints we shall adopt a few simplifying assumptions. First we shall assume that interest rates are constant and are known when consumption in time \( t \) is chosen. Second we shall assume that there are two rates, one for borrowing \( (= r_B) \) and one for lending \( (= r_L) \) with \( r_B > r_L \). This includes the special case for which \( r_B = +\omega \); that is, assets are constrained to be non-
negative.

We begin with the very obvious point that liquidity constraints are only likely to be of interest for agents who want to borrow. This has led to investigators concentrating on the case where either there is some income growth or agents have high time discount factors or the 'consumption needs' captured by the demographic variable occur early in the life-cycle. Note that the presence of any (or even all) of these is not sufficient to ensure that agents will want to borrow (see, for example, the final column of Table 2.1 which has very high income growth) but some such assumptions seem to be necessary.

With different borrowing and lending rates, the revised version of (2.1) is given by:

$$v_C(C_t, Z_t) = \beta(1+r_V)E_t v_C(C_{t+1}, Z_{t+1})$$

where $r_V$ is the 'virtual' interest rate used for optimal intertemporal allocation. Thus $r_V$ is defined to be the real rate that ensures that the Euler equation holds. It is the lending rate for lenders; the borrowing rate for borrowers and some intermediate rate for those who do not carry forward assets or debt from period $t$. Note that even if assets are constrained to be non-negative (formally, $r_B = +\infty$) $r_V$ will still be finite.

Suppose now that we do not observe the interest rate implicitly used by the agent but only the lending rate. This gives:

$$v_C(C_t, Z_t) = \beta(1+r_L)E_t v_C(C_{t+1}, Z_{t+1})$$

with equality if the agent is a lender. Thus in expectation, the mue using the lending rate to discount is non-increasing rather than constant. This can be re-written in more familiar Lagrange multiplier form as:

$$v_C(C_t, Z_t) = \beta(1+r_L)(1+\psi_t)E_t v_C(C_{t+1}, Z_{t+1})$$

where $\psi_t \neq 0$ and $\psi_t A_{t+1} \leq 0$ (where $A_{t+1}$ is the level of assets carried forward from period $t$ to $t+1$). The value of $\psi$ is $(r_V-r_L)/(1+r_L)$; since $r_V \geq r_L$ this is automatically non-negative and attains its maximum at $r_V = r_B$.

We can incorporate this into the Euler equation for the iso-elastic case:
\[ A \ln C_{t+1} = \tilde{\beta} + \alpha A Z_{t+1} + \phi_r \ln L + 0.5 \phi_2 \phi^2 + \phi \ln (1+\psi L) + u_{t+1} \]  \hspace{1cm} (2.8)

Thus consumption growth between \( t \) and \( t+1 \) is higher for liquidity constrained agents than for those who carry forward some assets (see Zeldes (1989a) and Deaton (1992)). That liquidity constrained agents will consume less in the current period than they would like is almost tautological; it hardly requires (2.8) to show this. There are, however, more interesting implications.

One trivial consequence of liquidity constraints is that if zero assets are carried forward for many periods then consumption changes will be set equal to (earned) income changes over this period. In these periods, the Euler equation (2.1) will not hold if we use the lending rate to discount future values. Instead the agent will appear to be a 'rule of thumb' agent who simply sets consumption equal to income. There is, however, one critical difference between the behaviour of a liquidity constrained agent and one who sets income equal to consumption in each period. For the former, we may observe periods in which the agent saves and hence periods in which consumption is either lower or higher than earnings. This asymmetry and the consequence difference from 'rule of thumb' behaviour will be explored in section 5.

The behaviour of a liquidity constrained agent is also superficially similar to an agent who can borrow as much as they like but who faces some positive probability of a catastrophic outcome in the future (see the discussion of Carroll (1993) above and the final column of Table 2.1). As we have seen, such an agent will never choose to borrow even if expected future income is much higher than current income. In terms of (2.8) the effects of increased uncertainty (higher \( \sigma^2 \)) and the effects of a more tightly binding liquidity constraint (higher \( \psi \)) are identical. Moreover the marginal propensities to consume out of current and future income are very similar for both types of agents. There is, however, one potentially observable difference. Impatient liquidity constrained agents will often choose to carry forward zero assets; agents faced with a possible catastrophe will never choose to do this. On the other hand, if assets are not observed or are measured with considerable error then it is may be very difficult to disentangle the effects of liquidity constraints and a strong precautionary motive.

There is another important effect of liquidity constraints that we can
see operating in (2.8). Even for an agent who is not liquidity constrained between periods $t$ and $t+1$, the variance term $\sigma^2_{t+1}$ may be larger because of possible liquidity constraints between periods $t+1$ and $t+2$. This follows since the possibility of borrowing provides some insurance; agents who are not liquidity constrained can tide themselves over runs of bad luck by borrowing against future income. If this option is removed then the variance of future consumption is increased. Thus the mere possibility of being constrained in the future may increase consumption growth for agents even if they are never actually observed to be constrained (for example, even if they always carry forward positive assets).

The possibility of future liquidity constraints also has another implication for intertemporal allocation. This effect derives from the budget constraint. Suppose that at time $t$ the agent knows that they will be constrained between periods $t+s$ and $t+s+1$ so that $A_{t+s+1} = 0$. Then the budget constraint between periods $t$ and $t+s$ depends only on assets at time $t$ and earnings in periods $t$ to $t+s$. Thus it is though the agent acts with a short time horizon (here equal to $s+1$ periods). Thus the presence of possible future liquidity constraints may lead agents to behave as though they are less forward looking than is suggested by the standard additive model. Once again, the role of family composition may be critical. If consumption 'needs' peak when there are older children in the home and households are liquidity constrained, then it may be that saving 'for retirement' only begins when children leave home.

This distinction between long run and short run behaviour is potentially important. As we have stressed above, one of the most remarkable features of the standard savings model is that it gives predictions for both the short run and the long run. In a model without liquidity constraints agents set current consumption to equalise the current mve and expected next period mve but they also set this level to equalise the expected mve in the distant future. The presence of impatience and liquidity constraints may break the link between long run and short run behaviour. Thus we may observe agents smoothing over the short run but not over the long run.

We now turn to other features of the consumption function with liquidity constraints. Once we include even highly stylised representations for real
needs or constraints then we have to resort to simulations to recover the consumption function. Here we present some of the main results from Deaton (1991) and Hubbard, Skinner and Zeldes (1994a) and (1995). Deaton (1991) presents results for infinitely lived, liquidity constrained agents who face both stationary and non-stationary earnings processes (see also Deaton (1992), section 6.2). Assuming impatience, which in this context means choosing parameters so that agents would 'typically want to borrow' (high time discount rates relative to real interest rates and/or some income growth) Deaton uses numerical techniques to derive the consumption function for various income processes. For the iid income case the consumption function is particularly simple. To a close approximation, consumption is set equal to cash-in-hand (current income plus assets) if the latter is below mean income; otherwise consumption is set equal to mean income plus some fraction of cash-in-hand above mean income (the fraction is 0.3 in the case Deaton examines)\textsuperscript{12}. Deaton calls such behaviour 'buffer stock' behaviour since agents accumulate assets only to insulate themselves from income fluctuations. One of the most interesting features of these results is that even small levels of assets can achieve considerable smoothing of consumption. For the iid case, mean assets are equal to one month's income but the standard deviation of consumption is only half of that of income. As we introduce more persistence into income, however, agents achieve less smoothing and as income approaches a random walk the variance of consumption tends to that of income.

Hubbard et al (1994a) and (1995), in what is certainly the richest set of simulation studies attempted to date, consider liquidity constrained agents in an environment with substantial uncertainty. Specifically, they allow for uncertainty over earnings (including unemployment insurance benefits), medical expenses (which are highly persistent) and the length of life. Earlier studies typically focused on only one source of risk. In the Hubbard et al simulations there is no bequest motive; earnings are exogenous (so the the retirement date is given and independent of the state of health) and the government provides a low consumption floor ($7,000 in their benchmark model). The richness of the institutional structure that Hubbard et al consider brings out the importance of institutional factors such as unemployment and medical insurance schemes.

One of the most important features that Hubbard et al incorporate into
their simulations is the presence of an assets test for medical and income support benefits. This leads to a non-convexity in the environment which induces many agents to rationally hold very low levels of assets. They compare their benchmark model (which has moderate rates of time discounting) with a liquidity constrained CEQ model and a buffer stock model (high discount rates and a low consumption floor). In general the predictions of the three sets of models are quite different; we shall discuss the comparisons of these predictions with the data in a later section. We note, however, that Hubbard et al (1994a) and (1995) do not present simulations for a model with perfect capital markets so that it is difficult to isolate exactly the differences made by allowing for a precautionary motive.

The second generalisation of the additive model that we consider is to allow for non-additive VN utility functions. Even leaving aside durables, the incorporation of some dependence of current tastes on past consumption has long been thought desirable. For example, some notion that consumption is 'habit forming' implicitly underlies Keynes' 'improvement' motive (see motive 4 in the list at the beginning of the paper). In such models, upward changes in consumption have a smaller utility effect than similar downward ones so that agents will not want to start off with high levels of consumption. Thus habits effectively act to lower the discount rate.

The analysis of temporal dependencies in preferences has a long history, see Browning (1991) for further discussion and references. Essentially two different models have been almost exclusively used in the consumption literature. The first of these is the 'habits-as-durables' model in which the effects of past consumption are captured in a (psychological) stock of habits which increases the current marginal utility of consumption. The other model is the 'short memory' model in which only last period consumption matters. These models are used since the effect of the past is captured by a single state variable (the stock of habits and last period consumption, respectively). We refer the reader to Deaton (1992) for further discussion of non-additive preferences; here we shall restrict ourselves to some informal remarks.

The introduction of habits and satiation into the model further weakens the possibility of deriving simple implications from the standard savings
model. To give one example, suppose that we observed that lottery winners went out and spent 'too much' in the first year after their win. 'Too much' here means too much to be rationalised by an additive model. One obvious explanation is that they have made major expenditures on housing, cars and durables. Less obvious is the effect of a windfall on non-durable but satiating goods (for example, exotic vacations). For such goods, it is entirely consistent with a standard savings model to observe 'lumpy' (or non-smooth) consumption. Thus for hypothetical lottery winners we might observe a large transitory increase in satiating goods over and above the permanent increase seen for non-satiating non-durables. The effects for habit forming goods are, of course, exactly the opposite. It will be clear that it is going to be difficult to rule out almost any behaviour if we allow non-additive preferences. We shall return to the issue of modeling many goods (some durable or satiating, some habit forming and some non-durable) in section 5 when we deal with modeling issues. For now we simply remark that it is our belief that ultimately an adequate understanding of consumption and saving will require a recognition that there are many goods and some of these are durable and that even the non-durables may be satiating or habit forming.

In this section we have reviewed some of the recent developments in the theory of intertemporal allocation. As we have seen, the past decade has seen an intensive investigation of several alternatives to the traditional CEQ model. One strand of this, which we call the standard additive model, retains the assumptions of the CEQ model concerning time-additive preferences and the existence of perfect capital markets but allows for precautionary saving. Perhaps surprisingly, this apparently modest increase in generality admits a much wider range of predictions, particularly when we have some latitude in the income process that we impute to agents. We have shown how different the predictions of the standard additive model can be from the CEQ model and we emphasise again that the latter may not be a good 'benchmark' for the non-CEQ model. This is not to say that the CEQ model is wrong, simply that it is far more restrictive than was previously thought. The other generalisations include allowing for liquidity constraints, habits/satisfaction or non-expected utility (essentially, non-additivities in budgets, non-additive preferences over certain outcomes and non-additive preferences over states respectively).
Which of these extensions (if any) is the most fruitful is an empirical matter. Before turning to the formal evidence regarding this we present some facts on saving.

3. FACTS ON HOUSEHOLD SAVING

3.1 Saving: data sets and measurement issues.

We begin with a summary of the data sets that allow us to examine the micro facts concerning household saving in the U.S. In Table 3.1 we list eight different sources that can be used to look at saving behaviour at the micro level; most of these can also be used to examine wealth. As can be seen from Table 3.1 there are a variety of sources covering different periods and different groups. For example, the HRS, the AHEAD, and the RHS data sets allow us to study the saving behavior of the elderly, while the other data sets consider the entire population. The SCF has the advantage of oversampling the rich households, who, as we will see below, do most of the saving.

To define saving we take the usual budget condition for financial assets:

\[ A_{t+1} = (1+r)A_t + Y_t - C_t \]  

(3.1)

where \( A \), \( r \), \( Y \) and \( C \) are financial assets, the real rate, earnings and consumption, respectively. We can define savings as the first difference of assets (\( A_{t+1} - A_t \)) or, equivalently, as (earned plus capital) income minus consumption (\( rA_t + Y_t - C_t \)). At the aggregate level, savings have been measured in these two ways: from the National Income and Product Accounts (NIPA) as the difference between personal outlays and disposable personal income and from the Flow of Funds (FOF) of the Federal Reserve System as the household sector's net acquisition of assets (including housing) minus its net accumulation of liabilities (see Wilson et al (1989) for an analysis of the discrepancies between the NIPA and FOF measures of saving). These simple schemes are not without difficulties.

One problem with the NIPA definition is that it includes the purchase of durables in consumption which implicitly assumes that such goods are consumed at once even though they are best thought of as additions to the stock of durables. An additional problem for the NIPA definition of saving is that contributions to government retirement plans or social security are not
included in personal income and are thus not included in saving. Even more bothersome is the fact that changes in inflation change the level of saving as measured by the NIPA definition. In an inflationary period, nominal interest rates incorporate the expectations of net capital losses on fixed dollar financial assets. One therefore has to account for the fact that higher interest rates are just the compensation for capital losses. Without adjustment, an increase in inflation causes the saving rate, as measured in the NIPA, to rise (see Hendershott and Pesek (1989)).

