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ABSTRACT

Consumption, Land Prices and the Monetary Transmission Mechanism in Japan

This paper documents the role of consumption in explaining the weak interest rate effect of monetary transmission in Japan. Economic theory suggests circumstances in which a rise in short term real interest rates can increase consumption, contrary to much conventional wisdom. This paper suggests that these circumstances are more likely to be prevalent in Japan and finds strong empirical evidence for a positive effect. Life-cycle theory also suggests that housing wealth effects on aggregate consumption including imputed rent are small and negative. Positive effects of the kind found in the UK and the US are due to the role of the credit channel. In countries where consumer access to credit is restricted, these restrictions can enhance the negative effect on consumption of higher house prices because saving for a housing deposit needs to be higher. Our evidence of a negative land price effect for Japan supports this hypothesis. We find no evidence of significant household credit market liberalization from a model for household debt in Japan. We also find evidence for a sizable negative effect on consumption from higher government deficits, suggesting fiscal policy also had limitations. These findings contribute to explanations of Japan's 'lost decade'.

JEL Classification: E21, E32, E44 and E51
Keywords: interest rate effect on consumption, japan's lost decade, land prices and consumption and monetary transmission in japan

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1. Introduction

The dotcom stock market bubble collapse of 2001-3 and the global financial crisis of 2008-9 have focused attention on the lessons of Japan's 'lost decade'. One of the now widely-accepted key lessons is the need for rapid refinancing of the banking system. However, widespread worries remain that the monetary transmission mechanism in the US and other industrial economies might be as weak as it appeared to be in Japan and that ten years of deflation might follow. This paper explains why monetary transmission via Japan's household sector is sharply different from that operating in the US and many industrial countries, and hence why analogies with Japan should not be taken too far. Indeed, pushing the analogies too far may have contributed to US monetary policy errors in 2002 to 2005.

The research focuses on the empirical analysis of Japanese consumption and household saving behaviour and discusses the role of the household sector in the monetary transmission mechanism in Japan. We develop models for aggregate consumption in Japan using the 'solved out' consumption function approach associated with Ando and Modigliani rather than the Euler equation approach. The main reasons for our choice are four: the Euler approach ignores long-run information and so is not useful for understanding historical experience; it is sensitive to the failure of strong assumptions about consumer rationality; the empirical evidence strongly rejects the central prediction of the theory; and the Euler equation is not useful for analysing policy. . However, our model incorporates forward looking income growth expectations and income uncertainty proxies, and the special role of housing wealth, which tend to be neglected in most studies of the 'solved out' form. We also examine the impact of demography, which is an important issue for Japan. Our model includes wealth and interest rate effects and investigates the role of residential land prices.

A key feature of this model, derived from inter-temporal consumption theory, is to use disposable non-property income rather than total disposable income as the key determinant of consumption in the long run. This is quite important, as property income measured in the national accounts is a poor measure of the income concept that follows from theory. For example, the decline in the saving ratio in the 1990s, despite lower asset prices, is partly the result of lower inflation and the reduction in measured property income in the national accounts - rather than, for example, being *necessarily* caused mainly by the ageing of the Japanese population.

Based on our empirical results, we have a good explanation of why lower short term interest rates do not stimulate total demand in the Japanese economy in the way that they work, for example, in the UK (see Muellbauer (2007)). First, in the US and the UK, there is an important asset price channel, which, according to our estimated Japanese consumption function is not just switched off in Japan but even works in reverse. Our evidence for data back to 1961 is that real land prices have a negative effect on consumption in Japan, controlling for income, financial assets and debt, interest rates and proxies for uncertainty and for income growth expectations. Thus when real land prices rise, young households and other renters have to save more. This dominates the wealth effect for older households, which we believe is small partly because of the inheritance tax advantages in Japan of leaving housing assets to one's children. However, for shorter sub-samples in which there is less variation in real land prices, this negative land price effect is weaker than for the full period. Nevertheless, for no period can we find a remotely significant positive effect from physical assets or real land prices on consumption.

In the UK and in the US, in contrast, there is an important house price channel. In these countries, higher housing collateral results in more borrowing and consumer spending[1]. The UK mortgage market is still dominated by adjustable rate mortgages, so reductions in short term rates feed through quickly into borrowing and house prices. First-time buyers in the UK until recently had access to close to 100% mortgages and so saving for a housing deposit did not have the priority it has in Japan. In Japan, lack of competition in banking as well as the dependence of banks on their profits from interest income rather than those from commissions (and recently the nonperforming loans problem) has left borrowing rates high relative to deposit rates. Japan does not seem to have experienced credit market liberalization for households on the scale seen in the UK from 1980 and in the US over a longer period. A second reason for the weak or even 'perverse' interest rate transmission mechanism for households in Japan comes from inter-temporal consumption theory. According to this theory, households with a high elasticity of inter-temporal substitution and a low asset to income ratio will experience negative effects on consumption from a rise in the real interest rate, while the opposite is likely to be true for households with the opposite characteristics. Japanese households have among the highest asset to income ratios in the world, and particularly for bank deposits. They may also be particularly cautious in the sense of being averse to fluctuations in consumption. Indeed we find a very significant and robust positive real

[1] The Bank of England's November 2008 Inflation Report now appears to have joined the growing consensus, p. 19.

interest rate effect in our Japanese consumption function. Thus, when short term rates fell after 1993, this had a negative direct effect on consumption spending in Japan, though paradoxically the later rise in real rates because of falling prices supported consumption.

