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The Life Cycle Model of Consumption and Saving

**Martin Browning
Thomas F. Crossley**

SEDAP Research Paper No. 28

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Abstract

The life-cycle model is the standard framework which economists use to think about the intertemporal allocation of time, money and effort. The model suggests that households should 'smooth' expenditures. One of the strengths of the model is that it provides a single framework which integrates allocation at many different frequencies. Accordingly, we provide an assesment of the life-cycle model by re-examining the empirical evidence for smoothing (1) within the year, (2) at year-to-year or business cycle frequencies, (3) over the working life, and (4) across the stages of life, such as working into retirement. We conclude that although unresolved challenges remain, the model has had many more successes than failures. We provide some calculations that show that where deviations from the model's predictions have been detected, they imply very small welfare costs for households. Moreover, economists are really just beginning systematic application of general theory models to microdata. Thus it is much too early to abandon the life-cycle model.

The Life Cycle Model of Consumption and Saving.

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“There are certain things one has to be an economist to believe, since no ordinary person could be so stupid” (with apologies to George Orwell¹).

1 Introduction

The life-cycle model is the standard framework which economists use to think about intertemporal allocation (of time, effort and money). As the quote at the top of the paper suggests, it is usually met with incredulity by non-economists. It is also held in increasing disrepute within the profession. We believe that reports of the demise of the theory are much exaggerated and in this article we provide a defence of the life-cycle model as a framework for thinking about consumption and saving decisions. The life-cycle model, at its most general, simply asserts that agents make sequential decisions to achieve a coherent goal using currently available information as best they can. At this level of generality, the standard model has no empirical content and is best thought of as a framework for organizing thinking about saving and consumption (and other) decisions. It is only when researchers begin imposing particular structures on the general model that they can generate empirical predictions. In this view it is critical to recognize that empirical tests of these predictions are tests of the particular restrictions imposed and not of the ‘life-cycle model’ itself; as we have already stated the latter is empirically vacuous and can never be rejected by empirical tests. As will become clear below we feel that the life cycle model is an extremely useful framework, but it is perhaps worth stating explicitly some of its virtues.

¹Orwell had ‘intellectual’ for ‘economist’.

The roots of the modern framework lie in the infinite horizon models of Ramsey (1926) and Friedman (1957) and the finite horizon ('life-cycle') models of Fisher (1930) and Modigliani and Brumberg (1956). The first positive feature of the modern life cycle framework is that it provides a coherent model for intertemporal allocation at all frequencies. Thus there is one model for allocation over the week, the year, the business cycle, the working life, the life-cycle (including youth and old age) and even the very long run (in the dynastic version of the model). This synthesis of the different frequencies of earlier life-cycle models is a considerable achievement. Even more importantly, the modern version treats uncertainty in a comprehensive and flexible way that is consistent with the insights gained from the earlier perfect certainty versions of the model.

A second attraction of the standard framework is that it allows researchers to incorporate genuine features of the world in a coherent and consistent way. To take three examples (among many), on the preference side we can allow for habits and satiation, discounting of the future and an aversion to a fluctuating standard of living. On the constraint side one can allow for, for example, borrowing rates being higher than lending rates and incomplete insurance markets. Finally, on the information processing side, one can allow for the fact that new information is always arriving and has to be incorporated into current decisions.

A third advantage of the life-cycle framework that is often neglected is that it imposes the intertemporal budget constraint on saving and spending decisions. Less formal treatments often ignore this.

A fourth positive feature of the life-cycle model is that although it is a

theory of consumption and not directly of saving behavior, it does allow us to formalize many of the motives for saving that have been suggested in the literature. For example, Keynes provides a list of nine motives of which the following can be captured in relatively simple versions of the standard framework: the ‘precautionary’ motive; the ‘intertemporal substitution’ motive ; the ‘life-cycle’ motive; the ‘bequest’ motive and the ‘improvement’ motive. On the other hand, it has to be admitted that some of the other motives that Keynes and others suggest cannot be so readily rationalized within simple forms of the standard model. For example, what Keynes calls the ‘avarice’ motive (“saving to satisfy pure miserliness”) is difficult to reconcile with the standard optimizing framework and attempts to stretch it to cover this motive are probably not worth the effort.

The final attractive feature of the modern life-cycle framework is that it allows a synthesis of many life-cycle decisions. Thus it is not simply a theory of intertemporal consumption but also of education and human capital choices, marriage, fertility, labor supply and other aspects of behavior. This span makes the theory potentially very useful and general but also, of course, puts it at most risk of being invalidated. Thus if it is necessary to assume that someone has, say, a high discount rate and a strong aversion to consumption fluctuations to reconcile their observed consumption behavior with the theory, then a researcher must also use the same features when modelling their other life-cycle choices. This ‘integrity of personality’ (for example, cautious people will be cautious in all aspects of their behavior) is one of the disciplines that the general model imposes. In contrast, psychological and sociological explanations of behavior are comfortable with people

having different modes of behavior for different contexts.

We have emphasized that the standard framework is simply a way of organizing our thinking. Whether it is a useful way of organizing our thinking will, in the end, depend on whether investigators can find relatively parsimonious versions of the framework that capture all of the significant features of consumption behavior that they see in the data. If researchers do not impose the requirement of parsimony then they will always be relaxing restrictions (adding more ‘spheres within spheres’) whenever they observe some new feature, until the theory ends up explaining everything and predicting nothing. As we document below, we feel that there are areas where the standard model has been signally successful and other areas where there are still significant challenges. Our own feeling is that it will be some time yet before it will be possible to make a convincing decision on the usefulness of the standard framework.

The theoretical development of the standard model has not been accompanied by the emergence of a consensus on terminology. For example, some authors take the Permanent Income Hypothesis (PIH) and Life-Cycle Hypothesis (LCH) to refer to infinite and finite horizon models respectively (following Friedman and Modigliani-Brumberg). Other authors use PIH to indicate models with quadratic preferences. Other authors take LCH to mean forward looking, optimizing behavior generally, while other authors claim that the LCH assumes perfect capital markets. In this paper we follow Browning and Lusardi (1996) who suggest ‘standard model’ for the most general neo-classical model (in contrast to Keynesian, rule of thumb, changing preferences, or behavioral life cycle models). They then use ‘standard

additive model' for the model with additive preferences and without liquidity constraints (sometimes known as the 'pre-cautionary' model), and finally 'certainty equivalent' model (CEQ) for the standard model plus quadratic preferences.

From Hall's 1978 paper until quite recently, most of the empirical application and testing of the standard model has been based on the estimation of Euler equations. This line of research has not lived up to its promise. Such research cannot even deliver credible answers to qualitative questions (who is constrained? how important is the pre-cautionary motive? etc.) much less precise and credible estimates of preference parameters. In part this is a data problem. Aggregate time series analysis is not very useful, and to make progress likely requires the use of panel data. Unfortunately, there is very little panel data with good consumption information. Nevertheless, disappointment in the Euler equation approach also reflects fundamental theoretical issues. The promise of Euler equations seemed to be that one could do empirical work without specifying the income process (and a myriad of other factors such as expected life span and past inheritances). It is now known that except for the very special case of quadratic preferences, estimating an Euler equation requires accounting for current perceptions of future consumption risk (see Browning and Lusardi (1996), section 2.3). This amounts to (at least) specifying income processes and so the Euler equation framework does not, after all, offer any 'free' advantages in tractability. Tractability is bought at the price of strong assumptions about preferences and income processes. Perhaps this should not be too surprising: the earlier 'consumption function' approach is also much simpler with quadratic preferences. As

suggested by Muellbauer (1994), Lattimore and Muellbauer (1995) and Attanasio (1999) there seems to be a need to return to ‘consumption function’ analyses which take explicit account of future income, future consumption needs and uncertainty.

For these reasons, we eschew a lengthy discussion of the Euler equation literature. Neither do we provide a survey of the field - interested readers are directed to Deaton (1992), Browning and Lusardi (1996) and Attanasio (1999) for extensive surveys of the literature and associated references. Instead we discuss a highly selected set of issues concerning how well households ‘smooth’ consumption. In section 2 we report the ‘state of play’ on the successes and failures of the standard model, organized by smoothing at different frequencies: high (within the year); medium (year to year or across the business cycle); low (across the working life) and very low (across stages of the life-cycle). It is critical to emphasize that ‘smoothing’ in the standard model does *not* mean keeping consumption or expenditures constant; far from it. Rather, smoothing means that agents try and keep the marginal utility of money constant over time which may involve quite variable expenditures; we shall give many examples below but the most obvious example is consumption within the day - we consume at distinct times rather than grazing continuously. Our broad conclusion is that the standard model is largely successful but that there remain some significant challenges (others might characterize them as failures). The third section argues that the puzzles or failures noted in the second section point the way to several areas for future work, and outlines what we think the latter are. Section 4 concludes.

To illustrate many of the empirical issues below, we use U.K. Family Ex-

penditure Survey (FES) data. This provides a long time series (1968 to 1995 in the version used here) of cross-section information on family expenditures, income and demographics. The FES is run continuously with about 7000 households each year keeping two week diaries of their expenditures on all goods. The long time-series allows us to treat business cycle and life-cycle effects in a satisfactory way, particularly if we construct ‘quasi-panels’ (details are given below). Attanasio and Weber (1995), section 2, provides an accessible and authoritative discussion of the FES data.

2 Evidence on smoothing at different frequencies

2.1 Within the year

In considering the evidence for within year allocation it is important not to miss the forest from looking too closely at particular trees. The key implication of the simple (‘additive’) life-cycle model is that the path of consumption expenditures should be independent of the anticipated income path (except for the latter setting a budget constraint). Consider monthly expenditures. It is well known that expenditures are higher in December as compared with the rest of the year but the same is not true of income. To illustrate, in Figure 1 we plot monthly averages for the U.K. FES data from 1968 to 1995 for (log) net household income and total consumption.² Consumption in December is a good deal higher than in the rest of the year (strictly, 21% higher) whereas income then is not significantly higher than

²To construct these series we first regress log income and log total consumption (where the latter is total expenditure divided by the total expenditure price index) on year dummies and then take the monthly means of the residuals.

in the rest of the year. Note that in this illustration we have reversed the usual roles of income and consumption in that it is income that is relatively smooth and consumption that varies. This is a good example of our warning in the introduction that ‘smoothing consumption’ does not mean keeping it constant. This very robust finding that income and consumption are not highly correlated within the year is consistent with the standard model but it tends to be overlooked because it is so familiar.

