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Life Cycle Time Allocation and Saving in an Imperfect Capital Market

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Abstract

This paper combines income and expenditure with time use data to provide a unique picture of the time paths of labour supplies, saving and full consumption for two-adult households over the life cycle. These data are used to test the life cycle model presented in the paper, at the core of which is the hypothesis that households face a borrowing interest rate that rises sharply with the amount of non collateral based borrowing. The household members jointly choose time paths of time use, consumption and saving over their life cycle in the face of this capital market imperfection. This model explains the data much better than does the alternative hypothesis of a perfect capital market. Finally, households are shown to differ significantly in their saving behaviour in a way that depends on secondary earner labour supply, with a strong positive association between saving and the secondary earner's income.

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1 Introduction

Perhaps the defining characteristic of the standard model of consumption choice over the life cycle[1] is that the income generation process is essentially exogenous to the household. As Heckman (1974) showed, if this assumption is relaxed, by introducing a leisure variable that is *not* separable from consumption in the household utility function, the great, central "puzzle" of the literature based on this model - why current consumption tracks current income so closely in the data - is rather easily resolved. Nonetheless, a controversy continues over how to resolve this puzzle within a model that takes the only household decision variables to be its dated consumptions, with its income stream treated as exogenous.

The leading contenders for resolution of this (model-contingent) puzzle seem to be precautionary or buffer-stock saving,[2] liquidity constraints in the extreme form of the complete absence of borrowing possibilities,[3] and demographic effects, especially the presence of children.[4] The first of these argues that, to avoid the consequences of adverse random shocks to income in the future, households in the earlier phase of the life cycle build up buffer stocks of assets, and then, in their mid-forties to fifties, begin accumulating savings for retirement and possibly for bequests. This approach seems to be capable of fully explaining the data on household expenditure and saving, in particular the tendency for consumption to track income in the early phase, while leaving virtually no explanatory role for liquidity constraints on the one hand, and demographic factors on the other. Indeed, the theory implies that liquidity constraints, even if they exist, are non-binding, because the household does not wish to borrow, being completely deterred by the risk that its future income will fall below the level that would enable it to repay its debt. Under absolute no-borrowing constraints, an impatient household's current consumption will be constrained by its income and so will track it over time. As opposed to the buffer stock model, households do

[1]For a comprehensive survey of the theory and evidence on this model see Deaton (1992). Browning and Lusardi (1996) provide a more concise survey of saving behaviour. Browning and Crossley (2001) and Carroll (2001) give shorter surveys of recent work.

[2]See for example Carroll (1994), and Gourinchas and Parker (2002). These references are meant to be representative rather than exhaustive.

[3]See for example Deaton (1991).

[4]See for example Attanasio, Banks, Meghir and Weber, (1999), Blundell, Browning and Meghir (1994), and Browning and Ejrnaes (2002).

not borrow because they cannot, not because they do not want to. Finally, the demographics approach suggests that if consumption is deflated for family size, it shows the relatively flat time profile consistent with the permanent income hypothesis, under which a household uses the perfect capital market[5] to decouple its consumption and income streams in such a way as to maintain constancy of its discounted marginal utility of income over time.

In his recent survey, Carroll remarks that the development of the precautionary savings model brings the life cycle model back to its roots in the work of Milton Friedman in the 1950's.[6] Friedman's analysis was called into question by the results of the models of the 1970's and 80's, based on explicit intertemporal optimization under uncertainty. Carroll argues convincingly that in fact Friedman's intuitions were more closely consistent with the data, and that the recent precautionary savings models provide a superior theoretical underpinning for these intuitions.

However, we should take notice of the fact that one of the single most important socio-economic developments in the forty-five years or so since Friedman's work, has been the large expansion in female labor force participation, with its far-reaching implications for the household's labor supply and income generation process.[7] The point which motivates the present paper is that it no longer makes any sense, if it ever did, to take the household's labour income as exogenous.

As long as models of consumption choices are estimated solely on the type of income and expenditure data available in family expenditure surveys, it does not seem possible to reject the claims made by any of the parties in contention just discussed.[8] However, when we expand the data set to include the household's time allocation and labour supply decisions, as this

[5]By which we mean one in which the interest rate is the same for borrowing and lending, is invariant to the amount borrowed or lent and to the identity of the economic agent, and has no quantity restrictions of any kind.

[6]Though it may be worth noting that Keynes also identified the precautionary motive as an important reason for saving. It is the first on his list of the motives for saving, see p.107 of Keynes (1936).

[7]Interestingly enough though, Friedman (1957), in defining his Permanent Income Hypothesis, is careful to refer to the "earners" in his "consumer unit" in the plural. This is perhaps because he does not derive his hypothesis from an explicit model of the utility maximising household. Ando and Modigliani (1963), on the other hand, in the formulation of their Life Cycle Hypothesis, do so, and so treat the household as a single individual, which tradition has been followed in the literature ever since.

[8]This seems to be the conclusion of Browning and Ejrnaes (2002).

paper does, we see that, precisely because of the importance of female labor supply in the modern household, the assumption of an exogenous process of household income determination is no longer sustainable. In other words, possible exogenous uncertainty in the income of the primary household earner may be small beer compared to the variations in household income generated by *endogenous* choices of secondary earner labour supply. This leads to a model which integrates life cycle choices of time allocation, labour supply and consumption.

In following up this approach, we do incorporate elements of both demographics and capital market imperfections. Decisions on female labour supply are closely related to the presence of children and the choice of sources of supply of child care. Moreover, it seems possible to explain the data only by assuming some kind of capital market imperfection, though our data do not support the extreme assumption of no borrowing. Also, we certainly would not rule out the possibility that some saving could be precautionary in nature, but do not believe, from our inspection of the data, that this can be anything like a complete explanation of household consumption behaviour over the life cycle.

An important feature of our modelling approach is the characterisation of the life cycle not in terms of calendar years, but rather in terms of six phases, through which a typical family goes over its lifetime. Essentially we are saying that the important differences between households at different stages of the life cycle are not captured sufficiently sharply by differences in calendar age of the head of the household, but rather depend more on whether or not they have children, and on what stage the children are at. By organising the data in this way we are trying to bring out more clearly than in the exisiting literature the effects of children on the time allocation and labour supply decisions of the household, and, through that, on its income stream and saving decisions. Thus, we argue that the time paths of saving and consumption of market goods reflect the movements in household income that are determined by changes in female labour supply over time, which in turn are determined by the process of substitution between market and household work associated with bringing up children.[9] We then go on to

[9]This bears a superficial resemblance to the model of Baxter and Jermann (1999). They explain the tendency for consumption of market goods to track income by arguing that as the wage rate rises over the life cycle, goods produced in the household (of which the most important is surely child care) become more expensive, and therefore substitution toward market goods takes place. In a sense they are spelling out a source of the non-

argue that the data strongly suggest that some form of imperfect capital market assumption is indispensable to explaining what happens to household consumption, saving, labor supply and leisure in the early stages of the life cycle. There may appear to be some evidence of "precautionary" saving, in the form of a high level of household saving before the advent of children, but this would be better characterized as "anticipatory" saving. In anticipation of the major impact that the arrival of children will have on family resources, and faced with a capital market that does not offer unsecured loans at a reasonable interest rate, young households save at a higher rate than at any other time in their lives.

Furthermore, the data indicate that households exhibit very considerable heterogeneity in their consumption, labour supply and saving decisions, within and across phases of the life cycle. In particular, saving behaviour depends very closely on female labour supply. For example, households with no significant female labour supply do virtually no saving once they have children, other than that involved in house purchase and superannuation schemes. This must imply a rejection of the precautionary saving model, since there is no reason to believe that such households are faced with any less income risk than two-earner households.[10]

The paper is structured as follows. In the next section we present two models of the household's decisions on consumption, saving and time allocations over the life cycle, which assume respectively perfect and imperfect capital markets. We go on to formulate empirical versions of these models in Section 3. Section 4 then presents empirical life cycle profiles of consumption, saving, labour supply and domestic work, obtained by combining information on income, household expenditure and time use. The results suggest a pattern of full consumption[11] over the life cycle that is very different from that obtained by studies of expenditure on market goods alone. Section 5 presents parameter estimates for the within-period demand system and com-

separability between consumption (of market goods) and household non-labour time that was the basis for Heckman's (1974) contribution. However, the problem with this theory is that the domestic production is carried out predominantly by the female, whose wage does not rise - if anything it tends to fall - over the life cycle. It is important to model two-person households, as we do here.

[10]Indeed, to the extent that there is a negative covariance between primary and secondary earners' incomes, their aggregate income could be less risky, in the sense of second order stochastic dominance, than that of a single earner household with the same expected value of total income.

[11]Defined as the value of consumption of market and domestically produced goods.

pares simulated consumption profiles for the perfect and imperfect capital market models in terms of how well they predict the data. As we would expect, the perfect capital market model predicts a smooth profile for adult consumption that in no way matches the data. We then show that the life cycle profiles of consumption and leisure can be closely approximated by the imperfect capital market model. Section 6 concludes.

2 The Models

The household has a lifetime of $T+1$ periods, with $t = 0, 1, ..., T$ denoting the period. As outlined above, we distinguish six phases of the household's life cycle, which form a partition of the set of time periods:

- $\phi_1 = \{0, .., \tau_1\}$: the two-person household has no children;
- $\phi_2 = \{\tau_1 + 1, .., \tau_2\}$: there are children of pre-school age;
- $\phi_3 = \{\tau_2 + 1, .., \tau_3\}$: the children are in primary school or early high school years;
- $\phi_4 = \{\tau_3 + 1, .., \tau_4\}$: the children are at high school or have left school;
- $\phi_5 = \{\tau_4 + 1, .., \tau_5\}$: the children have left home, both adults are of working age;
- $\phi_6 = \{\tau_5 + 1, .., T\}$: the adults are retired, receive a pension and may supply market labour.