A possible alternative explanation for a positive real interest rate effect on consumption is omitted variable bias: suppose that there had been substantial credit market liberalization in Japan, causing a rise in the ratio of consumption to income, and associated with a rise in real interest rates as credit rationing was replaced by market pricing of credit. We examine evidence from models for household debt to see if between the late 1970s and the 1980s or later there was any upward shift in debt which cannot be explained by conventional income, interest rate and asset price or wealth effects. UK and US evidence supports such shifts, but we find no such evidence for Japan.

This does not mean that the interest rate channel is missing for the overall economy. Financial assets have conventional positive effects on household spending of a size consistent with theory and evidence for other countries. Hence there is an asset price channel since theory predicts a positive effect of lower interest rates on financial asset prices. But it is offset by the negative direct effect of higher real interest rates on consumption and the negative indirect effect via higher land prices. Thus, the overall interest channel is far weaker than in the UK or the US. Evidence from GDP and income forecasting models for Japan show that reductions in nominal interest rates do have a positive effect on output at a one year horizon. This would be consistent with investment and perhaps exports responding in the conventional way to lower interest rates and the financial asset price changes they induce, even if the household channel is weak. It is important to emphasise that our research does NOT suggest that raising the policy rate will stimulate economic activity.

Finally, our GDP and income forecasting work has important implications on the efficacy of fiscal policy. We find significant negative effects from fiscal deficit to GDP ratios in recent years on future growth of GDP and income. The forecasts from these models are significant in explaining consumption growth and suggest that there is an important 'Ricardian' or 'rational' element in the behaviour of Japanese households.

The implication is that both fiscal and monetary policy had severe limitations in Japan in recent years. This is not, of course, a surprising result, but we provide theoretical and econometric evidence to explain the role of households in this fact.

The outline of the rest of the paper is as follows. Section 2 begins by summarising the Euler equation implied by commonly used CES preferences. It then uses simple inter-temporal consumption theory to explore the likelihood of a positive response of consumption to the real interest rate and to show that income uncertainty can be an additional factor in generating such a response. The theoretical justification from classical life-cycle theory for a housing wealth effect is then shown to be weak, at least for the conventional national accounts definition of consumption. However, on a credit channel interpretation, there can be substantial housing collateral effects and the role of relaxing deposit requirements for first time buyers, as well as the access of owners to collateral are discussed. The implication is that any effect of house prices or housing wealth on consumption is likely to be very dependent on the nature of credit markets and other institutional features and is therefore likely to differ from country to country.

Section 2 also discusses the role of aggregation and demography for aggregate consumption. It explains the model to be used for empirical work, which incorporates potential credit channel influences, but encompasses life-cycle models. Some of the relevant literature on consumption or household saving with special reference to Japan is reviewed.

Section 3 discusses data and measurement issues, with further details in an appendix, and charts the relevant variables. This is followed by a discussion of empirical models for forecasting non-property income, since income growth expectations play an important role in theory models. Our empirical estimates of Japanese aggregate consumption functions are then discussed. Robustness checks with regard to alternative formulations, variable definitions and sample periods are carried out. Co-integration checks are performed and instrumental variables estimates compared. Section 4 examines the factors driving the growth of household debt, looking for any evidence for credit market liberalization. Section 5 summarizes.

2. Theoretical Foundations of the Consumption Function

To interpret empirical results on the direct or indirect effects of interest rates on consumption of the type surveyed for Japan below, it is crucial to be clear on the other controls included in the consumption model and hence on its theory interpretation, for example, Euler equation or solved out consumption function.

2.1 The Euler Equation and inter-temporal Substitution

For a life-cycle utility function additive in each period's consumption and a constant intertemporal elasticity of substitution, the period utility function is

$\mathrm{u}(c) = c^{-\rho}$ or log c if $\rho \to 0$

The first order condition for optimization, or Euler equation, for a consumer facing a linear budget constraint is

$$c_t^{-1/\sigma} = E_t\{(1+r_t)/(1+\delta)\}c_{t+1}^{-1/\sigma} \qquad (2.1).$$

where the intertemporal elasticity of substitution σ=1/(1+ρ),ρ>-1, r is the real interest rate and δ is the subjective discount rate.

Hansen and Singleton (1983) showed that, under the assumption of log normal distributions for consumption and the real interest rate r,

$$\Delta \log c_{t+1} = \sigma \log(1+r_t) + \sigma(\text{uncertainty measure})_t + \text{constant} + \varepsilon_{t+1} \qquad (2.2)$$

Under rational expectations, ε_{t+1} is a stochastic error unpredictable from information at time t. The intertemporal elasticity of substitution σ can, in principle, be estimated from this relationship. One could therefore attempt to compare the average rate of substitution in the preferences of consumers in different countries. The intuition for the positive coefficient on it and a measure of consumption uncertainty is that higher rates at t depress consumption at t and so raise the planned rate of growth of consumption between t and t+1.

The 'news' aspect of ε_{t+1} was emphasized by Hall (1978) who popularized the Euler equation approach. Tests of the unpredictability of ε_{t+1} soon began to uncover the 'excess sensitivity' puzzle, in which log changes in consumption are found empirically to be far too sensitive to predictable log changes in income, see Campbell and Mankiw (1989, 1991) for comprehensive international evidence. This casts doubt on the validity of the underlying assumptions and also on the usefulness of equation (2.2) for comparing intertemporal preferences across countries. If (2.2) is invalid because of excess sensitivity, estimates of σ will be biased by the correlation of the interest rate with the omitted predicted log change in income.

