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*Savings, The Dwelling Sector  
and Participation Rates  
in The Treasury Macroeconomic  
(TRYM)  
Model  
By*

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This document is based on the research and development work undertaken in recent years in the Modelling Section of the Treasury. It has been released in the interests of making information of this kind available to others working in the same general field and of fostering public discussion and evaluation of the research results that are embodied in the model.

The authors would like to acknowledge the contributions of Mr Brett Ryder, Dr Barry Gray and Ms Priya Parameswaran. However the usual caveats apply.

**TRYM PAPER No. 5**

This document is one of a series presented at the June 1993 Treasury Conference on *The TRYM Model of the Australian Economy*. The full set of papers presented at the conference are listed below.

- *An Introduction to the Treasury Macroeconomic (TRYM) Model of the Australian Economy*  
(TRYM Paper No.1)
- *Documentation of the Treasury Macroeconomic (TRYM) Model of the Australian Economy*  
(TRYM Paper No. 2)
- *Employment, Investment and Productivity: Decisions by the Firm*  
(TRYM Paper No. 3)
- *Exports, Imports and the Trade Balance*  
(TRYM Paper No. 4)
- *Savings, Dwelling Investment and the Labour Market: Decisions by Households*  
(TRYM Paper No. 5)
- *Australia's Trade Linkages with the World*  
(TRYM Paper No. 6)
- *The Macroeconomic Effects of Higher Productivity*  
(TRYM Paper No. 7)

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## INTRODUCTION

The aim of this paper is to describe how the TRYM model analyses some of the important decisions made by households. These are the choice between consumption and saving, the level of investment expenditure on dwellings as consumers and investors, and participation in the labour force. These decisions are captured by four behavioural equations for private final consumption expenditure, the price of rents, dwelling investment and labour supply.

These decisions have been modelling in a simple and transparent way using the recently rebased National Accounts data. Our overall objective was to strike a balance between data and theoretical considerations, which we believe we have achieved given the small amount of time available since this new data became available.

The relationship between consumption, income and wealth is important for macroeconomic models. Not surprisingly, we find that there is a strong causal relation between these variables, consistent with Fisher's theory of intertemporal optimisation. We specify a general consumption equation that encompasses a number of different theories and let the data choose the relative strengths of different linkages.

In the dwelling sector, our objective was to explain dwelling investment in the post deregulation period. This objective is accomplished given the restriction that our experience with a deregulated financial market has been limited to only one complete cycle. Finally, labour supply was specified to take account of both movements in the demand for labour and supply factors, such as demographic and structural changes. Because we have modelled labour supply on an hours basis, we have in broad terms, attempted to capture some part of the significant shift towards part-time employment.

The basic structure of the household sector is as follows. Households sell labour services to the business and government sectors and receive a wage income in exchange for their labour services. They can also build up or run down their stock of private sector wealth. This wealth may be held in a variety of different forms - dwellings, business assets (real and financial), public securities and Reserve Bank liabilities. The expected rate of return from this stock of wealth provides a flow of expected income to the household sector.

Households appear to smooth consumption spending to some extent and savings are determined as a residual<sup>1</sup>. There are a number of factors that will influence the saving decision: the desire to smooth

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<sup>1</sup>. The level of savings in the TRYM model are not directly comparable to the ABS savings measure because there are differences in the measurement of property incomes.

consumption; desire (either implicitly or explicitly) to hold a particular level of wealth; and the level of uncertainty households experience. Government policies, such as taxes and transfer payments, can also affect the level of savings.

Having determined the split between consumption and saving, we assume households allocate consumption spending, in each period, between rent consumption and non-rent consumption. Dwelling investment by households is found to depend on a comparison between rental returns and the cost of funds and the state of the labour market.

The labour force participation decisions depend on the encouraged worker effect, real wages and average hours worked per employed persons.

Although the specification of these equations is based on economic principles there is no unifying theoretical framework, such as utility maximisation, that attempts to link them. This outcome reflects a trade-off between theoretical and data considerations. The main disadvantage of a unified utility maximisation framework is that it imposes constraints on the modelling of macro behaviour of households that may not always be reflected in the data. For example, there are little data on households' intertemporal discount rate and where there are data they are not available on a consistent basis. Moreover, the TRYM model is not designed to examine the effects of changes in microeconomic parameters that are best captured in an integrated framework. In addition, some of the macroeconomic variables that could have provided additional linkages between different decisions were found to have an insignificant effect on households decisions.

However, this does not imply that inter linkages between household decisions have been ignored where they will assist our understanding of macro economic issues. There are obvious inter linkages between some decisions, such as between the price of rents and dwelling investment equations. These can be interpreted as representing the demand and supply curves for dwellings respectively and are estimated jointly.

This paper is organised as follows. In section one households' consumption and saving decisions are examined. Dwelling investment is examined in section two while labour supply decisions are discussed in section three. In section four we draw appropriate conclusions from this work.

## **1.0 CONSUMPTION AND SAVING BEHAVIOUR**

The relationship between consumption, income and non-human wealth has been a subject of considerable analysis but remains an area of much controversy. There remains disagreement, for example, on the effects of interest rates and the prevalence of borrowing constraints. Nevertheless, these relationships form an important basis for macroeconometric models and the consumption

decision must be modelled even though there are some major outstanding issues (Blinder and Deaton 1985).

In modelling households' consumption-saving decisions, most economists follow one of two ways of implementing Fisher's theory of inter temporal optimisation; this theory allows households to smooth consumption through borrowing and saving (lending), allowing current income to deviate from current consumption. One strand is represented by the theoretical specifications suggested by the work of Friedman (1957) and Ando and Modigliani (1963) in which an important determinant of consumption is wealth.

In contrast, more recent work by DeLong and Summers (1986) suggests that current income plays a more important role, consistent with Keynes' consumption function. Our approach has been to adopt a general specification that encompasses the main ideas expressed in the literature and to allow the data to determine the relative ability of the competing theories to explain the macroeconomic data over the sample period.

The basic permanent-income hypothesis, developed by Friedman, postulates that consumption depends upon the long run average (permanent) income households expect to receive. This means that if actual income is above (or below) permanent income households' savings will rise (or fall). Private consumption should depend on the interest rate, the ratio of non-human wealth to permanent income, income variability, and certain life cycle variables. It is the level of an average expected income from wealth that is important rather than the stock of wealth. To the extent that most variation in income is transitory, the theory suggests that consumption should be smooth.

The basic life-cycle hypothesis, on the other hand, postulates that consumers try to stabilise their consumption over their entire life-time. This hypothesis also implies that consumption depends not just on current income but also on the actual value of assets and liabilities of those consumers relative to a desired level. This desired value of net private wealth is determined by a range of microeconomic influences that are beyond the scope of this study. In the long run, the hypothesis predicts a constant saving (or consumption) to income ratio but, in the short run, one that varies over the business cycle. It is the stock of wealth rather than the flow of income that is important in the determination of consumption.

A key difference between Fisher's approach and more recent research on consumption behaviour is the role of capital markets. For households to achieve a smooth level of consumption over their lives, they should be able to borrow as much as they wish now, on the basis that there should be sufficient expected income to repay the loan in the future. This is generally true for young households whose current income is low would need to borrow against expected high income in later years to maintain a smooth consumption profile. However, financial institutions do not

generally allow young households to borrow all they like, with the result that at a current point of time they could be liquidity constrained. This is a feature of an imperfect capital market. Another is the existence of interest rate spreads between borrowing and lending rates.

The presence of imperfect capital markets suggests that current income should play a much more important role in consumption decisions than both the permanent income and life-cycle hypotheses imply.

Therefore, in this modelling, private consumption was specified to depend on real non-property income, real non-human private wealth and changes in the unemployment rate and non-property income. However, the 1980s data suggest that fluctuation in current income has less of an effect on current consumption than it did during the 1970s. This result is consistent with the work of Blundell-Wignall, Browne, Cavaglia and Tarditi (1992)<sup>2</sup>.

There are two issues that must also be addressed before we estimate a consumption function. The first is whether households are forward looking. Although the permanent income and the life-cycle theories imply forward looking behaviour, our model specification assumes that the household and the business sectors, unlike the financial sector, are not forward looking. The information set of households consists of current and past information only. However, the inclusion of wealth in the consumption function suggests that there may be some forward looking information with respect to financial market's valuation of business and financial assets. This feature of the TRYM model is broadly consistent with other models, with the exception of the MGS model where a proportion of consumers can be forward looking.