It will be clear, then, that even at the aggregate level there are difficult problems in defining 'household sector' saving. These problems do not dissolve when we move to the individual household level. At this level, we can obviously use either of the two definitions of saving: income minus consumption or first differences of wealth. But which measure of consumption, income and wealth should we take? We have already discussed some of the problems with the former two. As for wealth, there is no 'correct' definition of wealth but rather measures that are more or less useful for different purposes. The only circumstance under which one could define wealth in a universally applicable way would be if the CEQ assumptions outlined in the previous section held. In that case expected future receipts (irrespective of their riskiness and liquidity) have the same impact on current decisions as currently held liquid assets. In general, however, the riskiness and fungibility of different assets and liabilities has an effect and this leads to ambiguity about which measure of wealth is useful in any particular application. Thus it may be useful in some contexts to include a measure of, say, 'pension wealth' whilst in other circumstances we may even want to exclude the current stock of durables.

However we define savings at the household level we need to make adjustments to reconcile these values with aggregate numbers. Partly this is because micro data does not provide the same information as aggregate statistics. Also, the change in net worth of the household sector differs from the NIPA and FOF measure of savings because those two measures ignore the effects of changes in the prices of assets already in the portfolios of the household sector. A final problem with the micro data is the noisiness of the savings data at the household level (see, for example, Avery and Kennickell
(1991), Bosworth, Burtless and Sabelhaus (1991), Attanasio (1993) and Alessie, Lusardi and Aldershof (1994)). Differencing an already noisy series (wealth) can lead to very high (and spurious) variability in the saving level.

There is also a more prosaic reason why the aggregate and micro savings rates may not coincide: the aggregate savings rate is the ratio of two means which will not generally equal the mean of savings to income at the micro level. That is, the aggregate savings rate and the average savings rate can be different even if based on exactly the same definitions. To illustrate that this difference may not be insignificant, suppose that log income is normally distributed and that savings is a simple piecewise linear function of income. Specifically, let savings be zero for households with below median income and 30% of income above median income for the higher income half of the population. If log income has a mean of zero and a standard deviation of unity then simple simulations give that the aggregate savings rate is 16% whilst the average (micro) savings rate is only 7% (and the median savings rate is zero!). This should always be kept in mind when comparing aggregate savings rates with the average rates given below. Note as well that the relationship between the two depends on the relationship between saving and income about which we know little so that is not possible to define simple adjustments that will be widely applicable. Finally, it should be noted that it is entirely possible to have the aggregate and average rates moving in different directions over time.

3.2 Household saving: the facts.

We present here some facts about household saving in the U.S.. We examine the behavior of saving across age, family composition, income, education and wealth groups. Note that this are all simple bivariate analyses; conclusions that are drawn may not necessarily hold in a multivariate framework. Before turning to the distribution of savings across age groups we should first note that people have ages and not households. It is important to bear in mind that different members of the household may have very different savings propensities. In particular, if young people stay at home and accumulate savings this will be attributed to their parents in the following
calculations. As to the facts: both Avery and Kennickell (1991) (who derive saving from first differencing wealth) and Bosworth et al (1991) (who derive saving both from differencing wealth and from income minus consumption) show that saving is positive for every age group. As can be seen from Table 3.2 (which is taken from Bosworth et al (1991)) mean saving rates increase until the period around retirement and then decrease. The other obvious feature of this Table is that saving rates declined between 1973 and 1983 for all of the over-35 age groups. As can be seen from Table 3.3 mean saving levels are a good deal higher than median levels which simply reflects the fact that saving levels are right skewed. The other obvious feature of Tables 3.2 and 3.3 is that saving appears to increase until the mid or late 60's. Finally, note that the median level of saving is quite low; indeed, a great many households make no saving at all.

Another demographic factor which is important for saving behaviour is the structure and composition of the household. Looking at saving across household types, saving rates are higher for married couples with no children and lower for households with children, while lone parents have the lowest saving rate in the population (see Bosworth et al (1991) and Avery and Kennickell (1991)). Smith (1994), who defines saving by first differencing wealth in the PSID waves in 1984 and 1989, finds evidence of a relationship between saving and marriage. Households who were continuously married enjoyed a large increase in assets of 7.1 percent per year. In contrast asset growth for continuously divorced households was half as large and actually was negative among widowed and separated families. Income disparities among alternative household configurations do not seem to account for all of these differences.

The distribution of saving across income groups shows a very strong positive relationship between income and saving. In particular, a large proportion of total saving is due to families in the top part of the income distribution. According to Avery and Kennickell (1991), an overwhelming proportion of total saving is due to the top income decile of families. The same finding is reproduced in Bosworth et al (1991). They find that saving is usually negative for the first and second income quintile and highest in the top quintile. Once again, we emphasise that this a cross-section finding; we cannot infer from it that savings are increasing in income over time for the
same household. Fairly obviously, the positive relationship between income and saving could be the result of a household specific fixed effect.

Given the correlation between income and education, it will come as no surprise that the distribution of saving across education groups also shows a distinct pattern; (see Avery and Kennickell (1991), Bernheim and Scholz (1993) and Attanasio (1993)). Attanasio (1993) takes account of cohorts when examining saving across education groups and shows that the age profile of saving is hump-shaped for each education groups, but especially for highly educated households. Some studies have indicated that households without a college degree tend to save very little, possibly "too" little (see Bernheim and Scholz (1993)).

Saving is also very concentrated in the top part of the wealth distribution in the U.S.. Avery and Kennickell (1991) record that almost all of the net saving between 1983 and 1986 was made by the top decile of the 1986 wealth distribution. Although some of this is spurious (since saving is defined as the difference between wealth in 1986 and 1983) it clearly reflects the importance of the rich in the saving distribution. Note also that there have been sharp changes in the wealth distribution per se, and the 1980's witnessed an increase in inequality in the wealth distribution (see Wolff (1994)). Finally, we simply note that saving is typically higher for homeowners and amongst those who holds stocks and bonds. (see Bosworth et al (1991) and Avery and Kennickell (1991)).

The picture that emerges from these facts is that saving is concentrated amongst those with high income/wealth/education. These findings poses some problems for the theory. First, why do so many households save so little? Second, what motivates the saving behaviour of the wealthy? Third, why do elderly households continue to save?

4. THE DECLINE IN THE U.S. SAVING RATE

4.1 Evidence on the decline in the savings rate.

As already mentioned in the last section, saving rates seem to have
declined sharply in the U.S. in the recent past. This is important enough to merit detailed consideration. Rossworth et al (1991) use aggregate data to document that between 1976/80 and 1986/90 total private saving as a percentage of net national product fell from 9.2% to 6.3%. Part of this fall was due to a fall in retained earnings by corporations, which went from 2.8 percent to 1.6 percent. Personal saving (total private savings minus retained earnings) fell from 6.4% to 4.7%. This change of -1.7% also masks some important differences in composition: -1.3% was accounted for by changes in private pension reserves whilst state and local government pension saving actually increased by +0.5%. Non-pension savings by households ("other personal savings") fell from a rate of 3.2% to 2.2% which accounts for the other -1.0%. Thus the aggregate data suggests that the saving rate of households (net of pension and retained earnings) fell by about one third over this decade.

As discussed in section 3, the treatment of durables, housing, pensions, inflation and capital gains can distort the message of the aggregate statistics. It is thus legitimate to question whether accounting for these factors changes the pattern over time. Hendershott and Peek (1989) correct the official NIPA saving series by adding saving via net purchases of government pension assets (including social security) and consumer durables and by subtracting the part of after-tax interest income attributable to inflation. Their finding is that the resulting alternative measures of the personal and private saving rate in the 1983-85 period are 5 percent (not percentage points) below their averages since 1950 and not, as reported in the official statistics, at all-time lows and 20 percent below their post-1950 averages. They also found that both personal and private saving have rebounded somewhat in 1983-85, again in contrast to the official series. Other authors have argued that the major explanation for the apparent drop in personal saving can be found in the treatment of housing and, to a lesser degree, of durable goods in the national accounts (see Kopcke, Munnell and Cook (1991)). The accounts understate homeowners' investment in their residence and overstate the consumption of durable goods. Adjusting the national accounts for these two phenomena eliminates the collapse of saving rates in the 1980's.

As mentioned before, the calculation of saving using the NIPA or FOF does not take into account capital gains on the assets already in the portfolio of
the households (see also Bradford (1990)). Skinner and Feenberg (1990) calculate an alternative measure of the saving rate that includes capital gains in housing and stocks (these gains are also added to national income). They find that this measure implies saving rate of over 15 percentages points during 1983–88; that is saving rates approximately equal to those during the period 1974–79.

Given the many possible different definitions of saving that exist, it is possible that some measures did decline and others did not. This is how we interpret the findings on the aggregate statistics that we have presented. If concern focuses on the flow of funds for investment purposes, then there probably was a substantial decline over the late 1970’s and 1980’s. On the other hand, there is much less evidence that wider measures of savings did experience such a sharp fall (if any at all).

The results discussed above are based on aggregate data, in particular the National Income and Product Accounts and the Flow of Funds of the Federal Reserve. There is very little evidence on the path of savings over time from the micro data. The main study that documents the decline in saving using micro data is Bosworth et al (1991). As discussed in section 3, the comparison between micro and macro data is not straightforward; many adjustments need to be made to make the different data comparable. Bosworth et al (1991) consider four major adjustments: the accumulation of reserves within private pension and welfare funds; home ownership and rental costs; business income and third-party payments. They use data from two micro data sets: the CES and the SCF. On the CES, they define savings as income minus consumption and find that the national average savings rate fell from 15.1% in 1972/73 to 10.8% in 1982/85 (see Table 3.2). For the SCF they use panels in 1962/63 and 1983/85 and first difference wealth. The change here is from 14% in 1963 to 9.5% in 1985.

Perhaps the most convincing aspect of this evidence is that the investigators use two different surveys and two different measures and yet come up with similar results for both the levels and for the decline. We turn now to explanations of the change in the saving rate, keeping in mind the potential importance of these measurement issues.

4.2 Reasons for the decline in the savings rate.
When discussing changes in the savings rate, it would be desirable to use directly the formal models that we discussed in section 2 to organise our discussion. Unfortunately the CEQ model seems too narrow to be used in a discussion of this issue at hand here and more general models do not yield simple relationships that are easy to exploit. Thus we proceed by considering relatively informal analyses of the reasons for the decline in saving rates. We begin with a consideration of changes in the age and demographic structure of the population. We then consider the precautionary saving motive and changes in economic conditions such as income, wealth and the development of financial markets. Finally, we refer to other non-economic explanations for the decline in saving.

The age structure of the population is the critical variable to consider in a Modigliani style life cycle model. If there is an increase in the proportion of the population that is elderly then we should expect the saving rate to decline since the elderly are supposed to be net dissavers. There seems to be a general consensus that this is not causing the decline (see, among others, Summers and Carroll (1987), Auerbach and Kotlikoff (1990), Bernheim (1991), and the discussion of Poterba to the paper of Bosworth et al (1991)). Partly this is because savings rates do not seem to vary dramatically across age groups (see Table 3.2) and partly because the change in the age structure is too small to be able to explain the decline of saving in the 1980's.

An alternative to the 'age' explanation is a 'cohort' explanation: people coming to maturity in different times (the 1930's and the 1960's, say) may have different attitudes to risk, thrift and borrowing (as well as many other things). Boskin and Lau (1988) find a substantial difference in the propensity to save by households born before and after 1939. This effect is substantial enough, according to their estimate, that if the younger generation had the same saving propensities as the older cohort then the ratio of saving to GNP in the period 1963-80 would have been 10% higher.

The Boskin and Lau findings on cohort effects are in contrast with the conclusions of Bosworth, Burtless and Sabelhaus (1991). They interpret the finding that savings declined for almost every age group (again, see Table
3.2) to argue that there is no evidence that the decline is concentrated among households headed by members of the baby-boom generation. In fact, both the data sets they used indicate that the relative decline in saving has been smaller among younger households, while the decline is more pronounced for household aged 45 or older.

It may be that different investigators are drawing different conclusions from similar facts because they are using different (implicit) identifying assumptions. It is impossible to disentangle age, cohort and time effects without some identifying assumption. We can illustrate this by considering Table 3.2 in which the age bands are ten years wide and the two data sets are ten years apart (so that the cohort aged 25-34 in 1972/73 is aged 35-44 in 1982/85). This allows us to read off cohort savings rates and see how they change over time. Looking at these 'diagonals' for those aged under 54 in 1972/325 we see that cohort savings rates are fairly stable over time; the changes are only -1%, -1.6% and -0.9% for the cohorts born in 1918-27, 1928-37 and 1938-47 respectively.

To illustrate the importance of the identifying assumptions, suppose that we assume that there are no age effects. Then Table 3.2 suggests a modest period effect (an average decline of about 1.2% with small inter-cohort differences) and strong cohort effects (with a bigger drop between the 1918-27 cohort and the middle cohort than between the latter and the youngest cohort). Alternatively one can identify everything by assuming that there are no cohort effects. In this case, if there were no period effect (that is, no decline over time) then younger cohorts would behave just like older cohorts did the previous decade. That is, that the youngest cohort would have had a savings rate of 12.1% in 1982/85 rather than the observed rate of 8.6%. This implies large period effects (or declines) of -3.5% and -6.3% for the 1938-47 cohort and 1928-37 cohorts respectively. Thus different identifying assumptions give wildly different inferences from the same reduced form (in the case six statistics in Table 3.2). Indeed, even the 'fact' of the decline depends on the identifying assumption; in one case it is -1.2% and in the other, over -3.5%.

Not many studies have taken into account the effects of cohort when studying saving (but see the papers in the book edited by Poterba (1994) for a
cohort analysis of saving in the G7 countries). Attanasio (1993) and (1994b) does allow for cohort effects in an analysis that uses data from the CES. He finds a typical hump shaped age-saving profile, albeit with positive (median) savings for the elderly. According to Attanasio, during the 1980's the saving profile of people born between 1925 and 1939 shifted down (even though the decline in saving could also be potentially explained by a general shift in the age-saving profile for all cohorts). Attanasio also examines the sensitivity of his estimates to the choice of 'consumption' and finds that part of the overall decline in saving (but not all) can be accounted for if durable expenditures are considered as saving rather than consumption (consistent with the criticism of the aggregate saving measure by Hendershott and Peek (1989) that we discussed above).