2.2 A basic Life-cycle Model to examine Interest Rate Effects.

In the standard two period model of household consumption choices, the inter-temporal budget constraint is given by

$$c_1 + c_2 / (1 + r_1) = A_0 (1 + r_0) + y_1 + y_2^e / (1 + r_1) \equiv W_1 \qquad (2.3)$$

where all variables are in real terms and c refers to consumption, y to disposable non-property income, A to end of period assets, r to the interest rate, W defines life-cycle wealth and the e superscript means ‘expected’. Now assume the utility function is additive and has the CES form. Then

$$U^{-\rho} = c_1^{-\rho} + [1 / (1 + \delta)] c_2^{-\rho} \qquad (2.4)$$

Maximising (2.4) subject to (2.2), gives a first order condition of the form (2.1) and combining this with the budget constraint (2.3), results in the solved out consumption function

$$c_1 = W_1 / k_1 \qquad (2.5)$$

where

$$k_1 = 1 + \{1/(1+\delta)\}^{\sigma}\{1/(1+r_1)\}^{1-\sigma} \qquad (2.6)$$

and $\sigma = 1/(1+\rho)$.

For small values of δ and r_1,

$$k_1 \approx 1 + [1/\{1+\sigma\delta+(1-\sigma)r_1\}]. \qquad (2.7)$$

Here the inverse MPC out of assets k_1 depends on the weighted average of the subjective discount rate, δ, and the market rate r_1. The responsiveness of consumption to the real interest rate, given A_0, y_1, and $y^e{}_2$ can be examined by differentiating the log of equation (2.5) w.r.t. r_1:

$$\frac{\partial \log c_1}{\partial r_1} = \frac{\partial \log W_1}{\partial r_1} - \frac{\partial \log k_1}{\partial r_1}$$
$$= \frac{\dfrac{-y^e{}_2}{(1+r_1)^2}}{W} + \frac{1-\sigma}{k_1(1+\sigma\delta+(1-\sigma)r_1)^2} \qquad (2.8)$$

Thus, a low value of expected discounted income relative to life-cycle wealth, which corresponds to a high share of assets in life-cycle wealth, and a low value of the elasticity of inter-temporal substitution, σ, make a positive response more likely. On all counts, Japan appears to qualify. Japanese households have a high ratio of assets, particularly liquid assets, relative to income. Also, liquid assets exceed debt for the aggregate of households, while in the last decade or more, the opposite has been true in the US and the UK. Households in Japan surely have very moderate income growth expectations given the ageing population and the large size of government deficits. Indeed, official growth forecasts have been low for more than a decade. Finally, σ measures the elasticity of inter-temporal substitution– the lower is σ, the less tolerant are households to such fluctuations and the more precautionary their attitude to saving decisions. Japanese households, on the average, are widely thought to exhibit such cautious tastes.

This simple two-period model can also be used to analyse the effect of income uncertainty on consumption decisions. In Muellbauer and Lattimore (1995), p.250-1, we show that the choice problem under income uncertainty can be reduced to an equivalent problem under certainty in which expected income is replaced by certainty equivalent income, see also Kimball (1990) and Gourinchas and Parker (2001,2) for convincing micro-evidence on the precautionary motive. This income is defined by expected income divided by a discount factor. This uncertainty discount increases with income uncertainty, and is greatest for households with the smallest values of σ – those most averse to consumption instability- other things equal. And while large asset holdings reduce the discount, a weak social security system increases it. A larger uncertainty discount is like a lower value of expected income, and so tends to reinforce the arguments for a positive response of consumption to higher real interest rates in Japan.

2.3 Housing Wealth Effects.

We begin by demonstrating the weakness of the housing wealth effect in classical life-cycle theory. Let c = non-housing consumption, p^h = relative price of housing, H = stock of housing, δ = rate of deterioration of housing, r = real interest rate, y^p =permanent real non property income, and A = real financial wealth. The consumer maximises life-cycle utility defined on the flows of c and on the stocks H, in each period.

Suppose expected p^h and the real interest rate are constant. Then the multi-period inter-temporal optimization problem is just a two-good problem (by the Hicks aggregation theorem [2], see Deaton and Muellbauer (1980), p.121)) with budget constraint:

$$c + p^h(r+\delta)H = y^p + r(A_0 + p^h H_0) \qquad (2.9)$$

where (r+δ)H= housing services and p^h (r+δ)= real user cost.

We are interested in the effects on a constant price index of consumption like the one in the national accounts. This includes imputed rent on housing. Holding base prices fixed and differentiating equation (2.9) w.r.t. p^h, we find:

$$\partial[c + p^h{}_0(r+\delta)H] / \partial p^h = rH_0 - (r+\delta)H \qquad (2.10)$$

[2] This says that goods whose relative prices are fixed can be treated like a single good. Here, expected relative prices for consumption at t, t+1, t+2 etc and similarly for housing are being assumed fixed.

But with $H \approx H_0$, the RHS of equation (2.10) is negative, since δ is positive. This point seems to have been overlooked in the classic work by Modigliani and Brumberg (1954), Friedman (1957, 1963) and Ando and Modigliani (1963). The simple implications of Equation (2.10) are liable to be somewhat modified in models with finite lives and transactions costs and depend on how well imputed rent is measured in the national accounts. Nevertheless, it is hard to place much store on a substantial aggregate housing wealth effect from classical life-cycle permanent income theory.

