# Consumption and Saving in the TRYM Model

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The views expressed in this paper are those of the author, and do not necessarily reflect the views of the Government or the Commonwealth Treasury. I would like to thank Peter Downes for his earlier work on demographics and the savings ratio. Any errors and omissions are of course mine.

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## ABSTRACT

Private consumption represents a large slice of GDP, and accurately modelling consumption is therefore an important part of any macroeconometric model.

The influence of demographic factors on consumption behaviour has recently attracted a fair bit of attention in Australia, with a number of authors including demographic variables in their estimated equations. This paper examines a range of factors that could be influential in determining private consumption, and gives particular reference to the way in which demographic influences might be captured in an aggregate consumption equation that is suitable for use in a macroeconometric model such as TRYM.

The paper concludes that while it is relatively easy to obtain a good degree of fit by incorporating demographic variables into the consumption function, the results must be carefully checked for interpretation. The incorporation of other variables, which might include changes in the institutional environment (such as financial deregulation), or changes in productivity growth may assist in obtaining more plausible estimates. Further work will be required before demographic influences can be successfully incorporated into the TRYM model.

# 1 INTRODUCTION

The determination of private consumption spending has long been studied by economists, yet consumption (and its shadow, household saving) remain a topic of considerable interest. The difficulty in empirically estimating a consumption equation is reflected in the number of papers, all with slightly different sets of explanatory variables, that have appeared in the literature.

So why has so much time and effort been devoted to estimating consumption functions?

From the point of view of a macroeconomic model such as TRYM, the consumption function is crucial. Private consumption represents around 60 per cent of GDP, so it is important to model consumption adequately in a purely arithmetic point of view . In addition, since output in TRYM is demand-determined in the short run, changes in consumption can quickly spread through the whole economy.

- For example, a fall in private consumption reduces aggregate demand. Lower demand implies lower utilisation of existing capital, which can feed through into business investment. A consumption shock can affect the entire economy.

The response of consumption to economic shocks is of particular importance to the short run dynamics of the model. One area of interest is how consumers respond to a debt financed tax cut. If Ricardian Equivalence were to hold, consumption would not change following a debt financed tax cut, since consumers recognise that the government's intertemporal budget constraint requires that the tax cut must be paid for in the long run.

Whether Ricardian Equivalence holds for the model is of more than academic interest. For example, if Ricardian Equivalence does not hold, then policy makers can increase output in the short run through debt financed tax cuts or increases in government spending. If Ricardian equivalence does hold, then these instruments are not available to policy makers, even in the short run.

Consumer behaviour can also be important in determining longer run properties of the model. Considerable attention has focussed on national saving in recent years (see for example FitzGerald 1993). Household saving (an important component of national saving) is determined as a residual from consumption and income.

The recent focus on the low level of private saving is in contrast to the early 1970s, when private saving was generally quite high. This substantial change in household savings is directly related to changes in household consumption relative to income (that is, a change in consumers' average propensity to consume). An important part of empirical work into consumption has therefore revolved around explaining these changes in the average propensity to consume.

Many of the initial explanations focussed on high levels of inflation during the early 1970s. More recently, particular attention has been focussed on the role of demographic change and financial deregulation.

Much of the empirical work on incorporating the effects of demographic change into the consumption function has been undertaken in the context of single equation models. These results can not always be translated to models of the full economy. This paper concentrates on attempting to incorporate the effects of demographic change into a consumption function in a form that is compatible with a full econometric model of the economy.

Estimation of an equation as part of a full model system places extra discipline on the form chosen for the consumption function. The specification of the long run properties of consumption will be particularly important, since consumer behaviour must remain consistent with the remainder of the model. In particular, restrictions may be required to ensure that the model has an identifiable long run equilibrium.

Ideally full consistency between the relevant sectors of the model could be achieved through joint estimation of the full range of decisions made by consumers, including labour supply, wage demands, consumption, consumption of rental services, and dwelling investment. Joint estimation would provide the advantage of explicitly linking all of these decisions together in the model just as they are linked in the economy.

For example, changes in the demographic composition of the population (such as an increase in the proportion of the population that is over 65) are likely to affect all decisions made by households to a greater or lesser extent. Consumption decisions will be affected, as will labour supply decisions, and the demand for housing. Joint estimation of all equations that model decisions by households would ensure that the effects of demographic change are treated consistently throughout.

Joint estimation of this type has not yet been achieved for the decisions made by households in the TRYM model, but it remains an area where further work will be undertaken.

The remainder of the paper is structured as follows. The following section briefly reviews the life-cycle theory of consumer behaviour. Particular emphasis is given to how changes in the age structure of the population would be expected to effect consumption under the Life-Cycle Hypothesis. This section also includes a discussion of relevant data for Australia. Section 3 examines some recent econometric analyses of consumption in Australia, while Section 4 presents the results of estimation of a consumption equation for the TRYM model of the Australian economy. The estimates presented in Section 4 indicate that, while the parameters on demographic variables add significant explanatory power to the consumption equation, the parameter estimates appear to be too large to be explained solely by changes in the age structure of the population. The main conclusions are outlined in Section 5.

## 2 MODELLING CONSUMER BEHAVIOUR

### The Life-Cycle Hypothesis

The specification chosen for the original TRYM consumption equation could be interpreted as being consistent with both the Life-Cycle Hypothesis (LCH) and the Permanent Income Hypothesis (PIH). This paper focuses more closely on the LCH, reflecting an interest in the effects of a changing demographic profile on consumption behaviour. However, the two theories are similar in a number of important respects.

The LCH was developed by Modigliani and Brumburg (1954), while the PIH is due to Milton Friedman (1957). Both theories were developed at approximately the same time, and both rely on the microeconomic foundations of utility maximisation by consumers. Consumers choose how much to consume in each period in order to maximise their lifetime utility, subject to an inter-temporal budget constraint.

- One important difference between the two theories is that the PIH makes the assumption that consumers live indefinitely, while in the LCH consumers have a finite life.

Under both theories the assumption of utility maximisation, combined with perfect capital markets leads to the conclusion that consumption in any period will depend only on total life resources, and income fluctuations in individual periods will not affect consumption.

Under the PIH, the assumption of infinitely long lived consumers means that 'total life resources' is meaningless, so is replaced by 'permanent income" - the amount that consumers expect to receive (on average) each year of their life.

The LCH can be used to address a wider range of issues than the PIH, since consumers must plan for retirement. Most consumers expect to work for only a certain proportion of their life, and must therefore make provision for consumption in retirement by building up savings during their working lives. It is this process of taking into account the varying stages in the average consumer's life that gives the LCH its name.

If the LCH or the PIH were to strictly hold in practice, consumption would be completely determined by total lifetime resources. Transitory departures of current income from permanent income will be reflected in changes in saving, except to the extent that they cause the consumer to change his or her expectation of permanent income. Other variables (particularly current income) would not be admissible in the consumption function.

However, empirical testing has indicated that a range of other variables is usually needed to effectively explain consumption. In particular, changes in current income are almost always found to exert an influence on consumption which is stronger than that predicted by theory. There are a number of possible reasons for this finding.

- It is difficult to measure total lifetime resources, and some sort of proxy must be found. This usually involves some combination of current income and wealth. To the extent that the proxy variable does not accurately capture changes in total lifetime resources, other variables may be required to effectively model consumption.

- In addition, credit markets are not perfect, and some consumers will not be able to borrow as much as they would like (based on their estimated total lifetime resources). These consumers are said to

be 'liquidity constrained'. Liquidity constrained consumers will tend to consume a large proportion of any change in current income.

- There is also the issue of whether consumers are sufficiently forward-looking (and have sufficient computational abilities) to enable them to estimate their total life resources and manage them through time. If consumers cannot accurately make either of these computations, then the LCH may break down.

Despite these shortcomings, the LCH remains the basis for estimated consumption functions in many Australian studies. The principle activity involved in estimating a consumption function that fits the data well has been the search for other variables that affect consumption. Some of these variables are suggested by the LCH, while others suggest a failure of the theory. A (non-exhaustive) list of variables that have been included in Australian consumption functions would include labour income, demographic variables, non-human wealth, inflation, interest rates, transfer payments, and confidence effects.