The second is the extent to which households consolidate their account with those of business and government sectors. There are two extreme positions here. First, households consolidate their accounts with those of business and government sectors, a view that is consistent with forward looking behaviour. Alternatively, households do not consolidate such accounts, a view that is consistent with myopic behaviour. In the TRYM model, we adopt a middle position that assumes households fully consolidate their accounts with the business sector but not with the government sector.

An immediate implication of this middle position is the non-fulfilment of the Ricardian Equivalence hypothesis. The theorem states that, for a given path of government spending, a debt financed tax cut has no real effects on the economy because consumers realise that the cut in current taxes will lead to higher future taxes and therefore consumption will not increase (Barro 1974).

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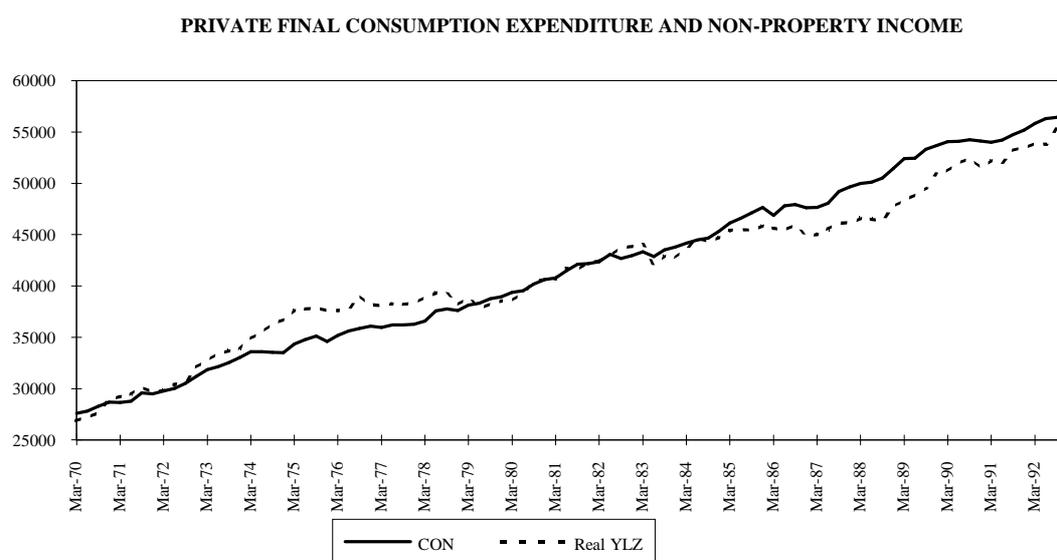
<sup>2</sup>. Hayashi (1985) also provides a critical survey of empirical work on liquidity constraints.

In the TRYM model, because households do not fully take account of the government's intertemporal budget constraint, a debt financed tax cut would make households better off causing them to increase their consumption. This means that in the TRYM model, size of government debt will have real effects on households' behaviour and the economy's short run real equilibrium. A fundamental feature of the model is that consumers do not anticipate the rise in taxes over the medium to long run whereas under the Ricardian assumption the rise in taxes would be fully anticipated.

## 1.1 Data considerations

### 1.11 Private final consumption

An important feature of the permanent income and life-cycle hypotheses is the relative stability of consumption over the business cycle compared with other components of GDP such as labour income. This is a feature that is also reflected in the aggregate consumption data, as evident in the following chart.



The TRYM model examines total private final consumption expenditure as measured in the National Accounts; in NIF10 and NIF88 consumption was disaggregated. The option to split consumption expenditure between durables and non-durables was considered, but not implemented for a number of reasons; in particular, the distinction between durables and non-durables is not always clear, and involve some measurement and definitional problems. Moreover, the aim and focus of TRYM is to model aggregate consumption-savings behaviour and disaggregation did not seem helpful. The approach adopted here is also consistent with the treatment of other components

of GDP, such as commodity exports and business investment, which have a greater claim for disaggregation.

### ***1.12 Measurement of non-property income***

The level of non-property income (YLZ) available to households, as defined in the TRYM model, consists of labour income and government transfers<sup>3</sup>. Labour income is the sum of wages, salaries and supplements less PAYE taxes (net of refunds) plus an imputed income for the self employed and employers. The employers and/or self employed are assumed to have the same after tax wage as those paid wages and salaries. Government transfers are largely personal benefit payments but include some other outlays, such as some payments to non profit institutions.

The TRYM definition of non-property income reflects our finding that it is difficult to obtain statistically different marginal propensities to consume out of labour and transfer incomes. Although we found some indication that the marginal propensity to consume from transfer income is somewhat less than the propensity to consume from labour income, we attributed this result to the correlation in economic downturns between higher transfer payments and greater uncertainty which reduces consumption. Faced with these estimation difficulties, we decided to constrain these different propensities to be the same.

### ***1.13 Measurement of wealth***

The methodology used to derive quarterly estimates of aggregate non-human private wealth is based on Piggott (1986) and Callen (1991). However, there are some differences in methodologies that have been outlined in the Economic Round-Up, Summer (1990) and Summer (1992) editions.

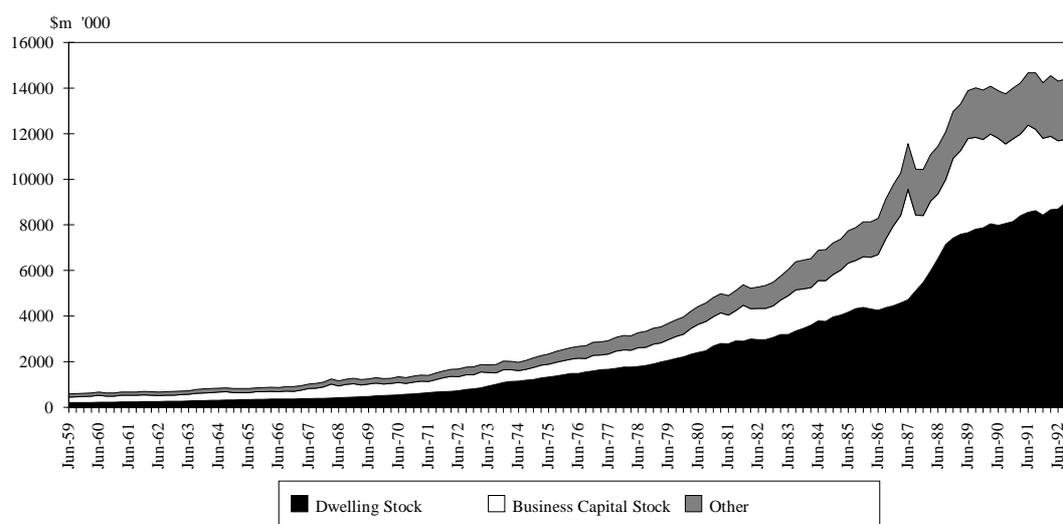
Private sector wealth in TRYM is derived as the sum of the market value of business assets (net of foreign ownership and private sector foreign debt), dwelling capital stock, Australian equity investment abroad, consumer durables, public securities and Reserve Bank liabilities.

In broad terms, private sector wealth increased fairly quickly, but at a steady rate, until the late 1980s. However, the 1987 stock market crash lowered the value of business assets and therefore wealth at market prices. However, in the first two years of the 1990s, the rate of growth of wealth declined, reflecting a slower rate of accumulation of physical assets as well as asset price deflation. The following chart shows the composition of wealth over time.

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<sup>3</sup>. This definition is broadly similar to other models' definition of disposable income (such as AMPS, AEM), but departs from the NIF tradition which is based around the national account concept of household disposable income.