2.4 The Household Credit Channel

This section discusses how access to credit interacts with house prices, interest rates and income growth expectations to influence consumption and how a change in access to credit changes consumption through two main mechanisms. In many countries, mortgage debt is the dominant form of household debt. The first mechanism concerns the mortgage down-payment constraint. Suppliers of mortgage credit set upper limits to loan-to-income and loan-to-value ratios to reduce default risk. This forces young households to save for the initial deposit, i.e. to consume less than income, the difference depending on the ratio of house prices to income and on the minimum deposit as a fraction of the value of the house[3]. A reduction in credit constraints in the form of a reduction in the minimum deposit as a fraction of the value of the house, will

[3] Note that most potential first-time buyers of housing saving for a housing deposit are not credit-constrained in the sense of being unable to smooth consumption. The savings they are building up for a future housing deposit can be run down or increased in anticipation of shorter-term income fluctuations and in response to changes in real interest rates.

raise the consumption of these households relative to income (see Japelli and Pagano (1994) and Deaton (1999), and micro evidence in Engelhardt (1996)).

Now consider the impact on consumption of higher house prices via the operation of the down-payment constraint. With weak access to credit potential first-time buyers save more with higher house prices (unless they give up on house purchase). Increased access to credit will weaken the resulting negative effect on consumption of higher house prices.

Next, consider the second credit channel mechanism operating via housing collateral. In a number of countries, the relaxation of rules and spread of competition has made it easier to obtain loans backed by housing-equity (see Poterba and Manchester, 1989). A rise in house prices then makes it possible to increase debt or to refinance other debt at the lower interest rates, given collateral backing. Effectively, the liberalization of credit conditions increases the "spendability" or liquidity of such previously illiquid housing wealth. The greater liquidity of housing wealth with easier access to credit gives housing wealth a buffer stock role.

Overall, combining the down-payment and collateral mechanisms with the life-cycle view relevant for some households, if existing owners have only limited access to home equity loans, the effect on their consumption of higher house prices will be small. Existing owners, who are not credit constrained and whose behaviour is governed by the life-cycle model outlined above, taking equation (2.10) literally, will have a small negative response to a real permanent increase in house prices unless they downsize to cheaper accommodation. By life-cycle theory, renters save more with higher house prices, as is implied by equation (2.10) when H_0 is zero. Hence, given the above discussion of the down-payment constraint, the aggregate consumption effect of a rise in real house prices is likely to be negative when access to credit is restricted, but switches to positive as access to credit expands.

In countries like the UK where floating rate debt is important, indebted households are subject to short-term shocks to cash flows when nominal interest rates change, see Jackman and Sutton (1982) for an exposition of the theory. Their consumption is thus likely to be influenced by changes in the debt service burden, which can be well represented by proportional changes in the nominal interest rate, weighted by the debt to income ratio. Better access to collateral will reduce the impact of such changes, as households with positive net equity can more easily refinance to protect cash flows against rises in nominal interest rates. The negative effect of nominal interest rate changes weighted by the debt to income ratio, should thus weaken with credit market liberalization, but increase in a credit crunch.

Finally, greater access to unsecured credit should increase the role of inter-temporal substitution, enhancing the role of income growth expectations and, on balance, making the real interest rate effect more negative.

2.5 Aggregation Problems and the Incorporation of demographic Effects

In stylized solved out multi-period extension of (2.5), where we proxy expected or 'permanent' income by current income, micro-level consumption is given by a linear function of assets and non-property income:

$$c_h = \gamma_h A_h + \lambda_h y_h \tag{2.11}$$

where γ_h, λ_h vary by age. Hence aggregate or average per capita consumption is

$$\bar{c} = \frac{\sum c_h}{N} = (\frac{\sum \gamma_h A_h}{\sum A_h})\bar{A} + (\frac{\sum \lambda_h y_h}{\sum y_h})\bar{y} \qquad (2.12)$$

Thus $\bar{c} = \gamma^* \bar{A} + \lambda^* \bar{y}$ will have non-constant γ^*, λ^* depending on demography and the distribution of income and wealth by demographic groups. In the long run, Gokhale, Kotlikoff and Sabelhaus (1996) argue that shifts in γ_h and A_h by age account for some of the secular decline in US saving rate. Similar arguments are common in Japan. However, cross-section evidence suggests that γ_h, λ_h may vary less across households than text book models might imply, Bosworth et al. (1991) and Murata (1999, ch. 8), for example, because of uncertainty about time of death. γ^*, λ^* are likely to evolve slowly over time as the age distribution, distribution of y and A by age and life expectancies evolve. Murata (1999, ch.5) using calibrations broadly consistent with micro data from the Family Saving Survey, finds that aggregate consumption models in which γ^*, λ^* are constant have very similar implications and fit as models where they evolve according to sample survey data.[4] Furthermore, as households make long-run portfolio decisions, the level and composition of assets is likely to reflect the demographic evolution, implying less direct impact on consumption of shifts in γ^*, λ^* due to demographic change.

[4] See further discussion below.