Each of these is discussed in more detail below.

**Labour Income**

As noted above, intertemporal utility maximisation and perfect credit markets imply that consumption ought not to be significantly affected by changes in current labour income. (The exception would be where a change in current labour income led consumers to revise their estimates of total lifetime resources).

However, empirical studies consistently find that consumption responds to short term movements in labour income.

Most authors take this as evidence that there are a number of liquidity constrained consumers unable to borrow sufficiently to allow full intertemporal optimisation. These consumers are likely to consume a large portion of any change in current labour income.

An important component of any consumption function is therefore determining the extent to which changes in current labour income feed through into changes in consumption.

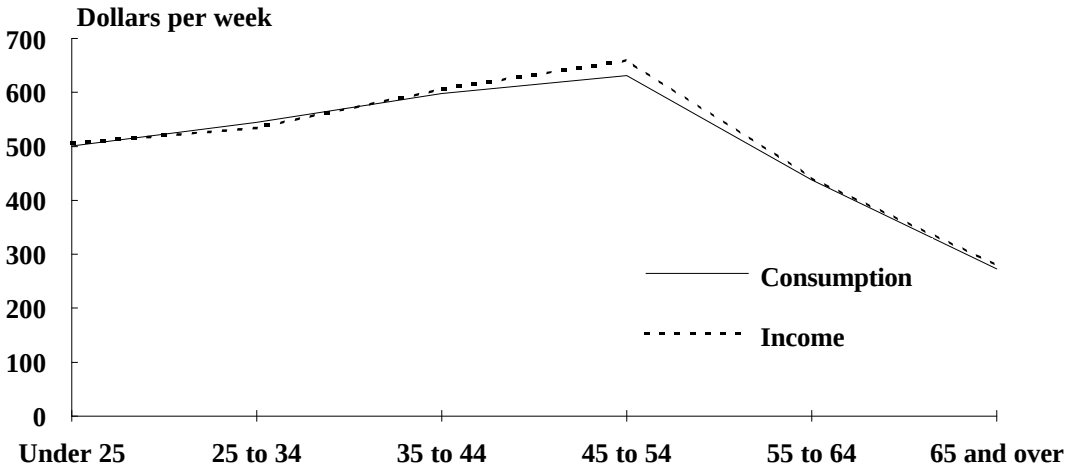
**Demographics**

The LCH implies that consumers will optimise their consumption over their life cycle. The optimal consumption profile is likely to be relatively smooth, while incomes could be more variable (for instance, retirement from the workforce will lead to lower income). Differences between consumers' desired consumption in any period and their income in that period will lead to borrowing and lending in order to achieve their desired level of consumption.

Data on income and consumption by age group is available from the Household Expenditure Survey (HES). The most recent survey was undertaken in 1988-89. Chart 1 shows consumption and income for various age groups, based on the HES[1]. The chart shows a distinct hump in both consumption and income for consumers in the 45 to 54 year old age group.

[1] The results are presented based on the age of the reference person for each household.

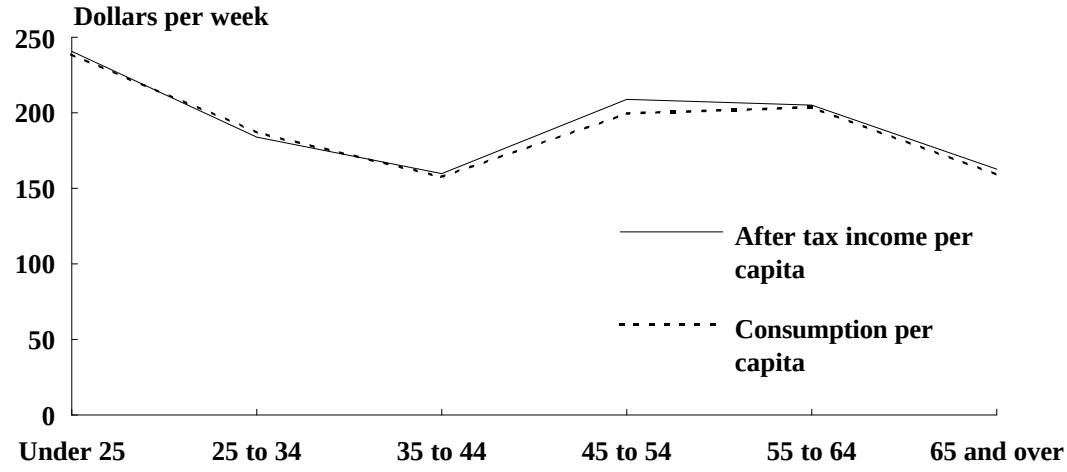
**Chart 1: Income and expenditure from the 1988-89 HES**




Edey and Britten-Jones (1990) use data from the 1984 HES (which exhibits a broadly similar pattern to that shown in Chart 1) to argue that consumption broadly follows changes in income, and that consumption smoothing is relatively unimportant over the longer term. However, (in common with the charts used by Edey and Britten-Jones), Chart 1 shows income and consumption on a per household basis, rather than a per capita basis.

Chart 2 shows per capita consumption and income for various age groups, again based on the 1988-89 HES. The chart shows a distinctly different pattern from Chart 1, and there are two features of the data that merit further discussion. Firstly, the close correlation between income and expenditure for each age group noted by Edey and Britten-Jones remains. This issue is covered in more detail below. Secondly, rather than being smooth, per capita consumption reaches a marked trough for consumers in the 35 to 44 age group.

**Chart 2: HES measures of consumption and income by age of reference person**

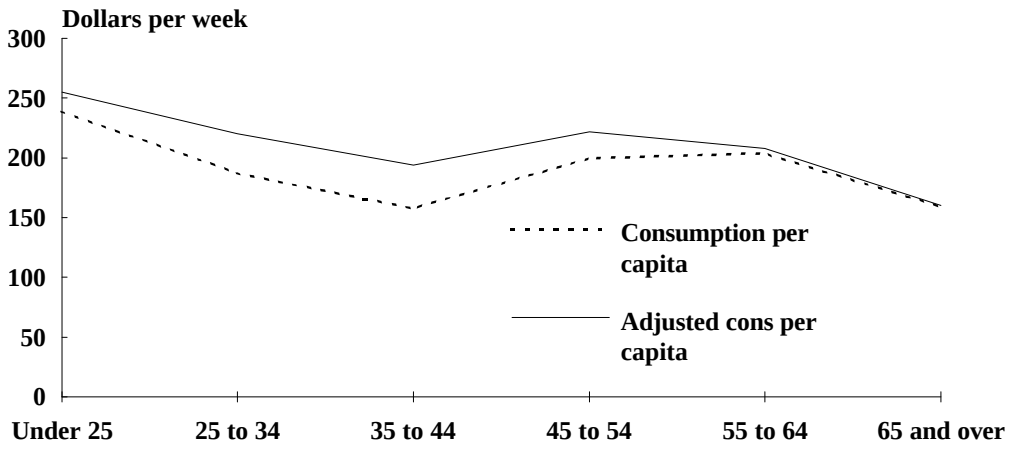



It is likely that at least some of the trough in consumption for 35 to 44 year olds can be explained by the large number of dependent children in households of this age group. Households in the 35 to 44 year old

age group have an average of almost two children under 18 per household - far more than any other age group.

The average consumption of these children is likely to be less than that of an average adult. Chart 3 shows per capita consumption by age group, where an adjustment has been made for the average number of children in each household. The adjustment is made by assuming that children under 18 years old consume (on average) 60 per cent of adult consumption. This adjustment produces a profile for per capita consumption that is smoother than indicated by Chart 2.

**Chart 3: Per capita consumption adjusted for the number of children**




While not completely removing the dip in consumption for 35 to 44 year olds, the adjusted series shown in Chart 3 indicates that there is a general downward trend in per capita consumption as the population ages.

This can be explained by productivity growth. Productivity growth endows younger consumers with higher lifetime resources than older consumers. The total lifetime resources of consumers who are currently young will be much higher than consumers who are currently retired (because older consumers earned most of their income when average incomes were lower than today). The LCH predicts the higher total lifetime resources of the young should lead to higher consumption by younger age cohorts relative to older age cohorts. That is, at any given point of time, per capita consumption of older consumers will be lower than that of younger consumers.