## PRIVATE SECTOR WEALTH AT MARKET PRICES



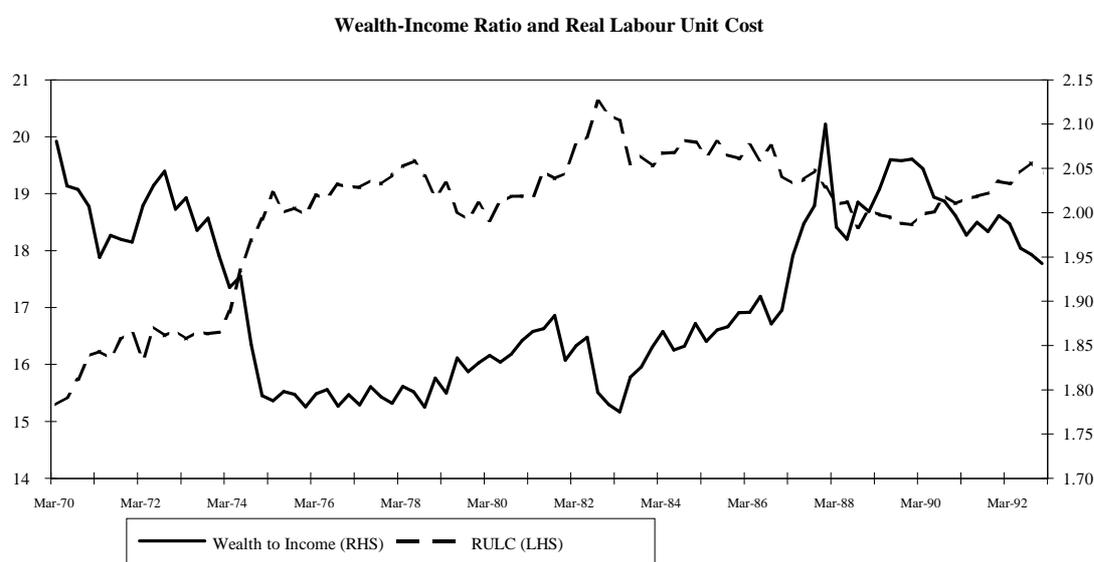
Between 1960 and 1975, the composition of Australia's net private wealth shifted quite significantly. The share of dwelling capital, for example, increased from about 35 per cent to 57 per cent, while business capital fell from about 43 per cent to 25 per cent. Other notable composition changes included a decline in public securities from about 11 per cent to 8 per cent, while consumer durables fell from about 11 per cent to 8 per cent and Reserve Bank liabilities also fell from about 3 per cent to 2 per cent.

Since 1975 the composition of private sector wealth has been relatively stable, with the relative shares of dwellings and business capital - in particular, remaining broadly unchanged. Exceptions have been the sharp rise in Australian equity investment abroad (from 0.8 per cent to about 5 per cent) while public sector securities continued to decline (from about 8 per cent to 6 per cent).

During 1986 and 1987 the value of private sector wealth was quite volatile; largely reflecting movements in share prices. House prices rose fairly quickly in 1988. An interesting feature of this period was, that prior to the 1987 crash, the share of dwellings stock declined while business assets rose. However, following the crash, the relative shares returned to their average levels, namely 56 per cent for dwellings and 27 per cent for business assets.

An important implication for the consumption function in the TRYM model is that the Pigou effect is somewhat small, because the data indicate that the money base only represents about one per cent of total private sector wealth. That is, as the price level falls, currency holders are wealthier from what is called the Pigou (or wealth) effect. Because the increase in wealth by some (ie holders of currency) is not offset by a decrease in wealth of others, consumption will rise at every income level.

According to the life cycle hypothesis, the ratio of wealth to total income, in the long run, should be relatively constant. As the following chart shows, the ratio of wealth to income has been generally stable over the mid-1970s to early 1980s. The movements that have occurred are strongly influenced by changes in real unit labour costs - as measured by Treasury.



There is an inverse relationship between the wealth to income ratio and real unit labour cost. The sharp rise in the real unit labour cost during the early 1970s was coincident with a sharp decline in the ratio of wealth to income; this is consistent with wealth being the discounted value of the stream of profits. Since the mid 1970s real unit labour cost has been broadly flat with the exception of the 1982-83 recession. This profile is also reflected in the wealth to income ratio. An additional influence on the rise in the wealth to income ratio during the late 1980s is the stock market boom followed by an increase in house prices.

### ***1.2 Specification of the consumption equation***

In the long run and under the theories described above, private final consumption expenditure is some proportion of after-tax non-property income and private non-human wealth, both deflated by the consumption deflator. This gives the following long run relationship:

$$\log(\text{CON}) = \log(\text{C0CON}) + \log\left[\frac{\text{YLZ}}{\text{PCON}} + \text{C1CON} * \frac{\text{WMZ}(-1)}{\text{PCON}}\right]$$

where: CON = private final consumption;

YLZ = non-property income;

PCON = private consumption deflator; and

### WMZ private sector non-human wealth.

The inclusion of the market value of private sector wealth in the TYRM model provides a channel through which the financial and property markets can influence consumption behaviour of households by affecting the value of financial and property assets. If asset prices were to rise faster than consumption prices, for example, the market value of real wealth would increase, contributing to an increase in consumption.

The above long run relationship can be interpreted as being consistent with either permanent income or life-cycle hypotheses. Under a permanent income hypothesis, the coefficient C1CON could be thought of as the average expected rate of return from non-human wealth. Therefore, the product of the rate of return from non-human wealth and the stock of non-human wealth provides a flow of property income to households. Alternatively, under a life-cycle hypothesis, C1CON could be thought of as the average marginal propensity to consume out of non-human wealth and depends on life-cycle factors such as age composition.

This long run relationship has two important properties. First, the long run marginal propensities to consume out of non-property income are the same irrespective of the source. Second, in the long run the marginal and average propensities to consume out of real labour income are equal.

In the short run, households appear to adjust their actual consumption only sluggishly toward their long run levels. This common observation can be explained on the basis of habits, a general tendency by households to smooth consumption, and uncertainty about whether changes are persistent. Accordingly, private consumption is modelled using a first order partial adjustment specification. Through the year changes in the unemployment rate (RNU) are also included and, apart from representing a purely cyclical influence, may capture the additional effects of consumer confidence and the distributional effects of changes in employment status (eg. individuals at the margin of the workforce might have higher than average marginal propensities to consume). Therefore the estimating equation was specified as:

$$\begin{aligned} \log(\text{CON}) = & (1-A0\text{CON}) * \log(\text{CON}(-1)) \\ & + A0\text{CON} * \{ \log(\text{C0CON}) + \log[(\text{YLZ}/\text{PCON}) + \text{C1CON} * (\text{WMZ}(-1)/\text{PCON})] \} \\ & + A2\text{CON} * [\text{RNU} - \text{RNU}(-4)] \end{aligned}$$

This preferred specification was arrived at after some experimentation with other variables and functional forms. Competing variables not included in the consumption function were changes in non-property income, interest rates, and inflation. The change in non-property income was statistically insignificant over the sample period suggesting that households are not liquidity

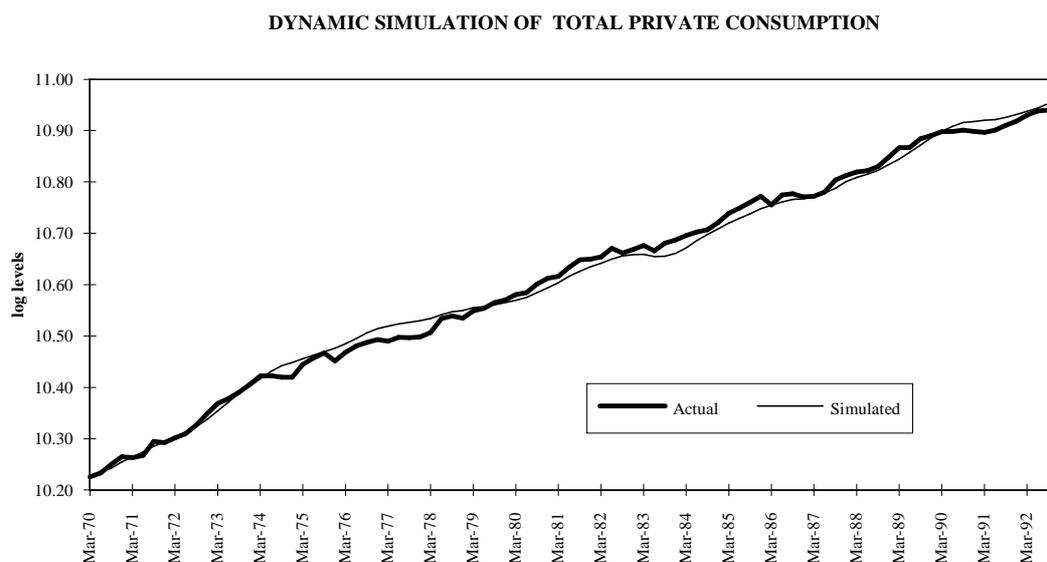
constrained; this result is consistent with the Blundell-Wignall, Browne, Cavaglia and Tarditi (1992) study.