2.6 A solved out Consumption Function

The Friedman-Ando-Modigliani consumption function requires an income forecasting model to generate permanent non-property income. Unlike the Euler equation, it does not ignore long-run information on income and assets. The solved out consumption function has advantages for policy modelling and forecasting. This basic aggregate life-cycle/permanent income consumption function has the form:

$$c_t = \gamma * A_{t-1} + \lambda * y_t^P \qquad (2.13)$$

where c is real per capita consumption, y^P is permanent real per capita non-property income and A is the real per capita level of net wealth. This equation also has a basic robustness feature missing in the Euler equation. Euler equations require well-informed households continuously trading off efficiently between consuming now and consuming next period. An extension of eq (2.13) in which current income potentially also plays a role is also consistent with a fairly rudimentary comprehension of life-cycle budget constraints. Any household with some notion of wanting to sustain consumption will realize that not all of assets can be spent now without damaging future consumption, and that future income has a bearing on sustainable consumption. As we shall see, practical applications of extensions of eq (2.13) capture these basic ideas.

Dividing equation (2.13) by y_t and a little manipulation gives:

$$c_t / y_t = \lambda^* [(\gamma^* / \lambda^*) A_{t-1} / y_t + 1 + (y_t^P - y_t) / y_t] \qquad (2.14)$$

The RHS of equation (2.14) has the form 1+ x, where x is usually a fairly small number.[5] We can then take logs, using the fact that log (1+x) ≈x and $\log(y_t^P / y_t) \approx (y_t^P - y_t)/y_t$ .We then see that

$$\log c_t = \alpha_0 + \log y_t + \gamma A_{t-1} / y_t + \log(y_t^P / y_t) \qquad (2.15)$$

where $\gamma = \gamma^*/\lambda^*$ and $\alpha_0 = \lambda^*$. Thus, α_0 embodies the evolving distribution of income and demography, while γ embodies the evolving relative influences of the asset and income distribution and demography. One might attempt to proxy the former by the inclusion of demographic variables such as the population proportions in different age groups. The log ratio of permanent to current income reflects expectations of income growth and in practice can be proxied by functions of forecast income growth rates. The log formulation is very convenient with exponentially trending macro data, since residuals are likely to be homoscedastic. Note that the widely used alternative log-linearisation of (2.13) using log A cannot cope with negative net assets. It also suffers from large approximation errors for small values of assets, so that splitting log assets into logs of subcomponents is not advisable. Adding further realistic features, such as habits, a role for variable interest rates and income uncertainty, splitting up assets into different types, and introducing a role for the credit channel gives rise to a modern empirical version of the Friedman-Ando-Modigliani consumption function that encompasses the basic life-

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[5] The justification for this is that one thinks of λ^* as being around 1, γ^* of the order of 0.03 or 0.04 and asset to income ratios on average perhaps 4. The proportionate deviation of permanent from current income on average would be expected not to exceed 20% given historical data on fluctuations in real income and plausible discount rates. In micro applications where data are more variable, the second order approximation log (1+x) ≈x -0.5x^2 would be preferable.

cycle model given by (2.15). For example, habits or adjustment costs, see Muellbauer (1988), results in a partial adjustment version of (2.15), where β is the speed of adjustment:

$$\Delta \log c_t = \beta(\alpha_0 + \log y_t - \log c_{t-1} + \gamma A_{t-1} / y_t + \log(y_t^P / y_t)) \tag{2.16}$$

Economic theory suggests a role for a variable real interest rate r and for income uncertainty θ because of precautionary behaviour, and we include these as linear terms in the extension of (2.16) to (2.17) below. This extension also splits total net worth into three components and adds two additional effects which could reflect credit constraints or rule of thumb behaviour by some households, and the possibility of time variation in some of the parameters induced by shifts in credit availability, discussed further below.

$$\begin{aligned}\Delta \log c_t \approx\ & \beta(\alpha_{0t} + \alpha_{1t} r_t + \alpha_{2t}\theta_t + \alpha_{3t} E_t \Delta \log ym_{t+k} \\ & + \gamma_1 NLA_{t-1} / y_t + \gamma_2 IFA_{t-1} / y_t + \gamma_{3t} HA_{t-1} / y_t + \log y_t - \log c_{t-1}) \\ & + \beta_{1t}\Delta \log y_t + \beta_{2t}\Delta nr_t (DB_{t-1} / y_t) + \varepsilon_t \end{aligned} \tag{2.17}$$

$E_t \Delta \log ym_{t+k} = \log(y_t^P / y_t)$ measures income growth expectations. NLA/y is the ratio of liquid assets minus debt to non-property income, IFA/y is the ratio of illiquid financial assets to non-property income, HA/y is the ratio of housing wealth to non-property income; $\Delta nr_t (db_{t-1} / y_t)$ where nr is the nominal interest rate on debt and db is debt, measures the cash flow impact on borrowers of changes in nominal rates; the speed of adjustment is β, and the γ parameters measure the MPCs for each of the three types of assets. The term in the log change of income can be rationalized by an aggregation argument over credit constrained and unconstrained households, Muellbauer and Lattimore (1995). Note that: $\beta = 1,\ \alpha_{1t} = 0,\ \alpha_{2t} = 0,\ \gamma_1 = \gamma_2 = \gamma_{3t} = \gamma,\ \beta_{1t} = 0,\ \beta_{2t} = 0$ and $\alpha_{3t} = 1$ are the restrictions which result in the basic life-cycle/permanent income model equation (2.15).