There has also been a recent spate of papers considering more focussed tests of whether household spending responds to anticipated within year income changes. Using aggregate time series monthly data, Wilcox (1989) presents convincing evidence that increases in Social Security lead to increases in retail sales in the month in which the increase takes effect rather than the (somewhat earlier) month in which it is announced. Since the latter is the point at which revisions to ‘permanent income’ take place, this does not look like the behavior predicted by a standard model. Furthermore, the increase in expenditures seems to be concentrated on durables and car purchases. Indeed, Wilcox’s results suggest that a 10% increase in Social Security benefits leads to a 3% increase in durables sales; this is an astonishingly high number given that Social Security benefits constitute a relatively small fraction of aggregate disposable income. Poterba (1988) uses monthly nondurable expenditure data to examine the effects of a small number of temporary US tax ‘events’ and concludes that ‘a transitory tax-induced income increase raises consumer [non-durable] spending by roughly one fifth as much’. Unfortunately no analysis is presented of the impact on durables but if the latter relative to nondurables is anything like that found by Wilcox

effect then the marginal propensity to consume from tax-induced transitory increases is probably a good deal higher than 0.2.

Although aggregate evidence is appropriate for changes that affect a sizable proportion of the population, much can also be learned from micro studies that focus on differences between households. A number of recent papers have considered micro data based evidence on this issue; these include Shea (1995); Shapiro and Slemrod (1995); Levenson (1996); Parker (1999); Souleles (1999); Browning and Collado (2000) and Hsieh (1999). We discuss an illustrative subset of these. Shapiro and Slemrod (1995) present survey evidence on the response to a specific and temporary change in tax withholding in the US. This change involves only the timing of tax payments and had no effect on lifetime income. They found that a significant proportion of respondents reported that they would change their expenditure plans. They also found that being in the ‘over-reaction’ group is not correlated with conventional indicators for being liquidity constrained.

Souleles (1999) and Parker (1999) present evidence using U.S. Consumer Expenditure Survey (CEX) data that anticipated within year income changes are synchronized with expenditure changes. Souleles uses the receipt of income tax rebates whereas Parker uses changes in take home pay that result from the cessation of Social Security taxes within the year for higher earners. In both cases it is plausible that the income changes are anticipated. Both Souleles and Parker find significant increases on some expenditures in the months when the income increases take place. In Parker (1999) these changes are concentrated on durables and semi-durables and goods that can be postponed more than other goods. Just as for Shapiro and Slemrod (1995),

Parker does not find any evidence that those who might conventionally be considered liquidity constrained are more likely to react to the anticipated change in income.

In a paper based on Spanish data, Browning and Collado (2000) also consider within year expenditures. They exploit the fact that a majority of Spanish workers receive a double-payment bonus in June and December (this bonus is automatic and is *not* performance related). They establish that who receives the bonus is largely ‘random’. Using a Spanish consumption panel data set which follows households for up to eight quarters, they show that the expenditure paths of ‘bonus’ and ‘non-bonus’ households for durable and non-durable goods over the 12 months of the year are indistinguishable. Their conclusion is that there is no effect of receiving the bonus on expenditure patterns within the year.

Finally, Hsieh (2000) presents a Souleles-style analysis of expenditure reactions to income tax refunds in Alaska and, just like Souleles, finds that household expenditures ‘over-react’ to these. However he also shows that the *same households* do *not* ‘over-react’ to payments from the Alaska Permanent Fund that are made regularly every Fall. This seems to us an important piece of evidence. As emphasized in our introductory discussion of the life-cycle framework, one of the disciplines it imposes is that agents have to act consistently across different decisions. Hsieh suggests that the differences arise since the Fund payments are very reliable and can be used as collateral for borrowing. However, this stress on liquidity constraints is at odds with the findings discussed above that those who ‘over-react’ are not strong candidates for being constrained. Browning and Collado (2000) suggest an alternative

reconciliation of Hsieh's finding and also the mixed findings of previous investigators. The reconciliation is founded upon the fact that the within year changes in income that Browning and Collado (2000) and Hsieh (2000) exploit are large and very regular (a point emphasized by Hsieh). In contrast the changes used in other studies are relatively small and come at variable times. To expect that Spanish workers will behave every June as though their income has doubled defies belief. In this case (and for the Alaska Fund case) the costs of computing the optimal response are trivial and have large benefits, so agents do behave as predicted by the standard model. Browning and Collado suggest that agents have bounded rationality and choose not to calculate the optimal consumption response to an income change when the latter is small and variable.

This explanation is closely related to the investigations of 'near-rational' behavior (see, for example, Akerlof and Yellen (1985) and Cochrane (1989)). To illustrate the differential welfare costs of simply setting consumption equal to income rather than allowing for the variable path, we consider a simple model in which utility within the year is additive over monthly consumption with the same sub-utility function for each month. We also set the discount factor and the interest rate factor over the year to unity. Given this, the optimal monthly allocation path $(\hat{c}_1, \hat{c}_2, \dots, \hat{c}_{12})$ is to keep consumption constant over the year, $\hat{c}_t = c^*$. For a given utility function we can calculate the exact utility from such a program. For illustrative purposes we use a constant relative risk aversion (CRRA or iso-elastic) subutility function with a coefficient of relative risk aversion of 2. We then consider nonoptimal paths with the pattern implied by a failure to smooth the anticipated income changes examined

by Parker, Hsieh and Browning and Collado, and calculate the compensation an individual following such a nonoptimal path would require to have the same utility as the optimal path.³ The first path we consider is taken from Parker (1999) in which the average household stops paying a Social Security deduction of 7% at the end of September so that income is 0.93 for the first nine months of the year and 1 for the last three months. The second path is taken from Hsieh in which average household income is \$2,664 per month with an average Alaska permanent fund pay-out of \$1,648 in October. Finally, the bonus scheme in Browning and Collado (2000) has households receiving 1/14 of annual income in 10 months and 2/14 in the other two months⁴. For Parker, Hsieh and Browning and Collado the required compensation, as a percentage of annual expenditures are approximately 0.1%, 2% and 7% respectively. Thus the proportional welfare costs from ignoring the variations in income over the year are seventy times greater for the Spanish bonus system than for the cessation of Social Security contributions. To put it even more graphically, the welfare costs of ignoring the Spanish bonus system are equivalent to an annual loss of almost a month's consumption and ignoring the Alaska Permanent Fund schedule costs a week of consumption. For the Social Security pattern the annual loss is equivalent to an afternoon's consumption. With such disparate welfare costs (and the opposite pattern

³These calculations are similar to those of the cost of deviations from optimal consumption paths at business cycle frequency presented by Cochrane (1989). We calculate exact welfare costs over certain paths while Cochrane uses a convenient second order approximation.

⁴Our calculations here overstate the welfare costs of ignoring the bonus scheme since it does accommodate the extra consumption that agents make in December.

for the costs of calculating the change) it is no surprise that agents appear to take account of some paths and not of others.

Within the year then, the standard model accommodates the lack of correlation between income and consumption at monthly and lower frequencies (which, say, "rule of thumb" models do not) and does a good job in predicting households' responses to anticipated income changes which are sufficiently large so that a failure to optimize would have non-negligible costs. On the other hand, the results of Parker and of Souleles and others, are rejections of the model. To accommodate these results we must introduce notions of 'near rationality' which are admittedly not found among the usual, parsimonious, variants of the life-cycle model. We might argue that such deviations from the predictions of the model are not important, in the following sense: if they are too small for households to care about, why should researchers care about them? However, note that this argument is undermined if the deviations from the model's predictions were important for any group or purpose. For example, if governments can conduct useful fiscal stimulus within the range of tax cuts to which households do not fully respond (because the welfare gains from responding are negligible), then the findings of Souleles and Parker are quite important. Even in this case, we would argue that this body of research does not suggest an abandonment of the standard model, but rather suggests a direction in which it can be most fruitfully developed. Liquidity constraints do not appear to be an important feature, while some form of 'near rationality' perhaps is.

2.2 Year to year and business cycle

Turning to consumption over the medium run a new set of issues arise. In Figure 2 we present some evidence on consumption over the business cycle using the FES data. We plot three year running means of log non-durable consumption over the years 1969 to 1994 for three cohorts (of couples with and without children): those born between 1928 and 1935 (for the years 1968 to 1987); those born between 1936 and 1943 (for all years) and those born between 1944 and 1951 (for 1976 to 1995).⁵ As can be seen, the swings for the three cohorts are relatively synchronized with obvious peaks in 1972/74, 1978/80 and 1989/91 (albeit with different amplitudes for different cohorts). The second feature of the figure is the size of the swings; for example, from 1982/84 mean consumption for the youngest cohort rises by about 11% to the peak in 1989/91. These patterns and variations are comparable to those seen in aggregate time series data (see Attanasio and Weber (1994) for a thorough discussion of the comparability with the aggregate data).