If the age structure of the U.S. population has not changed much over the past twenty years, the same cannot be said of other demographic factors, such as family composition. The 1980's witnessed an increase in one parent households headed by women, a decrease in average family size and in the number of children, and an increase in divorce and family dissolution. This volatility in composition is visible in the micro data sets used to study consumption and saving. For example, Avery and Kennickell (1991) document that 26.6 percent of their sample experienced a change in status in a three year interval. Similarly, Cochrane (1991) constructs a sample from the PSID from 1980 to 1984 that excludes households that experience some compositional change. His final sample is composed of only a little more than one third of the original observations. Many studies exclude 'non-standard' types of households but the saving behavior of these families can be of importance. Avery and Kennickell (1991) show that a large share of those who dissave (31.4%) is accounted for by households who experience a change in family status. Smith (1994) also finds evidence that family dissolution has a strong influence on saving and wealth accumulation. As discussed in section 3, lone parent households have the lowest saving rate in the population and there has been a shift towards this type of family structure since the 1960s. Thus changes in the family composition of the population might be a candidate for an explanation for the decline in saving rates. On the other hand, some authors argue that the income of these types of families is simply too low to
have a noticeable effect on the overall saving rate (see Bosworth et al (1991)).

Since a simple lifecycle model may not be able to account for the recent decline in saving, we next examine whether a precautionary savings model is better suited to explain the empirical findings. As we will see later, it is not easy to test for the presence of a precautionary saving motive. Furthermore, it is sometimes difficult to draw a clear-cut distinction between precautionary saving and other motives. Thus, we provide hereafter only some informal discussion on the potential relevance of the precautionary saving motive.

Some authors argue that programs such as Medicare and Medicaid have decreased the need to provide for emergencies. The extent to which the population is insured against the need for large medical expenditure has increased dramatically since 1950 (see Summers and Carroll (1987)). It is also possible that improved disability and life insurance coverage has reduced the extent of precautionary saving. The importance of these factors is also shown in simulations of models which include a precautionary saving motive (see Hubbard, Skinner and Zeldes (1995)). Skinner (1990) provides some evidence in favour of a decline in precautionary saving during the 1980's. Another aspect of the precautionary motive is the well-documented increase in female labor participation. The potential income insurance provided inside the household when there is more than one earner could lead to a reduction in precautionary saving. Summers and Carroll (1987) have considered this fact but do not find evidence that two-earner families have contributed to the decline in saving.

Another important variable to consider is income. We have seen before that it is high-income households who are doing most of the saving. The shift in the income distribution toward increasing inequality might be expected to have increased the savings rate so that the decline net of this would have been greater. Bosworth, Burtless and Sabelhaus (1991) examine the decline in saving across income classes and show that there is a uniform decline in saving across income quintiles. In fact, one of their main findings is that the saving rates of most population subgroups change in parallel over time. This suggests that the decline in saving must involve one or more factors that affect the great majority of households uniformly. They mention that one
possible explanation for lower saving may involve slower income growth. Traditional life cycle models cannot explain this positive correlation between saving rates and income growth (see Carroll and Well (1994)). Carroll, Overland and Well (1994) propose a model that includes habit formation to provide an explanation for the relation between saving and income growth and to potentially explain the decline in saving. This issue deserves more attention and more empirical work to be fully understood.

There are other relevant explanations related to income or changes in income. In particular, the income of the elderly has increased substantially relative to that of the rest of the population. The primary cause of this improvement has been the dramatic increase in social security benefits. The ratio of these benefits per aged adult to per capita disposable income has grown nearly 50 percent in the past twenty years (see Summers and Carroll (1987)). This fact is reconfirmed in other studies; for example, Hurd (1990) reports that the average real income of the elderly as conventionally measured in the Current Population Survey (before-tax money income) increased by about 28 percent between 1970 and 1987. The mean income of the entire population increased by only 10 percent in the same period. Insofar as this represents a transfer to a group with a low propensity to save it may be a partial explanation of any saving rate decline.

Apart from income, wealth is another important economic variable to consider when examining the decline in saving. For example, one can ask whether the big capital gains on housing and stock prices have led to a decrease in saving. There are a few studies on this issue. Bosworth, Burtless and Sabelhaus (1991) documented, for example, that the decline in saving was higher for home-owners than for renters. Skinner (1989) investigated whether appreciation in housing value had any effect on aggregate saving. Using data from the PSID he finds mixed evidence: house prices are estimated to have a small but significant impact on consumption. When corrected for household heterogeneity, however, the link between housing prices and consumption disappears. In a more recent study, Skinner (1993) uses the 1984-89 wealth data from the PSID to study the effects of changes in housing wealth on non-housing saving. He estimated that for the median household aged 45 and older, one dollar of real housing capital gains decreases non-housing saving by 2.8
cents.

These findings are not re-confirmed in the study by Hoynes and McFadden (1994), who look at the same question as Skinner (1993) but come to different conclusions. Unfortunately, their sample selection and the variables under consideration are different so that it is difficult to identify the source of the different conclusions. They find a statistically significant but very small increase rather than a decrease in the savings rate consequent on an increase in real house prices. However, in other specifications they find much larger (positive) effects. In another related work, Engelhardt (1994a) finds results which are more in line with the Skinner (1993) estimates. However, he splits the gains in housing price into positive and negative capital gains and shows that it is only the negative gains that are related to saving. Therefore only people who experienced negative capital gains saved more, while the households who experienced positive capital gains did not change their saving. This work does not support the hypothesis that the decline in saving can be explained by the gains in the housing market.

As far as bonds and stocks are concerned, both Bosworth, Burtless and Sabelhaus (1991), and Avery and Kennickell (1991) show that savings are higher among bonds and equity holders. This group represents approximately 29 percent of the population. Although the stock exchange market collapsed in 1987, the S&P Stock Index between 1983 and 1989 increased at a rate of 11.7% per year. There are only two studies which examine the effects of capital gains on stocks for saving. Bosworth et al (1991) found that the decline in the saving rate is actually smaller among bonds and stock-holders than it is among households with no marketable financial assets. Similarly, Attanasio (1993) does not find any evidence that these capital gains have decreased saving.

Another potentially important change in the composition of wealth has been the remarkable increase in the annuitization of household wealth in the 1980s. To present just a few figures, Social Security benefits represent almost 10 percent of US personal income compared to only 4 percent in the 1960's. In 1962, 9 percent of elderly Americans received income from private pensions; by 1988 this figure had risen to 29 percent. Also, while pension plans in the past represented only 5.2 percent of US household net wealth, by 1990 they represented 16.5 percent (see Auerbach, Kotlikoff and Weil (1993)).
A larger share of annuitized resources may imply both a decreasing bequest motive (strictly, a reduced risk of accidental bequest) and a reduced precautionary motive (to allow for mortality risk) and hence higher consumption. According to Auerbach, Kotlikoff and Weil (1992), while increased annuitization cannot explain all of the recent decline in the U.S. saving rate, it may represent an important piece of the puzzle. This explanation is again consistent with the evidence that saving has declined more for the older households.

There are also other 'composition of wealth' effects. A number of authors have suggested that the cash payouts to share owners associated with corporate restructuring could be a factor explaining the decline in private saving (see, among others, Summers and Carroll (1987), Hatsopoulos, Krugman and Poterba (1989) and Bernheim (1991)). Summers and Carroll (1987) mention, for example, that in 1985 corporate share repurchases totaled $27.3 billion and cash payments to shareholders in companies that were taken over totaled $94.8 billion. Share repurchases and takeovers resulted in a flow of income equal to 4 percent of disposable income from the corporate to the household sector. If households consumed 50 percent of these payouts, the personal and private saving rates would have fallen between 1 and 2 percent. The problem with this explanation is that the pattern of declining saving is common to other countries, which did not experience the same firm restructuring and it is common to the young and people in the lower part of the income distribution who are unlikely to be receiving takeovers premiums or interest on junk bonds (see also the discussion of Summers to Bosworth et al (1991)).

Another potentially important change in the 1980's was the development of financial markets and the potential lessening of financial constraints such as liquidity and down payment constraints. The sharp increase in consumer credit relative to income in the 1980's suggests that households may need to do less saving before major purchases. Summers and Carroll (1987) show that the average down payment for first time homeowners has decreased substantially. Also households have taken up increasing amounts of debt, as is documented in Kennickell and Shack-Marquez (1992) and Canner and Luckett (1991). Some indirect evidence in support of this argument can be obtained by examining the evidence on mortgages. Manchester and Poterba (1989) present cross-sectional
evidence suggesting that households with second mortgages are less wealthy than other households: each dollar of second mortgage borrowing is associated with a 75 cent reduction in household net worth. Their results as consistent with the view that increased access to second mortgages has reduced personal saving.

In a pair of papers, Jappelli and Pagano (1989, 1994) have shown that consumption is affected by capital market imperfections. For example, they document that the excess sensitivity of consumption to current income across countries can be attributed to the characteristics of capital markets, in particular to the wedge between the borrowing and lending rates, down-payment ratios, the size of the consumer credit market and other indicators of liquidity constraints and an inability to borrow. If households cannot borrow the desired amount, then aggregate net saving will be higher than in the presence of perfect capital markets. Another useful application of these ideas can be found in Guiso, Jappelli and Terlizzese (1992b) and (1994b).

This seems a powerful explanation of the decline in saving and one which has some testable predictions. If liquidity or down payments constraints are important, then only certain age groups of the populations should be affected. Everything else being equal, the removal of constraints should decrease the saving rate of the young, while the savings of people close to retirement should not be affected by the removal of these types of markets imperfections.

Can these factors provide an adequate account of the savings behavior of households? As we have seen before, there are alternative explanations for this phenomenon and these explanations typically have shortcomings. According to some authors, economic models are not able to provide a convincing explanation for the observed phenomenon and it is useful to resort to other explanations (see Bernheim (1991) and Thaler (1994)). We shall discuss this at length in section 7, but for now we present some of the ideas that are relevant in the present context. For Bernheim (1991, 1994b), proponents of the psychological paradigm can better identify several factors that contributed to the decline in saving. One factor that economic psychology emphasizes is the impact of personal experience on expectations. For example, generations born after the Great Depression seem to be less worried about financial security and therefore less inclined to save. As economic hardship promotes
conservatism, prosperity fosters extravagance. It is noteworthy that the unprecedented decline in saving has coincided with the longest peacetime expansion on record. Bernheim (1991) suggests that these years of prosperity may have created a (false) sense of security. This explanation rests on the implicit assumption that it is changes in cohort behaviour that have lead to the decline. As seen above it is by no means certain that this is the case.

Proponents of the psychological paradigm also point to changes in the composition of income and wealth as explanations for the low rate of saving. But their rational is in sharp contrast with the "economic" explanations previously mentioned. According to the psychological paradigm, some types of income are more 'spendable' than others (see also Shefrin and Thaler (1988)). Individuals may have difficulty resisting the temptation to spend unless they have to take explicit steps in order to access income. As a result, they may save a very small fraction of items like interest income but a very large fraction of undistributed corporate profits. In the 1980s personal interest income rose dramatically as a percentage of private disposable income, while there was a twenty year decline in undistributed corporate profits, followed by a slight upturn in the late 1980's (see Bernheim (1991)). Furthermore, investors swapped huge amounts of corporate equity for debt. As mentioned before, in the 1980's there was a wave of leverage buyout activity and a growing tendency for companies to repurchase stocks. When a stockholder tenders their share in a buyout or a repurchase agreement, they convert wealth to cash, at least temporarily. From a psychological perspective, the conversion shifts resources between mental accounts. In particular, it transforms wealth into cash and investors may well be tempted to consume at least a portion of the proceeds.

As we have seen there are many proposed explanations for the decline in savings (if there actually was a decline!). Such changes in behaviour over time constitute an important challenge for any model of savings. A 'satisfactory' model of saving will need to explain not only the behavior across the population but also such the changes over time. It is our belief that we are still some way from having such a model. To develop such a model we need to identify more precisely exactly what are the determinants of saving and consumption at a household level. This requires the specification and
testing of specific models. It is to this that we now turn.

5. EMPIRICAL RESULTS ON SHORT RUN INTERTEMPORAL ALLOCATION.

5.1 Econometric issues.

As discussed in section 2, most empirical work on intertemporal allocation using micro data has concentrated on the Euler equation for allocation between different periods. Thus we devote a good deal of space to this empirical work. In this sub-section we discuss the econometric issues that arise in estimating Euler equations and in the following sub-section we present some of the results. Attention in the latter sub-section is focused on tests of the standard additive model. In sub-section 5.3 we present a discussion of the empirical evidence that focuses specifically on the precautionary motive. Although important, the implications for the Euler equation do not exhaust the predictions of the standard saving model; in section 5.4 we consider tests of some other implications of the model.

There are a number of issues for modeling Euler equations. The issues we discuss here are: whether to model consumption or saving; the choice of functional form; the use of approximations to the Euler equation; dealing with the unobservability of consumption shock variances; the choice of goods to model; how to handle differences between the information sets of agents and econometricians; the stochastic specification and measurement error and the length of the sample period.

The first issue is whether to model consumption or saving. Most studies on the micro data choose to model consumption. This is because either a saving measure is not available or it is deemed too noisy. As discussed in the last section, very few panel data sets have wealth measures or good information on consumption and income. Moreover, even if wealth data is available, we need to first difference to derive saving so it is likely to be noisier than consumption. For evidence on this issue, see Attanasio (1993), Flavin (1991) and Alessie and Lusardi (1993) who all have recourse to robust estimation.