The credit channel features through the different MPCs for net liquid assets (Otsuka, 2006) and for housing; through the cash flow effect for borrowers; and by the possibility of parameter shifts with credit market liberalization. Credit market liberalization should raise the intercept α_0, as saving for a downpayment falls, implying a higher level of log(c/y). It should make the real interest rate coefficient α_1 more negative and raise α_3 ,the impact of expected income growth, since more opportunities for intertemporal substitution arise with easier access to credit; and raise the MPC for housing collateral, γ_3 as access to home equity loans increases. It should also lower the current income growth effect, β_1 since this could reflect the presence of credit constrained households, and the cash flow impact of the change in the nominal rate, β_2. since, with easier access to credit, refinancing in the face of a rise in nominal rates is more likely to be possible. In our work on the UK, Aron et al. (2008), we handle these shifts by writing each of these time-varying parameters as a linear function of an index of credit supply conditions, CCI so that CCI enters the model as an intercept shift and in interaction with several economic variables.

As we shall see, for Japan, empirical versions of equation (2.17) reduce to a far simpler and more parsimonious model, in part, because we can find no significant effects of credit market liberalization and because floating rate debt is relatively unimportant compared to the UK.

2.7 Literature Review

Several studies have examined asset effects on consumption in Japan[6]. Most analyses have found the MPC out of assets is around 0.05. Ando et al. (1986) used micro data from the *National Survey of Family Income and Expenditure* and found an MPC out of assets below 0.05. Ogawa et al. (1996) examined the asset effects on consumption using prefecture-level data from the same survey, confirming an MPC of around 0.05 for *liquid* assets. Using the *Japanese Panel Survey of Consumers*, covering young and middle-aged households, Hori and Shimizutani (2003) found the MPC out of assets to be around 0.05-0.10, with similar effects for liquid assets and shares. Horioka (1996) estimated a consumption function based on specifications in Modigliani and Brumberg (1954) and Ando and Modigliani (1963), and using the National Accounts data, obtained an MPC for net worth of 0.02-0.04 at the sample mean.

The effects of financial imperfections or down-payment constraints have also been examined. Hayashi et al. (1988) present a life-cycle simulation analysis, comparing saving rates in Japan and the US, suggesting that while it was likely that Japanese households saved more early in the life cycle to meet the higher down-payment requirement, the contribution of the early saving appears too small to explain a large differential in the aggregate household saving rate between the US and Japan. However, this study may have understated differences in the down-payment constraint between the two countries. Moriizumi (2003) finds micro evidence for a large effect on saving by young households in Japan linked to the down-payment constraint. Horioka (1988)

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[6] For the surveys on consumption or saving behaviour in Japan up to the middle of the 1990s, see Hayashi (1997) and Horioka (1993). More recently, Horioka (2004) has discussed the reasons for Japan's past high saving rate and the reasons for the recent decline.

focused on saving by type of motive, concluding it was likely that housing–related saving including down-payments was considerable in Japan, though approximately offset by dissaving, in the form of depreciation of the housing stock.

Concerning interest rate effects on consumption, Hayashi(1985), a leading study in the permanent income hypothesis as applied to Japan, estimated Euler equations using the National Accounts data and found the coefficient on the interest rate was not statistically significant (except for durables). Nakagawa (1999) estimated an equation explaining the saving rate in terms of the real interest rate, income risk and income growth expectations using aggregate data for five income quintile groups and obtained a positive and significant interest rate effect on consumption for higher-income households (negative effect on the saving rate). Nakagawa and Oshima (2000) estimated consumption functions following the consumption CAPM, using the National Accounts data for US, UK, France and Japan. They found that the coefficients on the real interest rate were negative and significant for US and UK, negative but insignificant for France, and positive but insignificant for Japan.

Horioka (2006) has argued that the stagnation of Japan's consumption during the 1990s is attributable to the stagnation of household disposable income, a decline in household wealth and increased uncertainty about the future. However, household income is itself endogenous. Unfortunately, he does not conduct an empirical analysis in his paper. There has been little empirical investigation of the role of increased uncertainty in the stagnation of household consumption during this period, though exceptions are Murata (2003) and Saito and Shiratsuka (2003).

On the question of monetary policy transmission, Ito and Mishkin (2004) and Hamada (2004), for example, implicitly accept the conventional view that monetary policy via households in Japan works much as in the US and the UK. There has not been a rigorous examination of whether this view is correct, as in our research. Horioka (2004) has suggested that consumer behaviour in Japan is different from that in US or UK, but that it is similar to that in Continental Europe, but does not discuss the implications for monetary policy transmission.

Drawing on Aron et al (2008), Muellbauer (2007) applied the consumption function outlined in Section 2.5 to UK and US data. He finds an MPC out of net liquid assets around 0.1, around 0.02 for illiquid financial assets and an MPC increasing with a measure of credit availability for housing wealth, reaching a maximum of around 0.03 for the UK and even higher values for the US. In both countries there is evidence for a negative real interest rate effect on consumption. For the UK, where floating rate mortgages dominate, there is an important negative time varying effect from the debt weighted change in nominal borrowing rates. This is consistent with the discussion in section 2.6. In both countries, forecast income growth rates are quite significant in explaining consumption.

3. Empirical Results for Consumption

3.1 Data and measurement issues.

Consumption data

Our consumption expenditure series is defined as “actual final consumption" which consists of “final consumption expenditure" plus "individual consumption by the government", such as medical expenses paid by pension funds, textbooks at school etc. plus consumption by non-profit institutions, which is very small (negligible).

Non-property income

Inter-temporal consumer theory uses a concept of non-property income as noted in section 2. The national accounts define personal disposable income PDI as the sum of labour, transfer and property income, after taxes and subsidies, and operating surplus (after tax). To measure non-property income, NPDI, we subtract after-tax property income and part of operating surplus from PDI as explained in Appendix 1.