The large common changes apparent in these data present a challenge for the standard model since there are only a limited number of possible explanations. To discuss these we use the conventional ‘log-linearized’ Euler equation; whatever one thinks about this as a basis for empirical work (see Carroll (1999) and Attanasio and Low (2000) for conflicting views) it cap-

⁵The reason for dropping the later years for oldest cohort is to exclude households in which the husband is aged 60 or over and thus avoid the issue of retirement. For the youngest cohort, we choose years so that no household with a husband aged 24 or less is included. Following Attanasio and Browning (1995) we have taken out the trend and life-cycle effects by first regressing cohort mean log consumption on (mean) demographic variables and then plotting residuals.

tures very neatly the predictions of the standard framework. Let c_t^h and \mathbf{z}_t^h represent, respectively, consumption and a vector of demographics that impact on consumption (for example, the number of children or labor supply) in period t for household h . The simple log-linearized Euler equation is given by:

$$\Delta \ln c_{t+1}^h = \beta_t + \boldsymbol{\alpha}' \Delta \mathbf{z}_t^h + \phi r_t^h + \varepsilon_{t+1}^h \quad (1)$$

where r_t^h is the real rate of interest for household h between periods t and $t+1$.⁶ The residual ε_{t+1}^h is a ‘shock’ that captures the impact of new information that becomes available between t and $t+1$; it is potentially correlated with both $\Delta \mathbf{z}_t^h$ and r_t^h which may both contain ‘news’ that shifts the marginal utility of money for household h . Importantly, this residual will not generally have a mean of zero across households in the same period; writing $\varepsilon_{t+1}^h = \tilde{\varepsilon}_{t+1}^h + \eta_{t+1}$, η_{t+1} can be thought of as a ‘macro shock’.

Each of the variables on the right hand side of the Euler equation is a candidate for a partial explanation of the large and common movements seen in figure 2. Consider, for example, an ‘exogenous’ business cycle downturn which leads to an increase in unemployment. If labor supply and consumption are complements (because of the costs of going to work and the possibility of substituting home production for market expenditures) then reduced aggregate labor supply (due to changes in the labor supply component of \mathbf{z}_t^h) will lead to a fall in aggregate consumption (even if the downturn was fully

⁶For simplicity we have absorbed the discount factor and conditional variance terms (capturing the pre-cautionary motive) into the factor β_t . We do not believe that it is currently feasible to make any reliable assessment of the role of changes in perceived risk on cyclical movements in consumption.

anticipated). Although this may be important for individual households it is difficult to believe that it can have much macro impact since cyclical unemployment hits a relatively small proportion of workers and the ‘costs of going to work’ are not a large proportion of any household’s consumption.

The posited cyclical downturn may also represent net ‘bad news’ about future prospects for workers and capitalists which will show up in the macro shock η_{t+1} . For example, the unanticipated element of the downturn will lead to revisions in ‘permanent income’ for many households which will have an effect on aggregate consumption. In Figure 3 we plot first differences in log consumption and in log income (both averaged over the cohorts in the year).⁷ It will be seen that consumption growth and income growth move together quite strongly (the coefficient in a regression of the former on the latter is 0.5 with a t-value of 6). This may appear to be a tracking of consumption with income that is too excessive for the standard model, but the changes in income contain ‘news’ to which household consumption should respond. Indeed, formal tests for ‘excess sensitivity’ using quasi-panel data typically do *not* find any evidence that consumption reacts to anticipated changes in income. However, as we discuss in the next section, the issue of how to model income processes, the persistence of income changes, and the information that agents can extract from these changes, is still very much an open question. Thus it is not yet possible to offer a convincing assessment of the compatibility of this feature of the data with the theory.

Regarding the role of the real rate, nominal interest rates on all debt and

⁷Note that the changes in consumption are annual differences so that they are not directly comparable to the three year running means of levels given in figure 2.

assets tend to move together so that there are strong common movements in r_t^h . Thus high real rates will lead to high average consumption growth (as households cut consumption in period t by either increasing saving or reducing debt). Hall (1988) reviews the evidence for the intertemporal substitution motive based on aggregate time series data and concludes that interest rate effects are weak at best. Similarly, most studies that look for interest rate effects on micro data do not find strong effects (see Browning and Lusardi (1996) for references). On the other hand, Blundell *et al* (1994), using FES quasi-panel data similar to that in Figure 2, find that once account is taken of demographic effects, consumption growth and interest rates are correlated over their data period (1970-1986). Turning to the data presented in Figure 4, one feature of the real interest rate series⁸ is that there is considerable variation in the real rate (with a low of -13% between 1974/75 and a high of almost +8% between 1985/86) so that tests for intertemporal substitution have some power. Another important feature of the real rate series is that it is negative for most of the 1970's and positive thereafter, whereas the consumption growth series does not display anything like this pattern. Consumption growth is negative in the years in which the real rate is lowest (the mid-1970's) but it also negative in the early 1990's when real rates were high.⁹ Thus intertemporal substitution does not appear to be a good candidate to explain consumption movements at longer horizons. On the

⁸To construct this series the nominal interest rate between years $t - 1$ and t we take is the end of year $t - 1$ yield on 90 Treasury Bills and the inflation rate between the two years is the proportional change in the average price level in years $t - 1$ and t .

⁹The coefficient in a regression of consumption growth on the real rate for the three cohorts in figure 2 is 0.1 with a t-value of 1.

other hand, there does appear to be some correlation between real rates and consumption growth over shorter horizons, particularly in the first half of the period. For the U.S., Parker (1999) reports that the real rate is more strongly correlated with consumption growth in recent years. A resolution of the strength of the intertemporal substitution motive requires better micro data than we currently have, but our own feeling is that the elasticity of intertemporal substitution is probably too low for most households to make intertemporal substitution a plausible candidate for explaining the patterns seen in Figures 2.

As well as common movements over the business cycle, we can also consider a much more focussed issue: do households manage to smooth over unemployment spells for one of the members ('unemployed' households, for short). This is of particular interest for 'testing' the theory since there are at least two reasons why this group might be considered the least likely to be able to 'smooth' consumption. First, current income is probably below 'permanent income' even when the unemployed worker receives Unemployment Insurance (UI) benefits. Second, unemployed households may not have access to the same credit markets as when they are employed.¹⁰ These two factors imply that unemployed households are more likely to be liquidity constrained than most other households.

Table 1 presents the distribution of changes in household income and household expenditure for a group of households in which a member moved from employment into unemployment. The data are drawn from the Cana-

¹⁰For example, anecdotal evidence suggests that labour force status is an important criteria among lenders.

dian out of Employment Panel.¹¹ The changes in income and expenditure are all self reported and refer to the change between the month just prior to the interview and the month just prior to job loss some 14-40 weeks previous. This Table has two obvious features. First, it is quite clear that some smoothing is going on. Expenditure changes are much smaller than income changes. Second, it is nevertheless true that job and income loss appears to be associated with some expenditure fall. Should this be interpreted as a failure of the standard model?

Household expenditure changes with unemployment confound three things: (1) the costs of working (that is, changes in the expenditure due to the non-separability of consumption from labor supply); (2) a response to the "permanent income" shock of job loss (again, income changes contain "news" and it is only fully anticipated income changes which should be smoothed); and (3) a response to "transitory" income changes. Only the last is inconsistent with the standard additive model and perhaps evidence of credit constraints or non-optimizing behavior.

One approach to isolating a "transitory income" response from the permanent income news and changes in costs of working associated with unemployment is to examine variation in the replacement rate of unemployment insurance. Focusing on the unemployed eliminates variation in labor force status. If an exogenous source of variation in replacement rates (that is, one that it uncorrelated with the news contained in job loss) can be identified

¹¹The Canadian Out of Employment Panel follows respondents for two years following a job loss and collects very detailed information, including information on household income, expenditures, assets and debts. See Browning and Crossley (2000) for details.

then the transitory response can be isolated. This is the approach taken by Gruber (1997) who uses variation in replacement rates across U.S states and through time, and by ourselves using a series of legislative reforms to the Canadian UI system (Browning and Crossley, 2000). Using data from the PSID Gruber finds that a ten percentage point cut in benefit levels (from 60% to 50% replacement, for example) would lead to an average fall of 2.5% in food expenditures, which is quite a small effect. We find an effect that is slightly smaller still in the COEP, with the same benefit cut leading to a fall in total expenditures of less than 1%. The cut in expenditures due to a one dollar cut in benefits implied by our results is less than seven cents (at the means of the data). Moreover, when we split the data by whether the households report having liquid assets prior to job loss, we find absolutely no effect of the replacement rate on those households who report having such assets. The largest replacement rate effect we find is for those respondents whom one would expect to be most vulnerable: those with families, but whose spouse has no labor force attachment¹², and whom had no liquid assets at job loss. Even for this group, which represents about 9% of our sample, a dollar cut in benefits leads to a fall in total expenditures of only 25 cents.

Another interesting aspect of expenditure patterns around unemployment is the role of durables. That durables are more volatile than nondurable over the business cycle is well documented (see Attanasio 1999, for example). Even more suggestive is the finding by Gruber and Dynarski (1997) that expenditures fall with unemployment by more than nondurables among low

¹²A second income in the household would likely facilitate access to credit markets.

educations households (who are most likely to be liquidity constrained). In a companion paper to the one just discussed (Browning and Crossley, 1999), we develop the idea that agents have access to 'internal capital markets' by postponing the purchase of durables during an unemployment spell. Although there is a welfare cost from not replacing a (functioning) durable at the optimal time, this is of second order importance. For example, the service flow from an old, undamaged winter coat is almost as great as that from a new one. If this is the case, then large changes in durable expenditures may not be reflected in large changes in service flows and hence welfare. This is another mechanism that breaks the chain between smoothed marginal utility, smoothed consumption and smoothed expenditures. In an empirical analysis based on the COEP (Browning and Crossley, 1999) we find that expenditures on small durables are much more sensitive to replacement rates than expenditures on food. There are two important aspects of our analysis. First, we again find this effect primarily among households without liquid assets - those who are likely to be liquidity constrained. Second, this excess sensitivity of durable expenditures is measured *conditional* on total expenditure and thus cannot be attributed to differences across goods in elasticities of intertemporal substitution or income elasticities.