Household types are indexed by $h = 1, ..., H$, and differ according to the value of the domestic productivity parameter k_h.

The household maximises its utility over its lifetime

$$u_h = \sum_{t=0}^{T} \rho^t \sum_{i=1}^{K} \varphi_{ih} u_i(x_{iht}, y_{iht}, z_{iht}; \phi_j) \qquad (1)$$

where ρ is a time preference discount factor, x is consumption of the market good, y is consumption of the domestic good, z is consumption of pure leisure. The distributional weights φ_{ih} sum to one, are taken as fixed throughout, and reflect the hypothesis that the household seeks a Pareto efficient allocation of its resources. The individual utility functions u_i are strictly increasing in the consumption goods and leisures and are strictly quasi concave. Households are assumed to have identical preferences in any given phase of the life cycle. The phase indicator ϕ_j, $j = 1,..,6$ allows for changes in preferences across phases.

In phases 1, 5 and 6 there are no children in the household. The index $i = 1, 2$, always refers to adults. In phases 2, 3, and 4, there are $K - 2 > 0$ children in the household, and their utility functions are therefore included in u_h in these phases. We can think of setting $\varphi_{ih} \equiv 0$ for $i > 2$ in the childless phases. u_h is clearly a simple form of "social welfare function" for the household, *i.e.* a *household welfare function.*

Each individual i has the time constraint[12]

$$a_{iht} + l_{iht} + z_{iht} = A \quad h = 1,..,H \quad t = 0,...,T \tag{2}$$

where l denotes a market labour supply, a the supply of labour to domestic production and A is total available time. The production functions of the household good are

$$\sum_{i=1}^{K} y_{iht} \equiv y_{ht} = f(a_{1ht}, a_{2ht}; k_h) \quad h = 1,..,H \;\; t = 0,...,T \tag{3}$$

and are assumed to be linear homogeneous and strictly quasi concave. We now consider the alternative models.

2.1 Model 1: A Perfect Capital Market

There is a single market interest rate at which all households borrow and lend, and which is invariant to the amounts borrowed or lent. The budget constraints in each period are then

$$\sum_{i=1}^{K} x_{iht} + s_{ht} = \sum_{i=1}^{2} w_{it} l_{iht} + (1+r)s_{h,t-1} + P_t \quad t = 0,...,T \tag{4}$$

$$s_{hT} = 0; \;\; s_{h,-1} = 0 \tag{5}$$

where w_{it} is i's net of tax market wage at t (we thus allow the possibility of changes in the wage over time), s_{ht} is saving (> 0) or dissaving (< 0)

[12]For children, $l_{iht} = a_{iht} \equiv 0$, although we realise that children often do household chores, and may well supply labour to the market (especially in developing countries). This is just a useful simplification in the present context.

at $t = 0, 1, ..., T$, $P_t \geq 0$ is a lump sum government transfer in each period, which in the retirement phase is the pension payment, and r is the one-period market interest rate, assumed constant over time. To be consistent with the assumption that there is no bequest motive, which implies saving at zero in the last period of life, we also assume there is no inherited wealth, so that assets are also zero at the beginning of period 0. These constraints can be collapsed in the usual way into the wealth constraint

$$\sum_{t=0}^{T} \delta^t [\sum_{i=1}^{K} x_{iht} - \sum_{i=1}^{2} w_{it} l_{iht} - P_t] = 0 \tag{6}$$

where $\delta = (1+r)^{-1}$ is the market discount factor.

The household maximises (1) subject to (2), (3) and (6). The first order conditions (assuming only interior solutions) for this are

$$\rho^t \frac{\varphi_{ih} \partial u_i}{\partial x_{iht}} - \lambda_h \delta^t = 0 \quad i = 1, .., K \; t = 0, .., T \tag{7}$$

$$\rho^t \frac{\varphi_{ih} \partial u_i}{\partial y_{iht}} - \mu_{ht} = 0 \quad i = 1, .., K \; t = 0, .., T \tag{8}$$

$$\lambda_h w_{it} \delta^t - \pi_{iht} = 0 \quad i = 1, .., K \; t = 0, .., T \tag{9}$$

$$\rho^t \frac{\varphi_{ih} \partial u_i}{\partial z_{iht}} - \pi_{iht} = 0 \quad i = 1, .., K \; t = 0, .., T \tag{10}$$

$$\mu_{ht} \frac{\partial f}{\partial a_{iht}} - \pi_{iht} = 0 \quad i = 1, .., K \; t = 0, .., T \tag{11}$$

together with the constraints. Here λ_h is the household's marginal utility of wealth and the μ_{ht}, the Lagrange multipliers associated with the production function constraints, give the discounted marginal utility of the domestic output. The π_{iht} are the Lagrange multipliers associated with the time constraints (2).

We see from (7) that the marginal utility of consumption of the market good, weighted by the ratio of discount factors $(\rho/\delta)^t$, must be constant over time, and equal to the marginal utility of wealth, but since this marginal utility of market good consumption is in general a function of the consumption of both market and household goods, as well as leisure, this does not imply constancy of the time path of market consumption, even within a given phase ϕ_j. The optimal consumption paths depend on the implicit price of the domestic good (recall the market good is numéraire). Thus, define

$$p_{ht} \equiv \frac{\mu_{ht}}{\lambda_h \delta^t} = \frac{w_{it}}{\partial f / \partial a_{iht}} \tag{12}$$

as the *current value implicit price* of the domestic good, which is equal to the undiscounted marginal cost of the domestic good. In general this will depend on the level of output of the domestic good, as well as on the after-tax wage rates and the marginal productivities, which in turn depend on the productivity parameters k_h. The first two conditions then yield the standard condition for within-period consumption choices

$$\frac{\partial u_i/\partial y_{iht}}{\partial u_i/\partial x_{iht}} = p_{ht} \tag{13}$$

The time paths of consumption of both goods will depend on how this price varies over time, as well as on how preferences for market and household goods change between phases in the model in which within-phase parameters are allowed to vary across phases. Differences across households in this price will lead to differences both in their within-period time and consumption allocations and in their time profiles of consumption, even given identical within-phase preferences across households . At given wage rates, a household with higher productivity in household production will have a lower value of this price and therefore will have a higher demand for domestic output, assuming this is not a Giffen good. This does not necessarily imply that this household will have a higher domestic time input - lower market labour supply - however, because higher productivity implies that a given domestic output can be produced with a smaller time input. Thus we cannot say *a priori* that households with higher (lower) female labour supplies are those with higher (lower) productivities in domestic production.[13]

The conditions (7) - (11) assume no corner solutions, and in particular (9) rules out (except trivially) households with a zero market labour supply.[14] For these however we simply have the condition

$$w_{it} \leq \omega_{iht} \tag{14}$$

where $\omega_{iht} \equiv \pi_{iht}/\lambda_h \delta^t$ is the current money value of foregone leisure and the implicit price of the household good is defined as

$$p_{ht} \equiv \frac{\mu_{ht}}{\lambda_h \delta^t} = \frac{\omega_{iht}}{\partial f/\partial a_{iht}} \tag{15}$$

[13] For further discussion, see Apps and Rees (1999).

[14] Such corner solutions may of course be especially relevant in the retirement phase. Note however that in the data, earnings from market labour supply are still positive for many households in the retirement phase.

Then, condition (13) still applies, with the implicit price of domestic output now determining the time paths of consumption of the market and household goods and leisure.

It will be useful for what follows to reformulate this model, by exploiting the separability between within-period and across period decisions. First, in each period $t = 0, ..., T$, for any given output of the domestic good the household chooses its allocations of time inputs to solve:

$$
\begin{aligned}
minC_{ht} &= \sum_{i=1}^{2} w_{it} a_{iht} && (16)\\
s.t.\ \ y_{ht} &= f(a_{1ht}, a_{2ht}; k_h) && (17)
\end{aligned}
$$

yielding, because of the linear homogeneity assumption, input demand functions $a_{iht}(w_{1t}, w_{2t,}y_{ht}; k_h)$, and total cost functions $p_{ht}(w_{1t}, w_{2t}; k_h)y_{ht}$, with p_{ht} the implicit price of the household good. Defining c_{ht} as total consumption expenditure in each period, and taking this as fixed for the moment, the household solves its within period allocation problem

$$
\begin{aligned}
max \sum_{i=1}^{K} \varphi_{ih} u_i(x_{iht}, y_{iht}, z_{iht}; \phi_j) &= u_{ht} && (18)\\
s.t.\ \ \sum_{i=1}^{K} x_{iht} + p_{ht} y_{ht} + \sum_{i=1}^{2} w_{it} z_{iht} &= c_{ht} && (19)
\end{aligned}
$$

yielding demand functions

$$x_{iht}(p_{ht}, w_{1t}, w_{2t}, c_{ht}; \phi_j, \varphi_{ih}),$$
$$y_{iht}(p_{ht}, w_{1t}, w_{2t}, c_{ht}; \phi_j, \varphi_{ih}),$$
$$z_{iht}(p_{ht}, w_{1t}, w_{2t}, c_{ht}; \phi_j, \varphi_{ih}),$$

and an indirect utility function

$$u_{ht}(p_{ht}, w_{1t}, w_{2t}, c_{ht}; \phi_j, \varphi_{ih}).$$

Note that a fully equivalent way of generating these demands is by assuming that the household in each time period first shares its income among its members, who then solve their individual utility maximisation decisions subject to budget constraints defined on these income shares.[15] This is in fact the approach adopted in the empirical analysis below, in section 4.1.

It is convenient to suppress the prices and wages, which are exogenously given throughout, in the indirect utility function, as well as the distributional weights, and to write it as $v_{ht}(c_{ht}; \phi_j)$.