In theory, the interest rate should influence households' consumption decisions because it represents the price of intertemporal substitution. However, the inclusion of interest rates and the yield curve were unsuccessful given our framework discussed above. This result is consistent with other studies (Hall 1988 and Mankiw 1989).

The inflation rate did have significant and negative effects on consumption over some estimation periods, but not others. This was largely due to a correlation between the surge in inflation in the mid 1970s and a weakening in consumption. Whether this consumption outcome was the result of higher inflation or some other influence, such as uncertainty, is not clear. Further, any mismeasurement of consumption prices will lead to a higher measure of the quantity of consumption and this influence could be producing a negative correlation in the 1970s. Finally, the influence of inflation over the 1980s was found to be statistically insignificant.

### ***1.3 Estimation and interpretation of results***

The consumption equation was estimated from the first quarter of 1980 to the fourth quarter of 1992. The choice of this period was based on two considerations: the lower quality of the wealth data in the 1970s and the structural change in the availability and access to consumer credit in the 1980s. All coefficients of the estimated equation have significant and anticipated signs. The following chart compares actual outcomes with a dynamic simulation of private final consumption spending.



As indicated, that the estimated equation fits the data reasonably well.

sample 1980:1 to 1992:4		
Parameter	Estimate	t-Statistic
A0CON	0.2085	3.705
A2CON	-0.0020	-2.736
C0CON	0.8118	15.963
C1CON	0.0132	3.804

The main features of the estimated equation are as follows. The coefficient C1CON was estimated to be 0.0132. This can be interpreted as implying that the real rate of return of net income available for consumption or savings from wealth is about 5 per cent per annum. It also implies that net property income should be about 10 to 15 per cent of total income, because private wealth is about 4 to 5 times the size of other income on an annual basis. This is consistent with the share of net property incomes measured in the national accounts.

The coefficient C0CON was estimated to be 0.81, implying a saving ratio of about 20 per cent<sup>4</sup> on this basis. When private wealth is 4 to 5 times annual labour income the savings ratio is sufficient to make private wealth grow at about 5 to 6 per cent per annum. Over the estimated period it actually grew at 5 per cent, which is broadly consistent with this estimate.

The coefficient A0CON was estimated to be 0.2, implying that consumption adjusts to its long run level with a mean lag of about 1 1/4 years.

The coefficient A2CON was estimated to be -0.002, implying that a one per cent increase in the unemployment rate in a year would cause consumption to fall by 0.2 per cent. This result could be due to increases in the level of uncertainty as the unemployment rate rises, causing households to lift their savings.

## 2.0 DWELLING SECTOR

Aggregate dwelling investment is a small but cyclically volatile component of GDP, making it a more important sector of the aggregate economy than its size would suggest. Further, dwelling

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<sup>4</sup>. This savings ratio is not directly comparable to the ABS savings measure.

investment is one of the most interest sensitive components of GNE and so plays an important role in the monetary policy transmission mechanism. In addition, the purchase of a dwelling represents the largest single investment decision undertaken by most households. Private sector non-human wealth data suggest that dwellings is about fifty six per cent of total private sector wealth thus representing the largest component of wealth. Therefore, fluctuations in the price of dwellings have a large impact on wealth. Movements in rents are important because it is one of the main determinants house prices. Therefore, accurate modelling of dwelling investment is more important to overall model properties than its size would suggest.

Our intention has been to model the dwelling sector in the current deregulated environment. This means that data prior to 1986, when the housing market was regulated, was excluded from the estimation period. This leaves a relatively small amount of data from which to test hypotheses, resulting in more weight being placed on theoretical considerations when specifying equations in this sector. This approach is different from that followed in NIF88 where the specification was based on the market prior to deregulation.

In broad terms, dwelling investment is influenced by two major factors; the rate of return from housing and the cost of funds. A primary determinant of the former is the rent price while the interest rate is a major component of the latter. The dwelling sector in the TRYM model is analysed by using two equations. The first is a consumer demand equation that determines the price of rents and therefore the rate of return on dwellings. The second equation determines dwelling investment using the factors mentioned above combined into a Tobin's Q-ratio.

### ***2.1 Data considerations***

Dwellings are demanded because they provide a flow of services over their lifetime. This flow will be referred to here as rental services or rents. Data are collected by the ABS on average rents paid in the market for rental accommodation. The average level of rents is then multiplied by the number of dwellings to produce an estimate of the aggregate value of the consumption of rental services. Owner-occupiers, like other owners of dwellings, are treated as other landlords and tenants. They receive and pay rents (from themselves), pay expenses, and enjoy a rate of return on their ownership of dwellings.

As noted above, these equations are only estimated from the first quarter of 1986. Financial deregulation has integrated the market for housing loans with capital markets creating the potential for large changes in the cyclical relationship between interest rates and dwelling investment. For example, under a regulated lending environment the quantity of funds available for lending is constrained and this, rather than the cost of funds, determines the level of transactions. In principal, our approach to modelling dwelling investment could still be used in the regulated system if the cost

of the marginal dollar borrowed could be measured properly. Unfortunately, these data are not available, thus limiting the estimation period to that mentioned above.

During the 1970s, there were large differences between the movements in the rent price series collected by the ABS (in constructing the CPI) and the census data on average rents. This suggests that either one or both of the series were incorrect in the 1970s and therefore the data for this period are unsuitable for estimation. While this difference had fallen considerably by the 1980s, the correlation between the relative price of rents (PCRE/PCNR) and relative expenditure share on rents (CNR/CRE) appears to change around 1986. It is not clear why this is so. It may be a feature of the data construction; for example, the data was spliced in 1984-85. Alternatively, the impact of a regulated capital market may have affected this relationship. For example, the requirement of a relatively high deposit by financial institutions may have forced many households into the rental market. For these reasons it was decided to restrict the estimation period to commence in 1986.

## *2.2 Specification of the demand for rental services*

The price of rent is determined by a simple consumer demand system consisting of rent and non-rent expenditures. Consumers regard rental services as an (imperfect) substitute for other consumption goods. This is captured by a constant elasticity of substitution (CES) utility function, which is defined over the consumption of rental services and other consumption goods. Once consumers have chosen the aggregate level of consumption spending based on their income and wealth, they then choose the utility maximising proportion of rent consumption. The solution to this maximisation problem yields the following demand curve.

$$\log(\text{CRE}/\text{CNR}) = C_0 \text{PCR} - \text{CDWSIG} * \log(\text{PCRE} * \text{PCNR})$$

where: CRE=rent consumption;

CNR=other consumption goods;

CDWSIG=the elasticity of substitution between rental and non-rent consumption;

PCRE=the price of rents; and

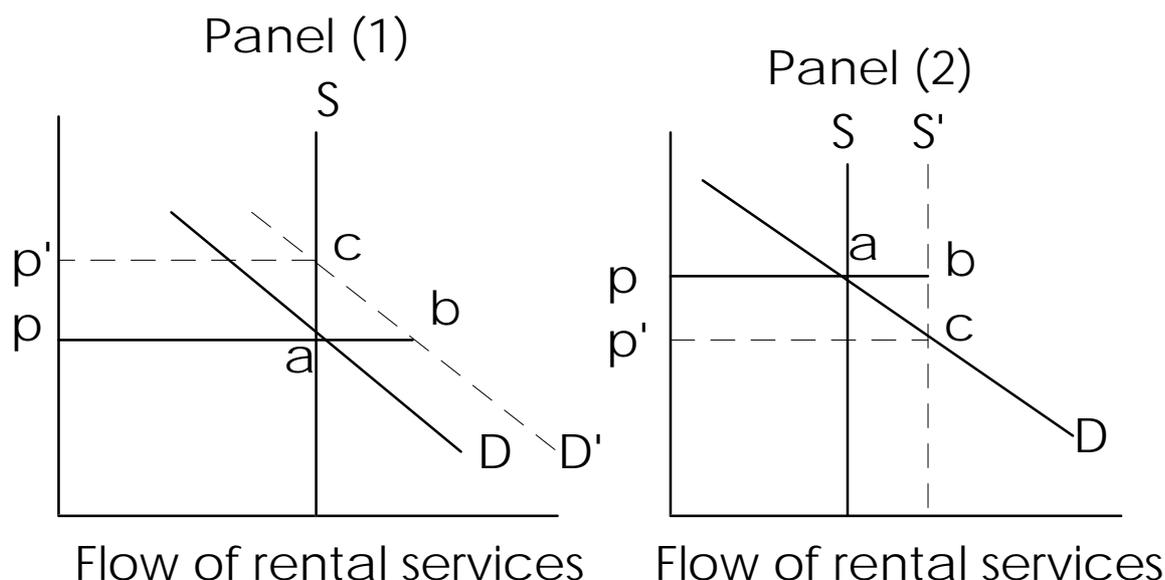
PCNR=the price of non-rent consumption.