*Correlation between income and consumption*

Charts 1 and 2 indicate that consumption by each age cohort closely matches the income of that cohort. This is not in line with the predictions of the LCH.

However there are a number of problems with the savings data presented in the HES. Firstly, the overall saving rate implied by the HES estimates of income and consumption are very low. Using the HES to estimate total saving leads to an estimate of total household saving that is only a small proportion of that measured in the national accounts. A second point of concern is that the incomes of the young appears implausibly high relative to that of older cohorts.

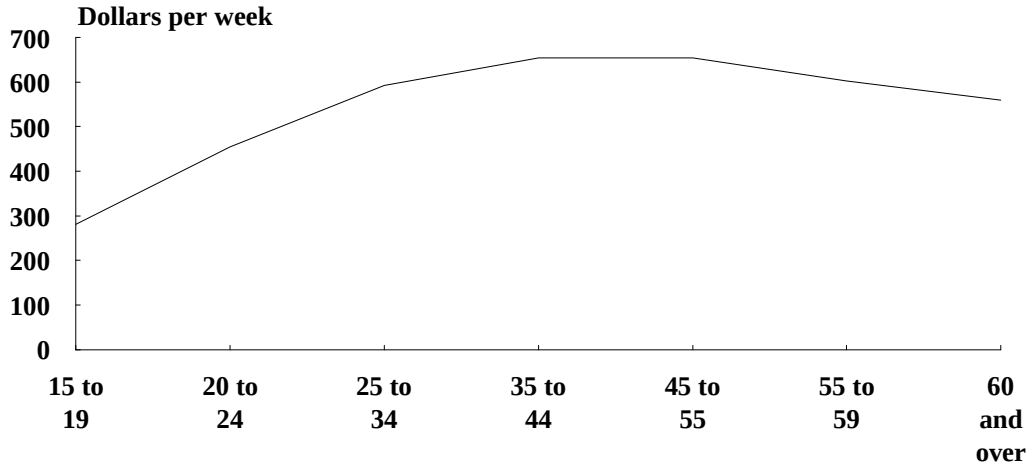
It may be that the problem is one of poor measurement of income in the HES, due to the HES being designed mainly as a survey of expenditure patterns. The ABS notes that in the HES "The collection of

income data is primarily undertaken to allow households to be classified into groups for expenditure analysis."[2]

An alternative source for data on the age distribution of income is the Weekly Earnings of Employees (Distribution) survey (ABS Cat No 6310.0). The most recent issue is August 1993, and the survey covers labour income from employees in their main job only. It therefore excludes additional income received from second jobs and property income. (Property income would be expected to rise with age).

Given these limitations, the main use of data from this source is to examine the shape of the earnings profile. Chart 4 shows the age distribution of income from the Weekly Earnings of Employees survey.

**Chart 4: Weekly earnings by age group.**




Compared with the HES, this survey reports much lower incomes for young employees, and higher incomes for older, more experienced workers. This is more in accordance with intuition than the earnings patterns estimated in the HES.

- The slight fall in average earnings for persons aged 55 and over may reflect differing retirement patterns. If the more well off consumers retire earlier, this would leave only the less well off in employment as they get older. This would tend to push down average earnings measured in the Weekly Earnings of Employees survey.

Note that Chart 4 will tend to overstate per capita income for older consumers, since the Chart shows only the incomes of those who remain in the work force. The average income of those aged over 60 will tend to be much lower, since many in this age group will have already retired.

*Implications for average propensities to consume*

The best overall picture for lifetime income and earnings patterns is likely to be derived from using HES data for lifetime consumption patterns and the Weekly Earnings of Employees (Distribution) survey for lifetime earning patterns. The combination of data from these two sources indicates that consumers' average propensity to consume is likely to vary over the life cycle, as they seek to smooth consumption in the face of a hump-shaped income profile.

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[2] ABS Catalogue No 6531.0 1988-89 Household Expenditure Survey, Australia Household Characteristics, p59

This leads to a few stylised facts about the income and consumption behaviour of individuals in each age group.

Young people appear to have a high average propensity to consume. The incomes of consumers in this age group tend to be below those of older consumers, while consumption is high. If the incomes of young people were low enough, the LCH and PIH suggest that young consumers could borrow against future income to finance current consumption. This would result in an average propensity to consume greater than unity. In any event, the average propensity to consume for young consumers appears to be quite high.

For 35 to 44 year olds the story is less clear. Incomes in this age group are rising, but many still have substantial family commitments.

By the time they reach the 45 to 64 year old age group, consumers' labour income reaches its peak. Normal life cycle consumption smoothing would therefore suggest that consumers in this age group are likely to save the highest proportion of their income. The average propensity to consume is likely to be relatively low for consumers in this age group.

Once they reach the age of 65, most consumers have left the labour force. Consumers in this age group will therefore have low labour income (although this will be partly offset by higher income from assets). Low income combined with relatively stable consumption will lead to a high average propensity to consume for consumers in this age group. Consumers in this age group may also elect to consume some of their asset holdings, gradually reducing their assets over time. The average propensity to consume for this age-group could therefore also exceed one.

The economy-wide average propensity to consume is formed by the aggregation of individual consumers' propensities to consume. If different age groups have different propensities to consume (as is suggested by the above analysis), then a change in the population structure is likely to lead to a change the aggregate average propensity to consume.

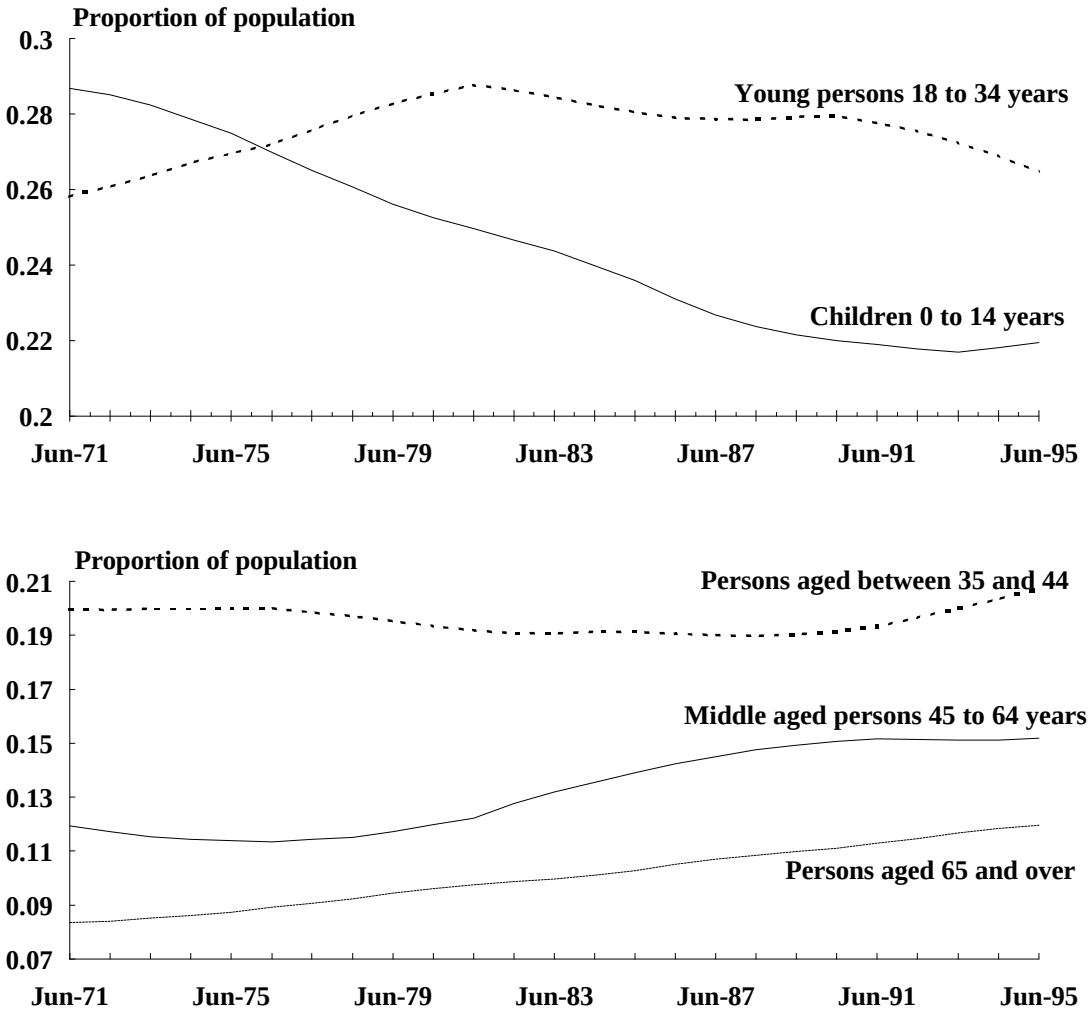
*Changes in the age structure of the Australian population*

Charts 5a and 5b show the movements in the proportion of the population in a number of age groups. There are three major points to notice. There has been an is almost continuous decline in the proportion of children aged under 14. This represents by far the largest demographic change over the estimation period. However, the effects of this change on consumption could be very difficult to model, since

- most spending will be undertaken by adults on behalf of their children; and
- changes have also occurred in the age at which people elect to have children.