[15] See Apps and Rees (2002) for the details of this formulation in a multi-person household with children.

The household then solves its intertemporal optimisation problem

$$\begin{aligned} max u_h &= \sum_{t=0}^{T} \rho^t v_{ht}(c_{ht}; \phi_j) && (20) \\ s.t.\ c_{ht} &= A \sum_{i=1}^{2} w_{it} + (1+r)s_{h,t-1} - s_{ht} + P_t \quad t = 0, ..., T && (21) \\ s_{hT} &= 0 \quad s_{h,-1} = 0 && (22) \end{aligned}$$

Given the assumptions on $u(.)$ and $f(.)$, it is straightforward to show that the solution to this three-stage procedure is precisely that given by conditions (7)-(11).

2.2 Model 2: An Imperfect Capital Market

There is clearly a range of possibilities in modelling an imperfect capital market. As a minimum, we would postulate that the interest rate on saving would be below that on borrowing. An extreme version of an imperfect capital market would have an upper bound on borrowing, possibly set at zero, as for example in Deaton (1992). However, the following formulation would seem both more realistic and consistent with the data we have. All households face the same saving interest rate r_s, and a borrowing rate r_{ht} which is an increasing function of the amount borrowed, $b_{ht} \geq 0$, such that

$$r_{ht} = r(b_{ht}) \quad r^{'}(.) > 0, \quad r^{''}(.) \geq 0 \tag{23}$$

and

$$b_{ht} > 0 \Rightarrow r_{ht} > r_s \tag{24}$$

for all h, t. Thus households can borrow, but at an increasing interest rate that is always higher than the lending rate. There is no capital rationing in the sense of an absolute upper bound on borrowing, but of course the function may increase very sharply and $b^{'}(.)$ could approach infinity asymptotically. Realistically, this borrowing function could vary across time and could also contain as arguments the household's income and/or assets, reflecting its default risk and ability to put up collateral for loans. However, on grounds of tractability we stay with this simple formulation. Its implication is that in equilibrium households may face different borrowing rates at the margin, and these rates may vary across periods, depending on the household's borrowing in each period. Fortunately the data set we have allows us to handle this in the estimation procedure.

The utility function, time and household production constraints remain unchanged. We just have to reformulate the household's budget constraints. We now let s_{ht} denote saving alone. We then have

$$\begin{aligned} c_{ht}+s_{ht}-b_{ht} &= A\sum_{i=1}^{2}w_{it}+(1+r_s)s_{h,t-1}-(1+r_{h,t-1})b_{h,t-1}+P_t & (25)\\ s_{hT} &= 0=s_{h,-1} & (26)\\ b_{hT} &= 0=b_{h,-1} & (27)\\ b_{ht} &\geq 0,\ \ s_{ht}\geq 0\ \ all\ h,t & (28)\end{aligned}$$

The key point is to note that in the three-stage solution procedure just set out for Model 1, the first two stages remain unchanged in the present model. That is, the within-period problems are identical. Thus we can focus on the intertemporal problem

$$maxu_h=\sum_{t=0}^{T}\rho^t v_{ht}(c_{ht};\phi_j) \quad (29)$$

subject to the constraints (25) to (28).

Associating Lagrange multipliers λ_{ht} with the constraints (25), the first order (Kuhn Tucker) conditions (assuming full consumption is always positive) are

$$\begin{aligned} \rho^t\frac{\partial v_{ht}}{\partial c_{ht}}-\lambda^*_{ht} &= 0 & (30)\\ (1+r_s)\lambda^*_{h,t+1}-\lambda^*_{ht} &\leq 0\ \ s^*_{ht}\geq 0\ \ [(1+r_s)\lambda^*_{h,t+1}-\lambda^*_{ht}]s^*_{ht}=0 & (31)\\ \lambda^*_{ht}-m^*_{ht}\lambda^*_{h,t+1} &\leq 0\ \ b^*_{ht}\geq 0\ \ [\lambda^*_{ht}-m^*_{ht}\lambda^*_{h,t+1}]b^*_{ht}=0 & (32)\end{aligned}$$

together with the constraints. Here $m^*_{ht}\equiv 1+r(b^*_{ht})+r'(b^*_{ht})b^*_{ht}$ is the *marginal cost of borrowing* to household h at time t, and $r^*_{ht}=r(b^*_{ht})$ can be called the household's *marginal borrowing rate.* Asterisks denote values at the optimum. We can immediately establish the intuitively reasonable[16]

[16]Though of course the data have households both saving, through compulsory superannuation payments and financing house purchase, and borrowing short term. The former can best be thought of as exogenous amounts that are subtracted from income in the preretirement phases, and added back in to P_t in the retirement phase, before the household solves its intertemporal optimisation problem. Overall this situation of "lending long" and "borrowing short" can be thought of as a further expression of the imperfection of the real capital market.

Lemma: *The household never both saves and borrows in the same time period.*

Proof: Suppose not, so that $s^*_{ht} > 0$, $b^*_{ht} > 0$, for some t. Then the first order conditions imply

$$(1 + r_s)\lambda^*_{h,t+1} = \lambda^*_{ht} = m^*_{ht}\lambda^*_{h,t+1} \tag{33}$$

But this contradicts the assumption that $r^*_{ht} > r_s$ and $r^{'}(.) > 0$.

Figure 1 illustrates the nature of the solution. Point γ is the initial endowment point. The household may lend from there at a constant interest rate r_s to reach an equilibrium at a point such as α, characterised by the first order condition

$$\frac{\partial v_{ht}/\partial c_{ht}}{\rho\partial v_{h,t+1}/\partial c_{h,t+1}} = 1 + r_s \tag{34}$$

Alternatively, according to its preferences, the household may borrow along the curve rightward from γ to reach equilibrium at a point such as β, characterised by the condition

$$\frac{\partial v_{ht}/\partial c_{ht}}{\rho\partial v_{h,t+1}/\partial c_{h,t+1}} = m^*_{ht} \tag{35}$$

where m^*_{ht} is the slope of the curve at the optimal point. Clearly household borrowing will be less than if it were possible to borrow at a constant rate equal to r_s (as indicated by the broken line). Our contention is that this reduced borrowing accounts for the large reduction in female labour supply and leisure in the second phase of the household's life cycle.

Figure 1 about here.

3 Empirical Specification

A number of simplifying assumptions are required to deal with the limitations of data available for estimation of the preceding models. Information on individual consumptions of market and domestic goods is typically missing in household survey data. While time use surveys provide data on adult leisures and child care, these do not allow the identification of individual preference parameters. Nor do these data permit the estimation of the parameters of an intra-household sharing rule.[17] We therefore assign shares of full consumption between adults and children prior to estimation on the basis of available data on assigned goods, specifically, on child care and government child care and education benefits, and apply an equivalence scale for unassigned market goods and domestic consumption (excluding child care). The details are described in Section 4.2. The resulting children's share within each household is then treated as a lump sum transfer from parents. This leaves the within-phase consumption and leisure demands of parents for estimation. Thus we have a two-adult household model.

The general formulation of the model in the preceding section specifies a phase parameter that allows for the way household preferences might change with the age of children. Since, in our view, changes in household preferences over the life cycle largely reflect the changing needs of children rather than those of the adults, we specify a system in which household preference parameters are constrained to be identical across phases.

3.1 Within-period Demand System

Given that we are estimating a two-adult household demand system, restrictions for aggregation need to be imposed. However, the required restrictions are valid only if all family members face the same prices. This condition is not satisfied if adult members face different prices (wage rates) for leisure. To deal with this problem, we specify the leisures of the two adults as inputs to the production of a general leisure good, z, that can be consumed by other family members.

The Almost Ideal (AI) demand system is selected for estimation of within-period preference parameters. Suppressing the household type and phase subscripts, the indirect utility function for adult $i, i = f, m$, takes the form

$$u_i(q, p, c_i) = (\ln c_i - \ln a_i(q, p))/b_i(q, p) \tag{36}$$

where c_i is adult i's full consumption, p and q are the prices of the domestic good and leisure, respectively. The price indexes $a_i(q, p)$ and $b_i(q, p)$ are assumed identical, and given by

$$\ln a(q, p) = \alpha_0 + \alpha_z \ln q + \alpha_y \ln p + 0.5\gamma_{zz} \ln^2 q + \gamma_{zy} \ln q \ln p + 0.5\gamma_{yy} \ln^2 p \tag{37}$$

$$\ln b(q, p) = \beta_z \beta_y \ln q \ln p \tag{38}$$

[17] For a proof, see Apps and Rees (1997).

where α_0, α_j, γ_{jl} and $\beta_j, j, l = x, y, z$, are parameters. The restrictions for adding up are $\sum \alpha_j = 1$, $\sum \beta_j = 0$ and $\Sigma\gamma_{jl} = 0$, for symmetry, $\gamma_{jl} = \gamma_{lj}$, and for homogeneity, $\sum \gamma_{jl} = 0$.

Household demands in share form are

$$S_z = \alpha_z + \gamma_{zz} \ln q + \gamma_{zy} \ln p + \beta_z \ln(c/a(q,p)) + \varepsilon_z \tag{39}$$

$$S_y = \alpha_y + \gamma_{yy} \ln p + \gamma_{yz} \ln q + \beta_y \ln(c/a(q,p)) + \varepsilon_y \tag{40}$$

$$S_x = \alpha_x + \gamma_{xz} \ln q + \gamma_{xy} \ln p + \beta_x \ln(c/a(q,p)) + \varepsilon_x \tag{41}$$

where $S_x = x/c$, $S_z = qz/c$ and $S_y = py/c$. Given adding up, we need only estimate the share equations for leisure and the domestic good.