Figure 1 shows the log ratio of consumer expenditure to non-property income. This is a preferable measure to the log ratio of consumer expenditure to PDI, which is approximately 1-s, where s is the household saving ratio. The reason is that the property income component of PDI is distorted by inflation. A large element of property income is interest on deposits, which depends on the nominal interest rate. With the real rate of interest constant, a decline in inflation will then reduce measured PDI even when the real budget constraint is unchanged. Figure 1 also shows the log real land price, revealing a negative correlation between the two, though clearly there are other trending and cyclical effects – an upward trend in the consumption ratio, and a sharp downward correction in the 1970s.

The changing demographic structure of Japan has often been linked with the decline in Japan's household saving rate and the positive trend seen in Figure 1, see Horioka (1997) for the most striking claims. Data revisions in 2006 resulted in a substantial upward revision of the consumption to income ratio (downward revision of the household saving ratio, Masubuchi (2006))., Figure 2 also shows the falling population proportion of those aged 14 or less and the rising proportion of those aged 65 or more. These are I(2) ("integrated of order two") variables in the 1955 to 2006 period so drawing robust conclusions about their role in explaining consumption/income, which is I(1), will always be very difficult. Prima facie, it is also not obvious whether there is any net effect: while the consumption needs of the young may be less than those of the elderly, their proportionate decline is also greater. Moreover, as Figure 4 reveals, life-expectancy in Japan has risen very steadily in this period. While an ageing population is supposed to raise the average saving rate according to the Modigliani life-cycle hypothesis, as the proportion of elderly dissavers rises, rising life expectancy with which it is positively correlated, has the opposite effect since it increases the need of the working population to save, see Murata (1999 ch. 8) for some evidence on this point.

Data from round the world suggests that those in the decade or two before retirement tend to have the highest saving rates in the population. Figure 3 shows the proportions of the population in the high saving age groups, as measured by the population proportions aged 40 to 64 and 45 to 59. The peaking in these proportions in the 1990s could be associated with the slight dip or flattening of the consumption/income ratio in this period, and its later rise. But that is pure speculation at this juncture and robust conclusions may not be available, even with a more complete model.

Wealth and Debt Data

Japan has produced flow of funds accounts and balance sheet data since the 1950s.

These are published as part of the financial flow of funds account, available quarterly back to 1964. End of year balance sheet data are also published as part of the extended national income and expenditure accounts. The latter also include estimates of physical assets and can differ somewhat in other dimensions, for example including estimates of shares in companies which are not publicly traded. As is usually the case, the household sector includes unincorporated businesses.

Data have been published on two bases: the 1968 SNA and the 1993 SNA. On the former basis, rather less detail is available, particularly on the debt side. For example, the mortgage/non-mortgage split is not available. On the 1993 SNA basis, not only the mortgage split but also information which throws some light on the unincorporated business element of debt is available back to 1979. This poses the issue of which definition of debt we should adopt. One is total household liabilities. The data back to 1979 indicate that around 30 to 40 percent of these liabilities are loans to companies, i.e. debt of unincorporated businesses. A second definition of household debt excludes these loans. To generate the data before 1979, we subtract a fixed proportion of 0.41 of debt, the proportion in 1979.

Assets could be divided several different ways. We follow the division set out in Section 2.5. We define liquid financial assets as currency and deposits, and illiquid financial assets as the sum of shares, pension funds and other financial assets, including bonds. Net liquid assets are defined in two ways: liquid assets minus the two alternative definitions of debt. Physical assets are dominated by land. We take the data back to 1955, splicing with the 1968 SNA data.

The data on shares poses some problems, as before 1969 they are based on book values and are at market values only from 1969. However, quarterly Flow of Funds data are available at market values back to end-1964. We therefore splice these end of year data at 1969 to take the series back to end 1964. We then adjust the earlier book values to market values, see Appendix 1.

Figure 5 shows ratios to non-property income of liquid assets and debt on the two definitions and net liquid assets on the lower definition of debt. Liquid assets substantially exceed even the wider definition of debt, and the net liquid asset ratio does not show the strong negative trends seen in the US and UK equivalents illustrated in Muellbauer (2007). On the face of it, there seems little sign here of the household credit market liberalization seen in many other countries.

The ratios to non-property income of illiquid financial assets and physical assets are shown in Figure 6. The latter is clearly correlated with the real land price index, also shown. The stock market peak in 1991 and the physical asset peak in 1990, following the "bubble" period, are notable, followed by a decline in the latter which began to rise only in 2006-7. The peak of physical assets relative to income in 1992 substantially exceeded even the 2007 peak of the UK equivalent, but illiquid financial assets relative to income have been lower than in the UK and especially lower than in the US with its substantial direct and indirect ownership of equities.

Other data

For the representative short-term interest rate, we take the overnight call rate, Rc, which is defined for the full sample, and divided by 100. The real tax adjusted interest rate, RCR is defined by Rc(1-tax rate)-Δlog PC. Here the tax rate is the property tax rate and PC is the consumer expenditure deflator. One indicator of income insecurity is taken to be the change in the unemployment rate, DUR, which is highly relevant in explaining UK and US consumption. The other indicator of income insecurity or volatility, SY, is defined to be the absolute value of the deviation between the current growth rate of real per capita non-property income, $\Delta \log y$, and its average growth rate over the previous 5 years. Figure 7 displays the growth rate of income and the two indicators of income insecurity.