The next issue involves functional form. This has generally been treated in an ad hoc way. The usual choice is the iso-elastic (CRRA) form. It is not completely clear why this is, since the CRRA form has some shortcomings. The
principal of these are that the ise is constrained, a priori, to be
independent of wealth (that is, it the same for rich and poor) and there is
only one parameter to control for intertemporal allocation and prudence.\(^{16}\)
Amongst the criteria that should guide the choice of functional form are:
congruence with theory (we should be able to impose theoretical restrictions
in a simple way); flexibility (for example, important elasticities should not
be constrained to be constant) and econometric tractability (for example,
linearity in parameters is desirable). The usual approach to choosing a
functional form is to choose a (one good) utility function and then to
differentiate it to give the marginal utility of money. In Attanasio and
Browning (1994) an alternative approach is adopted: a tractable and flexible
Euler equation is chosen directly. If desired, this can be integrated back to
the utility function. This procedure allows these authors to find a simple
functional form that nests the CRRA form and avoids the two problems mentioned
above. Attanasio and Browning find that the CRRA is decisively rejected
against the more general alternative.

The next issue involves the choice of whether to estimate exact or
approximate Euler equations. The theory states that the mue is a martingale:
thus an exact approach would derive the mue and then first difference. If we
choose the CRRA form, from (2.1) and (2.2) we have (ignoring demographics for
the moment):
\[
\beta(1+r_t)(C_{t+1})^{-\gamma} - (C_t)^{-\gamma} = e_t^{t+1} \quad \text{where } E_t(e_t^{t+1}) = 0
\]
(5.1)
There are two major problems with estimating this. First, it is non-linear in
parameters. This is not too much of a problem; much more serious is that C is
likely to be measured with error and we have no satisfactory way of dealing
with measurement error in non-linear equations. These considerations have lead
investigators to use the approximation given in (2.4):
\[
\Delta \ln C_{t+1} = \tilde{\beta} + \phi r_t + 0.5 \phi \sigma_t^{2} + u_t^{t+1} \quad \text{where } E_t(u_t^{t+1}) = 0
\]
(5.2)
This is linear in parameters and, as we shall see below, measurement error in
consumption can be readily dealt with. The problem with this approximation is
that it has introduced a new (unobservable) variable, \(\sigma^2\), into the analysis.

Since, as we shall see in the next sub-section, the inclusion of the
variance term in (5.2) seems to give considerable problems it is tempting to
use the exact form and avoid these problems. If we can overcome the non-linear measurement error problem, the exact approach with a CRRA form gives the same information about behaviour as approximations even if the latter includes some valid proxy for the consumption shock variance. This is because the parameter \( \gamma \) governs both intertemporal substitution and prudence; from an estimate of \( \gamma \) we can predict the reaction to an increase in \( \sigma^2 \). Of course, the addition of a valid proxy for this variance may give more precise estimates if the restriction on the coefficients in (5.2) is not rejected but formally estimates from the exact form give all the information concerning saving behaviour. Our own feeling is that this comes dangerously close to identifying precautionary saving off of functional form (specifically the imposition of the CRRA form) and is not robust. This is compounded by the fact that the \( \gamma \) parameter is not usually precisely estimated.

The next issue we discuss is the choice of good to model. This is often forced on us by data. For example, the PSID has two food expenditures ('food at home' and 'food outside the home') (but see Skinner (1987) for a more ambitious attempt to use other information in the PSID). The U.S. CES and the U.K. FES have much wider and more reliable measures of consumption but very little panel aspect (in fact, none for the FES). A minimum preferred set of measures would be for the purchases of non-durables and stocks of durables. Whilst the latter may be possible for cars, it is not for other durables\(^7\). In fact, though, investigators usually take what is given and assume additivity of any goods to hand from all other goods.

Most widely used additive separability assumptions are dubious at best. It is difficult to believe that preferences over non-durables are separable from the stock of durables. For example, the latter depends on car ownership and gas and bus expenditures are included in non-durables. It seems a \textit{priori} incredible that preferences as between gas and bus expenditures should be independent of car ownership. Similar remarks apply to housing and, say, heating expenditures. What is odd in all this is that we may not need to assume any separability at all for many of the purposes at hand. To see this, note that under intertemporal additivity the Frisch (or \( \lambda \)-constant or mue-compensated) demand for any good \( i \) in period \( t \), \( q_{it}^i \), depends only on discounted
prices \( p^t \) and the mne at time \( t, \lambda_t \):

\[
q^t_i = f^i(p^t, \lambda_t)
\]  

(5.3)

To estimate the parameters of \( f^i(\cdot) \) with an Euler equation we need only observe purchases of the good \( i \) over time and the (common) prices discounted by interest rates that may vary across agents. If there is limited relative price variability in the data then we may replace the vector \( p^t \) with some discounted price index\(^{18} \). None of this requires us to observe all consumption goods. In particular, if we only wish to test the standard model then we only need that good \( i \) is strictly increasing (or decreasing) in life-time wealth so that \( f^i(\cdot) \) is strictly monotone in \( \lambda \). This will certainly be the case for goods such as 'food at home'.

The redundancy of separability assumptions will strike some readers as rather odd since we usually regard food at home, say, as an imperfect proxy for total consumption. What, then, is lost if we do not observe the purchases of all goods? If we multiply both sides of (5.3) by \( p^t_i \) and add over \( i \) we have a Frisch consumption equation (see Browning (1989a)):

\[
x_t = \Phi(p^t, \lambda_t)
\]  

(5.4)

This gives (discounted) total expenditure as a function of discounted prices and the mne. If we do not observe all goods then we cannot estimate the parameters of the \( \Phi(\cdot) \) function in (5.4). Thus we cannot, for example, estimate the ise without observing all goods. This does not, however, prevent us from estimating the parameters of a particular \( f^i(\cdot) \) function in (5.3) and using these estimates to test for the validity of the orthogonality assumptions that derive from the standard additive model.

Although this justification for ignoring other goods may be valid for non-durables and some durables, it will not hold for other important 'goods' such as housing or labour supply. For these there is no price that we can plausibly include on the right hand side of (5.3) that will pick up the effects of these goods\(^{19} \). As far as we are aware there is no systematic discussion anywhere of the likely biases that ignoring non-separabilities may induce in estimates of (5.3).

Since the PSID has only food expenditures it is worth spending some time
examining this specific case. The food Engel curve is perhaps the most widely studied equation in empirical economics. It is somewhat surprising that almost no use has been made of all that we know about this equation in the consumption literature (but see Hall and Mishkin (1982) and Ogaki (1992)). For example, the PSID has information on 'food at home' and 'food outside the home'. Although these are usually lumped together\textsuperscript{20} and treated as 'food consumption' there may be room for latent variable methods that exploit the fact that one of these goods is a luxury and the other is not.

Another major problem with the food measure in the PSID is how noisy it is and the ambiguity that attaches to the period the measure refers to. Runkle (1991) estimates that 76\% of the between year variation in food expenditures is noise\textsuperscript{21}. The other problem is that it is ambiguous as to what period the food measures in the PSID cover. This presents problems for the timing of the arrival of new information. The question is formulated as follows: "How much do you spend on food in an average week?". Responses are collected in the Spring and they may pertain to the first quarter of the interview year or to the past year. This is not a trivial issue given the importance of timing the instruments correctly and of knowing precisely the information set.

A far better measure of consumption would be expenditure on non-durables in a given period. Unfortunately there is very little panel data that has such information. For developed countries the only panel data we are aware of is for Japan and the U.S. (both four quarters; see Hayashi (1985) for results on the Japanese data set) and Norway and Spain (both 8 quarters, see Mork and Kerry-Smith (1989) and Browning and Collado (1994) respectively). Although these panels are likely to be very informative, their limited duration somewhat reduces their usefulness. This is particularly the case for the four quarter surveys since the longer surveys suggest that there are important seasonal effects in consumption and income processes.

One way to circumvent the lack of long panels with reliable and full consumption information is to use long time series of expenditure surveys to construct quasi-panel (or 'cohort mean' or 'synthetic panel') data (see Browning, Deaton and Irish (1985)). This method follows the same cohort over time by taking means of variables for, say, thirty year olds in one year and thirty one year olds in the next year and then treating these means as panel
data observations on the same 'individual'. These quasi-panels have some advantages over true panels. For example, we can construct very long panels (over 20 years for the U.K.) with no attrition. There is also less measurement error than in the PSID and averaging takes some of that away. On the other hand, small cell sizes re-introduce measurement error in the form of sampling error (consumption and income are correlated in cross-section even if the CEQ model holds). It is also the case that some dynamic processes cannot be modeled with quasi-panels (see Moffitt (1993)).

If we do have data on many goods (as in quasi-panels, for example) and wish to model consumption rather than individual (Frisch) demands then we need to be clear how consumption is defined. This is relatively straightforward: some measure of total expenditure on many goods, denoted $x$, is taken and then it is divided by some price index, denoted $P(p)$ where $p$ is the price vector for the many goods available in the period. The result is 'consumption'. The conditions under which this procedure is valid (which are much weaker than within period homotheticity) are given in Gorman (1959); see Blundell et al (1994) for an empirical demonstration that the choice of price index does not much matter.

The next issue we consider is that the information set of econometrician and agent obviously differ. If we follow the usual practice and assume that agents know everything available to the econometrician then any lagged variable observed by the econometrician is a valid instrument. The problem that arises is that whilst the agent may know everything the econometrician does (at least, about the agent's variables) the econometrician may not know very much that is of relevance for the agent. This will lead to a lack of power in tests of the over-identifying restrictions that are the main vehicle for testing the predictions of the model. The other problem that may arise is that the investigator may use information that was not a part of the agent's information set (see Pfischke (1995)). In this case the instruments may not be orthogonal to consumption changes.

We turn now to the stochastic specification. A major part of this is the accounting for heterogeneity. To see how we handle this, consider again equation (2.4). Apart from the need to allow for changes in demographics we can also allow that the discount factor and the $l_se$ vary across agents.

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Finally, we might want to include a person specific fixed effect in the discount factor. This has the virtue of absorbing any fixed part of the (unobservable) consumption variance term. The drawback of including fixed effects is that we lose efficiency if the fixed effects are not required and we have to be much more careful about exogeneity. In particular, we cannot use a 'within' estimator since the instruments are not strongly exogenous (see Keane and Runkle (1992)). Finally, we can allow for white noise taste shocks whilst recognising that this induces an MA(1) structure into the error term which invalidates the use of once lagged instruments.

As already discussed, most of the variables used in an Euler equation are likely to be subject to considerable measurement error. Multiplicative measurement error in the consumption measure used in (5.2) invalidates once lagged consumption growth as an instrument (but not necessarily other once lagged variables which are orthogonal to measurement error on consumption). The problem with dropping this instrument is the usual one: we lose discrimination. On the other hand, the results of Altonji and Siow (1987), Nelson (1994) and Lusardi (1994) suggest strongly that not taking serious account of measurement error can lead to bias. Generally, since the use of twice lagged instruments allows us to take care of measurement error, white noise taste shocks and time aggregation all at once, dropping once lagged instruments seems like a very sensible precaution if identification can be achieved without them.

One other aspect of the stochastic specification also deserves mention. In the standard model one of the primary variables that drives consumption decisions is the (anticipated) real interest rate. Consequently, it is desirable to include the real rate in the Euler equation since this allows us to estimate the ise which is one of the very few parameters that the whole estimation exercise is supposed to be getting at. We can do this in short panels if can impute different marginal tax rates to agents and use the net-of-tax real rate. This runs the risk that the variation (most of which is now coming from marginal tax rates) is correlated with other things and the real rate variable is simply proxying for heterogeneity in tastes. The other alternative is to use a longer sample period and to exploit the variation in the real rate over time. This is likely to be more efficacious if we have data
from before and after 1980 since the real rate changed a lot over that period. If the real rate is omitted, then this provides yet another argument for including a fixed effect in the Euler equation since individual net-of-tax real rates are likely to be quite persistent across time.

Finally we come to the issue of the sample period. As discussed in Chamberlain (1984) the orthogonality conditions apply across time for each individual and not across agents. Thus the usual asymptotic results only hold as the number of time periods in the panel become large. Many studies account for the effect of common macro shocks by inserting time dummies in the Euler equations. Altug and Miller (1990) have provided a more rigorous interpretation for the time dummies by appealing to the restrictions implied by the complete market assumption.

5.2 Euler equation estimates and tests.

There have been a great number of Euler equation consumption studies over the past few years; in Table 5.1 we list 25 such studies that have used micro data from various developed countries. There is a great variety in the specifications used in these papers. As evidence of this, in columns 2 to 6 we present the data set; the sample period; the utility function used; a list of controls for taste shifters and the consumption measure used. There are also other important differences in specification (for example, the inclusion of a fixed effect) which it is difficult to tabulate but which must be kept in mind.

Although most investigators have some discussion of their substantive findings it is the case that almost everyone concentrates on the implications of their results for the validity of the standard additive model. The generic test of this is the test of the over-identifying restrictions from the orthogonality condition. One problem with this test is that it may have low power against specific alternatives such as some group being liquidity constrained. This is particularly likely if some of the instruments are not highly correlated with the variables included in the Euler equation since such variables increase the degrees of freedom of the test of the over-identifying restrictions but do not increase much the test statistic itself. Thus many
investigators seek to enhance the power of their tests by concentrating on particular departures from the standard additive model which leads to tests using specific linear combinations of instruments.

As discussed in the section 2 and in the previous sub-section there are a number of specific alternatives that might lead to a failure of the orthogonality conditions. These include: non-additivities in preferences (habits or durability); the presence of liquidity constraints; non-separability of the good modeled from labour supply or housing; using the approximate Euler equation without taking account of the error variance term (see equation (5.2) above); the existence of some group who simply spend a fixed proportion of current income ('rule of thumb' behaviour); the use of the wrong functional form; the use of instruments that were not in the agents' information set; the exclusion of predictable variables that do affect consumption (for example, changes in demographics or the real rate) and the presence of serially correlated taste changes.