On the production side of the model, we specify Cobb-Douglas functions for leisure, z, and the domestic good, y, as

$$s_z = \sigma_z + \xi_z \tag{42}$$

$$s_y = \sigma_y + \xi_y \tag{43}$$

where $s_z = w_2z_2/(w_1z_1 + w_2z_2)$ and $s_y = w_2a_2/(w_1a_1 + w_2a_2)$. The implicit prices, p and q, are computed for each record as functions of wage rates and the production parameters specific to each record, together with a scaling factor, consistent with the CD form. Using actual rather than predicted production parameters implies that the unobserved domestic productivity for each record is systematically related to the error term of the relevant production share equation. Thus, for example, households in which the female partner specialises in domestic work will, ceteris paribus, be found to have a larger production share, and therefore a lower domestic price, due to a higher domestic productivity. This specification, of course, gives rise to an endogeneity problem. However, with missing data on domestic productivity, there is inevitably a trade-off between parameter bias due to omitting this variable and that due to computing a domestic price in this way. Our model implies the judgement that the former is the more serious.

3.2 Intertemporal Demand System

Introducing the phase subscripts into the above indirect utility function we can write it as

$$u_t = \hat{a}_j(q_t, p_t) + \frac{\ln c_t}{b_j(q_t, p_t)} \quad j = 1, .., 6 \tag{44}$$

with

$$\hat{a}_j(q_t, p_t) \equiv \frac{-\ln a(q_t, p_t)}{b_j(q_t, p_t)} \tag{45}$$

The solution to the household's problem yields the life cycle and across-household profiles of full consumption, and the estimated demand and labour supply functions within periods can then be used to derive profiles of market and domestic consumption, saving and secondary earner labour supplies, for the perfect and imperfect capital market models respectively.

3.2.1 Perfect Capital Market

Given the assumed functional form for indirect utility, the first order conditions for this problem in the perfect capital market case are

$$\frac{\rho^t}{\delta^t b_j(q_t, p_t) c_t} = \lambda \quad t \in \phi_j,\ j = 1, .., 6 \tag{46}$$

$$\sum_{t=0}^{T} \delta^t c_t = W \equiv \sum_{t=0}^{T} \delta^t (A \sum_{i=1}^{2} w_{it} + P_t) \tag{47}$$

where W is "full wealth". The important thing to note is that the marginal utility of consumption expenditure in each period depends on the prices of the domestic good, p_t, and leisure, q_t, and therefore on the wage rates and the domestic productivity. Thus the entire time profile of consumption, as well as its allocation within each period as between market and domestic consumption, depends on this productivity. The solution of the system is given very simply by

$$c_t = \alpha_t c_T \tag{48}$$

$$c_T = \frac{W}{\sum_{t=0}^{T-1} \delta^t \alpha_t + \delta^T} \tag{49}$$

$$\alpha_t \equiv \left(\frac{\rho}{\delta}\right)^{t-T} \frac{b_6(q_T, p_T)}{b_j(q_t, p_t)} \quad t \in \phi_j,\ j = 1, .., 5 \tag{50}$$

3.2.2 Imperfect Capital Market

In principle, this problem could be fairly complicated to solve. However, from the data, we can establish that, at the margin, the average household is in equilibrium at the saving interest rate in phases 5 and 6, and at borrowing interest rates in phases 1 to 4, where it can also be established from the data the latter are higher than the former. Denoting the discount factors by $\delta(t, j)$, $j = 1, ..., 6$, $t = 0, ..., T$, we can use these to collapse the single period budget constraints into a lifetime wealth constraint, which we write as

$$\sum_{t,j} c_t \delta(t, j) = W \tag{51}$$

where wealth W is computed from the full income data and the discount rates. The household again maximises the utility function in (44) subject to this wealth constraint, yielding the first order conditions

$$\frac{\rho^t}{\delta(t, j) b_j(q_t, p_t) c_t} = \lambda \quad t \in \phi_j, \ j = 1, .., 6 \tag{52}$$

together with the wealth constraint. We then have to solve the equations

$$c_t = \hat{\alpha}_t c_T \tag{53}$$

$$c_T = \frac{W}{\sum_{t,j} \delta(t, j) \hat{\alpha}_t + \delta(T, 6)} \tag{54}$$

$$\hat{\alpha}_t \equiv \frac{\rho^{t-T} \delta(T, 6) b_6(q_T, p_T)}{\delta(t, j) b_j(q_t, p_t)} \tag{55}$$

for the optimal time path of consumption expenditure.

4 Evidence on Life Cycle Profiles

The first step in our approach has been to define the life cycle not in terms of calendar years, but in terms of six phases which seem to us to represent the key transitions in the life cycle of a typical household. Given the decision to have children, which we take here as exogenous, the life cycle evolves in a way which seems to be determined by them. This view of the life cycle leads to a representation of the data on labour supplies, consumption and saving for the average household which is as familiar to everyday experience as it is foreign to the economics literature on lifetime consumption decisions.[18] Before

[18] This is not to say that the importance of "demographics" has been ignored, as we hope our discussion in the Introduction has made clear. Our contention is that the effects of having children on female labour supply choices, in the presence of an imperfect capital market, are much more significant than seems to be recognised in the literature, and that this significance is made clearer by the way in which we organise the data.

they have children, both household members have high labour supplies, high saving and plenty of leisure. The presence of pre-school children dramatically changes the pattern of labour supply, leading to large falls in market labour supply of the secondary earner (usually female), saving, and leisure.[19] As the children grow up these changes are gradually reversed, with the state, through the public education system, taking over a large part of the burden of child minding and education, allowing increases in secondary earner labour supply. Consumption of market goods steadily increases and borrowing falls, with high saving levels again being achieved in the pre-retirement period, when the children have left home. A notable feature of the household's capital market behaviour is the substantial long term saving in the form of house purchase, usually mortgage financed, and saving for retirement in a (possibly compulsory or strongly tax-advantaged) contractual scheme, combined with short term borrowing, often at high interest rates, which is at its peak when the children are young. Our contention is that if the capital market were perfect, the effects of children on labour supplies and on the market/domestic consumption mix would be much less dramatic, with higher borrowing in the early years allowing substantial smoothing of these paths. We now go on to fill in the details of this picture.

4.1 Data

Ideally, panel data are required to compute life cycle consumption and saving profiles. Given that panel data are not available, we use micro-level cross section data. We construct life cycle profiles using information from two complementary surveys, the Australian Bureau of Statistics (ABS) 1998 Household Expenditure Survey (HES) and the ABS 1997 Time Use Survey

[19]As shown also in Apps and Rees (2001) using 1993-4 data, this pattern is lost in the studies that define the life cycle on the age of the male (or female) partner. When the life cycle is defined on the ages of the children as here, it is immediately obvious that the data do not support the buffer stock model of Gourinchas and Parker (2002) or Attanasio, Banks, Meghir and Weber (1999). A key problem is that the definition of the life cycle in these studies leads to the aggregation of two-income phase 1 and single-income phase 2 households on the left hand side of their single hump profiles of income and consumption (see, for example, Figure 2 in Gourinchas and Parker, 2002). The same problem appears in Blundell et al (1994) who note specifically that what is interesting in their results is that although female participation falls in the early years household income does not. However, their finding is an artifact of aggregating phase 1 and phase 2 households.

(TUS).[20] The HES contains data collected by interview on household consumption expenditure and individual incomes, earnings and hours of work. The TUS provides detailed information collected by diary on time allocations to ten activities.[21] We aggregate these into three: market work, domestic work and leisure. The TUS also includes information collected by interview on individual incomes and "usual hours of work". Both surveys provide data on a common set of demographic, education and occupation variables. We select matching samples of two-adult households from these datasets. For the purpose of the analysis in this section, all two-adults households are included in the samples, with the exception of those that do not have children and the female partner is aged from 35 to 44 years. Our reason for excluding these households is that they are likely to represent couples who have decided not to have children and, ideally, we would like to exclude all such households. The sample drawn from the HES contains 3994 records and that from the TUS, 1922 records.[22]

In addition to income and expenditure data, the HES provides detailed information on household debt, house price, mortgage and loan repayments and contributions to mandatory retirement saving and to life insurance. The information on loans is highly disaggregated, for example, by purpose, type of lender, term of loan, etc. The HES also includes estimates of indirect government taxes and benefits as well as the usual detailed data on direct taxes and benefits.

The matching data samples are split into the six phases on the following criteria. Phase 1 comprises couples in which the female partner is aged under 35 years and there are no dependent children present. Phase 2 includes all

[20]The analysis is, in effect, based on a single cross section (all results are presented in 1998 prices) and therefore does not take account of cohort effects. While we recognise that cohort effects can be important, it does not seem to us that they would alter the direction of our key results.

[21]The activity episode classification distinguishes between labor market activities and nine major categories of non-market activities. Market hours are calculated as the sum of time allocations to all subcategories of labor market activities excluding travel to work and job search. Domestic work is computed as the sum of time allocations to the categories "domestic activities", "purchasing goods and services" and "child care/minding". For each episode, information is recorded for a "primary" and, if relevant, a "secondary" activity. Where primary and secondary activities are reported, the weighting used is 0.6:0.4.

[22]There are 124 records excluded from the HES full sample of two-adult households and 68 from the TUS sample, on the criteria that no children are present and the female partner is aged from 35 to 44 years.

couples with at least one child under 5 years who is not yet at pre-school. Phase 3 represents couples with at least one child under 10 years at school or pre-school and phase 4 is defined as couples with older dependent children still living at home. Phase 5 comprises couples selected on the criteria that the female partner is aged 45 years or more, there are no dependent children present and, in the case of couples in which the male partner is aged 55 or more, at least one partner is not in full or semi retirement or "out of the workforce". Phase 6 includes all couples in which the male partner is 55 or older, and both partners are in full or semi retirement or report being unemployed or "out of the workforce".