To conclude this subsection, we summarize our evaluation of the standard model's ability to match year to year and business cycle patterns of consumption as follows. First, researchers still don't know enough about elasticities of intertemporal substitution or income process to credibly assess the model's ability to explain movements in consumption over the business cycle. More positively, Gruber's results, along with our own, suggest that

the standard model does a remarkably good job of describing the expenditure behavior of households across unemployment spells. What's more, our own results suggest that the deviation from the predictions of the standard model that is detectable in the data can be entirely attributed to a group of households whom are very likely to be credit constrained. Thus there is no need to invoke non-optimizing models to understand the data.

2.3 Within the working life

In this sub-section we consider smoothing within the 'working life' - that is, between the completion of schooling and retirement. We concentrate on one issue that has been a constant theme in the literature of the last 30 years: the correlation between income and consumption over this period of the life-cycle. The first paper to explicitly raise concern about the incongruence between the implications of the simplest life-cycle model and the data was Thurow (1969). Thurow noted that in U.S. cross-sectional data both income and consumption had a similar inverted U-shape with peaks of both paths occurring at a roughly similar age. In Figure 5 we present mean (log) income and consumption against age for a sample of U.K. couples (with and without children) in which the husband was born between 1936 and 1943 (so that households are aged between 25 and 32 in 1968 and between 52 and 59 in 1995 - this is the 'middle' cohort used in the previous sub-section).¹³ This pattern has been observed in many data sets (see, for example, Browning, Deaton and

¹³Cyclical and growth effects are taken out of these data. To do this, we take residuals from a regression of log income and consumption on year dummies for all households in the FES (about 200,000 households over 28 years). We then take means for the sample discussed in the text.

Irish (1985), Carroll and Summers (1991) and Attansio and Weber (1995)) and there is very widespread agreement that this ‘consumption tracking’ represents a real correlation in the world.¹⁴

The 30 year old research question is: what is the source of this correlation? A number of alternative explanations have been suggested. First, it may be that most households set current income to some constant fraction of current income (‘rule of thumb’ behavior). This is clearly not compatible with the standard framework (except under strong conditions on the income process). In contrast the four principal alternative explanations all fit within the standard framework. Thurow’s own suggestion was that households are impatient and liquidity constrained; that is, they would like to spend more than their current income when they are younger but they cannot borrow. An alternative was suggested by Nagatani (1972). He also assumes that households are impatient but instead of being liquidity constrained they are ‘prudent’.¹⁵ Prudence leads households to treat future uncertain income cautiously and not to spend as much currently as they would if the income were

¹⁴Although there is still a possibility that it reflects a sampling phenomenon. All of the studies referenced are based on ‘married’ households. Since high lifetime wealth households marry later, Browning and Ejrnæs (2000) suggest that some of the coincident rise in consumption and income in the earlier part of the life-cycle is simply due to sample selection. That is, as we follow groups from, say, age (of husband) 25 to age 40, we are gradually introducing more high income/ high consumption households.

¹⁵It is important to distinguish prudence (which is equivalent to the within period utility function having a positive third derivative) from risk aversion (a positive second derivative). For example, quadratic preferences display risk aversion but no prudence. Prudence in the consumption context leads to the pre-cautionary motive for saving. The analysis of the role of prudence in consumption and saving decisions has been one of the central themes in the literature for the last 15 years; see Deaton (1992), Browning and Lusardi (1996)) or Carroll (this JEP) for further references.

certain with a value equal to the (mathematical) mean of future income. Both the liquidity constraint and prudence explanations have difficulties explaining the simultaneous downturn in income and consumption in later working life. A third reconciliation of consumption tracking with the standard model that does take account of the latter is due to Heckman (1974). He suggested that wages have an inverted U-shape and labor supply responds positively to this (as predicted by the standard model). Consequently income also follows an inverted U-shape path. If, moreover, consumption and labor are (Frisch) complements (because there are costs of going to work and also possibilities for substituting market purchases for home production) then consumption will track income. The final explanation is that the path of children present in the household follows an inverted U-shape and this drives consumption (Tobin (1967) and Browning, Deaton and Irish (1985)). This last explanation leaves something of a mystery as to why income is then correlated with consumption.

The role of these different factors is still controversial. In a widely cited paper Carroll and Summers (1991) present evidence against the rule of thumb explanation and the Heckman rationalization (the latter requires labor supply elasticities that are higher than those found in the data) and come down in favor of impatience and prudence (in fact, the ‘buffer stock’ model of Mendelson and Amihud (1982), Deaton (1991) and Carroll (1997)) whilst remaining agnostic about the importance of children. Carroll (1994) and Hubbard, Skinner and Zeldes (1994) present evidence based on U.S. data that income processes estimated from micro-data and a precautionary motive can lead to the observed inverted U-shape for consumption without any need to account

for demographics.¹⁶ Attanasio, Banks, Meghir and Weber (1996) use a simulation model with parameter estimates from U.S. quasi-panel consumption data and find that even if there is no prudence, allowing for family size and non-separabilities with female labor supply gives a peak in consumption at the same age as observed in the data. They also find, however, that income uncertainty and a precautionary motive is needed to match the observed ratio of peak consumption to early consumption. In a closely related paper, Gourinchas and Parker (1999) argue that whilst accounting for family size can go some way to removing the ‘excessive’ correlation between consumption and income they also need to introduce a considerable precautionary motive. All of these papers agree that some precautionary motive is needed to account for the consumption tracking in the earlier part of life. In contrast, Browning and Ejrnæs (2000) find that if the numbers and ages of children is taken into account (for example, older children ‘cause’ higher expenditures than younger ones) then there is no need to invoke prudence and all of the inverted U-shape in consumption can be attributed to children. According to this view there is no need to invoke a significant precautionary motive to explain consumption tracking.

We believe that two conclusions can be drawn from the literature discussed here. First, our assessment is that the life cycle model is quite successful in explaining consumption patterns within the working life. All of the explanations given above that are still under active consideration are variants of the life cycle model. No one seems to currently feel the need to go outside

¹⁶Note, however, that the principal focus of the Hubbard *et al* paper was on consumption and asset behavior at the end of the working life.

this framework. Indeed, the Browning and Ejrnæs paper would suggest that even very simple versions of the standard model can be reconciled with the data. The second conclusion we draw is based on the fact that even when using very similar (or even identical) data (usually the PSID or quasi-panels constructed from the US CEX or the UK FES), conclusions vary. This points toward the currently available data not being very informative so that priors tend to emerge as posteriors. We shall return to this below, but it leads us to conclude that the greatest need to resolve the source of the ‘consumption tracking’ seen in the data is to collect richer data. In particular, long panels with good consumption information and information about prospective fertility plans and income expectations would allow us to control for some of the different explanations above. As Browning and Ejrnæs (2000) stress, a finding that consumption tracks income for individual households that start off with significant assets would make one skeptical of the liquidity constraint or prudence explanations.

2.4 Stages of the life cycle

At the lowest frequency, the standard model predicts that individuals should smooth across stages of the life cycle. We would expect borrowing prior to labor market entry, wealth accumulation during the working life, and dissavings in retirement. Agents should smooth consumption (in the sense of holding marginal utility constant) across the transitions from school into work, and from work into retirement. Issues around such low frequency smoothing are some of the most important current challenges to the standard model.

Beginning with the early life-cycle transitions, one might ask: why do students (who have high expected lifetime wealth) spend so little? Browning and Lusardi (2000) discuss eight possible answers, many of which can be reconciled with the standard model. Unfortunately, there is currently very little empirical exploration of these alternatives.

Turning to the transition to retirement, one is confronted with two facts. First, apparently similar households appear to reach retirement with very different wealth levels (see the evidence and earlier references contained in Bernheim, Skinner and Weinberg, 1997), and strikingly, many arrive with little or no wealth (see the evidence and earlier references in Lusardi, 2000). The second fact, which is perhaps a consequence of the first, is that a first pass at the consumption data would suggest that households fail to smooth across the retirement threshold: consumption appears to fall with retirement (Banks, Blundell and Tanner, 1998, Bernheim, Skinner and Weinberg, 1997).

Bernheim, Skinner and Weinberg (1997) investigate the heterogeneity in wealth at retirement. There are number of candidate explanations for this heterogeneity within the standard framework. However, these authors emphasize that the coherency of the standard framework means that an explanation of wealth levels must be consistent with consumption growth rates and consumption levels as well. For example, high wealth households may be households with low discount rates (that is, very patient households). Note though that the standard model implies that households with low discount rates with have high consumption growth. Thus if heterogeneity in discount rates underlies the observed heterogeneity in retirement wealth, the pre retirement consumption growth rates should be correlated with retire-

ment wealth levels. Berhneim, Skinner and Weinberg test this and a number of other candidate explanations against data on wealth, consumption growth and consumptions levels. They find that the standard model has a great deal of difficulty in explaining the heterogeneity in retirement wealth in the sense that each of the candidate explanations they consider appears to be inconsistent with either the consumption level or consumption growth patterns in the data.

Engen, Gale and Uccello (2000), on the other hand, argue that substantial heterogeneity in wealth at retirement is not inconsistent with the standard model. They emphasize that different realizations of earnings shocks will lead optimizing and *ex ante* homogeneous households to have different *ex post* wealth levels at retirement. Comparing simulations of a calibrated stochastic life-cycle model to data from the Health and Retirement Survey and Survey of Consumer Finances, they find that more than half of the households in the data have wealth-earnings ratios that exceed the median target ratio for households with the same characteristics in the simulations. However, the distribution of wealth-earnings ratios in the data has thicker tails than suggested by their simulation model, suggesting some over saving by households with high wealth-earnings ratios and undersaving by some households with low wealth-earnings ratios.