Particular departures from the standard additive model are going to imply particular failures of the orthogonality conditions. For example, is it lagged income, lagged consumption or positive expected income changes that are correlated with current consumption changes? Is the correlation positive or negative? Is it only there for particular groups? This will increase the power of our tests against the particular departure posited. There is, however, a further element to this. If we do indeed find some specific failure of the orthogonality conditions we need to identify the full set of departures that are consistent with that particular failure. Is it only the one that lead to the test in the first place or are there other explanations?

One specific violation of the orthogonality conditions that has received wide attention is the possible (partial) correlation between realised consumption changes and either lagged earnings or predicted changes in earnings. In column 7 of Table 5.1 we present the results of one or other of these two (excess sensitivity\(^{22}\)) tests. Finally, in column 8 we present some of the other implications of the results reported.

To develop a specific alternative, we start with what is far and away the most widely questioned assumption used in the standard additive model: the absence of liquidity constraints. As discussed in section 2.3 above, one way
to consider this problem is that for some households we have the 'wrong' interest rate. If the net-of-tax real lending rate is used in the empirical implementation then tests for liquidity constraints effectively come down to trying to pick up the presence of $\psi$ in (2.8). Thus we could approach this question by considering what is correlated with this latent variable. In practice, though, two other approaches have been used to derive observable implications of the presence of liquidity constraints.

The first derivation can be used if we have information on asset levels. To illustrate this we consider the influential study of Zeldes (1989a) which provides what is probably the most widely cited Euler equation evidence against the model that assumes perfect capital markets. Zeldes actually provides three tests of which the first is considered the most telling. In this test he splits his sample into those with high and low assets at the beginning of the period and then includes lagged income levels in each of the Euler equations for each group. He finds that the lagged income term is only significant for the low asset group. This exemplifies the two features of estimation we mentioned above. The splitting into groups on the basis of beginning of period assets raises the power of the test; if we pooled both groups then the coefficient on lagged income would be 'less significant'. The test also facilitates identification: Zeldes (1989a) remarks that "it seems unlikely that [a failure of assumptions not connected with liquidity constraints] would lead to a rejection for low-asset consumers but not for high-asset consumers".

Whilst beginning-of-period asset levels and income are correlated with being liquidity constrained, it should be emphasised that there may be other predictors that also have supplementary explanatory power. Jappelli (1990) looks at the evidence for liquidity constraints by exploiting the data from the Survey of Consumer Finances on credit refusal or being a discouraged borrower. He finds that not only financial assets or wealth, but also age, race, family size, marital status and income are important determinants of being refused credit or being a discouraged borrower. He also shows that splitting the sample according to some measures of beginning of period assets is unlikely to isolate the group of households more likely to be liquidity constrained. Jappelli finds that within the group with low liquid assets to
disposable income as many as 68 percent of households are not constrained. Other studies (for example, that of Caskey and Peterson (1994)) also indicate that demographic levels may be important determinants of being constrained. Note that we can include demographic levels to stratify our sample since only changes in demographics should enter the Euler equation directly.

If asset levels are not observed then we may have recourse to the test which includes instrumented earnings growth in the Euler equation. Since this is a function of lagged variables (and any current variables that are perfectly anticipated) it should be uncorrelated with consumption growth. As can be seen from the number of unstarred coefficients in column 7 of Table 5.1 this test has been used very widely.

A study of Table 5.1 suggests that there is no consensus at all on whether the standard additive model is valid. Just about the same number of studies find evidence of excess sensitivity as do not. Indeed, even amongst studies that use the very restrictive CEQ assumption there is no clear pattern. It is frustrating in the extreme that we have very little idea of what gives rise to the different findings. Mariger and Shaw (1993) give some indications for papers estimating CEQ models on the PSID but we still await a study which traces all of the sources of differences in conclusions to sample period; sample selection; functional form; variable definition; demographic controls; econometric technique; stochastic specification; instrument definition etc.

There is less controversy on the validity of the standard additive model in studies that use quasi-panel data. These mostly find that there is no strong evidence against the perfect capital markets assumption. Attanasio and Browning (1994) present evidence that this is more because we can treat demographics and labour supply satisfactorily than because of differences in the data set. Using Euler equations that do not control adequately for demographics they find evidence of excess sensitivity. However, including controls for demographics and age or labour supply this evidence disappears. Since income, labour supply and demographics are all correlated over the life-cycle it is no surprise that allowing for the latter two reduces the importance of the former. Thus the results of Attanasio and Browning (1994) are better thought of as showing how difficult it is to find convincing tests
for excess sensitivity rather than as evidence for or against any particular variant of the standard model.

One important feature of column 7 of Table 5.1 is that almost all studies find that the expected income growth (or lagged income) variable has the sign predicted by 'rule of thumb' or liquidity constraint derivations (that is, expected income growth has a positive coefficient and lagged income a negative one). Even though many of these studies use the same data set, this seems somewhat unlikely if the standard additive model is valid for all agents. This suggests that the insignificant findings are the result of low power rather than a non-rejection of the orthogonality conditions. There is also other evidence that many tests of excess sensitivity may have low power. Very few studies present measures of fit for the auxiliary equation used to predict income growth but those that do (Altonji and Siow (1987), Lusardi (1994) and Attanasio and Weber (1994)) report very low $R^2$'s. In the three cases where authors take especial care to increase the predictive power of the income growth equation (Lusardi (1994), Shea (1995) and Garcia et al (1994)) the investigators do find evidence of excess sensitivity.

One other tentative conclusion for modeling that emerges from all the studies cited in Table 5.1 is the importance of allowing for measurement error. The papers that account for measurement error (for example, Altonji and Siow (1987) and Runkle (1991)) tend not to find evidence of excess sensitivity. However, this may simply be because allowing for measurement error reduces the power of the test for excess sensitivity.

Given Table 5.1, it is not difficult to find evidence to cite for or against the standard additive model (or even the additive CEQ model). Since, however, none of the studies cited takes into account all of the issues raised in section 5.1 above, any specific piece of evidence is open to question.

Even though there is considerable controversy as to whether there is excess sensitivity, let us suppose that we did have convincing evidence for it. What could we infer from it? Many investigators take a finding of excess sensitivity to indicate either that some agents use a 'rule of thumb' for consumption or that some agents are liquidity constrained. Since both hypotheses imply excess sensitivity it is not clear how finding the latter would, on its own, allow us to identify which is the cause. We have already

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discussed one way to identify the source: split the sample according to low beginning of period assets (see the discussion on Zeldes (1989a) above). If the latter is assumed uncorrelated with being a 'rule-of-thumb' consumer then this does identify what is causing the excess sensitivity. Note, however, that if 'rule-of-thumb' households typically set consumption equal to income then they will have low assets and the inference is confounded.

If asset levels are not available, a source of identification is to note that there is an asymmetry in the response of consumption growth to expected income growth if there are liquidity constraints but not if consumers use 'rules of thumb'. If income growth is expected to be negative then liquidity constrained agents can smooth by saving. It is only when income growth is expected to be positive that consumers may find themselves constrained and hence having to set consumption changes equal to income changes. Thus we could allow for non-linear effects of expected income growth (for example, by including positive and negative income growth as separate regressors, see Shea (1995) and Garcia et al (1994)) and test for linearity. Note, however, that Shea allows for asymmetric effects but finds the exact opposite of the prediction from a model with liquidity constraints.

As an example of identification that uses a somewhat more structural approach, Meghir and Weber (1993) provide a test that allows us to discriminate between liquidity constraints and intertemporal preference dependencies. Since both these departures from the basic model give that lagged consumption behaviour influences current consumption it is not clear how we can decide between them on the basis of a test that uses the latter. Rather than looking at total consumption, Meghir and Weber exploit the differential impact of these two departures on the structure of demand. Broadly, liquidity constraints may affect the allocation of total expenditure to a period but they should not affect the dispersal of this total over different goods. On the other hand, habits will lead to different effects of past demands on the current structure of demand, even when we condition on total expenditure²⁶.

In the end, the results on the validity of the standard additive model from consumption Euler equations are deeply ambiguous. The results are such that no one coming to this literature with even mild priors concerning the
importance of, say, liquidity constraints is going to go away with different opinions. As evidence of this we note that one of the authors (MB) feels that, based on the results in Table 5.1, there is no strong evidence against the standard additive model whilst the other (AL) believes that there is. Although a full 'sensitivity' study on the PSID would be extremely useful we feel that it is unlikely that any really convincing evidence regarding the validity of the standard additive model is going to be found using Euler equations on data of the sort used in Table 5.1.

5.3 Empirical evidence on the precautionary saving motive.

Given the central place that the precautionary motive has assumed in the theoretical literature it is not surprising that there have been several recent attempts to quantify the importance of this motive. Some of this has taken the form of matching results of simulations to broad facts; we shall discuss this in the next section which deals with life-cycle saving. There has also been a good deal of work on the short run implications of the precautionary motive and it is to this that we now turn. All of the recent empirical studies have followed the route of including some measure of risk either in a consumption, saving or wealth equation or in an Euler equation and then testing for its significance. In Table 5.2 we list ten studies that follow this approach. As can be seen, a wide variety of left hand side variables and measures of risk have been used.

The central problem that faces anyone who wishes to determine the role of precautionary saving in this way is to identify some observable and exogenous source of risk that varies significantly across the population. All three adjectives (observable, exogenous and variable) are operative here. As regards observability: we obviously need to observe either some measure of risk directly or some proxy for it if we are include it as a 'right hand side' variable. Some investigators use measures of income variance that are derived from observed income processes (see Carroll (1994), Carroll and Samwick (1992) and Kazarosian (1994)). These are sensitive to assumptions about measurement error and how much the agent knows that the econometrician does not. Another approach is to proxy risk with the variance of consumption in an Euler
equation (see Kuehlwein (1991) and Dynan (1993)). This is problematic if there is cross-agent variation; measurement error or some durability in the consumption measure used in estimation. Direct measures of subjective measures are more attractive in this respect (See Guiso, Jappelli and Terlizzese (1992), (1994a) and Lusardi (1993)) but they are problematic since they depend on the answers to questions that respondents may not understand well or may not have any incentive to answer accurately. Dominitz and Manski (1994) use an original data set to analyse the use of subjective expectations concerning income.

Sizable variability in the measure of risk is also important since most of the left hand side variables that have been suggested as regressors (for example, saving rates or wealth to permanent income measures) are likely to be quite noisy.

The exogeneity issue is, however, the most problematic. The issues can be illustrated by referring back to one of the (many) tests in Friedman (1957). Suppose we calculate saving rates for agents who are in different occupations (see, for example, Skinnor (1988)). If we can order occupations by the earnings risk attached to them then we can check whether saving rates are significantly higher for those in riskier jobs. The problem with this is that the agent's choice of occupation may be correlated with attitudes to risk. Suppose, for instance, that risk aversion and prudence are positively correlated across the population. Risk averse agents will choose less risky jobs but they will also be more prudent and, ceteris paribus, save more. Thus even if there is a strong precautionary motive for all agents we may not observe a positive cross-section correlation between earnings risk and saving rates. Conversely, a negative correlation between risk aversion and prudence will lead us to underestimate the precautionary motive.

The problem here is compounded by the fact that earnings risk may also be correlated with other important aspects of earnings. For example, paths over time and risk may be correlated so that some of the observed variation in saving rates may be associated with variation due to the life-cycle motive rather than to the precautionary motive. Equally, the rate of return may be correlated with risk, the obvious example being self-employed people who may face riskier income streams but with much higher rates of return on
investments in their own business. In this case the precautionary motive is confounded with the intertemporal substitution motive.

To circumvent the endogeneity problem, Friedman (1957) suggests another source of variation in earnings risk that we can take as exogenous: race. If blacks face higher earnings risk than whites then this should lead to them having higher saving rates. The problem here is that although the source of variation may be taken to be exogenous, preferences may also be correlated with race. For example, in equation (5.2) \( \beta \) and \( \sigma_{t+1}^2 \) may both depend on race (in a linear fashion) so that even if a race dummy is significant we cannot identify whether this is due to differences in discount factors or attitudes to consumption risk. Starr-McCluer (1994) presents another example of how to deal with the endogeneity issue.

One possible alternative is to identify episodes in which certain state insurance schemes (such as unemployment insurance, health insurance or old age pensions) were extended to different segments of the population and to trace their reactions to these changes in the micro data. This has some claim to being exogenous; the extension of a program (rather than a marginal change in the program for current members) is likely to be 'large' and we can observe the timing of such extensions quite precisely. It may even be that some changes were large enough to induce observable changes in the aggregate data although such investigations will be plagued by the lack of a 'control' group who experienced no change.

Yet another approach to assessing how important it is to allow for a precautionary motive in the empirical work would be to set up an exact Euler equation that nests the quadratic (CEQ) model as a special case and then to test directly for the significance of the extra 'non-CEQ' parameters. This could be done using the method developed by Attanasio and Browning (1994) to derive their generalisation of the CRRA model (see the discussion in (5.1) above). This has not been attempted.

Table 5.2 presents what has been attempted; it is our hope that the information given there is sufficiently self-contained not to need further elaboration. As can be seen from column 5 of this Table, there is mixed evidence on the strength and quantitative importance of the precautionary saving motive. Our tentative reading of the evidence presented in these papers
is that whilst there may be some precautionary motive it is not likely to be as important as some studies suggest. It is also not clear how well the uncertainty due to income risk can characterise the saving and wealth distribution. For example, the model of Carroll and Samwick (1992) strongly underpredicts the fraction of households with low saving rates. Finally, it seems to us unlikely that the wealthy are significantly motivated by their fear of future income or consumption shocks. As we have seen in section 3, a large of proportion of saving is due to rich households which certainly bounds the possible quantitative importance of the precautionary motive due to income risk.