4.2 The Average Household

Table 1 reports life cycle profiles of median net household income,[23] expenditure on market goods and saving, in columns 1 to 3 respectively, using the HES sample. Cell size is given in column 5. The excess sensitivity puzzle is confirmed by the profiles in columns 1 and 2, which show the strong tendency of household consumption to track net household income, with the highest median consumption expenditure coinciding with the highest net income in phase 4. This is brought out clearly in Figure 2, together with the sharp fall in median income and slight fall in median consumption as the household moves from phase 1 to phase 2. The latter is then followed by the usual "hump" shape from phases 2 to 6. Saving is at its highest in the pre-children phase, drops sharply in phase 2 with the arrival of children, and fails to rise to near its phase 1 level until phase 5 when the children have left home.

Table 1 and Figure 2 about here

¿From Table 1 it is evident that market income and consumption, and therefore saving, are strongly associated with the number of dependent children, shown in column 4. However, the profiles can give an entirely misleading picture of the true paths of consumption and of the impact of demographic variation, because the consumption variable excludes the household's implicit expenditure on domestic production. A measure of full consumption expenditure is required, deflated by an empirically plausible equivalence scale. Information on the household's implicit expenditure on leisure is also essential because, as the time use data we now present indicates, it cannot

[23]Net household income includes all government direct (cash) benefits but not indirect benefits through, for example, the eduation and health systems.

be assumed to be separable from domestic work and labour supply.

Table 2 reports life cycle profiles of time allocations to market and domestic work. The table lists TUS weighted data means for male and female market hours, domestic hours and total hours of work, in columns 1 to 6 respectively. Comparing these hours profiles with those for net household income and consumption in Table 1, it is immediately apparent that much of the variation in net household income across phases 1 to 5 reflects changes in female labor supply or, more specifically, the reallocation of time from market to domestic work by the secondary earner after the arrival of children. Across these phases there is relatively little variation in male market hours but large changes in the hours of the female partner, which are negatively related to domestic hours of work. This is shown in Figure 3.

Table 2 and Figure 3 about here

The strong negative relationship between female market and domestic hours suggests that the two types of work become closer substitutes after the arrival of children. The most dramatic substitution occurs in phase 2, reflecting the fact that young children generate a high demand for care. This can in general be provided at home or bought on the market, but the time use data show that there is a very large domestic supply of child care.[24] The figures also show that *total* hours of work rise and therefore leisure falls dramatically with the arrival of children, and this is then steadily reversed over successive phases of the life cycle.

When consumption expenditure includes the time cost of domestic output, the profile tends to track total hours of work, rather than net income. This is demonstrated in Table 3. Column 1 of the table presents the profile of domestic consumption expenditure, computed as the product of time allocated to domestic work and the net wage, instrumenting for the gross wage.[25] The profile is graphed in Figure 4. Much of the time spent on domestic work when the children are young is allocated to child care. In phases 2 to 4, the data means for the time the female partner allocates to child care are 2253, 1447 and 366 hours, and the male partner, 876, 689 and 198 hours, respectively. Column 2 of the table reports the medians of the total cost of parental time allocated to child care in these phases.

[24]Most of the time allocated to domestic work by the female partner is spent on child care, particularly in the early phases.

[25]On the assumption of constant returns to scale of time inputs, the expenditure on domestic consumption at the implicit price of domestic output is given by the value of time spent in household production.

To obtain a reliable measure of household full consumption, indirect government benefits need to be included. These are important because they are large, averaging over $12,000 per household in the sample, they vary quite dramatically across phases, and they tend to vary inversely with the household's cost of domestic child care across phases 2 to 4. Column 3 of the table reports the profile of median total indirect government benefits.[26] The very high levels in phases 3 and 4 are due to public spending on child care and education, shown separately in column 4. Families with children at school or in tertiary education receive by far the largest support from public spending on education. - in the order of $8,000 to $9,000 p.a. This contrasts with government spending on child care and education in the pre-school phase, which averages only $1,093 per family.[27] It is therefore not surprising to find that families in phase 2 allocate a very large share of their resources to child care. The life cycle profile of median household full consumption, computed to include market and domestic consumption and indirect government benefits, is presented in column 5, and also depicted in Figure 4.[28] If we were to exclude indirect benefits, the peak in full consumption would appear in phase 2, to coincide with the peak in total hours of work. Including indirect government benefits shifts the peak to phase 3.

Table 3 and Figure 4 about here

If we sum the cost of parental child care time and government education benefits we obtain data means of $44758, $45762 and $16480 in phases 2 to 4. Deflating market consumption expenditure and the time cost of domestic work (excluding child care) by an "equivalence scale" that sets the cost of a child to 0.4 that of an adult[29] yields an estimate of the full consumption cost

[26]The HES estimate of indirect government benefits covers non-cash benefits and services for education, health, housing and social security and welfare. The data means of the estimates for phases 1 to 6 are: $4,380, $10,227, $17,903, $18,021, $5,359 and $10,620. For details of the calculation of these benefits, see ABS (2001).

[27]Note that the table reports medians. In phase 2 the data mean for indirect government benefits is $10,227 pa., which includes medical costs for the birth of a child. Around half of the figure, $5142, represents education benefits, of which $4059 is spending on school aged children who are also present in phase 2 households. The median for indirect education benefits reported in the table for phase 2 is only $1916 because there are no school chidlren in the majority of households in the phase.

[28]To include domestic production expenditure, we combine information on time use from the TUS with the consumption data for each record in the HES, instrumenting for male and female leisures. For further details, see Apps and Rees (2002).

[29]This ratio of child to adult consumption is used, for example, in Blundell et al (1994) to

of children that is, on average, just over half that of adults in the household. Child costs of this order are consistent with our estimate of a "sharing rule" in Apps and Rees (2002) based on an individualistic model and survey data that also include domestic work, child care and leisure.

We calculate the full consumption costs of children in this way, and subtract the result from household full consumption to compute the profile of two-adult median full consumption shown in Column 6 of Table 3 and depicted in Figure 4. The resulting U-shaped profile of the parents' consumption tends to match that of their leisure, suggesting that parents cut back on both consumption and leisure, instead of borrowing more, in order to support their children in the early child rearing phases.

The explanation for this that we suggest is that parents face higher interest rates in the earlier phases, and particularly in phase 2, together with a lack of access to good quality, affordable market child care.[30] Because there is very little government support for child care, and very high effective tax rates apply to the incomes of mothers who work,[31] the household's optimal choice is, first, to reallocate the mother's time from market to household work, since she generally faces a lower wage rate, and secondly, for both parents, but especially the mother, to work longer hours in total, and so reduce leisure, in phase 2.

In later years, the cost of children to parents is substantially reduced by public funding of education and the child care it provides. In other words, when the child reaches school age the public education system takes over many of the child-minding activities that the household itself has to undertake for pre-school children. This allows the female partner to expand her market labor supply in phase 3 while simultaneously reducing total hours of

deflate household market consumption expenditure. Here we extend this to consumption of domestically produced goods excluding child care, the costs of which we calculate directly from the data.

[30]To appreciate the inefficiencies and consequent high cost of market child care, one need only consider the impact that government financial support, central planning and regulation has had on primary school care and education, and what would happen to female labour supply and school attendance if that sector had been treated in the same way as child care.

[31]Like the US and Germany, Australia has a tax-transfer system that is, in effect, a system of joint taxation, due to recent reforms to family payments within the income tax system. Married mothers who work lose around half their earnings in taxes and reduced family payments, and so many cannot meet the cost of formal child care out of their net incomes.

work. The effect is accentuated in phase 4. Household income, labor supply and market consumption expenditure all peak in phase 4, with teenaged children living at home, while saving is at its peak in the following phase, when the children have left home but market labor supply is still high. Thus, the profile of total hours of work, together with that of adult full consumption in column 4, is, we argue, to a significant extent an outcome of an imperfect capital market and variations in the public funding of the costs of children. Once the children have reached school age, access to public education and child care allows parents to maintain family consumption without cutting back excessively on leisure.

This argument is supported by the data on saving and borrowing, and on housing, available in the HES. These show, on the one hand, how much families must save under a mandatory system of superannuation. They also have an overwhelming incentive to invest in owner occupied housing if, ultimately, they are to buy housing over their life time at an affordable (and in fact very low) user cost. Table 4 lists contributions to superannuation and life insurance (column 1) and mortgage repayments of capital (column 2), by phase. When the sum of these is subtracted from saving, many households are found to be in the position of having to borrow short term to finance these forms of long term contractual saving. the median of the amounts they must borrow short term in each phase, calculated as the difference between saving and the sum of mortgage repayments of capital and superannuation contributions, is shown in column 3. The largest amount appears in phase 2.

Table 4 about here

The imperative to save for full home purchase is indicated by the dramatic rise in the percentage of home ownership (column 4) and decline in debt to house price ratio (column 5) from phases 1 to 6. It is straightforward to show that the user cost of owner occupied housing, obtained by discounting repayments of capital and the initial equity at the time of purchase, becomes negative over time, due primarily to capital gain but also to low transactions costs relative to private rental.[32]

[32]The data suggest that home ownership is analogous to an annuity with a very high rate of return, especially if households minimise transactions costs by rarely moving over the life cycle. Note that in phase 6, over 90 per cent of households are home owners, and the debt to house price ratio is less than one per cent. The data also indicate there is relatively little "trading-down".

4.3 Within-Phase Heterogeneity

The data show that there is a very high degree of heterogeneity in respect of female labor supply and savings behaviour across households with the same wage rates and demographics, which is concealed in the overall average figures considered above. The underlying idea of the models considered earlier was that households choose lifetime paths of male and female labor supplies, saving and consumption of household and market goods, given wage rates (net of taxes), interest rates and productivities in household production. Differences in domestic productivities across households lead to differences in choices of these endogenous variables, for households facing the same wage and interest rates and capital market conditions.