With respect to the fall of consumption with retirement, households experience a number of changes around retirement: certainly in labor supply, and mortality risk; often in their size and health status as well. That the marginal utility of consumption should depend on family size is noncontroversial, and we have good evidence that consumption is nonseparable from

labor supply (for example, Browning and Meghir, 1991). That the marginal utility of consumption should also depend on age or health status also seems very plausible. Thus there are a number of reasons why a consumption fall at retirement might be consistent with consumption smoothing. Banks, Blundell and Tanner (1998) assess the degree of smoothing across the retirement threshold, while controlling for many of the factors listed above. They find that changes in household size and composition explain part of the fall in consumption around retirement, and that changes in mortality risk and labor supply explain a further part. Ultimately, however they can only account for some two thirds of the retirement fall in consumption: the predicted fall in consumption growth is around 2 percentage points, while actual consumption growth falls by some 3 percent points around retirement. While one can argue that they may not have completely controlled for nonseparabilities, it is nevertheless difficult to believe that further nonseparabilities explain all of the residual retirement fall in consumption. This fall in consumption does appear to be inconsistent with the theory and indicative of systematic negative surprises at retirement - ‘mistakes’. Interestingly though, the unexplained dip in consumption growth is only in the years immediately around retirement (See for example Figure 3 in Banks, Blundell and Tanner.) Thus if we think the consumption fall reflects mistakes, we are forced to conclude that households suddenly realize their mistake at retirement and then optimally reallocate expenditures over the rest of life.

Some authors (Engen, Gale and Uccello, 2000) have characterized this residual fall in consumption at retirement as ‘small in economic terms’. To assess that claim, we can make the same kinds of welfare calculations as we

presented in subsection 2.1. We assume now that lifetime utility is additive over annual consumption, with the same, isoelastic sub-utility function for each year. Individuals have a working life of 40 years and an exogenous and certain period of retirement of 20 years. We set the interest rate equal to the discount rate, so that the optimal program is constant consumption. As before we take a coefficient of relative risk aversion of 2. We then calculate the compensation (increased lifetime wealth) that an individual would need so that a nonoptimal program (with consumption too high before retirement, and too low thereafter) would deliver the utility of the optimal program. We calculate that a retirement dip of the size report by Banks, Blundell and Tanner (about 1%) implies a welfare cost of 0.003% of lifetime consumption, or less than a day's consumption (spread over an entire lifetime). A retirement dip of 5% implies a welfare loss of just over a week's consumption.

Because the educated seem to have smaller falls in consumption at retirement and because many households, particularly low education households, report little or no planning for retirement (Lusardi, 2000), some authors have suggested that 'mistakes' occur because of the complexity of the planning task at low frequencies. These calculations suggest that, complexity aside, perhaps mistakes of these magnitudes just aren't costly enough for individuals to care about. On the other hand, it's important to note that the welfare loss is nonlinear in the size of the dip. A retirement dip of 20% implies a welfare loss of 0.68%, or almost half a year's consumption, and larger falls are even more costly. Banks, Blundell and Tanner report a *mean* dip, which may hide considerable heterogeneity. The failure of Engen, Gale and Uccello to fit the tails of the distribution of wealth/earnings ratios may sug-

gest that some individuals are drastically under-saving, and thus enduring considerable welfare losses. What's more, our calculations assume a constant coefficient of relative risk aversion. We think there are good reasons to believe that the poor are much more adverse to fluctuations. Thus what is needed is estimates of the distribution of consumption dips at retirement and the correlation of those dips with consumption or wealth levels. Such estimates obviously cannot be derived from pseudo panel data but only from true panel data on consumption.

Finally, we turn to the post retirement stage of the life-cycle. Many authors would view dissaving after retirement as an acid test of the standard model. The empirical evidence seems to be that while the elderly may dissave they certainly do not dissave as much as predicted by the usual variants of the standard model. Some savings in retirement may be attributable to mortality risks (Davies, 1989) or to a combination of mortality risks and risks of large medical expenditures (Palumbo, 1999). Nevertheless, Palumbo's simulations suggest that even the combination of these risks cannot slow dissaving sufficiently to match the data.

Thus issues related to low frequency smoothing are important current challenge to the standard model. Nevertheless, we believe that we have not heard the last word on these issues. There are four reasons for this belief. First, it is only very recently that researchers have begun to have access to data that is really suitable for addressing these questions (for example, panel data on the elderly to examine whether they dissave). Second, there are modelling and econometric problems that have yet to be dealt with in a completely satisfactory way (for example, we are only now beginning to

model nonseparabilities in labor supply or health, and consumption). Third, it seems to us that there is a need for more careful consideration of the institutional arrangements that affect households planning at low frequency, such as the means testing of public pensions. One fruitful step in this direction is Hubbard, Skinner and Zeldes (1994). Finally, there is not an attractive alternative model of behavior with which to interpret the data. Each feature of the data seems to require an independent "behavioral" explanation. No such explanation has the coherency of the standard model, and such explanations have not been exposed to the full range of data features in the way that Bernheim, Skinner and Weinberg have tested the standard model.

3 Future Directions.

We have surveyed the empirical evidence on consumption smoothing at different frequencies. Our assessment is that although the standard model is quite successful, there remain some significant challenges. In addition to these problems, there are a number of other challenges to the theory that don't fit naturally into our survey of smoothing at different frequencies. First, we note that portfolio choice is an important area of difficulty for the standard model. The most prominent example is the equity premium puzzle along with associated puzzles such as the low participation in share ownership and the fact that households seem to hold portfolios that are difficult to rationalize with the standard model (see, for example, Kocherlakota (1996) and Cochrane(1997)). A second area of potential difficulty for the standard model is the great heterogeneity in wealth holdings of households, even within age and income classes; see, for example, Auerbach and Kotlikoff (1987), Huggett

(1996) and Samwick (1997). An associated issue, is that the saving behavior of the very rich (who do a fair proportion of aggregate household saving) is hard to rationalize in the standard model. In this context it is worth noting that households may follow an intertemporally optimal consumption program (one satisfying the Euler equation) albeit at a level that leads to increasing wealth. Thus, the standard model may do a good job of explaining the path of consumption even if it fails badly at explaining the level.

A third area in which the life-cycle framework is lacking is in explaining cross-national differences in savings rates (see Deaton (1992) for a very thorough discussion). This was one of the original motivations for Modigliani style life-cycle models but the attempt to relate savings rates to differential population structures has not been a success. A final issue is the ability of the standard model to provide an explanation for various aggregate consumption and savings episodes in the recent past. Here the record is mixed. For example, Attanasio and Weber (1994) discuss the U.K. consumption boom in the late 1980's and provide plausible explanations that are founded in the standard framework. On the other hand, there are no widely accepted explanations for the decline in the US savings rate in the mid-1980's. Given the macroeconomic importance of this shift, a model of intertemporal allocation which fails to rationalize such aggregate movements cannot be fully satisfactory.

Despite these challenges, our view is that the standard model is just reaching its prime of life. It is important to note that the empirical testing and implementation of the standard model on *micro* data is still in its infancy. In many of the areas in which the standard model currently has problems

(for example, savings before and after retirement and portfolio choice) it is only very recently that good micro data, and in particular, panel data, has become available. There is much new data gathering and empirical analysis left to do.

In the remainder of this third section of the paper, we mention a number of directions in which we think the standard model, and in particular its empirical implementation, can be developed. We also try to draw connections between these avenues of development, and the challenges to the standard model outlined above.

Current empirical investigations of consumption patterns over the life cycle typically condition on a variety of demographic effects, such as household size and composition, or education. In section 2.3 we discussed the role of conditioning variables, particularly the number and ages of children, in explaining the hump shape in consumption over the life-cycle. The standard model's ability to explain consumption patterns at this frequency depends critically on how demographic effects are introduced (compare Browning and Ejrnaes (2000) with Gourinchas and Parker (1999)). Our view is that there is much to be gained from modelling consumption and fertility or education choices jointly. Such a research agenda has the potential both to strengthen the case for the standard model and expose yet uninvestigated shortcomings.

For example, Browning and Ejrnaes (2000) demonstrate that the life-cycle hump in consumption can be 'explained' by the time path of fertility. But this then begs the questions: why is the time path of income correlated with the time path of fertility? It may be that for real, finite lived agents, capacities for earning, fertility and consumption are driven by the same set

of biological and time constraints. For students who invest heavily in human capital (and thus postpone earnings), time constraints and increasing within period returns to investment may also make it optimal to postpone fertility. Completion of their training would then be associated with both rising income and fertility driven consumption growth, all consistent with the forward looking, optimizing behavior posited by the standard model.

On the other hand, it may well be that some households postpone fertility until they "have enough money to start a family". That is, capital market imperfections or a pre-cautionary savings motive may have more impact on households decisions regarding education or fertility than on consumption conditional on these. Jointly modeling these "conditioning variables" with consumption may uncover important aspects of the world that are difficult to discern from conditional consumption patterns alone.

A second area that seems potentially fruitful to us is theoretical and empirical work that takes proper account of the range of goods that household consume, and different properties of those goods. Some goods are durable and some are habit forming. Some goods are indivisible. Some goods must be purchased irreversibly, while for others there are well established second hand markets. Some goods are purchased for direct consumption while others are intermediate goods to be combined with labor in home production. The varied properties of different goods will lead to a variety of optimal purchase strategies, all consistent with the broad goal of smoothing marginal utility. Some optimal purchase strategies may imply quite volatile expenditures.

In section 2.2 we discussed Browning and Crossley (1999), which reports simulation evidence that forward looking, optimizing households should syn-

chronize durables purchases to income, and empirical evidence that indeed they do. Baxter and Jermann (1999) develop a model in which smooth marginal utility is associated with volatile market expenditures as households move back and forth between home production and market expenditures. In our view, examples such as these represent only a beginning in the proper modeling of the way in which households combine different kinds of goods, including durables and nonmarket time, to produce a flow of consumption.

Households face not only a rich array of goods and home production possibilities, but also a rich set of financial and real assets to hold. And just as we can point to a variety of properties of goods that will be relevant to household decision making, so too with assets. Assets differ not only in their expected financial return and riskiness, but also in their liquidity and, in the case of many real assets, the flow of consumption services they provide. Different assets are in many cases not substitutes. Researchers are only just beginning to accumulate data on the portfolios that households hold, and are nowhere near understanding why they hold them. The available assets may not only determine the portfolios that households hold, but also what goods they consume. For example, faced with illiquid assets that pay a sufficient premium, households may optimally chose to hold illiquid financial assets and smooth shortrun income fluctuations by manipulating their durables stock. We also want to emphasize that these issues are not only relevant for wealthy households. Edin (1991) and Edin and Lien (1996) have documented the rich variety of strategies that welfare mothers use to make ends meet. These include informal credit and insurance markets, the sale of durables and of home production and work in informal and underground labor markets.