The other movements that are worth noting are the steady increase in the proportion of the population aged over 65 since 1970, and the similar increase in the proportion of prime savers aged between 45 and 64.

**Charts 5a and 5b: Changes in demographics**




The changes in demographics outlined in the above charts could be expected to exert an influence on the aggregate propensity to consume. The steady increase in the proportion of the population aged over 65 would tend to increase the aggregate average propensity to consume. However, there have been two offsetting influences since the beginning of the 1980s. Firstly, there has been a reduction in the proportion of young persons aged between 20 and 34. Secondly, the proportion of high-saving middle aged persons increased through the 1980s, although the proportion in this age group stabilised in the 1990s.

**Productivity Growth**

Changes in the average rate of productivity growth will also affect consumption and savings under the LCH. Modigliani notes that productivity growth implies that younger age cohorts have larger lifetime resources than older ones. Other things being equal, this will result in the savings of the younger cohorts being larger than the dissaving of the retired (who had lower lifetime resources).

A change in the average level of productivity growth will therefore have an impact on the aggregate level of savings in the economy. Consider the effects of an unanticipated slowdown in the average rate of productivity growth in the economy.

Lower average productivity growth will reduce consumers' expected lifetime resources. As expected lifetime earnings fall, the consumption of the young will fall relative to that of the old. That is, young consumers will do less dissaving, and the aggregate savings ratio will rise. An unexpected slowdown in productivity growth will continue to exert a downwards influence on consumption until the consumers who did less dissaving in their youth become older, at which time their saving will be less than it would have been if productivity growth had been higher. Eventually, the savings ratio will return to equilibrium.

**Wealth**

Under the LCH consumers build up wealth when their current income exceeds their desired consumption. When desired consumption exceeds current income, wealth is run down to finance current consumption. This is most likely to occur during retirement.

In his 1986 paper Modigliani suggests a form of the consumption function where consumption depends only on labour income and wealth.

$$C = \alpha . Y_L + \delta . W$$

Where $Y_L$ is aggregate labour income; and
W is wealth.

This form of the consumption has formed the basis for the estimation of a number of Australian consumption functions (especially in macroeconometric models, including the Murphy Model and Treasury's NIF and TRYM models).

Some studies have elected to disaggregate wealth further on the basis that some assets may be more easily realised than others. For example, consumers may find it difficult to realise the value of assets such as housing to finance current consumption (it can be time consuming and costly to take out a home equity loan or sell a house), but cash deposits can be consumed directly. It is argued that consumption may be more responsive to the value of liquid assets compared with illiquid assets, particularly in the short run.

- This argument, while it has some intuitive appeal, is not consistent with either the LCH or PIH. Under these theories total lifetime resources (or permanent income) determine consumption, and the composition of assets has no effect on consumption.

The hypothesis that a one per cent increase in the value of housing assets will effect consumption differently from a one per cent increase in the value of liquid assets can be tested econometrically. Details of the estimation results obtained are included in Section 4.

**Inflation**

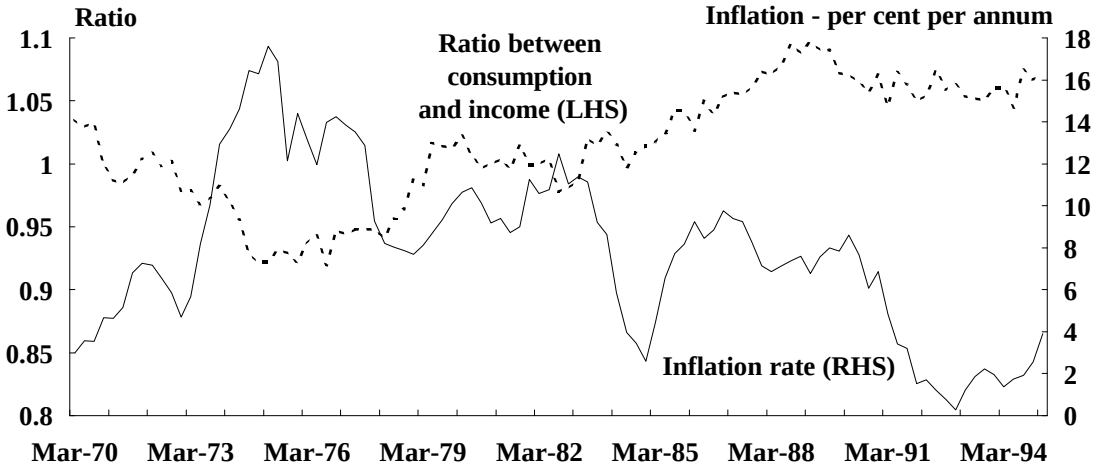
A number of Australian studies have found a significant relationship between consumption and inflation. These studies have indicated that an increase in inflation leads to a reduction in consumption.

Theoretically, it is not clear why this should be so, although Deaton (1977) has suggested that inflation may depress consumption because consumers mistake nominal price rises for real price rises when inflation is unanticipated.

Others (for example, Anstie et al 1983) have noted that official measures of household income are likely to be poor measures of households' economic income in times of high inflation. This mis-measurement of income could result in an inflation term being admitted into consumption equation.

In Australian studies, much of the explanatory power of inflation terms appears to be derived from the correlation between the timing of the fall in consumption relative to labour income and the increase in inflation in the early 1970s (see Chart 6).

**Chart 6: Consumption growth and inflation**




More recent studies have tended to find no statistically significant relationship between consumption and inflation.

**Interest rates**

The relationship between interest rates and consumption is quite complex, and there are a number of channels through which interest rates could affect consumption. Real interest rates determine the rate at which consumers can borrow and lend, and should therefore be important in determining how total lifetime resources are allocated to consumption in each period.

However, it is not clear a priori what impact a change in interest rates will have on current consumption. Changes in interest rates have both an income and a substitution effect. For example, an increase in real interest rates means that the price of consumption in future periods falls relative to current period consumption. This will tend to increase future consumption relative to current consumption (ie current savings will increase to finance greater consumption in the future). This is the substitution effect. On the other hand, an increase in real interest rates means that consumers need to save less in the current period to finance any given level of consumption in the future. This is an income effect, which will tend to increase current consumption.

- The short-run impact of changes in interest rates will therefore depend on whether the income effect or the substitution effect dominates.

*Cash flow effects of changes in interest rates*

As is noted above, econometric evidence indicates that consumption is excessively sensitive to short run changes in labour income compared to the (small) effects suggested by both the PIH and the LCH. One possible reason for this occurrence is that a number of consumers are liquidity constrained.

Interest rates could also impact on consumption through cash flow effects on liquidity constrained consumers. For example, an increase in interest rates will result in higher interest repayments for

consumers with borrowings. This reduces the disposable income (or cash flow) of consumers with borrowings. Liquidity constrained consumers will not be able to borrow to maintain their consumption in the face of lower cash flow, and so consumption will fall.

Recent increases in debt levels (following financial deregulation) may have increased the importance of this effect, and hence made consumption more sensitive to changes in interest rates.