To give an indication of the significance of this source of heterogeneity, Table 5 presents labour supply, income and saving profiles for two household types defined according to female labour supply, as an indicator of domestic productivities. We are limited to this strategy because of missing data on domestic output.

Table 5 about here

Ideally we would like to distinguish between those households in which female labor supply is zero or "marginal"[33] throughout the life cycle, and those in which it is significant and relatively large over the entire life cycle. This categorisation requires panel data. Since we have access only to cross section data, we present profiles for a sample of "in-work" households in phases 2 to 5 selected on the criterion that the male partner's "usual hours of work" exceed 25 per week. The sample contains 2438 records. We partition the sample into two groups of equal size within each phase according to the female partner's "usual hours of work".[34]

Panel A of the table presents the results for households in which the female partner reports fewer hours of work, and Panel B, for those in which she works longer hours. Columns 1 and 2 give the TUS data means for male and female market hours for the two groups. There is relatively little variation in male hours. In contrast there is a tendency toward polarisation in female hours. Households tend to split into two distinct types: those in which the female partner supplies relatively little or no market labour and those in which she is employed full-time or works relatively long part-time

[33]In the Heckman (1993) sense.

[34]We exclude households in which either partner is unemployed.

hours.[35] We label the former "traditional" and the latter, "non-traditional".

Columns 3 and 4 of Table 5 present HES medians for household private income and female earnings. The results reflect the fact that non-traditional households have higher incomes in each phase due to the additional market hours and earnings of the female partner, and not to higher male wage rates. The evidence also suggests that very little of the variation in female hours can be explained by female wage rates or demographics[36]. Thus, household income tends to track female hours within phases as well as between phases of the life cycle. From column 5 it can be seen that household saving also tracks female labour supply. Non-traditional households not only have higher household incomes within each phase, they also have much higher levels of saving.[37]

The differences between household income and saving profiles of each type might lead one to expect corresponding differences in market consumption expenditure. However, this is not the case, due to large transfers from non-traditional to traditional households through the tax-transfer system.[38] This is achieved by high effective tax rates on the labour incomes of second earners. Column 6 of the table presents profiles of taxes net of benefits, including indirect taxes and government benefits, for each household type. In phase 2, the traditional household receives, on average, an overall net benefit of $2333 whereas the non-traditional household has a net loss of $6611, a difference of almost $9,000. This reflects the fact that, ceteris paribus, non-traditional households pay much more in income taxes, while receiving very little in family payments or compensation for the cost of child care.[39] In the retire-

[35] Part-time employment status is defined as 1-35 hours of work per week and full-time as 35 hours of work or more per week.

[36] Traditional households have an average of 2.10, 2.21 and 1.66 children in phases 2 to 4 respectively. The corresponding figures for non-traditional households are 1.87, 2.10 and 1.60.

[37] Note that income generated by household production is inherently non-saveable, though to the extent that it substitutes for market consumption it may permit higher saving.

[38] The Australian personal income tax is based on the individual. However, when combined with the relatively new system of family payments, which are highly targeted on joint and second earner income, the overall system is one of joint taxation, as in the US and Germany.

[39] This highly unequal distribution of the tax burden between non-traditional and traditional households is a relatively recent phenomenon in Australia, and has been largely a consequence of reducing the overall progressively of the tax-transfer system, as in other OECD countries, notably the US. In effect, lower rates at the top of the distribution of

ment phase, with higher levels of saving, they are less likely to be eligible for the income tested age pension. In effect, non-traditional households save for their own retirement and contribute to financing pensions for traditional households, by working longer hours and paying higher taxes.

Because this outcome is achieved primarily by targeting a system of family payments tightly on the basis of second earner and family income, its impact is greatest, in terms of effective average tax rates, on second earners in part time work. Under this type of regime, small differences in domestic productivities are likely to be sufficient to give rise to the considerable heterogeneity in female labour supply decisions that we observe.

5 Results

The earlier models showed how the optimal path of life cycle consumption, c_t, $t \in \phi_j$, $j = 1,..,6$, depends on the marginal utility of consumption in each phase, as a function of the discount factors $\delta(t, j)$, $t = 0, ..., T$, and the price index $b_j(q_t, p_t)$. The price index, in turn, depends on the prices of the domestic good, p_t, and leisure, q_t, and therefore on wage rates and domestic productivity. Thus, unless we have information on all price variables, including the discount rates, it is not possible to test alternative life cycle models without making up data on those that are missing. Here, data on domestic productivity, and therefore on the p_t, are missing. However, unlike previous studies, we have information that allows us to make a plausible choice of discount factors $\delta(t, j)$. Specifically, we propose that those households who borrow short term face an interest rate above their lending rate.

5.1 Demand System Parameters

The within-period demand system is estimated on data for a sample of "in-work" two-adult households in phases 1 to 5 selected from the HES on the criteria that the male partner's usual hours of work exceed 25 per week, neither adult is unemployed, earnings from wages/salaries are the primary source of income, and earned and unearned incomes are non-negative. The sample contains 2163 records. A matching sample is selected from the TUS

income have been funded by raising taxes on working married women. It is important to see the issue in this context, and not in terms of a conflict between non-traditional and traditional households.

and information on time use from this sample combined with the data in the HES sample by instrumenting for male and female pure leisures, as noted in Section 2.[40]

The data on earnings and hours are used to compute hourly earnings as the measure of the gross wage. The system is estimated on predicted wage rates, net of taxes, to avoid parameter bias arising from the endogeneity of earnings, and with the female wage corrected for selectively. Full income is defined on the basis of a time constraint of 14 hours per day, which means that each adult is given a fixed allocation of 10 hours of "own time" (pure leisure and/or sleep), with the residual of leisure time beyond own time being treated as an input to the general leisure good, z. Thus, total consumption within each phase is the sum of the household's expenditure on market consumption and on the domestic and leisure goods with own time omitted in the latter.

We estimate the system on all records ignoring corner solutions on the assumption that domestic work is analogous to a particular type of employment. Under this assumption, corner solutions are potentially a general problem, arising in respect of both market and domestic work choices. We take the view that dealing with the issue here is outside the scope of the present study. Table 6 reports the parameter estimates of the system. All are significant at well above the 5 per cent level. The intercept term, α_0, is set at log (20,000). The cost function is concave for almost all records.

Table 6 about here.

5.2 Intertemporal Profiles of Consumption

The criterion we apply as a "test" of the alternative hypotheses concerning the capital market is how well the life cycle consumption profile generated by the actual data on saving can be predicted using the estimated preference parameters and selected discount rates. The first step is the construction of a reference or baseline consumption profile, which involves computing consumption expenditure in each period, c_t, $t \in \phi_j$, $j = 1, .., 6$, as set out in (21). The calculation uses sample data means for time allocations, wage rates and the tax-transfer system in each phase, and median saving in phases 1 to 5. Consumption in phase 6 is obtained by compounding up previous saving/borrowing at the appropriate discount rate. As noted in Section 3.2, compulsory superannuation payments and the capital component of mort-

[40]For details see Apps and Rees (2001, 2002).

gage repayments are treated as exogenous amounts subtracted from income in the preretirement phases (i.e., as taxes), compounded up and added back into P_t in phase 6. Table 7 presents results using a real rate of 1.0 per cent.

Table 7 about here

Column 1 of the table reports 2-adult total consumption expenditure computed as described. Column 2 gives the full consumption expenditure of the two adults obtained by subtracting their leisure expenditure in each phase. Column 3 presents separately the leisure expenditure of the adults and column 4, household full consumption expenditure, computed as the sum of that of the adults and the transfer they make to the children to cover their full consumption costs. These profiles are taken as the reference for comparison with results for the perfect and imperfect capital market models. The costs of children computed for the reference case are held constant across the models.

To test the perfect capital market hypothesis we compare the reference profiles with those predicted using the same sample means for time allocation, wage rate, taxes, transfers and indirect government benefits, and the same discount rate for borrowing and lending, but not the data on saving. Instead we use the estimated preference parameters, $\beta_j, j = z, y, x$, to obtain c_t as set out in (48) to (50). Table 8 reports the results in the same format as in Table 7.

Table 8 about here

The profiles predicted by the imperfect capital market model are presented in Table 9, again in the same format as Table 7. The results are derived for real borrowing rates of 2.4, 2.0 and 1.6 in phases 2 to 4, respectively. Though these rates may appear low in absolute terms, they are proportionately much higher than the lending interest rate. It is also important to keep in mind that they represent across-household averages, and that there is considerable heterogeneity across households in saving/borrowing behaviour within each phase, particularly in the early phases. Most households will in fact face either much higher or lower rates.

Table 9 about here

The profiles of 2-adult total consumption expenditure, c_t, reported in column 1 of each of the preceding three tables are compared graphically in Figure 5. The reference profile is strongly U-shaped across phases 1 to 5, as we would expect from the evidence in Section 2. The imperfect capital market model predictions match very closely those of the reference profile. In contrast, the perfect capital market model predicts that the household will smooth consumption expenditure on a per capita adult basis. The negative slope of the profile reflects the choice of a real interest rate greater than the time preference rate.

Figure 5 about here

The perfect capital market model also predicts smoothing of adult full consumption and leisure, which, in the case of the latter, is clearly inconsistent with the data. Figures 6 and 7 show graphically the predictions of the two models for household and 2-adult full consumption expenditure. Each figure includes the corresponding reference full consumption profiles. Figure 6 illustrates some of the implications of the perfect capital market hypothesis. Because the model generates a smooth profile of 2-adult full consumption, adding in the costs of the children's full consumption gives a more strongly humped profile of household full consumption across phases 1 to 5 than indicated by the data. In other words, evidence of a more humped shaped profile of full consumption across the phases in which children are present is required in order to support the perfect capital market hypothesis.