Because net investment is typically a small fraction of the capital stock, the stock of dwellings and therefore the supply of rental services is essentially predetermined in the short run. Thus the relative price of rents adjusts to ensure that demand equals the fixed level of supply. This suggests that the demand equation should be inverted. The resulting equation determines the relative price of

rents as a function of the predetermined share of rental services. This yields an equation for the equilibrium price of rents of the form:

$$\log(\text{PCRE}/\text{PCNR}) = C_0 \text{PCR}^{-1} / \text{CDWSIG} * \log(\text{CRE}/\text{CNR})$$

The demand and supply relation in the dwelling sector is depicted in the following chart.



In the short run, the supply of dwelling services - defined as the ratio of dwelling investment to dwelling stock, is fixed. Therefore changes in demand for dwelling rents affect the price of rents in the short run as indicated by the above equation. To illustrate the comparative static effects of the dwelling market, suppose that our initial position is at point  $a$  in panel (1). Suppose also that private final consumption rises because of an increase in income or wealth. This will cause the demand for rental services to shift to the right from  $D$  to  $D'$ . If this increase in demand is not matched by an equivalent rise in supply then, at unchanged rent prices, there will be an excess demand for dwelling services - measured by the distance between points  $a$  and  $b$ . This will cause the price of rents to rise (from  $p$  to  $p'$ ) until the new equilibrium is reached - which is at point  $c$ . Alternatively, if the supply of rental services rises by more than private consumption - see panel (2), at unchanged rent prices there will then be an excess supply for dwelling services - measured by the distance between points  $a$  and  $b$ . This will cause the price of rents to fall (from  $p$  to  $p'$ ) until a new equilibrium is reached, which is at point  $c$ .

The dynamic specification of the above model is as follows. Because most rents are fixed by contracts for periods of a year or so, actual rents are likely to lag behind equilibrium rents as defined

by the above equation. Accordingly, an error correction specification was used for the rent price equation.

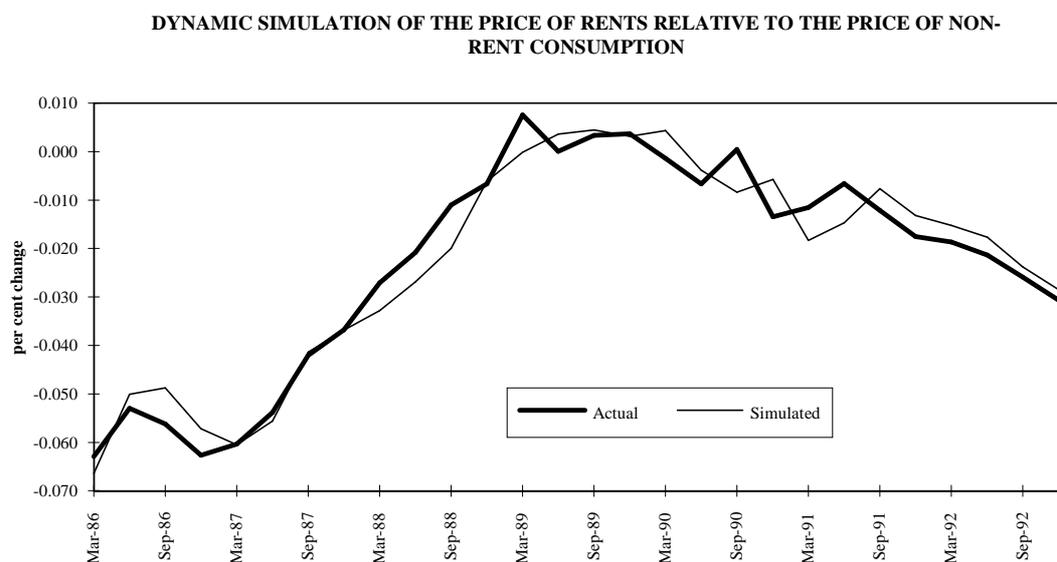
$$\Delta \log(\text{PCRE}/\text{PCNR}) = A2\text{PCR} * \Delta \log(\text{CNR}/\text{CRE})$$

$$- A0\text{PCR} * [\log(\text{PCRE}(-1)/\text{PCNR}(-1)) - C0\text{PCR}$$

$$- 1/\text{CDWSIG} * \log(\text{CNR}(-1)/\text{CRE}(-1))]$$

### 2.3 Estimation and interpretation of results

The estimation results appear to be satisfactory given the difficulties with the data. The following chart shows the actual and dynamic simulation of the relative price of rents to the price of non-rent consumption.



The estimated equation appears to fit the data reasonably well.

Parameter	Estimate	t-statistic
A0PCR	0.1113	2.736
A2PCR	0.4392	4.239
C0PCR	-1.7002	-1.500

CDWSIG	0.8857	1.489
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Any gap between the actual and desired equilibrium price of rents is closed by about 11 per cent per quarter, implying a mean lag of adjustment of about 2 1/2 years.

The equation also implies that the elasticity of substitution between rents and non-rent consumption is 0.88. This estimate is not well determined but is at a sensible level and consistent with other studies. For example, Yates (1981) reports some cross section estimates of this elasticity using two different data sets. For one data set, her estimates ranged from 0.701 to 0.871. Estimates using the other data set ranged from 0.874 to 1.256. These elasticities are similar to those found in overseas studies (Yates, 1981, page 321). The TRYM estimate of 0.89 is within the range of these estimates and below the value of unity imposed in the AEM model. Other feature of the above equation is that an increase of one per cent in non-rent consumption, among other things, increases the relative price of rents by 0.43 per cent after one quarter.

#### ***2.4 Specification of the supply of rental services (dwelling investment)***

Dwelling investment is specified using a comparison of the rate of return to the cost of funds. This is equivalent to a comparison of the market and replacement values of dwelling, in the spirit of a Tobin Q-ratio. The Q-ratio for dwellings (QRATH), defined as the ratio of the equilibrium rate of return on the dwelling stock to the cost of funds, is the primary determinant of dwelling investment. The ratio has the following interpretation. When the Q-ratio is equal to one, dwelling investment will be sufficient to yield the desired level of growth of the dwellings stock (KDW). When the Q-ratio is greater than one, households invest more in dwellings and when the Q-ratio is less than one households will tend to invest less.

The equilibrium rate of return on dwellings (ER) is calculated as the ratio of the price of rents (PCRE) to the implicit price deflator for dwelling investment (PIDW), adjusted for the rate of tax on the consumption of rents (RTCRES) and the amount of rental services produced each quarter by a unit of dwelling capital.

$$ER = (1 - RTCRES) * PCRE * (0.035306) / PIDW;$$

The constant 0.035306 is the historical average ratio of production of dwelling rents to the dwelling capital.

In the long run, the cost of funds for dwellings will be equal to the 10 year bond rate (RGL). In the short run, however, the cost of funds for dwelling investment may also be influenced by short term interest rates. We let the data determine the relative importance of long and short term interest rates. In particular, the actual cost of funds for investment in dwellings is calculated as a weighted

average of long bond rates (RGL) and the 90 day bank bill rate (R90), less long run inflationary expectations and the depreciation rate on dwellings (RDKDW). The method used to measure INFEXP (inflationary expectations) is discussed in the Financial Sector.

$$\text{Cost of funds} = ((C1DW * RGL + (1 - C1DW) * R90) - \text{INFEXP} / 400) * RDKDW$$

QRATH is therefore defined as follows:

$$\text{QRATH} = [(1 - \text{RTCRES}) * \text{PCRE} * (0.035306) / \text{PIDW}] / [((C1DW * RGL + (1 - C1DW) * R90) - \text{INFEXP} / 400) * RDKDW]$$

In the long run, when the Q-ratio is at unity, investment in dwellings (IDW) - as a ratio of the dwelling capital stock (KDW) - is at a level sufficient to ensure that dwelling capital grows at the equilibrium growth rate of the economy (GR) adjusted for the rate of depreciation on the capital stock (RDKDW). GR is the sum of the growth of underlying efficiency (and therefore per capita) growth in the economy and growth in the adult population.