However, changes in interest rates will also have a direct effect on the income of consumers that are net lenders. The effects are likely to be the strongest for consumers who derive a high proportion of their income from holdings of wealth (typically the elderly). The effects of a rise in interest rates for these consumers will be to increase their income and hence their consumption.

*Interest rates and wealth*

The market value of government securities directly depends on interest rates. A rise in interest rates will generate a fall in the price of bonds, resulting in a capital loss for bond holders. The market value of wealth will therefore fall.

The measure of private sector wealth used in the TRYM model includes wealth held in the form of government securities. Since wealth is valued at market value, it is responsive to changes in interest rates. The inclusion of a wealth term in the consumption function will therefore indirectly incorporate an effect on consumption due to changes in interest rates. This could hinder attempts to separately model the effects of interest rates on consumption.

**Transfer Payments**

Recipients of transfer payments (such as unemployment benefits and pensions) will, in general, have relatively low incomes. These consumers are also more likely to be liquidity constrained than the general population because financial institutions are unlikely to lend money to individuals with low incomes. As a result, it might be expected that transfer recipients would have a high propensity to consume out of current income.

- Reflecting these influences, the marginal propensity to consume out of transfer income was imposed to be equal to one in an early version of the NIF model.

Once again, this proposition can be tested by estimating a separate coefficient for the effects of changes in transfer payments on consumption.

**Confidence Effects**

Confidence effects may also affect consumption. This is likely to be particularly important for purchases of consumer durables. For example, the decision to purchase a new car can easily be delayed if consumers do not feel confident about their future income prospects.

Rising unemployment is often associated with low consumer confidence, since it causes consumers to be more uncertain about their own employment prospects. As a result, consumption functions often include a change in unemployment term to capture confidence effects.

## 3 RECENT EMPIRICAL STUDIES OF CONSUMPTION IN AUSTRALIA

This section briefly reviews the specifications used for consumption equations estimated in several recent Australian papers.

Smith (1991) focuses on two main factors as possible reasons for the substantial increase in consumption relative to household income over the period since the early 1970s: financial deregulation and changing demographics.

The paper attempts to model these effects in three different models of consumption behaviour:

- The first model is that due to Anstie et al (1983), who model consumption as a simple log linear function of Hicksian (economic) income. This approach highlights the importance of taking capital gains and losses into account when measuring income.

- The second model is the life-cycle model of consumption proposed by Ando and Modigliani (1963). In this model human and non-human wealth enters the consumption function, with human wealth being the discounted expected sum of lifetime labour income.

- The third model is a rational expectations version of the life-cycle model, where only unanticipated changes in income affect consumption.

Smith finds that significant demographic effects (using either the proportion of the population aged over 65 or the proportion of the population aged between 45 and 54) can be obtained under each specification of the model. There is, however, a tendency for the magnitudes suggested by the models to be on the large side.

In the rational expectations version of the model, Smith also finds that two variables designed to capture the effects of financial deregulation are significant and correctly signed. These are:

- a negative effect on consumption from the after tax real interest rate; and

- a positive effect on consumption from the interest rate differential between banks borrowing and lending rates. (This variable is designed to pick up the availability of credit - the wider is the interest rate differential, the larger the supply of credit).

However, none of the models tested can fully explain the upwards trend in the consumption ratio over the period in question, and the rational expectations versions of the model retain a significant exogenous time trend.

Lattimore (1994) estimates a single equation consumption function using annual data from 1951-52 to 1990-91.

In common with most empirical studies, Lattimore finds that current income growth is important in determining consumption growth. Wealth effects are also found to be important. Lattimore uses the ratio of assets to income as the relevant measure of wealth. Assets are weighted according to their liquidity, with a higher weighting being given to liquid assets in comparison to illiquid assets.

An interesting addition to normal wealth measures is a variable that Lattimore terms the 'housing effect variable'. This variable is designed to capture the effects of changes in house prices on saving. An increase in house prices creates a capital gain for home owners, which might be expected to have an upwards influence on consumption. However, higher house prices imply that non-home owners must save a larger deposit in order to purchase a house, and could also face higher rental payments. These effects may depress current consumption.

Confidence effects are captured in the model through the inclusion of a strike variable and the unemployment rate as explanatory variables. The strike variable measures the number of hours lost to strikes per hour worked - the greater are the number of strikes, the lower will be confidence, and hence consumption. The unemployment variable enters with a negative coefficient for the same reason - the higher is unemployment, the lower is confidence.

In contrast to a number of earlier studies, inflation was not found to be a significant determinant of consumption. Lattimore suggests that this could be the result of incorrect measurement of economic income in earlier studies.

Demographics are also found to affect consumption, with the proportion of the population aged between 20 and 34 and the proportion aged between 45 and 64 both having a significant impact on consumption. As predicted by the theory, Lattimore found that the proportion of 20 to 34 year olds in the population had a positive effect on consumption, while the proportion of 45 to 64 year old consumers tended to depress consumption, reflecting the higher savings rate of these consumers.

Lattimore's estimated equation suggests that the proportion of the population in a certain age group affects the *growth rate* of consumption, rather than the level of consumption. The estimates indicate that a permanent increase in the proportion of the population aged between 20 and 34 permanently increases the growth rate of consumption.

Murphy (1991) reports on the consumption equation used in the Murphy Model.

The Murphy Model consumption function is based on the approach taken by Ando and Modigliani, in which consumption depends on labour income and the stock of wealth. The equation is similar in many respects to that used in the TRYM model (discussed in more detail below). The level of consumption adjusts towards an equilibrium path, which is determined by labour income and the stock of non-human wealth. The (imposed) propensities to consume out of labour income and non-human wealth are 2/3 and 1/3 respectively.

The equation also includes a (positive) time trend, and a term for the change in the unemployment rate (to capture confidence effects).

Interest rates exert an influence on consumption in the Murphy model through two separate channels. Firstly, the equation contains a variable that measures the change in the yield curve (measured as the difference between 90 day bank bills and 10 year bond yields) between the current quarter and the average value in the previous year. This term is designed to capture the tightness of monetary policy, and appears in the equation with a lag of 4 quarters. This implies that it takes some time for the effects of changes in interest rates to flow through to consumption.

Changes in interest rates also enter the consumption equation through a variable that measures the difference between the average interest rate paid on outstanding government bonds and the interest rate paid on newly issued bonds. This term captures the effects on consumption of capital gains and losses incurred by existing bond holders.

**The TRYM consumption function**

The TRYM consumption function is also a partial adjustment equation. The desired level of consumption (CON*) depends on after-tax real labour income and real non-human wealth, in accordance with the Life-Cycle Hypothesis.

The current TRYM specification is given by:

$$\ln(CON) = (1-a_0)\times\ln(CON(-1)) + a_0\times\left\{\ln(c_0)+\ln\left[\frac{YNZ}{PCON}+c_1\times\left(\frac{VMZ(-1)}{PCON}\right)\right]\right\} - a_1\times[RNU-RNU(-4)]$$

## Results

Sample 80(1): 95(2)

| Parameter | Interpretation | Estimate | t-Statistic |
|---|---|---|---|
| $a_0$ | partial adjustment | 0.253 | 4.56 |
| $a_1$ | change in unemployment | 0.005 | 0.70 |
| $c_0$ | long run constant | 0.719 | 18.96 |
| $c_1$ | wealth | 0.021 | 5.95 |

$R^2$ = 0.998 SE=0.68% DW=2.22

With the exception of the change in unemployment term, all coefficients have significant and correct signs. There is considerable inertia in consumption with the lagged dependent variable determining a significant proportion (74 per cent) of the current quarter's consumption.

The long run coefficient on wealth ($c_1$) gives the quarterly expected after-tax real rate of return on wealth. This estimate implies that the annual expected after-tax real rate of return from wealth is around 8½ per cent.

- In terms of income flows, this implies that expected income from private sector wealth[3] is roughly equivalent to around 50 per cent of after-tax labour income, which is much higher than measured property income in history. National Accounts estimates show that after-tax real property income only accounts for around 20 per cent of household disposable income.

The estimated average propensity to consume out of total income is 0.72, which implies a high average savings ratio. This adds weight to the suggestion that income from wealth is overestimated, since overstating income (including expected income from asset holdings) will result in the average propensity to consume being understated.