The three directions just cited are tightly interwoven. Conditioning variables may be thought of a goods (children) or assets (education). Many assets are also goods (housing, durables). The central themes are that households should optimally make these choices jointly, and that optimal choices will reflect the real features of the goods and assets available to the household.

Finally we come to what may well be the most important issue: the need to allow for heterogeneity in estimation and in using empirical estimates in general equilibrium models (see Browning, Hansen and Heckman (1999) for a discussion of the latter). Heterogeneity is usually the most important feature of any analysis using micro data and usually the most difficult issue to deal with. That agents have different preferences, face different opportunity sets (whether or not these are the result of their own past choices) and have access to different information sets is uncontroversial. Since researchers are only just beginning to develop data sources and statistical methods that allow us to handle heterogeneity in a satisfactory way, they necessarily have to invoke strong homogeneity assumptions to carry out any empirical work. A major goal of any micro-empirical analysis should be to ascertain whether these assumptions are the weakest required for identification and whether they are critical (in the sense of introducing significant bias in simulations of the model at hand).

4 Conclusion

We have surveyed the empirical evidence on the life-cycle model of consumption and savings. Our assessment is that, to date, the standard model (in its common and relatively parsimonious variants) has had more successes than

failures. Indeed, it could hardly have survived as long as it has without. Where researchers have found deviations from the model's predictions that stand up to careful empirical investigation, those deviations appear to involve small welfare costs. There is no clear evidence that individuals make costly mistakes, though it is important to note that most of the available empirical results refer to average behavior.

The profession is just at the start of a systematic application of general theory models to micro-data, and thus it is much too early to abandon the standard model. The way forward is to incorporate into theoretical and empirical work appropriate allowance for heterogeneity among households, and for the specific features of the variety of goods households consume and assets they hold. Such developments may both enhance the model's ability to explain the world *and* strengthen the chance that the data will reject it.

Our concluding thought on the current status of the life cycle model is this: perhaps one need not be quite so stupid to believe it.

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References

- Akerlof, George A., and Janet L. Yellen, (1985). "A Near Rational Model of the Business Cycle with Wage and Price Inertia," *Quarterly Journal of Economics*, Supplement 1985, 100:824-38.
- Attanasio, Orazio (1999), "Consumption", in John B. Taylor and Micheal Woodford (Eds.) *Handbook of Macroeconomics*, Volume IB, chapter 11.
- Attanasio, Orazio., James Banks, Costas Meghir and Guglielmo Weber, (1999), "Humps and Bumps in Lifetime Consumption", *Journal of Economic and Business Statistics*, 17(1):22-35.
- Attanasio, Orazio, and Martin Browning, (1995), "Consumption over the Life Cycle and over the Business Cycle", *American Economic Review*, 85():1118-1137.
- Attanasio, Orazio and Hamish Low (2000), "Estimating Euler equations", mimeo, UCL, London.
- Attanasio, Orazio and Guglielmo Weber, (1994), "The UK Consumption Boom of the Late 1980s: Aggregate Implications of Microeconomic Evidence." *Economic Journal*, 104 (November):1269-1302.
- Attanasio, Orazio and Guglielmo Weber, (1995), "Is Consumption Growth Consistent with Intertemporal Optimisation? Evidence from the Consumer Expenditure Survey", *Journal of Political Economy*, 103,1121-1157.
- Auerbach, A., and L. Kotlikoff (1987), *Dynamic Fiscal Policy*, Cambridge: Cambridge University Press.
- Banks, James, Richard Blundell and Sarah Tanner, (1998), "Is There a Retirement-Savings Puzzle?", *American Economic Review*, 88(4):769-788.
- Baxter, M. and U. Jermann, (1999), "Household Production and the Excess Sensitivity of Consumption to Current Income" *American Economic Review*. 89(4):902-920.

Bernheim, B., J. Skinner and S. Weinberg, (1997), "What accounts for the Variation in Retirement Wealth Among U.S. Households?" NBER Working Paper 6227.

Blundell, R., M. Browning and C. Meghir, (1994), "Consumer Demand and the Lifetime Allocation of Consumption", *Review of Economic Studies*, 61:57-80.

Browning, Martin and Dolores Collado (2000), "The Response of Expenditures to Anticipated Income Changes: Panel Data Estimates", forthcoming, *American Economic Review*

Browning, Martin and Thomas F. Crossley (1999), "Shocks, Stocks and Socks: Consumption Smoothing and the Replacement of Durables during an Unemployment Spell", Working Paper in Economics and Econometrics No. 376, Australian National University.

Browning, Martin and Thomas F. Crossley (2000), "Unemployment Benefit Levels and Consumption Changes." Forthcoming, *Journal of Public Economics*.

Browning, Martin, Angus Deaton and Margaret Irish, (1985), "A Profitable Approach to Labor Supply and Commodity Demands Over the Life Cycle", *Econometrica*, 53:503-44.

Browning, Martin and Mette Ejrnaes, (2000), "Consumption and Children", Mimeo, University of Copenhagen.

Browning, Martin, Lars Hansen and James Heckman (1999), "Micro Data and General Equilibrium Models", in John B. Taylor and Michael Woodford (Eds.) *Handbook of Macroeconomics*, Volume IA, chapter 8.

Browning, Martin and Annamaria Lusardi (1996), "Household saving: micro theories and micro facts", *Journal of Economic Literature*, 34(4), 1797-1855.

Browning, Martin and Costas Meghir (1991), "The effects of male and female labor supply on commodity demands" , *Econometrica*, 49(4), 925-51.

Carroll, C., (1994), "How Does Future Income Affect Current Consumption?" *Quarterly Journal of Economics*, 109:111-148.

Carroll, C., (1997), "Buffer stock saving and the life cycle/permanent income hypothesis", *Quarterly Journal of Economics*, 112(1):1-55.

Carroll, Christopher (1998), "Death to the log-linearized Euler equation!", mimeo, Johns Hopkins University.

Carroll, C. and L. Summers, (1991), "Consumption growth parallels income growth: Some new evidence.", in B.D. Bernheim and J.B. Shoven, (Eds) *National Saving and Economic Performance*, Chicago University Press for NBER, Chicago, 305-43.

Cochrane, John H. (June 1989). "The Sensitivity of Tests of the Intertemporal Allocation of Consumption to Near-Rational Alternatives." *American Economic Review*, 79(3):319-337.

Cochrane, John H. (1997). "Where is the Market Going? Uncertain Facts and Novel Theories." *Federal Reserve Bank of Chicago Economic Perspectives*, 21(6):3-37. (November).

Davies, J. (1981). "Uncertainty, Consumption and Dissaving in Retirement," *Journal of Political Economy*, 89:561-577.

Deaton, A. S. (1991), "Saving and liquidity constraints", *Econometrica*, 59(5), 1221-48.

Deaton, A. S. (1992), *Understanding consumption*, Oxford: Oxford UP.

Edin, Karthryn, (1991), "Surviving the Welfare System: How AFDC Recipients Make Ends Meet in Chicago." *Social Problems*, 38(4 November):462-474.

Edin, Kathryn and Laura Lien, (1996), "Work, Welfare, and Single Mothers' Economic Survival Strategies." *American Sociological Review*, 61 (February):253-266).

Engen, Eric M., William G. Gale and Cori E. Uccello, (2000). "The Adequacy of Household Saving." *Brookings Papers on Economic Activity*.

- Fischer, I., (1930). *The Theory of Interest*. New York: MacMillan.
- Friedman, M., (1957), *A Theory of the Consumption Function*, Princeton UP for NBER.
- Gourinchas, P. and J. Parker, (1999), "Consumption over the Life Cycle", NBER working paper #7271.
- Gruber, J., (1997). "The Consumption Smoothing Benefits of Unemployment Insurance." *American Economic Review*, 87(1):192-205.
- Gruber, J. and S. Dynarski, (1997). "Can Families Smooth Variable Earnings?" *Brookings Papers on Economic Activity*. 0(1):229-84.
- Hall, R., (1978), "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence", *Journal of Political Economy*, 86(6):971-87.
- Hall, Robert (1988), "Intertemporal Substitution in Consumption", *Journal of Political Economy*, 96, 339-57.
- Heckman, J., (1974), "Life cycle consumption and labor supply an explanation of the relationship between income and consumption over the life cycle", *American Economic Review* 64:188-194.
- Hsieh, C., (1999), "Do Consumers React to Anticipated Income Shocks? Evidence from the Alaska Permanent Fund", Mimeo, Princeton.
- Hubbard, RG, J. Skinner and S. Zeldes, (1994), "Precautionary Savings and Social Insurance", *Journal of Political Economy*, 103:360-399.
- Huggett, M. (1996), "Wealth Distribution in Life-Cycle Economies," *Journal of Monetary Economics*, 38(3):469-494.
- Kocherlakota, Narayana R., (1996). "The Equity Premium: It's Still a Puzzle." *Journal of Economic Literature*, 34(1 March):42-71.
- Lattimore, R., and J. Muellbauer, (1995), "Consumption" in M. Pesaran and M. Wickens (eds), *Handboook of Applied Econometrics*, Blackwell.