5.4 Tests of other implications of the standard saving model

There are also other implications of the standard saving model that have been examined in the literature. We discuss three here that exemplify different approaches. The first paper we discuss is Wilcox (1989). This paper uses macro data. As discussed in the introduction, we are sceptical that much can be learnt from aggregate time series data about individual behaviour but work that uses the timing of specific events in this way does seem to be of value (see also Blinder and Deaton (1985)). Wilcox notes that there is difference in timing between announcements and implementation of changes in Social Security benefits and looks for when consumption reacts. According to the standard model all changes in consumption should be made on receipt of the new information and not on receipt of the actual payment. Essentially, then, Wilcox is proposing an orthogonality test of the conventional kind but one in which knowledge of the exact timing of an announcement is exploited. Using aggregate monthly data for the U.S. from 1965 to 1985 Wilcox presents evidence that consumption reacts to the actual change in benefits and not to the announcement of the change. Interestingly, most of the effect seems to be concentrated on the purchases of durables in general and automobiles in particular. This weakens the suggestion that significant liquidity constraints are driving Wilcox's results since cars can be used as collateral for loans.

Alessie et al (1994) also present evidence that relies on the specific timing of a change in government policy, in this case imposed credit restrictions. Specifically they use the abolition of credit restrictions in
the U.K. in 1982 to test whether household demand for cars was affected by the change. If the conditions of the standard model without liquidity constraints hold then the relaxation of credit restrictions should have no effect. If, on the other hand, liquidity constraints are important then we will observe a change in purchasing behaviour at the policy change date. Using a quasi-panel constructed from U.K. FES data from 1973 to 1986 and National Transport Surveys for 1976 and 1986 (to give the stocks of cars held) they provide Euler equation results that allow for non-separabilities between cars, durables and non-durables. The most important of their findings from the formal model and from a more informal data analysis is that there is strong evidence that the abolition of credit controls lead to a change in behaviour in the way predicted by a model with liquidity constraints.

Yet another test of one of the implications of the standard model is given by Deaton and Paxson (1994). They start from the observation that in a CEQ model, consumption should follow a random walk. Thus if we follow a group of households over time we should see consumption 'spreading out'. Using time series of expenditure surveys from Taiwan, the U.K. and the U.S., Deaton and Paxson document very striking increases in the dispersion of consumption over time for the same cohorts (their figure 4, which shows dispersion against age, controlling for cohort, is particularly striking). They also show that the results are robust to plausible allowance for family size effects. These findings are consistent with a simple CEQ model. Furthermore, Deaton and Paxson go on to show that other features of the distributions of consumption, earnings and income over time are also surprisingly close to the predictions of a CEQ model. For example, they point out that prudence would inhibit the increase in consumption variance so that their results suggest at most a weak precautionary saving effect. Of course, increasing consumption inequality is not solely a prediction of a CEQ model (increasing earnings variance with 'rule of thumb' behaviour gives the same prediction) but it is striking how well the predictions of the CEQ model stand up to this very focused scrutiny.

We have presented brief accounts of these three studies to show some of the others ways that we can examine the implications of variants of the standard model. The method of Wilcox uses a divergence between announcement and implementation dates; the Alessie et al paper uses the timing of a policy
change that removed a particular restriction in an important market and the Deaton and Paxson paper examines the implications for cohort inequality. All three papers cleverly exploit very different implications, each of which deserves further investigation but they also suggest that there may be other unexploited implications that can also be examined. Our feeling is that this line of investigation is likely to lead to more convincing and robust results than, say, further Euler equation estimates on the PSID.

6. EMPIRICAL EVIDENCE ON LIFE-CYCLE SAVING.

6.1 Life-cycle savings behaviour.

As stated in section 2, we identify the life-cycle model with the proposition that agents seek to keep the marginal utility of expenditure constant from period to period. The Euler equations given in the previous section exploit this and the conditions for the standard model to examine short run behaviour but we can also consider much longer run behaviour. Broadly, agents should save so that consumption in retirement gives the same marginal utility as consumption earlier in the life-cycle (with due allowance for any discounting). Note that this does not imply that consumption levels should be smoothed over time; fairly obviously households may spend more when there are children present and less when they are not working in the market (that is, after retirement). Additionally, declining health or vigour in older age may lead to planned (or anticipated) falls in consumption over the life-cycle.

Since we do not have very long panels we cannot follow the same individuals from school to retirement and beyond. Thus we have to make auxiliary assumptions about the constancy of certain behaviour over time or over the life-cycle to examine longer run behaviour. This typically makes an explicit comparison of marginal utilities across time impossible. Consequently we have to resort to more informal methods.

The simplest method of all to look at life-cycle behaviour is to take one cross-section and graph means of consumption against age. This is the method adopted by, for example, Carroll and Summers (1991) (see also Carroll (1993)). Carroll and Summers graph a number of 'life-cycle' consumption profiles (strictly graphs of consumption against age) for different education and
occupation groups from the U.S. CES for 1960/61 and 1972/73. The most
important finding in the Carroll and Summers paper is that for all education
and occupation groups, the shape of the income and consumption paths are very
similar; they refer to this as the "consumption/income parallel". This is
inconsistent with a CEQ model, particularly for high education agents who have
a (predictably) rising income profile. The coincidence between income and
consumption in the early part of the life-cycle is not, however, necessarily
inconsistent with a standard model that allows a precautionary motive; see the
remarks toward the end of section 2.3 above.

It is important to emphasise that the graphs in Carroll and Summers
(1991) do not follow the same agent over time. Thus they confound age and
cohort effects. Moreover, education has an important cohort component which
further complicates drawing inferences. There may also be selection effects
when groups are defined on the basis of occupation which is clearly not fixed
for any individual. Most importantly, Carroll and Summers do not control for
other life-cycle events that impact on consumption and saving. Once we take
such events into account it is not even clear that the evidence Carroll and
Summers present is inconsistent with a simple CEQ model.

Attanasio and Browning (1994) present graphs that are similar to those of
Carroll and Summers. The main difference is that Attanasio and Browning use
several years of U.K. FES data to follow cohorts through time. They reproduce
the finding that consumption and income move together over the life-cycle.
When they allow for demographics, however, all of the life-cycle variation in
consumption disappears. Specifically, deflating consumption by plausible adult
equivalence scales leads to a completely flat life-cycle path for adjusted
consumption (see also Blundell et al (1994)). At a minimum, this suggests that
the finding that consumption and income move together over the life-cycle may
have other explanations than that current income is 'causing' current
consumption. Of course, the demographics 'explanation' of the life-cycle path
of consumption still does not explain why unadjusted consumption is correlated
with income. As discussed in Browning (1992) we believe it is extremely unwise
to focus on two life-cycle paths (income and consumption in this case) and
make inferences about causality without considering other choices such as
education; human capital formation; career choice; marriage; family
composition and labour supply. This is not to say that the life-cycle facts are consistent with a simple CEQ model but rather to suggest caution in drawing inferences concerning the validity of a particular variant of the life-cycle model from two life-cycle paths.

The model of precautionary saving examined in section 2 give testable predictions for saving and wealth accumulation. Hubbard, Skinner and Zeldes (1994a, 1994b, and 1995) consider three sets of facts concerning wealth, saving and consumption in the U.S.: the typical ratio of assets to income in the population at any time; the age patterns of wealth and savings and the short run (five year) co-movements of income and consumption. They employ a no bequest non-CEQ model with moderate discount rates and liquidity constraints. They find that this model can better fit the facts on these three issues than a CEQ model with liquidity constraints or what they interpret as a buffer stock model. Note however that the latter interpretation might be resisted by an advocate for buffer stock behaviour since it assumes a very high rate of time preference which may not be necessary for buffer stock behaviour if there is significant income growth. Note as well, that the CEQ model they use is actually a perfect certainty model. In particular, they take the lifespan to be given and known. As is well known, the CEQ model with uncertainty and the perfect certainty model may not give the same results if lifetime is uncertain (see, for example, Davies (1981)). In particular, consumption will decline in old age in the CEQ model with uncertainty but not in the perfect certainty case.

Hubbard et al (1995) also estimate standard Euler equations on their simulated data and find results for excess sensitivity that are very close to those of Campbell and Mankiw (1990) on the aggregate data and Lusardi (1994) on the micro data (a coefficient for expected income growth of 0.4). As we noted in section 2, it is not possible to separate the effects of liquidity constraints and precautionary saving in these simulations and the two could be confounded.

This style of empirical work in which simulations are used to fit some features of the data is halfway to full dynamic structural modeling. Thus Hubbard et al (1994b) use dynamic programming techniques to simulate paths for agents in realistic settings. However, rather than estimating the parameters
of the utility function they fix them and then use informal goodness of fit measures (literally comparing columns of predicted and actual) to evaluate different configurations of the parameters. Consider, for example, the discount factor. Only three values are considered (1.5% and 3% for the 'benchmark' models and 10% for the buffer stock model) and these are taken to be fixed within education groups (although allowance is made for the uncertainty of life so that there is effective higher discounting in old age). It would be highly desirable to allow for more heterogeneity in the parameters of the model and to allow that these may be correlated with, for example, the 'choice' of income processes that agents make. Since the present methods used by Hubbard et al use vast amounts of computer time it is perhaps overly ambitious to suggest full structural modeling but it is the obvious next step.

6.2 Saving for and in retirement.

In the original life-cycle model of Modigliani and others saving for retirement played a particularly important role. It is thus appropriate to consider explicitly saving for retirement and saving in retirement. We focus attention on three main questions: do younger people save enough for retirement? Do government incentives to increase saving for retirement actually increase saving? Do the elderly dissave? The latter not only has intrinsic interest but it is also important since all standard saving models predict that eventually households will start to dissave whether or not there is a bequest motive or uncertain lifetime (see, for example, Hurd (1990)). Thus this prediction can be considered a 'critical experiment' for the life-cycle model in its most general form.

We start with the issue of whether agents save enough for their retirement period. There are at least three problems here. The first is, how do we define 'enough'. In a standard model this depends on preference parameters and the real rate of interest. If the discount factor is higher than the real rate of interest (as is often assumed in, for example, buffer stock models) then agents may 'rationally' plan to have low consumption in later life. For example, an agent with a log consumption utility function who has a discount factor that is two percentage points above the real rate will
plan to have consumption that is twice as high at 35 as at 70. This implies that if there is a good deal of heterogeneity in discount factors then we may observe many agents in the population arriving at retirement with low or negative assets. Furthermore, if there is uncertainty but there are also some safety nets and/or some public provisions which are asset-tested, then holding little or no assets can even be an optimal strategy.

The second issue is: 'enough' for whom? Browning (1994) documents that for the 'average' married couple the wife is typically younger than her husband and will typically survive to a greater age. Combining these two factors he finds that a wife can expect to live about fifty percent longer in the retirement period than her husband. Thus husband and wife may have very different views about what is enough for retirement unless they are perfectly in sympathy. This simple observation has wide-ranging implications. For example, the level of savings by a household depends not only on the level of household income but also on the the distribution of income within the household. This in turn means that for some distributions the marginal propensity to save is not defined: it can be anything between zero and unity depending on who receives the extra income (wives having the higher marginal propensities to save). Similarly, the age distribution within the household also affects the level of saving and we can no longer talk of the 'age of the household' but only of the ages of its members.

The third issue is how do we measure savings that are made for retirement? There are definitional and measurement problems. On the definitional question: as discussed in section 2, once we move away from a CEQ model we cannot simply sum current assets and the expected flow of future funds to arrive at an aggregate wealth figure. Thus it is not clear how to aggregate current assets in tax sheltered assets and other financial assets. For example, Engen and Gale (1993) show that the early withdrawal penalty on Individual Retirement Accounts (IRA's) provides a theoretical justification for IRA saving and non-IRA saving to be imperfect substitutes for those some time away from retirement. Even less clear is how we should aggregate these assets and housing wealth, future Social Security pension receipts and entitlements to free medical care after retirement.

As well as the question of how we aggregate different assets is the
question of how we can measure them. The new Health and Retirement Survey (HRS) and the Survey of Assets and Health Dynamics of the Oldest Old (AHEAD) incorporate new survey techniques that result in substantially smaller biases resulting from missing wealth components. One of the striking findings is that household wealth holdings reported in these data set are substantially higher than the figures reported in other surveys, which suggests that wealth generally tends to be under-reported (see Juster and Smith (1994)).

With these considerations in mind, we start examining some of the evidence provided in the papers that examine this issue. Direct evidence on the adequacy of retirement savings is provided by Hamermesh (1984). He concludes that for couples, consumption early in retirement exceeds by 14% the income that their financial, pension and Social Security wealth can generate. He finds that they respond to this insufficiency by reducing their consumption as they age. This finding, however, is dependent on the imputation method that Hamermesh uses for total consumption and is also at odds with the evidence presented earlier which suggests that saving is typically positive for households just after the conventional retirement age (see, for example, Table 3.3). Banks, Blundell and Tanner (1995) also examine consumption patterns directly and conclude that whilst some of the fall in consumption after retirement can be rationalised within a standard model that allows for complementarities between consumption and labour supply, there is still an additional 'unexplained' fall in consumption.

As regards wealth levels at retirement, a number of studies have documented the very great heterogeneity in these (see Diamond and Hausman (1984), Venti and Wise (1993) and Gustman and Juster (1995)). Very many households enter retirement with very little in the way of financial assets and not very much in wider definitions of wealth that include housing equity. On the other hand, some households have high levels of wealth that can obviously finance high post-retirement consumption levels and/or bequests. Another consistent feature of estimates of wealth holdings is how these vary across family types (see, for example, Kennickell and Shack-Marquez (1992), a study from the Congressional Budget Office (CBO, 1993) and Smith (1994)). Typically married couples have the highest levels of wealth and lone parents the lowest with singles in between (but with quite low levels of wealth). This
mirrors the pattern for saving given in section 3. Finally, wealth levels at retirement seem to be highly correlated with education levels: low levels of wealth are found for those with the lowest level of education.