[3] Estimated by multiplying $c_1$ by the current estimate for private sector wealth (VMZ) and dividing by the current estimate of quarterly after-tax labour income (YNZ).

The equation is estimated using quarterly data from 1980:1 to 1995:2. Most other equations in the TRYM model are estimated from the start of the 1970s. The consumption function was estimated over a shorter time period to remove the rapid increase in the average propensity to consume over the 1970s from the estimation period.

Incorporating demographic effects into the consumption equation could help to explain movements in the average propensity to consume, and therefore allow the consumption equation to be estimated over a longer sample period, thereby increasing the reliability of the parameter estimates.

## 4 RE-ESTIMATING THE TRYM CONSUMPTION FUNCTION

One of the first decisions that must be made with regard to estimating a macroeconomic consumption equation is the degree to which consumption will be disaggregated. The national accounts measure of consumption includes a very wide variety of items, ranging from essentials (such as food and shelter) to luxury items and long-lived assets. Microeconomic theory suggests that spending on each of these individual components of consumption is likely to behave differently in response to changes in prices and consumers' incomes.

However, for an aggregate macroeconomic model such as TRYM, it is not practical to estimate separate equations for the range of individual goods included in consumption. Some sort of aggregate equation is required.

A number of studies (including some econometric models) have elected to disaggregate consumption by modelling expenditure on consumer durables separately from the remainder of consumption. Consumer durables include items such as cars, washing machines and other long lived consumer items. Blinder and Deaton (1985) include clothes as consumer durables.

- The main identifying feature of consumer durables is that they provide a stream of services over time, and for this reason the purchase of consumer durables can be thought of as an investment decision by households rather than as consumption per se. In thinking of the purchase of consumer durables as an investment decision, it becomes apparent that purchases of consumer durables are likely to depend on different factors than those that determine non-durable consumption. Factors such as interest rates and the implicit rates of return from investing in consumer durables are likely to be important, with a reduced role for income.

There are, however, significant problems associated with the modelling of consumer durables. A large range of data are required, including (at a minimum) consumption expenditure on consumer durables, the size of the stock of consumer durables, and average depreciation rates. Much of this data is either unavailable or of poor quality. Factors such as these explain why Church, Smith and Wallis (1994) found that for UK models, the costs of disaggregating expenditure on consumer durables appear to outweigh the benefits of doing so.

Consistent with the equation in the 1993 Conference version of the TRYM model, a decision was made to treat all consumption as homogenous. This reflects the data problems noted above, and the desire for simplicity and transparency in the model.

The estimated equation is based on similar theoretical grounds to the earlier TRYM equations, and is specified in error correction form. Desired consumption is assumed to depend on after tax labour income and wealth. For a representative consumer, we have:

$$CON^* = c_0 \times \left[ \frac{YLZ}{PCON} + c_1 \times \frac{WMZ}{PCON} \right]$$

Estimation was undertaken using a general to specific approach, starting with the variables outlined above. The equation that produced the best fit was given by:

$$\begin{aligned}\Delta\ln(CON) = {} & \Delta\ln(NAP) + CLAM/4 \\ & + a_2 \times \left[\Delta\ln\left(\frac{YNZ}{PCON \times NAP}\right) - CLAM/4\right] \\ & - a_4 \times \left[RNU - RNU(-1)\right] \\ & + a_5 \times \left[\Delta\ln\left(\frac{VMZ}{PCON \times NAP}\right) - CLAM/4\right] \\ & + c_3 \times \left(P4564 - P4564(-1)\right) \\ & + c_4 \times \left(P65O - P65O(-1)\right) \\ & - a_0 \times \left\{\begin{array}{l}\ln\left(CON(-1)\right) - \ln\left(c_0 + c_3 \times P4564 + c_4 \times P65O\right) \\ - \ln\left[\dfrac{YNZ(-1)}{PCON(-1) \times NAP(-1)} + c_5 \times \dfrac{VMZ(-1)}{PCON(-1) \times NAP(-1)}\right]\end{array}\right\}\end{aligned}$$

The results were as follows:

Sample 71(2):95(1)

| Parameter | Estimate | t-Statistic |
|---|---|---|
| $a_2$ | 0.276 | 5.35 |
| $a_4$ | 0.006 | 3.15 |
| $a_5$ | 0.064 | 3.02 |
| $a_0$ | 0.258 | 4.23 |
| $c_0$ | 1.07 | 8.50 |
| $c_3$ | -2.34 | -3.96 |
| $c_4$ | 2.28 | 8.84 |
| $c_5$ | 0.009 | 6.41 |

**Diagnostic Statistics:**

| | | |
|---|---|---|
| $R^2$ = 0.43 | | |
| SE = 0.68% | | |
| DW = 2.20 | | |
| Box-Pierce Q (1-8th order auto correlation) | | 7.50 |
| Jarque-Bera test for Normality | | 5.06 |
| Chow test for Parameter Stability | | 0.79 |
| Ramsey's Reset test | | 0.002 |
| Breusch-Pagan Heteroscedasticity tests: | | |
| | Trend | 0.25 |
| | Y-H | 0.50 |
| | Joint | 0.86 |

There are a number of aspects of the estimation process and results that are worthy of further discussion.

**Wealth**

Non-human wealth was initially decomposed into housing wealth (representing illiquid wealth) and non-housing wealth (representing relatively liquid wealth) for estimation purposes. The propensities to

consume out of each type of asset were allowed to vary in both the short run and the long run. This allows, for example, consumers to treat all assets similarly in the long but differentiate between an increase in liquid and illiquid wealth in the short run.

Likelihood ratio tests were used to test the restrictions that the coefficients on housing and non-housing wealth are the same in both the short and long run. In each case the restrictions were accepted at the one per cent level. That is, the estimation results indicate that it is the total stock of wealth is important in determining consumption, and that the relative liquidity of the various components of wealth do not influence consumer behaviour, even in the short run.

**Interest rates**

During the estimation process, attempts were made to include interest rate effects in the consumption equation in a number of ways. Changes in both long and short term interest rates were included in the short run dynamics, but neither proved to be significant.

An attempt was also made to incorporate an estimated mortgage interest rate term into the short run dynamics of the consumption equation. This was included in an attempt to capture the effect of changes in interest rates on credit constrained consumers, particularly those with housing loans.

- The TRYM dwelling investment equation estimates the cost of credit in the dwelling sector as a combination of short and long term interest rates. This combination can be thought of as the mortgage interest rate.

No significant relationship could be found between consumption and the estimated mortgage interest rate.

**Inflation**

Inflation proved to have a significant effect on consumption when estimation was undertaken over longer sample periods (ie those that included the early 1970s). The estimates indicated that an increase in inflation tends to depress consumption.

However, the inflation term was not significant for estimates over more recent time frames (particularly for estimates commencing in the 1980s). This suggests that the fall in the average propensity to consume in the early 1970s may have been caused by factors other than inflation, and that the confluence of high inflation and low consumption at that time may not have represented a causal relationship.

**Transfer payments**

Labour income was decomposed into wage income and transfer income during the estimation process to allow testing of the hypothesis that the propensity to consume out of transfer income is higher than that of ordinary wage income. A significant difference between the propensities to consume out of each type of income could reflect the presence of liquidity constraints for the beneficiaries of transfer payments.

No statistically significant relationship could be found between changes in transfer payments and changes in consumption. The high level of volatility in transfers data (with changes of ten per cent in a quarter not uncommon) could have been a factor in preventing a stable relationship.

The further possibility that only recipients of unemployment benefits are liquidity constrained was also tested. Recipients of old age pensions may not be liquidity constrained, since they are likely to be

relatively asset rich, and unlikely to wish to borrow money to finance consumption. On the other hand, unemployment benefit recipients are likely to be younger than pensioners and less likely to have a large amount of property income.

Estimation was therefore undertaken allowing the changes in unemployment benefit payments to exert a separate influence on consumption from other labour income (all other transfer payments were retained in labour income). This also proved to be unsuccessful.

Changes in unemployment benefit payments are highly correlated with the change in unemployment term, which is included in the equation to capture short run confidence effects. Unsurprisingly, no statistically significant relationship could be found when both terms were included together. Estimation using only the change in unemployment benefit payments term produced a negative relationship between the change in unemployment benefit payments and consumption.