- Levenson, A., (1996). "Do Consumers Respond to Future Income Shocks? Evidence from Social Security Reform in Taiwan", *Journal of Public Economics*, 62(3):275-95.
- Lusardi, A., (2000). "Explaining Why So Many Households Do Not Save." Mimeo.
- Mendelson, H. and Y. Amihud (1982) "Optimal consumption policy under uncertain income", *Management Science*, 28, 683-697.
- Modigliani, F. and R. Brumberg, (1954), "Utility analysis and the consumption function: an interpretation of cross-section data", in Kurihara, K., (ed.) *Post-Keynesian Economics*, Rutgers UP, New Brunswick, NJ, 388-436.
- Muellbauer, (1994), "The Assessment: Consumer Expenditure" *Oxford Review of Economic Policy* 10(2):1-41.
- Nagatani, K., (1972), "Life Cycle Saving: Theory and Fact", *American Economic Review*, 62, 344-53.
- Palumbo, Micheal, (1997). Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle," *Review of Economic Studies*, 66(2):395-421.
- Parker, Jonathan (1999), "The reaction of household consumption to predictable changes in payroll tax rates", *American Economic Review*. 89(4):959-973.
- Parker, Jonathan (2000), "Spendthrift in America? On two decades of decline in the U.S. saving rate." in Ben S. Bernanke and Julio Rotemberg, (Eds.) *NBER Macroeconomics Annual 1999*. MIT press.
- Poterba, J., (1988), "Are Consumer's Forward Looking? Evidence from Fiscal Experiments", *AEA Papers and Proceedings*, 413-418.
- Ramsey, F., (1928), "A Mathematical Theory of Saving", *Economic Journal* 38:543-559.
- Samwick, A. (1997), "Discount Rate Heterogeneity and Social Security Reform," mimeo, Dartmouth College

Shapiro, M. and Slemrod, J., (1995), "Consumer Response to the Timing of Income: Evidence from a change in Tax Withholding", *American Economic Review*, 95((1):274-283.

Shea, J., (1995), "Union Contracts and the Life-Cycle/Permanent Income Hypothesis", *American Economic Review*, 95((1):186-200.

Souleles, N., (1999), "The Response of Household Consumption to Income Tax Refunds" *American Economic Review*. 89(4):947-958.

Strotz, R., (1956), "Myopia and inconsistency in dynamic Utility maximization", *Review of Economic Studies*, 23:165-80.

Thurow, L, (1969), "The optimum lifetime distribution of consumption expenditures" *American Economic Review*, 59, 324-30.

Tobin, J., (1967), "Life-cycle savings and balanced growth" in W. Fellner et al (eds) *Ten Economic Studies in the Tradition of Irving Fisher*, New York.

Wilcox, D., (1989), "Social Security Benefits, Consumption, Expenditure and the Life Cycle Hypothesis.", *Journal of Political Economy*, 97(2):288-304.

TABLE 1: Income and Expenditure Changes with Unemployment				
Percentile	10th	25th	50th	75th
household income	-1500	-800	-400	0
household expenditure	-700	-300	0	25
Note: 'Percentile' refers to the position of the household in the 'expenditure change' distribution.				

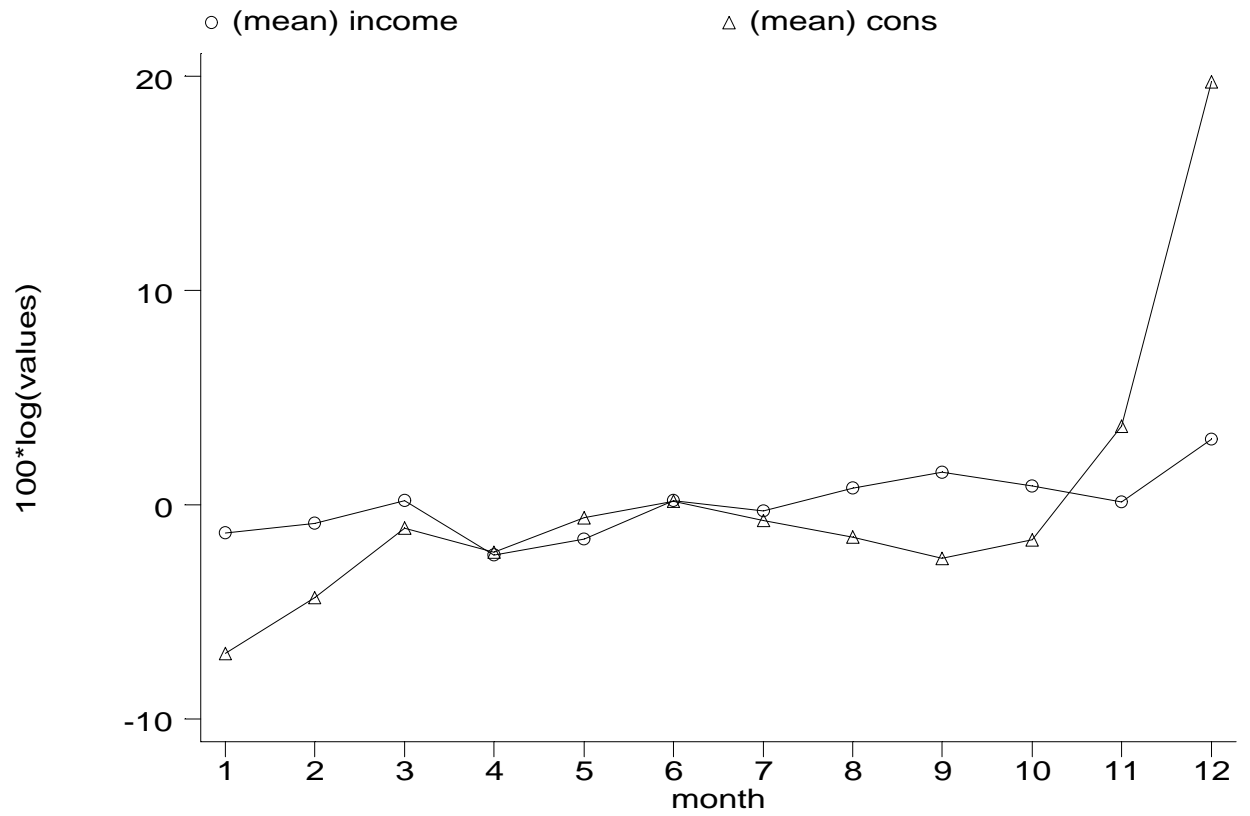


Figure 1: Seasonal patterns of income and expenditures.

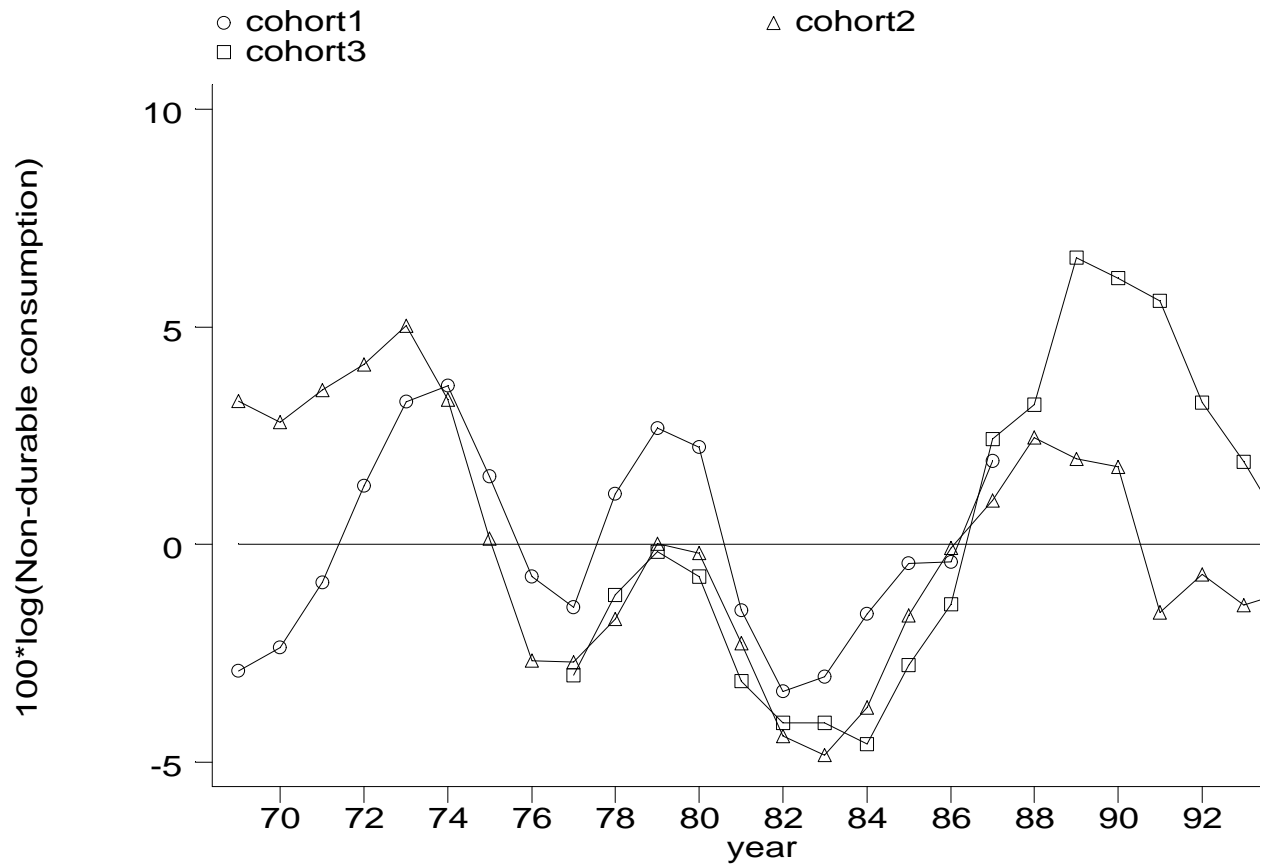


Figure 2: Business cycle patterns of consumption growth.