The lags between a change in the Q-ratio and dwelling investment is of particular interest here. Both contemporaneous and lagged values of the Q-ratio are found to impact on investment in dwellings. This is consistent with the influence of lags in households' response to changes in economic fundamentals due, for example, to the time taken in planning housing investment and in gaining approval to start construction. Due to the relatively small sample size and the presence of serial correlation among the Q-ratios, the size and significance of the coefficients on the different lagged values of the Q-ratio tended to vary in an erratic and implausible fashion. The estimated parameters on different lags of the Q-ratio have been constrained to be the same. This smooths the reaction of dwelling investment to the Q-ratio and gives a significant overall coefficient. This constraint is accepted by the data.

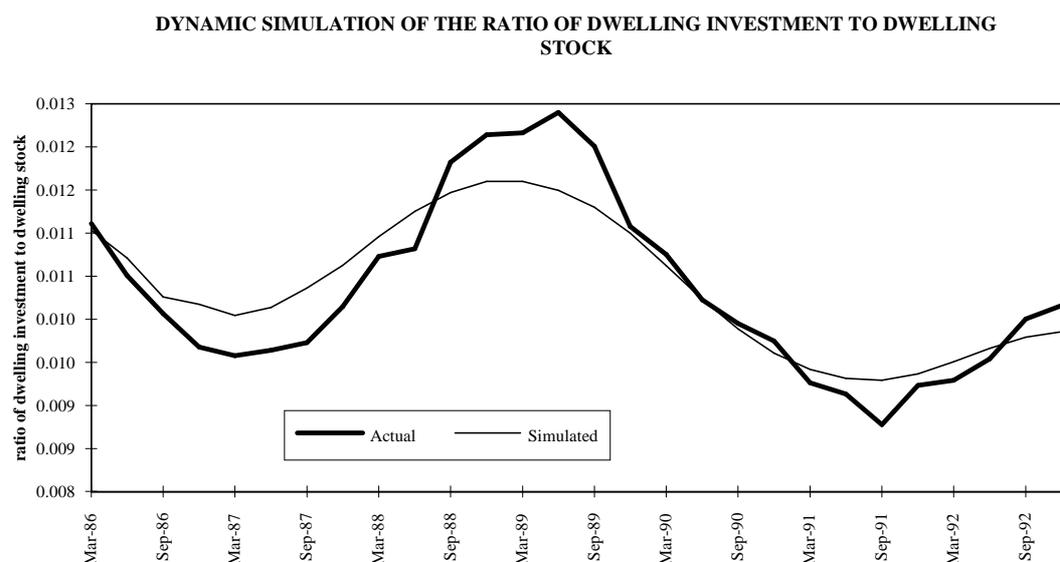
Past dwelling investment is also used to explain contemporaneous dwelling investment. This captures the discrete nature of dwelling investment that may take longer than a quarter to complete and the associated inertia or serial correlation in dwelling investment behaviour.

To capture some of the short term influences on dwelling investment, labour market pressures, such as the unemployment rate, are included. In particular, if the actual unemployment rate (RNU) is higher than the equilibrium rate (NAIRU), households' confidence will fall and this will lead to a reduction in investment in dwellings. The data appear to accept this confidence, or uncertainty effect on dwelling investment. The preferred dwelling investment equation is therefore as follows:

$$\begin{aligned}
\text{IDW/KDW}(-1) = & [\exp(\text{GR})-1+\text{RDKDW}]*(1-\text{A1DW}-\text{A2DW}-\text{A3DW}-\text{A4DW}) \\
& +\text{A1DW}*\text{IDW}(-1)/\text{KDW}(-2)+\text{A2DW}*\text{IDW}(-2)/\text{KDW}(-3) \\
& +\text{A3DW}*\text{IDW}(-3)/\text{KDW}(-4)+\text{A4DW}*\text{IDW}(-4)/\text{KDW}(-5) \\
& +\text{A0DW}*\text{QRATH}+\text{A0DW}*\text{QRATH}(-1)+\text{A0DW}*\text{QRATH}(-2) \\
& +\text{A0DW}*\text{QRATH}(-3)+\text{A0DW}*\text{QRATH}(-4) \\
& +\text{A5DW}*\text{[RNU-NAIRU]}
\end{aligned}$$

### 2.5 Estimation and interpretations of results

The following chart shows the actual and dynamic simulation of the ratio of dwelling investment to dwelling stock.



As indicated, the estimated equation tends to consistently underestimate extent of the dwellings cycle. There are probably additional cyclical effects due to expectations of capital gains or the availability of funds not incorporated in the above specification. Given the small sample size, we have avoided the temptation to overfit the data using variables that the future may show were only important over the past cycle.

Sample: 1986:1 to 1992:4		
Parameter	Estimate	t-statistic

A0DW	0.000339	3.28
A1DW	0.417	2.386
A2DW	0.521	3.171
A3DW	-0.0314	-0.216
A4DW	-0.256	-2.111
A5DW	-0.0000959	-2.408
C1DW	0.351	3.043

The equation implies that if the rate of return from investing in dwellings is 10 per cent greater than the cost of obtaining funding for the investment, dwelling investment as a ratio of the capital stock will increase by 0.017 per cent after 5 quarters.

The equation also implies that:

- an increase in investment in dwellings today will be followed by higher investment for two quarters and then two quarters when the quantity of dwelling investment falls as a proportion of the capital stock. This lag structure seems to plausibly reflect the nature of investment in housing;
- if the actual unemployment rate exceeds the NAIRU by 1 per cent, dwelling investment will fall by about [0.0001] as a percentage of the capital stock; and
- the estimate for C1DW implies that about 2/3 of the weight should go on long term interest rates and about 1/3 on short rates when measuring the cost of funds in the Q-ratio.

### 3.0 LABOUR SUPPLY BEHAVIOUR

The notion of labour supply encompasses several important dimensions that include the size and demographic composition of the population, the proportion of the working-age population that is employed or seeking employment (ie. the participation rate), the number of hours worked per period (ie. per week, per month or per year) and the quality of labour (ie health, nutrition and education). However, econometric studies of labour supply have traditionally focused on a smaller subset of factors, namely decisions on whether to participate in the labour force and on the number of hours to work. This approach is also adopted in the TRYM model.

Studies of labour supply suggest that a range of factors influence an individual's decision to participate in the labour force. These include: age, gender, level of real wages and labour market opportunities. There are other variables that are difficult to include in macroeconomic models such as: attitudes towards work-leisure, household structures and fixed costs associated with work (eg the availability for child-care facilities, loss of government benefits upon employment, travel and other work related expenses).

At the aggregate level, the conventional approach to modelling labour supply is to ignore the issue of aggregation by assuming a homogeneous labour market. In reality, labour markets are segmented with different wages and hours of work being offered across different labour markets. Because macro models do not explicitly take account of the segmentation of labour markets, their ability to explain important compositional changes in the labour force - such as shifts towards part-time work - is limited.

There are important issues at both the aggregate and disaggregate levels. At the disaggregate level, the most important considerations appear to be age and gender and by type of employment. There also appears to be differences in employment elasticities between primary and secondary workers.