- An increase in unemployment benefit payments brought about via an increase in unemployment represents a fall in overall income (as the employed move into unemployment they suffer a loss in income, even though there is an increase in unemployment benefit payments). Coupled with the possibility of a fall in consumer confidence brought about by higher unemployment, this could help to explain why an increase in unemployment benefit payments is associated with a fall in consumption.

Separately modelling unemployment benefit payments and other labour income did not add anything to the explanatory power of the equation, and added an extra degree of complexity. The original specification was therefore maintained.

**Demographics**

For estimation purposes, the population was stratified into age groups identified above. That is:

- young persons aged between 20 and 34 (P2034);
- persons aged between 35 and 44 (P3544);
- pre-retirees aged between 45 and 64 (P4564); and
- persons aged 65 and over (P65O).

Demographic influences on consumption were estimated by allowing the long run average propensity to consume to vary in response to changes in the relative shares of the population in each age group. The long run relationship between income, consumption and wealth was therefore estimated as:

$$CON^* = \left(c_0 + c_1 \times P2034 + c_2 \times P3544 + c_3 \times P4564 + c_4 \times P65O\right) \times \left[\frac{YNZ}{PCON} + c_5 \times \frac{VMZ}{PCON}\right]$$

Initial estimates included all four age strata, and produced coefficients with plausible signs, but none of the parameter estimates were statistically significant. The best fit was achieved by including only the proportion of the population aged between 45 and 64 year (the prime savers), and the proportion of the population aged over 65.

The estimates shown above for the parameters on the demographic variables are correctly signed and significant. They imply that the larger the proportion of the population aged between 45 and 64, the lower is per capita consumption (for given per capita labour income and wealth), while the higher is the proportion aged over 65 the higher is per capita consumption (again, for given per capita income and wealth).

The estimated parameters on the demographic variables were relatively stable, with estimation over different sample periods producing very similar estimates. The results for the proportion of the population aged over 65 are similar to those reported in Smith (1991), although Smith's results were produced using a different type of model. Smith reports that a rise of 2.5 percentage points in the aged dependency ratio leads to an increase in the consumption ratio of 5.8 percentage point increase in the consumption ratio, and suggests that the estimates appear somewhat high.

Indeed, the magnitudes of the estimates appear to be too large to be explained by demographics alone. For example, the long run average propensity to consume implied by the above estimates is given by the interaction of the demographic coefficients and the long run constant. That is,

$$LRAPC = c_0 + c_3 \times P4564 + c_4 \times P65O$$

**Chart 7: Long run average propensity to consume**

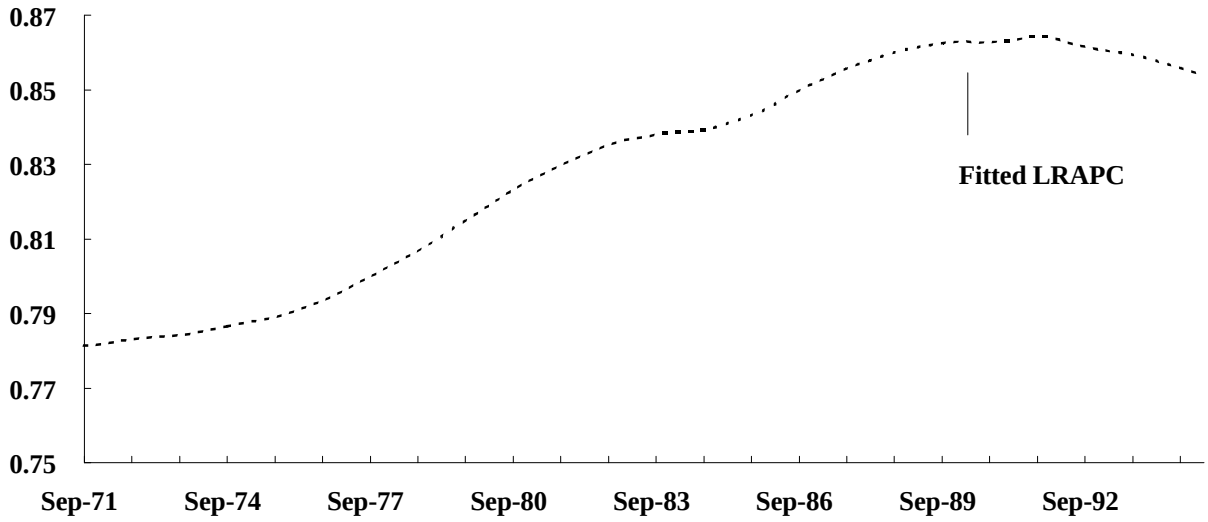



Chart 7 shows the estimated long run average propensity to consume. The chart indicates that the fitted LRAPC increased by around 7 percentage points between 1971 and the early 1990s. A 3.2 percentage point increase in the proportion of consumers aged over 65 contributed 7.3 percentage points to the increase.

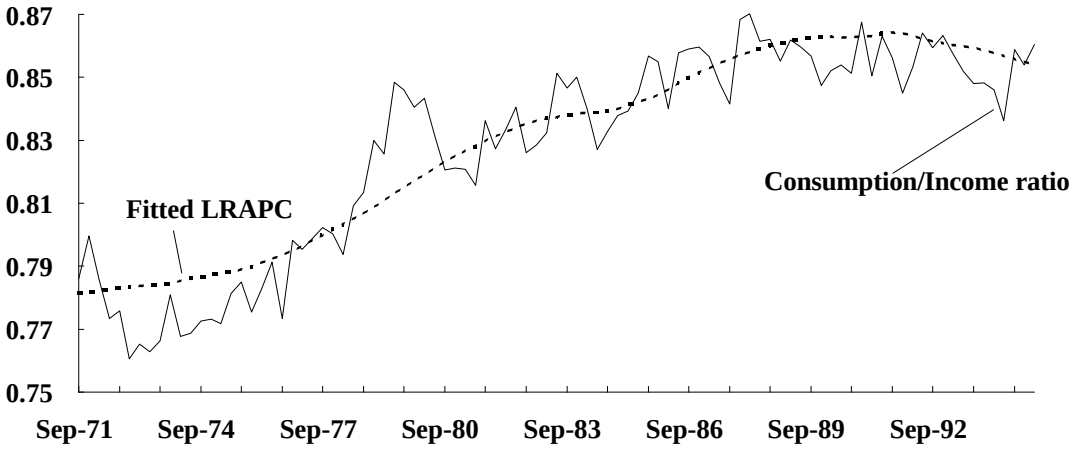
Currently, the proportion of the population aged 65 and over is around 12 per cent. While it is not straight forward to directly calculate the implied average propensities to consume for each age group from the above estimates, it is apparent that the propensity to consume of those aged over 65s would have to be substantially higher (perhaps several times higher) than that of the rest of the population to produce the above results. This seems unlikely.

Estimates presented in FitzGerald (1993) suggest that changing demographics could have resulted in a decline in the savings ratio (implying an increase in the consumption ratio) of between one and one and a

half percentage points over a similar period. A movement of this size would be more in keeping with believable average propensities to consume across the various age cohorts.

The evidence above suggests that the demographic variables must be capturing influences on consumption that are in fact caused by other variables that have been omitted from the consumption function. Chart 8 shows the historical ratio of consumption to estimated income (which is given by labour income (YNZ) plus expected income from wealth (c5*VMZ)). The fitted long run average propensity to consume (which depends only on demographics) is capturing the strong upwards trend in the consumption to income ratio.

**Chart 8: Ratio between consumption and income**




The approach taken to modelling the effects of changes in demographics outlined above implicitly assumes that each age cohort's average propensity to consume does not change over time. This assumption does not appear to be valid.

The LCH identifies a number of possible factors that would cause consumers' long run average propensity to consume to change over time. These include the relative lengths of consumers' working lives and retirement, the generosity of government provided pensions, and changes in the rate of productivity growth. The likely effect of each of these possibilities is discussed in the following paragraphs.