Comparing Figures 6 and 7, it is immediately apparent that the imperfect capital market model predicts full consumption paths that are much closer to the reference profiles, although there are some differences. The most marked departure is in the retirement phase, where the imperfect capital market model yields a higher level of full consumption, and a correspondingly lower level of expenditure on leisure. This may in part be due to the omission of an imputed value for owner occupied housing in the reference profile. The evidence on life cycle rates of home ownership and on housing debt discussed in Section 2 suggests that the imputed value of owner occupied housing is likely to be a much larger component of full consumption in phase 6 than in earlier phases.

Figures 6, 7 about here

6 Conclusions

Our descriptive picture of a household's life cycle time allocation, income and consumption, defined in terms not of calendar years, but of key phases in the evolution of the family, helps resolve some of the "puzzles" that have been noted in the existing literature, but suggests a new one: Why, in the phase in which the household has pre-school children, are there such dramatic changes in time allocations, consumption and saving? The data on borrowing and interest rates suggest that the standard assumption of a perfect capital market is untenable, but so is the hypothesis that households do not borrow short-term. By modelling household life cycle choices under respectively perfect and imperfect capital markets, we show that in the former case we cannot reasonably explain the data, in the latter case we can. These results have interesting implications for public policy, at a time when declining fertility is seen as the major cause of population ageing, and consequential problems in sustaining social security programmes, such as Pay-As-You-Go pension systems. Greater support for households during the critical phase could help overcome the problems presented by an imperfect capital market and reduce the costs of having children. This should be a fruitful area for future research.

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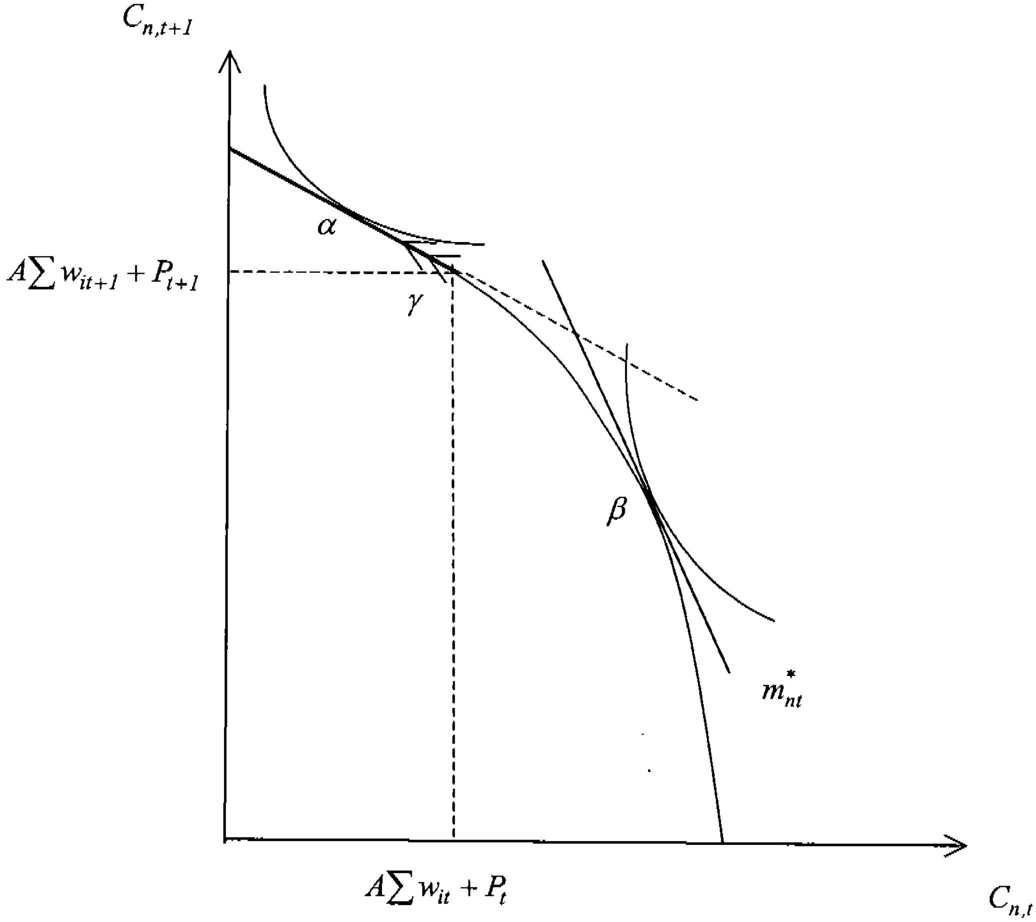

Figure 1 Lending and borrowing in an imperfect capital market

TABLE 1 Median net income, market consumption and saving ($pa, 1998)

Life cycle phase	Net market income 1	Market cons expend 2	Saving (1 - 2) 3	# dep kids 4	HES cell size 5
1	51688	40422	7852	-	385
2	39520	38577	1092	2.01	708
3	44720	42312	2652	2.16	609
4	52000	50721	1196	1.62	737
5	46644	39682	5148	-	757
6	18980	22695	-2392	-	798
All	40664	38249	1508	-	3994

Figure 2: Median net income, consumption and saving ($pa, 1998)

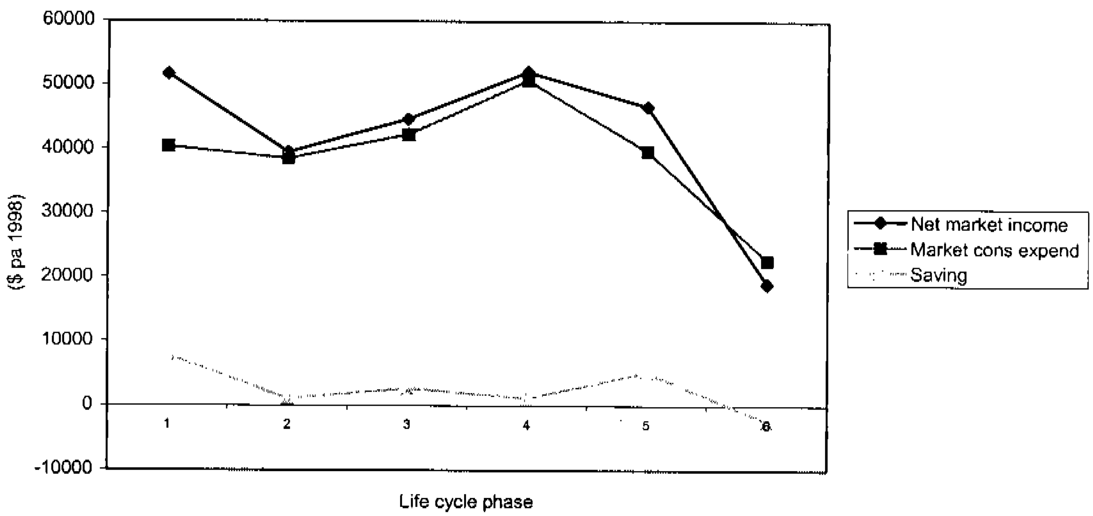

TABLE 2 Data means* for hours of market and domestic work pa

Life cycle phase	Male hours of work Market 1	Domestic 3	Total 3	Female hours of work Market 4	Domestic 5	Total 6
1	2134	585	2737	1619	937	2579
2	2011	1533	3543	490	3590	4079
3	2102	1422	3524	671	2913	3584
4	2002	989	2992	1085	1927	3012
5	1931	848	2779	949	1670	2618
6	70	1419	1490	23	1782	1805
All	1599	1173	2772	720	2176	2897

*Weighted

Figure 3: Mean hours of market and domestic work

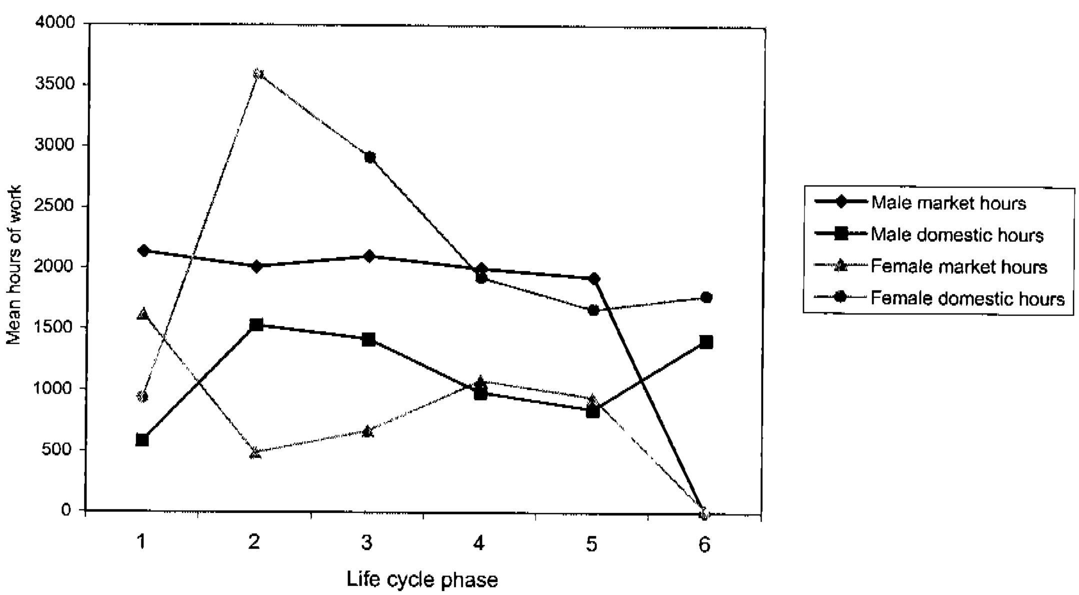

TABLE 3 Median consumption expenditure and indirect benefits ($pa, 1998)