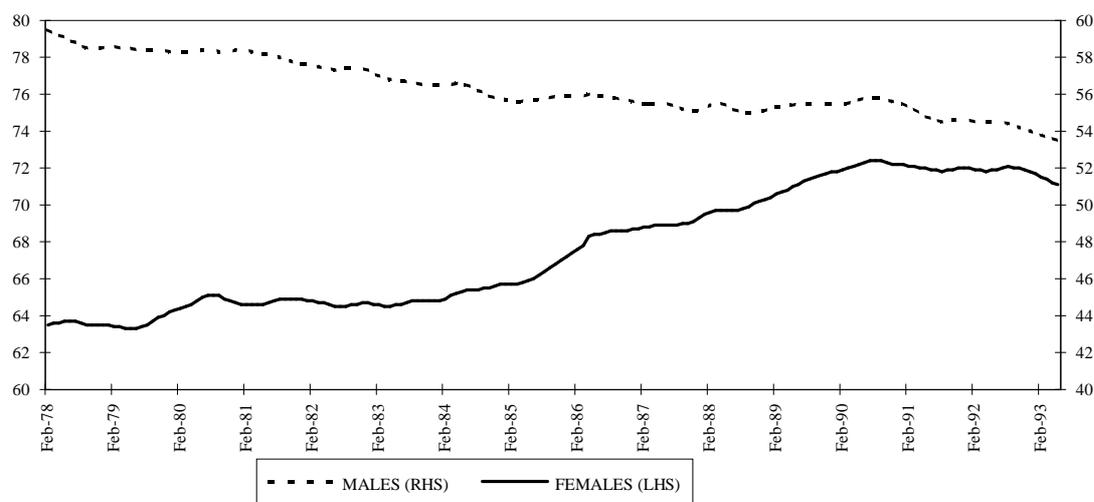
At the aggregate level, many of these issues are relatively less important because the age and gender composition of the population change little and slowly. The most important issues are the effects of higher incomes and on participation rates. Since the focus in the TRYM model is to explain aggregate behaviour, we will be examining the average responses across divergent groups.

Further because labour supply equation in the TRYM model is estimated on an hours basis, we are able to broadly account for the shift towards part-time employment.

### ***3.1 Data considerations***

Over the 1980s and early 1990s, the labour force grew at an average rate of [2.5 ] per cent per year, although there are large variations in the annual growth rates. The significant variations in the annual growth rates reflect both varying adult population growth rates and demographic changes. There have also been significant compositional changes in the labour force participation rates measured by gender and type of work sought (and found).

LABOUR FORCE PARTICIPATION RATE BY GENDER



Full-time participation rates among males of all ages have shown a trend decline while for females there has been an upward trend. This upward trend for females is particularly significant for part-time participation rates (Fahrer and Heath 1992). These trends have also been evident in the United States (Smith and Ward 1985) and other similar countries. Therefore, gender accounts for substantial variation in participation rates between individuals.

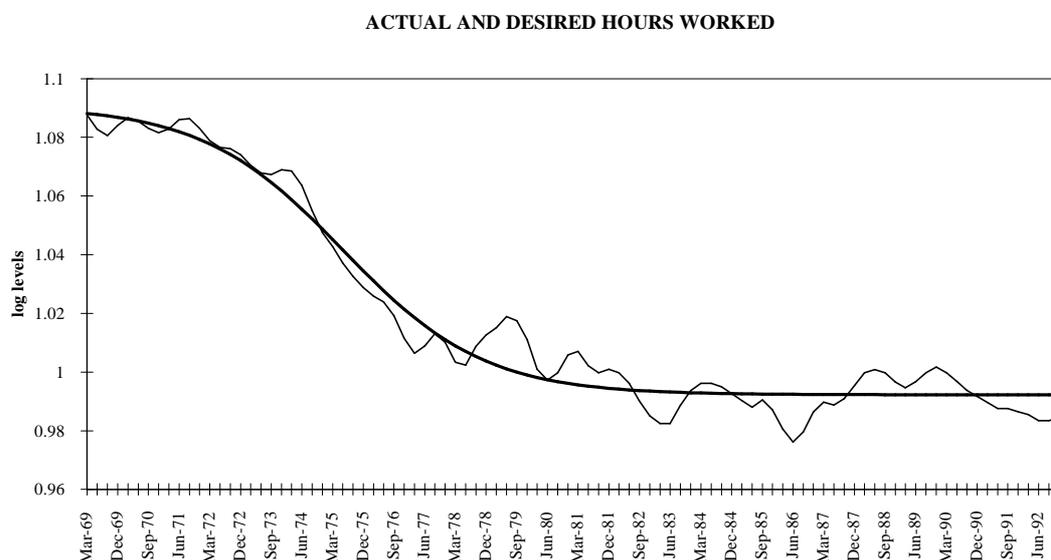
The upward trend of female participation rates reflects a number of factors. Rising male real wages, and therefore real incomes, would suggest that married woman should have reduced their commitment to the labour force (ie the income effect), but this effect has been more than offset by increases in female wage rates, availability of child care facilities and employment possibilities that are available to women (ie substitution effect). Further, improved educational achievements by females not only have increased real wages but have also resulted in changed attitudes towards obtaining meaningful employment outside their homes. Other factors include the increased availability of household appliances (which are labour-saving), have encouraged females to seek full and part-time employment.

The overall trend decline in male participation rates has been attributed largely to the decline in full-time employment. However, there are significant changes within this aggregate result. Disaggregated data suggest that the fall in participation rates is greatest among older ages, possibly suggesting early retirements, but there have been strong increases in part-time participation rates among 15-24 year old males, perhaps reflecting increased participation in full-time education (DEET 1991).

These trends in the labour force suggest that labour supply should explicitly take account of at least the full-time and part-time status of labour supply and the average hours worked per person.

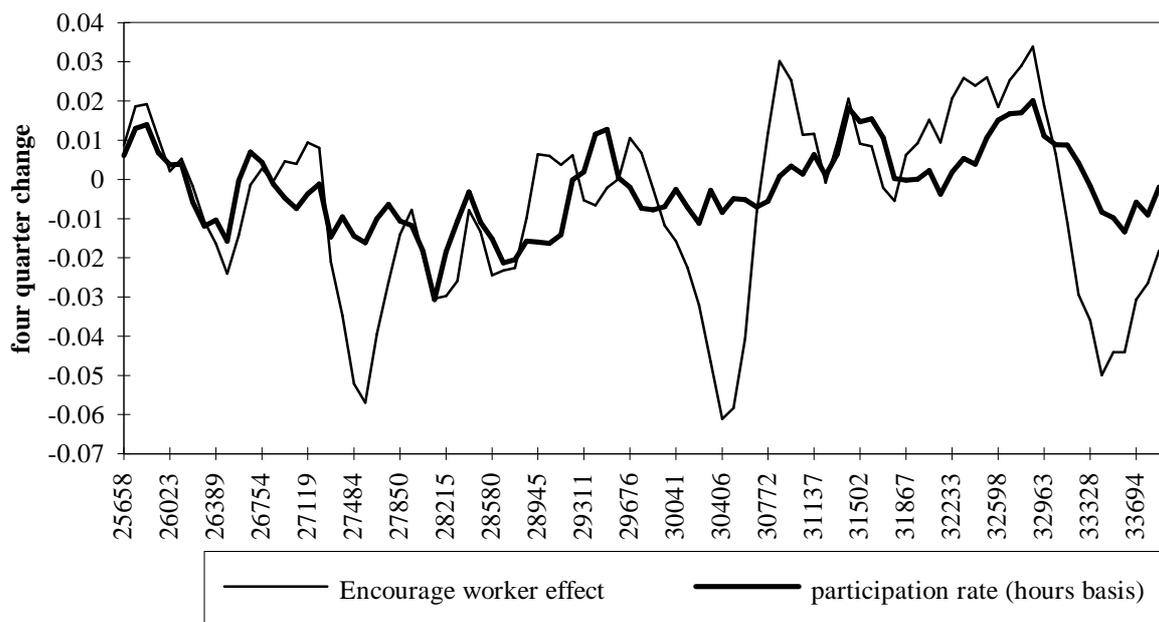
However, the traditional approach to the modelling of labour supply has been on a heads basis. This is reflected in the NIF10, NIF88, AMPS and AEM models. This approach to labour supply assumes that individuals do not respond to the hours of work available when deciding whether to participate in the work force. Such decisions are particularly relevant to individuals who operate on a households basis. For example, reduced working hours by one adult may allow another adult to increase their participation in the labour force. Alternatively, reduced working hours by one adult may reduce household incomes and induce other adults to seek paid employment.

In the TRYM model, labour supply and participation rate are examined using an hours worked conceptual basis. The following chart shows actual hours worked, as measured on a trend basis by the ABS.