In a series of papers, Bernheim (1993, 1994a and 1994b) has examined the adequacy of accumulation by 'baby boomers' (those born between 1946 and 1964) to provide for retirement. According to his calculations, the typical baby-boomer is saving at one-third the rate required to finance a standard of living during retirement comparable to the standard of living that it enjoys before retirement. He argues that the parents of the baby boomers also decreased their savings with respect to previous generations but they benefited from a series of fortuitous developments which will not be available to baby boomers. For example, real social security benefits increased dramatically during the 1970's and private retirement benefits were significantly expanded and improved during the same period. Additionally, they (the parents) experienced a period of high inflation that wiped out much of their liabilities and finally they enjoyed a sharp increase in the relative price of housing which created big windfall gains. If baby boomers rely on what their parents have saved, they may be misguided in their judgements. According to Bernheim, baby boomers are not only financially vulnerable but they may not even perceive correctly their vulnerability.

A study from the Congressional Budget Office (CBS, 1993) on this issue came out with quite different conclusions. Whilst some of this study's findings agree with Bernheim (for example, the less educated are making less provision for retirement) there are critical differences which derive from the measure of wealth chosen to evaluate the adequacy of accumulation. Whether or not one includes the value of housing equity in counting the assets available for consumption at retirement makes a big difference. From the CBO study, assuming that housing wealth will not be used to finance retirement reduces available resources by a factor of three at the median. Home ownership was an important factor in the accumulation of wealth in the 1980s. Young households who are homeowners show a relatively higher wealth-to-income ratio in 1989 than in 1962 and those who do not own their homes show similar or lower wealth to income ratios. Indeed, even the CBO study expresses concern that the non-homeowners may be unable to accumulate wealth at a rate that is sufficient to
give them a comfortable life in retirement.

It is clear that the house is an important asset in household portfolio. Kennickell and Shack-Marquez (1992), for example, report that the principal residence accounts for 32.2 percent of the assets of the household sector in 1989. However, one can argue whether housing wealth provides a good vehicle for consumption at retirement. In a pair of studies Venti and Wise (1989, 1990) show that there is little decumulation of housing equities and some decumulation is only observed very late in age. Merrill (1984) finds that the elderly with few liquid assets or low income are no more likely to trade down their housing equity than other elderly. On the other hand, Sheiner and Weil (1992) find some evidence that households reduce home ownership as they age, even though they estimate that 42% of households will leave behind a house when the last member dies. Even though reverse annuity mortgages are now available, there seem to be little use of them (see Venti and Wise (1991)).

Thus it seems that a substantial fraction of US households will depend on Social Security for support in retirement. As against this, a substantial minority of households are now holding assets in targeted retirement saving accounts. This is the second issue that we examine: the effect on savings of schemes such as IRA’s and 401k’s. These are schemes which raise the rate of return on savings for retirement by allowing contributions to be made out of gross income and also exempt income from the assets purchased from tax. As is well known, the theoretical effect of the introduction of such schemes on aggregate saving is ambiguous. There may be a positive effect for current non-savers some of who may now be induced to save by the higher return. However, this positive increment may be offset by the behaviour of current savers. For them, the introduction of such a scheme has the usual negative income effect and positive substitution effect; the net effect is ambiguous. Thus we necessarily must have recourse to the data to sign the aggregate effect.

Unfortunately, empirical work in this area confronts a serious identification problem that no one has satisfactorily overcome. There seems to be widespread agreement that there is a positive correlation between wealth and participation in 'targeted' savings scheme. There is no consensus about the inference that can be drawn from this. The positive correlation is consistent with the existence of heterogeneity in 'tastes for saving' (or
discount rates) and with substitution effects (including the entry of new savers) overcoming income effects. Since there is no universally accepted instrument for program participation there are fundamental disagreements about the effect of these programs on net savings. The policy prescriptions that follow from the views about the source of the correlation differ dramatically. If the correlation reflects only a fixed effect then the current policy of allowing tax sheltered saving is simply a transfer to agents with high marginal tax rates and a high propensity to save. We refer the reader to Poterba, Venti and Wise (1993, 1994) and Engen, Gale and Scholz (1994) or Gale and Scholz (1994b) for two very different views of the efficacy of such policies and to Bernheim (1994c) for a discussion of the merits of the two sides of the debate.

Closely related to these issues is the question of whether the elderly dissave. In the simplest life-cycle model with no bequests and no uncertainty about the life span decumulation should begin at retirement. Introducing uncertain lifetime and a bequest may push back the age at which saving becomes negative but it does not invalidate the prediction that the elderly will eventually start to dissave. Although this area could bear more theoretical investigation30 this does seem to be one of the robust predictions of the life-cycle model since it is difficult to believe that liquidity constraints are important in later life and earnings risk is unimportant.

This issue has been widely investigated and in fact it represented the first attack on the simple life cycle model (see the review provided in Hurd (1990)). We have seen that the wealth accumulated in housing equity shows little tendency to decline. Do other types of wealth show any decumulation? The critical point to note here is that to correctly establish whether the elderly decumulate we need to have panel data. We cannot simply compare wealth holdings or saving of different age groups. The evidence from cross-sectional data (see, for example, Table 3.3) confounds age and cohort effects. An alternative is to follow the same cohort through a series of cross-sections, a technique which has proven useful for pre-retirement households. For the elderly, however, this suffers from the fact that mortality is negatively correlated with wealth and that the poor are more likely to live with their children or enter nursing homes (which means that they would drop out from the
sample or be part of other households). This introduces a bias in the cohort average over time since the older the cohort the higher the proportion of those who had high wealth at retirement. We have also to be careful about family composition since the decumulation of couples can be lower than singles given that the expected 'lifetime' of the household is greater for couples.

In panel data, however, we can handle these problems by considering only a sample of households who survive to a late age and follow their asset levels through time. Hurd (1990) presents evidence of decumulation in later old age. Although this finding is comfort for advocates of life-cycle models it does little to settle whether, for example, liquidity constraints are important for younger people. Thus if this finding turns out to be robust then it provides evidence in favour of using the life-cycle model in general but not of which variant (CEQ or non-CEQ, with or without habits and liquidity constraints). There are many investigators, however, who feel that the life-cycle framework itself is too restrictive and that other ways of looking at behaviour provide a better understanding of savings behaviour. In the next section we present some of the relatively new work that uses a 'behavioural' framework.

7. NON-STANDARD SAVINGS MODELS

Johnny Hodges played with the Duke Ellington band for over thirty years. During all that time Ellington paid Hodges daily; the reason for this was that if he paid him weekly then Hodges would go hungry for six days of the week. Evidently Hodges had a considerable problem with self-control. Recent behavioural models of saving have posited that most people have a self-control problem and that this invalidates straight-forward application of a standard life-cycle model (see Thaler (1990) and (1994)).

A second feature of the lifetime allocation problem that behavioural economists emphasise is the complexity of the dynamic optimisation problem that agents face (see, for example, Bernheim (1993)). This may be overcome if the problem is one that many people face and where outcomes are revealed in a relatively short time since then agents can observe others and 'rules of thumb' may be developed. At a minimum, glaring mistakes can be avoided. This route is not available for people aged, say, forty in 1994 who are thinking
about saving for retirement. The demographic composition of the population, the level of development of the economy and of support for the currently old has changed so much in the past thirty years that looking at what their parents did is likely to be a very poor guide. Against this, we might remark that the size of errors that Bernheim (1993) suggests some people are making (saving is less than half of what is 'needed' for retirement) could be avoided by fairly crude programs if these agents were indeed interested in saving as much as Bernheim suggests they should: we don't need the exact solution, only a good one. The point remains, however, that we can question whether the assumption of unbounded computational abilities used in our model of economic decision making is viable. Thaler (1994), for example, advocates models of bounded rationality as a better characterization of individual behavior.

The third putative failing of the standard framework is the assumption of fungibility. The marginal propensity to spend out of different sources of wealth (increases in housing equity due to increases in house prices; changes in future pension rights etc.) is not the same. Behaviourial economists posit that individuals create 'mental accounts' for their different assets causing their marginal propensity to consume from those assets to vary with the level of temptation associated with each one. Thaler suggests that this non-substitutability is not consistent with a life-cycle model. The imputation of this implication to the standard framework seems to follow from an identification of the latter with the CEQ model. As we have seen, it is by no means a prediction of the model without certainty equivalence that agents will treat all sources of expected income and wealth identically. In particular, the existence of a precautionary saving motive breaks the perfect substitutability of assets. Another example is when there exists liquidity constraints. If consumers cannot borrow against some of their assets, we would observe that less liquid assets have a lower marginal propensity to consume.

It is instructive to consider in more detail one typical example cited by behavioral economists: the case of Christmas clubs. Such a club requires a fixed weekly payment throughout the year and then pays out the amount saved at the end of the year. The existence of such clubs poses a problem for standard models since the rate of return is usually low (since administration costs are high) and agents are 'locked' in during the year. Thus a Christmas club
provides a lower return and less flexibility than a conventional savings account. Two salient features of the Christmas club example seem important to us. First, the consumption path that agents actually achieve (lower consumption during the year and higher consumption at the end of the year) is the same path that a forward looking agent with no self-control problems would achieve by saving in bank. Put another way, Ellington and Hodges did manage to find some mechanism that ensured that Hodges ate every day. Thus the predictions of the standard model for consumption paths would be essentially correct. On the other hand, the predictions of the standard model for portfolio behaviour are wholly unable to account for the specific asset position taken. It is our belief that this applies more generally: if the standard model (with or without liquidity constraints) fails in the direction of agents not exercising self-control it is likely to be in predictions of portfolio behaviour and not the actual consumption paths realised.

More effort is required of both behavioral economists and economists who use the standard life-cycle framework to achieve more understanding. Thus protagonists of the standard framework (amongst whom the first co-author includes himself) would ask: what specific features of the data that are regularly used (the PSID or quasi-panels, for example) are better rationalised within a behavioural framework rather than a standard framework? On the other hand, advocates of a behavioural position can reasonably ask: can the 'anomalies' that they identify really be rationalised within a life-cycle framework? We emphasise here that we should not tie our hands behind our backs and use only a CEQ model with limited heterogeneity (in tastes and environment). The remark by Thaler (1994) that in the standard life-cycle framework "the only policy variable [to increase the U.S. savings rate] is the after-tax rate of return" ignores the developments of the past ten years in standard life-cycle modeling.

To illustrate the progressive strategy of seeking for features of the data that are inconsistent with one view or the other, we quote Bernheim (1994) who uses the fact that non-college graduates save very little (see the last section) to argue that general economic literacy is an important determinant of saving behavior. According to him, "patterns of wealth accumulation among those without a college degree bear little or no
resemblance to the pattern that should emerge from sophisticated decision making. In contrast, those with college degrees not only save more adequately for retirement, but also generally behave in a way that more closely resembles the outcome of sophisticated planning". Implicitly, then, this seems to be an argument against using the standard framework for less educated agents. Within the standard framework, however, one explanation for this observation would be that there is heterogeneity in discount factors and this leads some agents to choose less schooling and less consumption in later life (relative to their earlier life) than their better educated contemporaries.

Thaler (1994) suggests that allowing that some people have a high discount rate 'renders the theory empty' which is a position we agree with if we are looking at just one narrow aspect of behaviour. What gives the standard life-cycle framework real bite is that we must account for a whole range of behaviour (short and long run saving, schooling and occupation choice, fertility choice, portfolio decisions, retirement decisions etc.) with the same set of parameters. Therefore the same parameters should explain the saving behavior at different stages of the life cycle, the wide heterogeneity of wealth across households and the reasons why saving have declined over time, just to mention a few of the facts that we have considered in this survey. This is an ambitious undertaking which we have hardly yet begun much less tried and discarded.
The designations in italics are our titles but they almost always follow Keynes.

Even this is contentious; some researchers have used the term standard to refer to, for example, the Modigliani model or the permanent income model.

See Mayer (1972) for an excellent discussion of the antecedents of the 'new' theories of consumption that arose in the mid-50's.

Although widely used, the CEQ terminology is not universally accepted. Some investigators refer to this variant of the life-cycle model as the Ramsey model or as the Permanent Income Hypothesis (PIH) or Rational Expectations PIH, RE-PIH. Given the care that Friedman (1957) takes to allow for the precautionary motive and the emphasis he places on liquidity constraints this latter terminology seems to us inappropriate.

Note that we leave open the existence of a bequest motive.

We do not consider this extension below since it has not yet lead to any empirical work on micro data. See Epstein (1991) for a discussion of these models.

To the horror of some readers we have here introduced new nomenclature. Some investigators call this set of assumptions the 'precautionary saving' model or the unwieldy 'life-cycle model with additive preferences and perfect capital markets'. We prefer our term to the former since the model allows for many other motives as well as the precautionary motive and it also maintains perfect capital markets which many 'precautionary' models rule out.

See Browning (1989a) for the extension to a many good framework.

See Browning (1989b) for non-parametric (revealed preference) conditions.

An alternative is to assume that $1 + e_{t+1}$ is log-Normally distributed in which case the approximation we shall give is exact.

If we allow for uncertain interest rates then we need to assume that there is zero probability that the realised lending real rate exceeds the realised borrowing real rate (see Browning and Robb (1985)).

Deaton derives the exact solutions and shows they are very similar to this rule and that the welfare loss from using this approximation is small.

We know of nothing but vague anecdotal evidence that this actually happens.

Using aggregate data, Wilcox (1991) documents that durable goods outlays have been the fastest growing category of real personal expenditure during the 1980's. They expanded at an average rate of 5 percent per year and in 1989 accounted for 16.1 percent of total personal consumption expenditure as against a share of 12.3 percent in 1980.

For example, they include movers and renters in their sample and do not use self-reported home values, as in Skinner (1993), but rather price data from 112 metropolitan areas.

As already discussed, in an expected utility model this one parameter also governs attitudes to risk.
Even in surveys where the ownership of particular durable goods is recorded, the actual value of these is not.

Formally, we can allow for durables if we adopt a neo-classical model and include the user-cost instead of the price. This is more satisfactory for, say, washing machines than it is for housing.

The use of the discounted marginal wage (even if available for all adult members of the household) has the usual problem that it relies too strongly on the life-cycle model of labour supply with spot markets to be widely acceptable.