Life cycle phase	Domestic Cons expend 1	Domestic child care 2	Indirect govt benefits 3	Indirect govt educ benefits 4	H'hold full cons expend 5	Adult full cons expend 6
1	13827	-	2704	-	60453	60453
2	53245	31815	11700	1916	107881	49600
3	47967	24939	16484	10642	109739	50311
4	30421	6749	16900	11477	100654	55793
5	23047	-	4160	-	69402	69402
6	25343	-	11076	-	59736	59736
All	38368	-	11024	-	86289	58100

Figure 4: Domestic and full consumption ($pa, 1998)

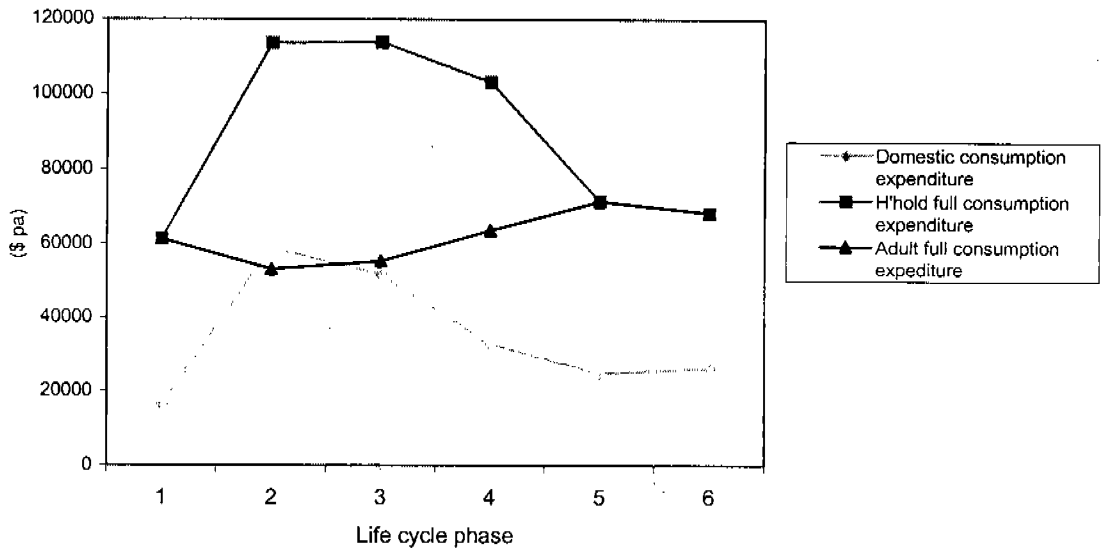

TABLE 4 Long term saving ($pa, 1998)

Life cycle phase	Super+ Life 1*	Mortgage repay (cap) 2*	Saving – (mort+super) 3***	% home owners 4	Housing debt % 5**
1	1135	3502	4093	54.8	48.2
2	1566	2716	-2747	67.7	37.4
3	1926	2901	-1508	78.0	26.9
4	2510	2405	-2227	87.4	16.9
5	2387	1377	2262	85.3	9.5
6	312	103	-2444	91.7	0.9
All	1659	1656	-1137	79.77	18.5

*Data means **Debt to house price ratio

***saving minus mortgage repayments of capital and contributions to superannuation

TABLE 5 Labour supply, income, saving and taxes, by household type ($pa,1998)

Life cycle phase	Male mkt hours 1*	Female mkt hours 2*	H'hold private income 3**	Female earnings 4**	Saving 5**	Taxes-benefits 6*
Panel A: Type 1: Traditional households						
2	2200	22	39884	0	104	-2333
3	2277	73	46956	0	2392	-2265
4	2174	460	55588	7788	-260	885
5	1944	132	51324	0	4680	12280
Panel B: Type2: Non-traditional households						
2	2207	1058	61672	20020	4836	6611
3	2244	1332	67496	24700	5304	4081
4	2289	1773	82056	29680	5408	10316
5	2228	1781	72020	27508	10244	17932

*Data means **Medians

TABLE 6 Demand system parameters

Parameter 1	Estimate 2	Std error 3
α_z^0	0.3391	(0.0251)
α_y^0	0.3295	(0.0152)
γ_{zz}^1	0.0423	(0.0189)
γ_{yy}^1	0.1397	(0.0121)
γ_{yz}^1	-0.1086	(0.0125)
β_z^1	0.1683	(0.0064)
β_y^1	-0.1840	(0.0061)
Log L	4588.62	

TABLE 7 Reference consumption profiles, $pa (1998)

Life cycle phase	2-adult total consumption exp, c_t 1	2-adult full consumption exp 2	Leisure expenditure 3	Household full consumption exp 4
1	118577	64182	54386	64182
2	74314	44831	29483	106641
3	79668	44909	33533	109309
4	93666	46850	46816	95109
5	114432	64608	49818	64608
6	110631	57281	53353	57281

TABLE 8 Perfect capital market consumption profiles

Life cycle phase	2-adult total consumption exp, c_t 1	2-adult full consumption exp 2	Leisure expenditure 3	Household full consumption exp 4
1	123592	75039	48550	75039
2	113514	67886	45623	127691
3	108981	64926	44056	128498
4	102300	60349	41951	108613
5	93129	54587	38542	54587
6	78372	47358	31014	47358

TABLE 9 Imperfect capital market consumption profiles

Life cycle phase	2-adult total consumption exp, c_t 1	2-adult full consumption exp 2	Leisure expenditure 3	Household full consumption exp 4
1	118084	69392	48684	71392
2	74499	42810	31689	102612
3	79692	46089	33603	109665
4	93816	52892	40924	103154
5	115856	69316	46540	69316
6	109427	68156	41271	68156

Figure 5: Two-adult total consumption profiles ($ pa, 1998)

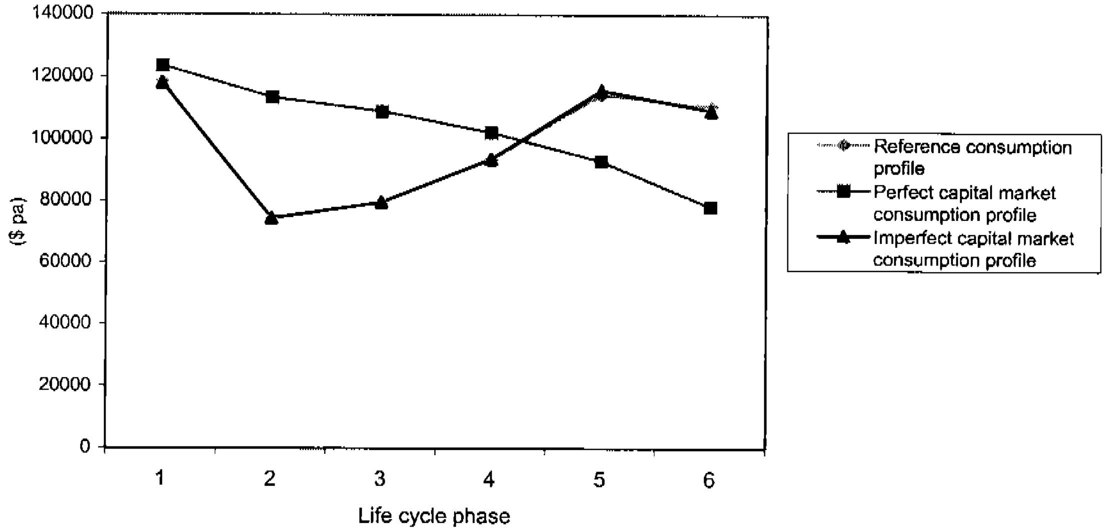

Figure 6: Perfect capital market model

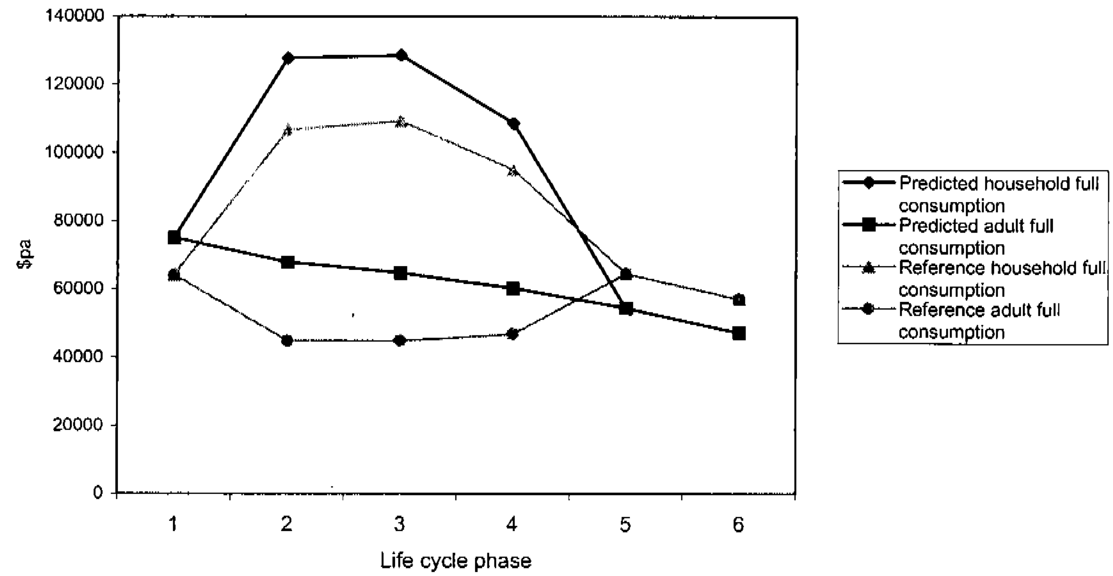

Figure 7: Imperfect capital market model