It can be seen that this series largely follows a logistical growth function over this period but with an additional cyclical variation. This cyclical component was much less significant in the 1984-85 based National Accounts. Our investigations have shown that this cyclical component appears to be most easily explained as being demand induced. As such, including it in the measure of labour supply produces spuriously high correlations between the measurement of labour demand and labour supply. Therefore we decided to abstract from this cyclical component by using the logistical growth function component alone to represent the marked decline in average hours households wish to worked in the ABS average hours series over this period.

The following chart compares four quarter changes in employment and the participation rate.



It indicates that the two series are closely correlated and this is called the encouraged worker effect. It can be explained by two important factors. First, some people participate in the labour force with the expectation of finding employment. However, if the perceived chance of finding employment rises (falls) then the benefits of being in the labour force increase (decrease). People become encouraged (discouraged) and therefore enter (leave) the work force. In these circumstances a lag between changes in employment conditions and the resulting change in participation rates can be expected.

Second, some people do not move between the labour force category and unemployment, but enter (leave) the work force upon finding (losing) employment. For example, some young adults continue their education until they find a job without meeting the ABS definition of being unemployed. Some older workers may choose to retire once the job has finished rather than be unemployed and search for work. Some secondary workers within households may be offered work, particularly casual and part-time work, without ever being unemployed. Similarly, they may not seek another job when the current one ends. In these circumstances, a contemporaneous correlation between employment and labour supply could be expected.

### ***3.2 Specification of the labour supply equation***

Therefore in the TRYM model, the long run participation rate (measured on an hours basis) depends upon the after-tax real wage (adjusted for underlying labour productivity) and the encouraged worker effect (measured as the ratio of employment to adult population). Two time trends, one for the 1970s and one for the 1980s, have also been included to account for other trends in the

participation rates- due to demographic factors, and structural changes in the work force that occurred over the 1980s. This gives the following equilibrium relationship for the participation rate.

$$\begin{aligned} \log(\text{NLF}*\text{NHLR}/\text{NAP}) &= \text{C1LS} + \text{C2LS}*\log[\text{NT}*\text{NHLR}/\text{NAP}] \\ &+ \text{C3LS}*\log((1-\text{RTN})*\text{WT}/(\text{NH}*\text{PCON})) - \text{CLAM}*\text{QTIME}] \\ &+ \text{C4LS}*\text{D80}*(\text{QTIME}+10.725) \\ &+ \text{C5LS}*\text{QTIME} \end{aligned}$$

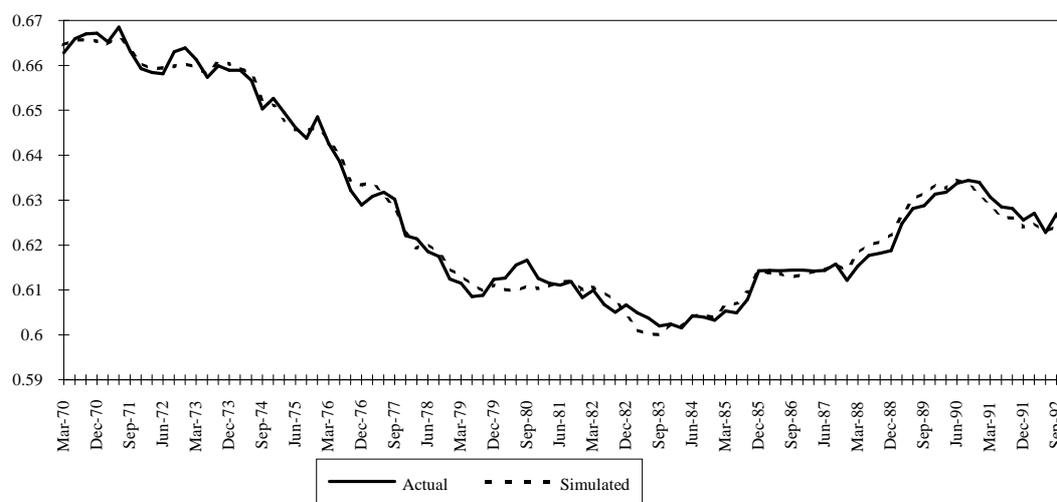
In the short run, movements in the participation rate are also explained by an additional term that captures changes in the encouraged worker effect in the current quarter. An error correction specification was used to incorporate the long and short run responses.

$$\begin{aligned} \Delta \log [(\text{NLF}*\text{NHLR})/\text{NAP}] &= \text{A1LS}*\Delta \log (\text{NT}/\text{NAP}) \\ &- \text{A2LS}*\Delta \log (\text{NT}(-2)/\text{NAP}(-2)) \\ &- \text{A3LS}*\{\log[\text{NLF}(-1)*\text{NHLR}(-1)/\text{NAP}(-1)] \\ &+ \text{C1LS} - \text{C2LS}*\log[\text{NT}(-1)*\text{NHLR}(-1)/\text{NAP}(-1)] \\ &- \text{C3LS}*\log((1-\text{RTN}(-1))*\text{WT}(-1)/(\text{NH}(-1)*\text{PCON}(-1))) \\ &- \text{CLAM}*\text{QTIME}(-1)] \\ &- \text{C4LS}*\text{D80}(-1)*(\text{QTIME}(-1)+10.725) - \text{C5LS}*\text{QTIME}(-1)\} \end{aligned}$$

### ***3.3 Estimation and interpretations of results***

The labour supply equation was estimated from the first quarter of 1976 to the fourth quarter of 1992. All estimates have anticipated signed and significant. The following chart shows the actual and dynamic simulation of the participation rate.

DYNAMIC SIMULATION OF PARTICIPATION RATE ON AN HOURS BASIS



The estimated equation appears to fit the data quite well.

Sample 1976:1 to 1992:4		
Parameter	Estimate	t-Statistic
A1LS	0.5520	10.023
A2LS	0.158	2.703
A3LS	0.384	5.589
C1LS	0.369	7.287
C2LS	0.528	13.322
C3LS	0.0741	3.214
C4LS	0.00693	7.179
C5LS	0.00326	4.269

The equation suggests that the adjustment towards equilibrium is fairly quick, with any difference between the actual and desired participation rates being closed with a mean lag of two years. The estimated equation also suggests that changes in real wages have a smaller influence on the

participation rate than the encouraged worker effect<sup>5</sup>. The elasticity with respect to wages was estimated to be 0.07 per cent compared to the elasticity with respect to encourage worker effect of 0.53 per cent. Other interesting results are the coefficient on the time trends. They suggest that the participation rate grew on average by 0.33 per cent per quarter more during the 1970s than may have been expected given the employment ratio and real after-tax wages, while during the 1980s the participation rate grew by an average of 0.69 per cent per quarter faster.

#### 4.0 CONCLUSION

This paper models households decisions regarding consumption/saving, work/leisure and dwelling investment in a simple and transparent way. The approach adopted here incorporates both theoretical and data considerations.

All equations are specified and estimated using the recently rebased National Accounts data. We have been careful to allow the data to validate linkages between sectors where inter linkages appear possible. Developments in the labour market, such as the level and changes in employment and unemployment for example, affect consumption, dwelling investment and labour supply decisions. These linkages are consistent with theoretical considerations.

Consumption is based on an Ando-Modigliani specification, though it could also be interpreted in a manner consistent with a permanent income hypothesis. The estimate parameters are significant and have sensible economic interpretations. One key finding is that the short run marginal propensity to consume out of wages and government transfers is very low once our measure of wealth is included in the specification.

Our modelling of the dwelling sector is confined to the period of deregulation. This constraint on Australia's experience with a deregulated financial market means that the data is limited to only one complete cycle. Nevertheless, a sensible specification was chosen and estimated yielding plausible results. The specification includes a Q-ratio that captures interest rates and consumption levels through rent prices, and a variable to reflect the state of the labour market. As more data becomes available we will be able to test our specification more rigorously.

Finally, our equation for labour supply captures the important employment, income and average hours worked linkages that are important to a macro economist. All the estimated coefficients are significant and have sensible macroeconomic interpretations. The modelling of aggregate labour

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<sup>5</sup>. This result is consistent with other studies that show changes in real wages do not have a strong affect labour supply. An important reason for this relatively weak response to changes in real wages is due to the differing reaction of workers in different wage categories- ie high vs low paid workers.

supply in TRYM will never be as complete as more detailed but partial studies because it only explains participation rates in terms of endogenous macroeconomic variables and time trends. Nevertheless, TRYM's labour supply equation captures the broad features of the data quite well.

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