*Relative lengths of working age and retirement*

Under the LCH, consumers fund consumption in retirement by building up a stock of wealth during their working lives. If consumers anticipate a longer period of retirement relative to their working life (for example, because of a trend towards early retirement or an increase in average life expectancy) then they will need to accumulate a larger stock of wealth during their working lives. This will, other things being equal, tend to increase savings and depress consumption during the consumers working life.

Note, however, that an unanticipated increase in life expectancy could have the opposite effect on the consumption of retired persons. If consumers do not anticipate the increase in life expectancy, they may not accumulate enough wealth to finance the desired level of consumption through a longer than anticipated retirement. This could cause retired consumers to reduce their consumption below the desired level to ensure that their resources last until the end of their life.

*Government provided pensions*

The relative level of old age pensions could have a similar effect on consumers' saving during their working lives. The higher are government provided old age pensions relative to average income, the less consumers need to save during their working life in order to finance a given consumption level during retirement. Changes in eligibility arrangements for pensions could also influence consumption and savings decisions for individual consumers, although it is unlikely that these effects would be picked up in aggregate data.

*Changes in productivity growth*

Changes in labour productivity growth may help to explain movements in consumers' average propensity to consume over the 1970s. Labour productivity growth in Australia fell substantially in the early 1970s, following relatively strong growth throughout the 1960s. Average labour productivity growth rate during the 1960s was around 2.5 per cent, while productivity growth averaged only 1.3 per cent per annum between 1972-73 and 1994-95. If consumers did not anticipate the slowdown in labour productivity growth, this would be expected to have a dampening influence on consumer spending during the early 1970s.

However, it would be unwise to attribute all of the increase in the savings rate in the early 1970s to the decline in productivity.

- The fall in the average propensity to consume was quite pronounced. This would only be achieved if a large proportion of consumers were forward looking (as required by the LCH), and that these consumers recognised that the fall in productivity was permanent (rather than a temporary shock).

- As noted above, consumption appears to be excessively sensitive to the level of current income. This sensitivity suggests that the LCH does not fully hold for some reason. The effects of a reduction in productivity growth could therefore be somewhat muted compared to those implied by the theory.

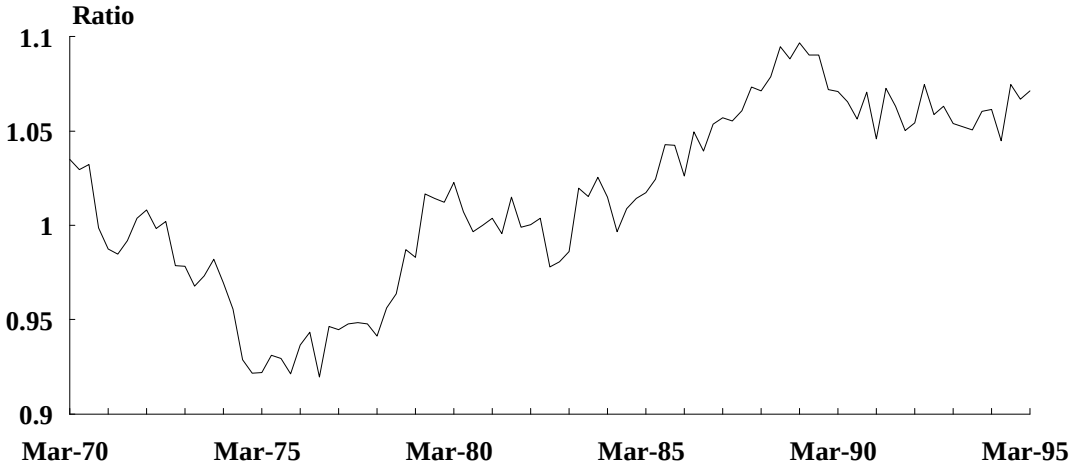
    – For example, the consumption of liquidity constrained consumers may not change at all following a decline in productivity growth if their desired consumption remains above their current income.

**Other factors which may have influenced the consumption ratio**

High wages growth in the early 1970s resulted in a substantial increase in the share of national income accruing to labour. If consumers were sufficiently forward looking, they may have realised that this was not sustainable, and therefore expected the labour share of national income to fall again in the future. Consumers would therefore have regarded the increase in labour income as temporary, and (in accordance with the LCH) the majority would be saved.

Chart 9 shows consumption and labour income. The Chart indicates that the rapid increase in labour income in the early 1970s was not accompanied by a similar increase in consumption. This lead to a fall in consumption relative to labour income, and suggests that consumers may indeed have regarded the increase in income in the early 1970s as temporary.

**Chart 9: Ratio of consumption to labour income**




Smith emphasises the role of financial deregulation in explaining changes in the consumption ratio. One effect of financial deregulation was to increase the supply of credit to consumers. This may have resulted in the a drop in the number of liquidity constrained consumers, which would be expected to result in an increase in consumption relative to current income.

However, financial deregulation has been most important through the 1980s, when the consumption ratio has been more stable.

## 5 CONCLUSIONS

The Life Cycle Hypothesis suggests that the age structure of a population could be play a role in determining aggregate consumption behaviour. The demographics of the Australian population have changed markedly over the last 25 years, with a substantial fall in the proportion of the population aged under 14, and an increase in the proportion of the population aged 65 and over.

The estimates presented in this paper show that while it is relatively easy to introduce demographic variables into the consumption function and obtain a good degree of fit, the results must be examined carefully.

In a simple consumption function such as the one proposed in this paper, the parameter estimates associated with demographic variables appear to be too large to be explained by changes in the age structure of the population alone. The demographic parameters may be capturing the influence of other factors on consumption. These could include changes in the institutional environment (such as financial deregulation), changes in productivity growth, and changes in other aspects of consumer behaviour (such as labour supply decisions, including early retirement). In practise, all of these influences will interact with changes in the demographic structure of the population to affect consumption.

All in all, the results presented above probably raise more questions than they answer. However, insofar as framing the right questions represents an important part of empirical research, they provide a good starting point for continuing investigations into consumer behaviour in TRYM.

**REFERENCES**

Ando, A and Modigliani, F "The 'Life Cycle' Hypothesis of Saving: Aggregate Implications and Tests" *The American Economic Review*, March 1963.

Anstie, R.K, Gray, M.R. and Pagan, A.R "Inflation and the Consumption Ratio", in A. R. Pagan and P.K. Trivedi (eds) *The Effects of Inflation* Centre for Economic Policy Research 1983.

Antioch, L and Taplin, B "Savings, Dwelling Investment and the Labour Market: Decisions by Households" *TRYM Paper No. 5* June 1993 Conference

Blinder, A and Deaton, A "The Time Series Consumption Function Revisited" *Brookings Papers on Economic Activity* 2:1985

Church, K.B, Smith, P.N and Wallis, K.F "Econometric Evaluation of Consumers' Expenditure Equations" *Oxford Review of Economic Policy* Vol 10 No 2.

Edey, M and Britten-Jones, M "Saving and Investment" *The Australian Macro-Economy in the 1980s - Proceedings of a Conference*, Reserve Bank of Australia, 1990

Deaton, A.S "Involuntary Saving through Unanticipated Inflation" *The American Economic Review* June 1975

FitzGerald, V.W *National Saving: A Report to the Treasurer* AGPS Canberra 1993

Friedman, M "A Theory of the Consumption Function" Princeton University Press, 1957

Lattimore, R "Australian Consumption and Saving" *Oxford Review of Economic Policy* Vol 10 No 2.

Modigliani, F "Life Cycle, Individual Thrift, and the Wealth of Nations" *The American Economic Review*, June 1986.

Modigliani, F and Brumberg, R "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data" in K. Kurihara, ed. *Post Keynesian Economics*, Rutgers University Press 1954.

Murphy, C.W "Saving Policy Issues Examined with a Macroeconometric Model" *Saving and Policy - Proceedings of a Conference* Centre for Economic Policy Research 1991

Simes, R.M and Horn, P.M "Wealth, Inflation and the Consumption Function" *Paper presented to the 15th Conference of Economists* August 1986.

Smith, P.N "The Consumption Ratio: Theory and Australian Evidence" *Saving and Policy - Proceedings of a Conference* Centre for Economic Policy Research 1991

Taplin, et al "Documentation of the Treasury Macroeconomic (TRYM) Model of the Australian Economy" *TRYM Paper No 2* June 1993 Conference