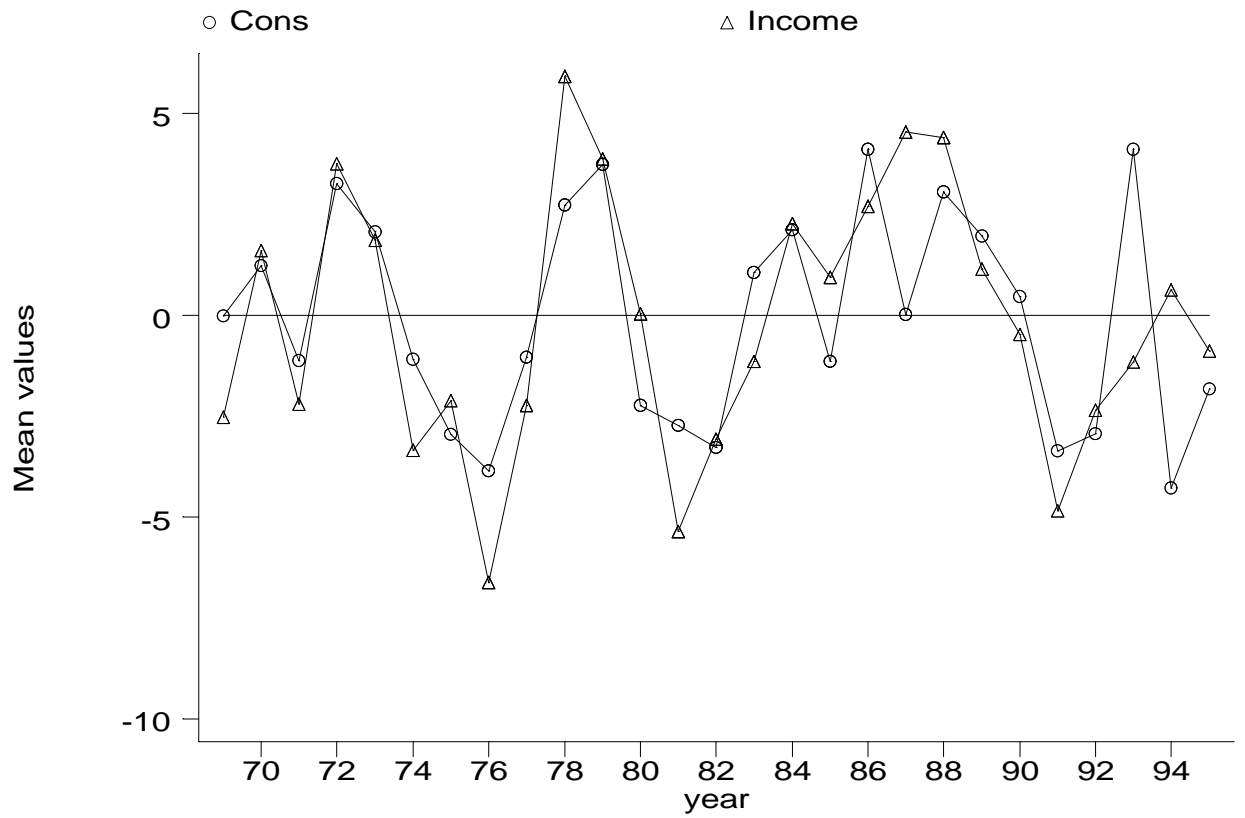


Figure 3: Consumption growth and income growth over the business cycle.

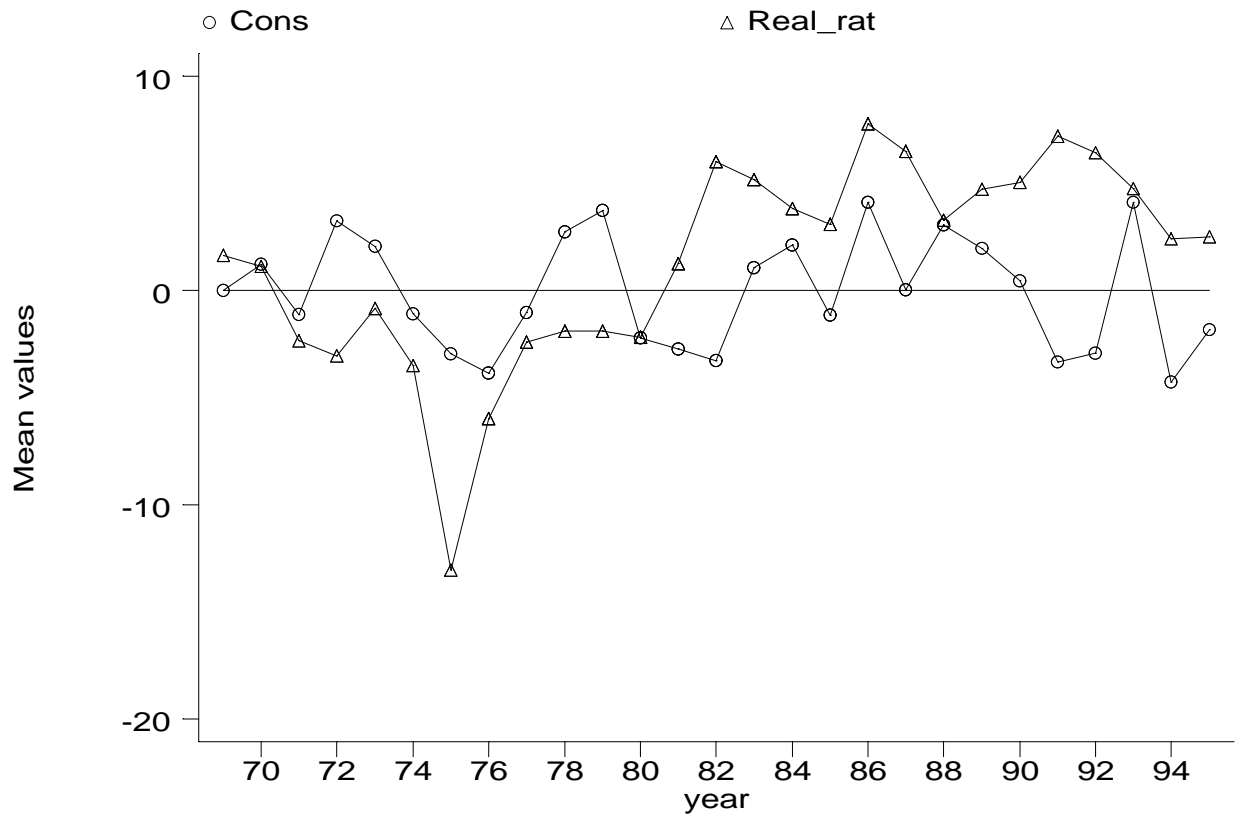


Figure 4: Consumption growth and real rates over the business cycle.

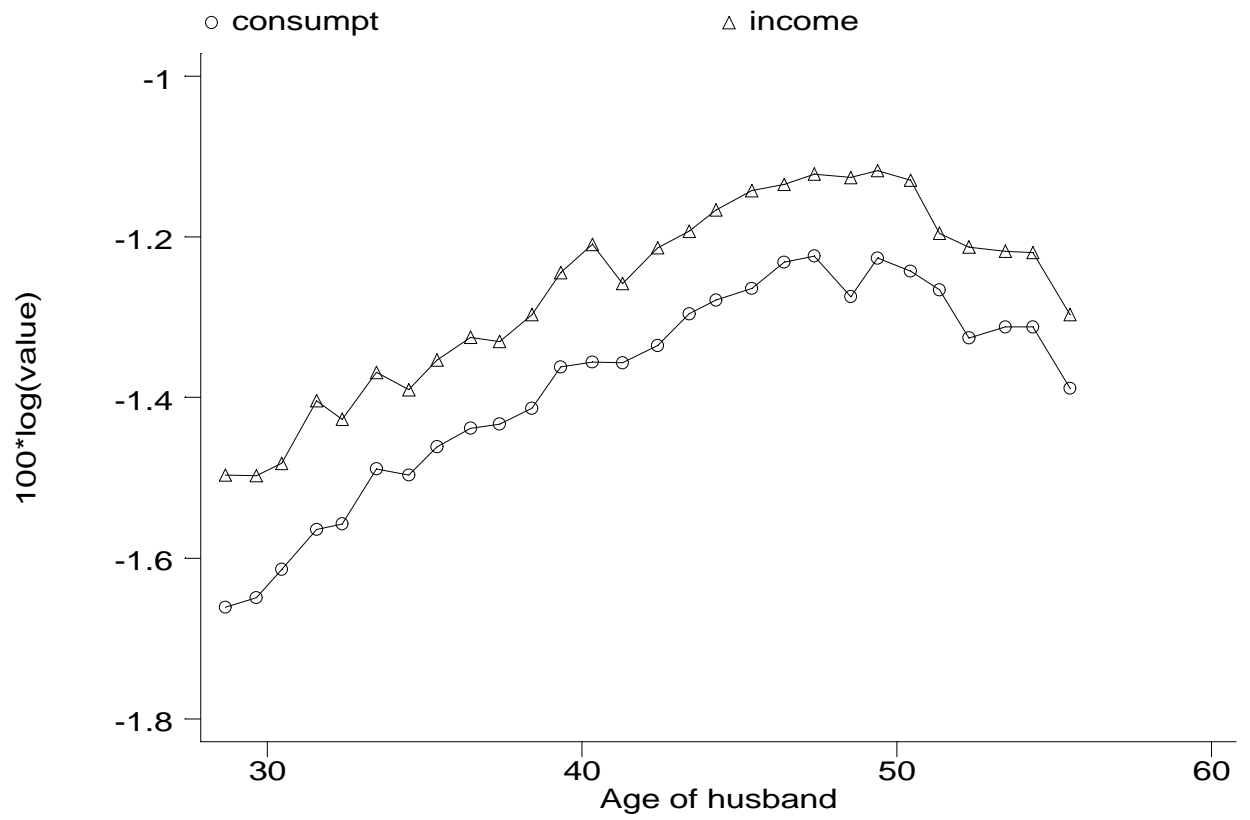


Figure 5: The life-cycle pattern of income and consumption.

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