Some authors first construct real values for these and then add these real values to form a composite commodity 'food'. Although this adding of apples and oranges is inappropriate, the error that results is small since the relative prices of these two goods move together closely so that the resulting composite is probably not too different from the correct composite which divides the total expenditure on the two goods by some (two good) price index.

In an unpublished paper, Shapiro (1991) has the even more alarming estimate of 95%.

The term was first used by Flavin (1981) in the context of a CEQ model; we use it here to refer to a more general failure of the model.

It should be noted that the validity of this empirical finding is not universally accepted. For example, Zeldes allows for a fixed effect by including person specific dummies. This is not valid if the instruments are pre-determined but not strictly exogenous, see Keane and Runkle (1992). The latter authors show that using an alternative (consistent) estimator leads to quite different qualitative results.

And the two that find the 'wrong' sign (Bernanke (1984) and Runkle (1991)) have low t-values.

Note, however, that this could be due to publication censoring: investigators who find the 'wrong' sign may continue with specification searches until they have the 'right' sign.

So long as we rule out models in which past behaviour only affects the discount factor, as in Uzawa (1968).

Although the fact that the great majority of the excess sensitivity parameters are of the 'correct' sign for a 'liquidity constrained' story does give MB some pause.

This is part of a much larger literature that is emerging on intra-household allocation. One as yet uninvestigated area that may be of signal importance for savings behaviour is the effect of possible family dissolution. If we introduce the possibility of divorce into our life-cycle models then this may undermine many of the predictions that we currently derive from 'unitary' (single utility function) models of the household.
IRA's became available in 1982 and reached their greatest popularity in the year before the Tax Reform Act of 1986. Holdings of such accounts are currently estimated at about $10 billion. 401K plans were created by 1978 legislation and became widely available in the early 1980s. Between 1983 and 1990, the number of participants in 401 plans rose from 4.4 to 20.8 million. Personal retirement assets increased over four fold between 1984 and 1991, much more than any other component of wealth (see Poterba, Venti and Wise (1994)).

For example, we believe that an additional area that merits further theoretical investigation is the consequences of illness or a diminished 'zest for life' which tends to 'kink' the marginal utility of money and reduce the desirability of current consumption as against bequests (see Börsch-Supan and Stahl (1991) and Börsch-Supan (1992)).
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R 1


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<th></th>
<th>$\epsilon = 0$</th>
<th>$\epsilon = 0.01$</th>
<th>$\epsilon = 0.01$</th>
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<tr>
<td>$Y_1 = 1, Y_2 = 2$</td>
<td>$Y_1 = 2, Y_2 = 1$</td>
<td>$Y_1 = 1, Y_2 = 2$</td>
<td></td>
</tr>
<tr>
<td><strong>First period consumption</strong></td>
<td>1.5</td>
<td>1.49</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Savings rate</strong></td>
<td>-0.5</td>
<td>0.255</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Mpc from cash-in-hand</strong></td>
<td>0.5</td>
<td>0.51</td>
<td>0.97</td>
</tr>
<tr>
<td><strong>Mpc from second period earnings</strong></td>
<td>0.5</td>
<td>0.47</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Discount rate for future expected earnings</strong></td>
<td>0</td>
<td>2%</td>
<td>108%</td>
</tr>
<tr>
<td><strong>Variance of second period log consumption</strong></td>
<td>0</td>
<td>0.01</td>
<td>0.21</td>
</tr>
</tbody>
</table>
### TABLE 3.1: U.S. DATA SETS FOR SAVING

<table>
<thead>
<tr>
<th>DATA SET</th>
<th>PERIOD</th>
<th>DEFINITION OF SAVING</th>
<th>MAJOR FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Study of Income Dynamics (PSID)</td>
<td>1968 - present</td>
<td>First difference of wealth</td>
<td>Active and passive saving.</td>
</tr>
<tr>
<td>Health and Retirement Survey (HRS)</td>
<td>1992 - present</td>
<td>First difference of wealth</td>
<td>Only older respondents. Pension provider surveys.</td>
</tr>
<tr>
<td>Aging and Health (AHEAD)</td>
<td>1993 - present</td>
<td>First difference of wealth</td>
<td>Only older respondents.</td>
</tr>
<tr>
<td>Survey of Income and Program Participation (SIPP)</td>
<td>1984- present</td>
<td>First difference of wealth</td>
<td>Overlapping panels. Only some components of wealth.</td>
</tr>
<tr>
<td>National Longitudinal Survey (NLS)</td>
<td>1985 - present for wealth</td>
<td>First difference of wealth</td>
<td>Various specific cohorts followed.</td>
</tr>
</tbody>
</table>
### TABLE 3.2: SAVING RATES (%), BY AGE

<table>
<thead>
<tr>
<th>Age</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saving ratio 1972/73</td>
<td>9.5</td>
<td>12.1</td>
<td>16.8</td>
<td>22.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Saving ratio 1982/85</td>
<td>9.6</td>
<td>8.6</td>
<td>10.5</td>
<td>15.8</td>
<td>11.5</td>
</tr>
</tbody>
</table>


### TABLE 3.3: (THREE YEAR) SAVING LEVELS, BY AGE

<table>
<thead>
<tr>
<th>Age</th>
<th>20-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65 -69</th>
<th>OVER 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Saving</td>
<td>13,300</td>
<td>14,800</td>
<td>18,700</td>
<td>22,400</td>
<td>30,500</td>
<td>1,400</td>
</tr>
<tr>
<td>Median Saving</td>
<td>2,400</td>
<td>3,200</td>
<td>4,200</td>
<td>500</td>
<td>500</td>
<td>-500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Authors</th>
<th>Data Set</th>
<th>Sample Period</th>
<th>Preferences</th>
<th>Controls for Taste Shifters.</th>
<th>Consumption Measures</th>
<th>Excess Sensitivity (se)</th>
<th>Other Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall &amp; Mishkin (1982)</td>
<td>PSID</td>
<td>1968-75</td>
<td>Quadratic</td>
<td>Age, # of children and adults</td>
<td>Food</td>
<td>0.200 (0.065)</td>
<td></td>
</tr>
<tr>
<td>Bernanke (1984)</td>
<td>SCF</td>
<td>1967-70</td>
<td>Quadratic</td>
<td>Age, # of adults, occupation.</td>
<td>Automobile</td>
<td>-0.0136 (0.019)</td>
<td></td>
</tr>
<tr>
<td>Hayashi (1985b)</td>
<td>SFC (Japan)</td>
<td>1981:2-1982:1</td>
<td>CARA</td>
<td>None</td>
<td>Seven consumption goods</td>
<td>0.158 (0.020)</td>
<td>Durability of services is substantial</td>
</tr>
<tr>
<td>Altonji &amp; Slow (1987)</td>
<td>PSID</td>
<td>1968-81</td>
<td>CRRA</td>
<td>Age, education, children, area, marital status</td>
<td>Food</td>
<td>0.091 (0.91)</td>
<td>Weak evidence of asymmetries</td>
</tr>
<tr>
<td>Mork &amp; Smith (1989)</td>
<td>CES (Norway)</td>
<td>1975-77</td>
<td>Quadratic</td>
<td>Age, children, family size</td>
<td>Five consumption goods</td>
<td>0.378 (0.151)</td>
<td>Food not representative of consumption</td>
</tr>
<tr>
<td>Zeldes (1989a)</td>
<td>PSID</td>
<td>1968-82</td>
<td>CRRA</td>
<td>Age, family size</td>
<td>Food</td>
<td>-0.071* (0.016)</td>
<td>Importance of macro shocks and non-separability</td>
</tr>
<tr>
<td>Altug &amp; Miller (1990)</td>
<td>PSID</td>
<td>1968-83</td>
<td>CRRA</td>
<td>Age, size and sex composition of household</td>
<td>Food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors</td>
<td>Data Set</td>
<td>Sample Period</td>
<td>Preferences</td>
<td>Controls for Taste Shifters</td>
<td>Consumption Measures</td>
<td>Excess Sensitivity (se)</td>
<td>Other Implications</td>
</tr>
<tr>
<td>-------------------------</td>
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<td>-----------------------------------------</td>
</tr>
<tr>
<td>Lawrence (1991)</td>
<td>PSID</td>
<td>1974-82</td>
<td>CRRA</td>
<td>Family size, age, race, education</td>
<td>Food</td>
<td>Consumption is sensitive to income</td>
<td>Varying time preferences across households</td>
</tr>
<tr>
<td>Lage (1991)</td>
<td>PSID/CES</td>
<td>1974-84</td>
<td>Quadratic</td>
<td>Age, number of adults and children</td>
<td>Total consumption</td>
<td>0.21 (0.023)</td>
<td>Measure of cons. matters</td>
</tr>
<tr>
<td>Runkle (1991)</td>
<td>PSID</td>
<td>1973-82</td>
<td>CRRA</td>
<td>Age</td>
<td>Food</td>
<td>0.018* (0.015)</td>
<td>Measurement error in food</td>
</tr>
<tr>
<td>Keane &amp; Runkle (1992)</td>
<td>PSID</td>
<td>1975-82</td>
<td>CRRA</td>
<td>Age</td>
<td>Food</td>
<td>-0.011* (0.008)</td>
<td></td>
</tr>
<tr>
<td>Engen (1993)</td>
<td>PSID-CES</td>
<td>1977-87</td>
<td>CRRA</td>
<td>Family size, sex, race</td>
<td>Nondurables</td>
<td>-0.004* (0.005)</td>
<td>Mortality risk is important</td>
</tr>
<tr>
<td>Meghir &amp; Weber (1993)</td>
<td>CES</td>
<td>1980-87</td>
<td>Direct trans-log</td>
<td>Age, # adults, # children, race, education, tenure, area, labour supply</td>
<td>Food; transport, services</td>
<td>No evidence of excess sensitivity</td>
<td>Test for intertemporal non-separabilities</td>
</tr>
<tr>
<td>Authors</td>
<td>Data Set</td>
<td>Sample Period</td>
<td>Preferences</td>
<td>Controls for Taste Shifters.</td>
<td>Consumption Measures</td>
<td>Excess Sensitivity (se)</td>
<td>Other Implications</td>
</tr>
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</tr>
<tr>
<td>Mariger &amp; Shaw (1993)</td>
<td>PSID</td>
<td>1968-81</td>
<td>Quadratic</td>
<td>Age, # adults, # children</td>
<td>Food</td>
<td>No evidence of excess sensitivity</td>
<td>Relevance of macro shocks</td>
</tr>
<tr>
<td>Blundell et al (1994)</td>
<td>FES</td>
<td>1970-86</td>
<td>General</td>
<td># children, housing tenure, family size, labour supply</td>
<td>Six consumption goods</td>
<td>0.545 (0.368)</td>
<td>Importance of demographics and labour supply</td>
</tr>
<tr>
<td>Attanasio &amp; Browning (1994)</td>
<td>FES</td>
<td>1970-86</td>
<td>Generalised CRRA</td>
<td>Age, # children, family size, labour supply</td>
<td>Nondurables</td>
<td>0.086 (0.073)</td>
<td></td>
</tr>
<tr>
<td>Attanasio &amp; Weber (1994)</td>
<td>CES</td>
<td>1980-90</td>
<td>CRRA</td>
<td>Family size, # children, marital status, labour force variables</td>
<td>Food; nondurables</td>
<td>0.100 (0.103)</td>
<td>Non-separability between food and nondurables</td>
</tr>
<tr>
<td>Eberley (1994)</td>
<td>SCF</td>
<td>1983-86</td>
<td>CRRA</td>
<td>Family size, # children, marital status, labour force participation</td>
<td>Automobiles</td>
<td>-0.30* (0.15)</td>
<td>Evidence of transactions costs</td>
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</table>
### TABLE 5.1 (CONTINUED)

<table>
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<th>Excess Sensitivity (se)</th>
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<tr>
<td>Engelhardt (1994a)</td>
<td>PSID</td>
<td>1975-87</td>
<td>CRRA</td>
<td>Age, family size, marital status, education, race</td>
<td>Food</td>
<td>0.043 (0.035)</td>
<td>Test for down payment constraint</td>
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<td>Garcia et al (1994)</td>
<td>CES/PSID</td>
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<td>CRRA</td>
<td>Age, family size</td>
<td>Food; nondurables</td>
<td>0.561 (0.207) 0.284 (0.148)</td>
<td>Allowance for asymmetry in expected income changes</td>
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<tr>
<td>Jappelli et al (1994)</td>
<td>PSID/SCF</td>
<td>1971-86</td>
<td>CRRA</td>
<td>Age, # children and # adults, employment status</td>
<td>Food</td>
<td>-0.012* (0.027)</td>
<td></td>
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<tr>
<td>Lusardi (1994)</td>
<td>CES/PSID</td>
<td>1980-87</td>
<td>CRRA</td>
<td>Age, family size</td>
<td>Food; nondurables</td>
<td>0.368 (0.135)</td>
<td>Measurement error in CES income</td>
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<td>Shea (1995)</td>
<td>PSID</td>
<td>1981-87</td>
<td>CRRA</td>
<td>Family composition</td>
<td>Food</td>
<td>0.063 (0.785) 2.242 (0.951)</td>
<td>Allowance for asymmetry in expected income changes</td>
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</tbody>
</table>

Data sets - PSID: Panel Study of Income Dynamics (USA); CES: Consumer Expenditure Survey (USA); SCF: Survey of Consumer Finances (USA); FES: Family Expenditure Survey (U.K.); SFC: Survey of Family Consumption (Japan).

* Parameter of "excess sensitivity" for lagged income (so that a negative sign signifies excess sensitivity); for all other studies the parameter given is for (instrumented) income growth or change (so that a positive sign signifies excess sensitivity).

The two estimates for Garcia et al (1994) refer to constrained and unconstrained groups respectively. The two estimates for Shea (1994) correspond to positive and negative expected income changes respectively.
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<th>Main Finding</th>
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<td>Variance of consumption growth</td>
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<td>Carroll (1994)</td>
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<td>Consumption</td>
<td>Income variance, equivalent precautionary premium.</td>
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