3.2 Modeling Income Growth Expectations

Income growth expectations are a central feature of inter-temporal consumption models. Indeed, it has sometimes been claimed that housing wealth or collateral effects on consumption are an illusion, being merely a proxy for omitted income growth expectations, see King (1990) commenting on Muellbauer and Murphy (1990), Attanasio and Weber (1994) and Attanasio et al (2009)[7]. Poterba (2000) similarly makes the point that the size of the stock market wealth effect on consumption depends on the source of the asset price shock since some shocks may signal a shift in income expectations. This makes it important to control for income growth expectations.

We follow Muellbauer (1996), which forecasts US income growth, using a general to specific methodology in paring down a very general model to a parsimonious form. The general model includes a trend, a split trend from 1973 for the slowdown in Japanese growth which then occurred and the level of log real per capita income to capture trend reversion. Other variables include log US GDP, the log real exchange rate,

[7] However, the last two references fail to control for current income, perhaps the most obvious driver of consumption.

log real oil prices, log real asset prices, the real interest rate, the change in the nominal interest rate, and the government surplus and debt to GDP ratios. Table 1 reports the parsimonious specifications found after testing down.[8]

There is strong evidence for reversion to the split growth trend and the 3-year moving average of government balance/GDP has a positive coefficient. The table also shows an alternative specification in which lags in the ratio of government debt to GDP replace government balance/GDP. The lagged government debt/GDP ratios have highly significant coefficients, negative in the long run, as shown in the last column in Table 1. US log GDP is also significant and real oil prices are then not significant, though they would be if US log GDP were omitted. The influence of the US as leading economy and key trading partner for Japan is thus confirmed. The change in nominal interest rates over the previous three years has a negative effect on next year's household income growth, suggesting that, overall, monetary policy has some effect on growth. However, the real interest rate is insignificant, and positively signed. Columns 2 and 3 show the income forecasting equation fitted over alternative samples, showing remarkable parameter stability.

The actual and fitted values and residuals from the parsimonious model, namely the second column of Table 1 are shown in Figure A1 and the recursive stability tests in Figure A2 at the end of the paper. The latter are quite satisfactory. There are other variants of the model in which this basic structure is maintained but a few more variables can improve the fit a little. For example, lagged changes in the investment to GDP ratio tend to be significant with positive coefficients. The imputation to consumer

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[8] With the help of Autometrics software, Doornik (2007). Since the residuals reveal some heteroscedasticity, reflecting the greater volatility of pre-1975 growth, robust standard errors are reported

expectations of the fitted values from such a model assumes some intelligence, if not full rationality, on the side of consumers.

3.3 Results for Euler Equations

As noted in section 2.1, the unpredictable 'news' feature of the residual in a consumption Euler equation, is a key implication of the theory. However, Campbell and Mankiw (1989, 1991) showed that this prediction was rejected in virtually every country they studied since predictable income growth, or 'excess sensitivity' proved highly significant in explaining consumption growth. They are careful to note that since time aggregation and transitory noise in consumption induce first order autocorrelation in the residuals, instruments dated t-2 should be used to test the 'news' hypothesis. We therefore use a simplified version of the income forecasting equation just reported in Table 1 to generate the income growth forecast.[9]

Strictly speaking, the Euler equation does not apply to expenditure on durable goods. Hence Table 2a reports results for the excess sensitivity test for Euler equations for different definitions of non-durable goods and services. The instrumented log change in real per capita income is highly significant, see columns 2 to 4, showing variants including and excluding the real interest rate and an income volatility measure.

[9] In this version, log real per capita income and the change in the nominal interest rate are lagged one year more. Then the interest rate term and log US GDP become insignificant and are omitted. The fitted value form this equation is lagged one year, thus embodying information lagged two years.. Similar results are obtained whether the equation variants using government surplus to GDP or government debt to GDP are used.

Column 1 shows the Euler equation including only the real interest rate. Though the real interest rate is very significant, columns 2 and 4 suggest that the coefficient is grossly upward biased because of its correlation with instrumented income growth omitted from column 1. Estimated Euler equations of the kind shown in column 1 therefore offer no basis for comparing estimates of the elasticity of intertemporal substitution across countries. The overwhelming evidence for excess sensitivity is consistent with violations of some of the key assumptions behind the Euler approach, including rational expectations and the absence of credit or liquidity constraints.[10] This is another powerful reason for preferring the augmented solved out consumption function approach set out in Section 2.6.

3.4 Results for Aggregate Consumption

Our aim is to estimate for Japan variants of equation (2.17) discussed in section 2.6. We use annual data from 1961 to 2006. In slight modification, we also include the lagged log real land price. It quickly becomes apparent that the ratio of physical assets to income and the real land price have negative coefficients and we therefore report equations in which each is included separately. Further, we cannot reject the hypothesis that the marginal propensities to spend out of deposits and illiquid financial assets are the same, and are equal to minus the coefficient on household debt. This may be because “deposits” includes a substantial amount of longer term time deposits which are

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[10] Habits have sometimes between proposed as a potential reason for excess sensitivity. An Euler equation with habits includes lagged consumption growth as a regressor. However, when instrumented current income growth is included in Table 2 runs, lagged consumption growth is completely insignificant, with a coefficient close to zero.

therefore not so liquid. At any rate, we can work with net financial wealth, which is always very significant and with a long run MPC of around 0.05 to 0.07, see Table 3a. This is consistent with estimates reported by Ogawa et al. (1996) and Hori and Shimizutani (2003) discussed in section 2.7.[11]

The fitted values obtained from Table 1, column 2 are taken as proxies for expected income growth, and are strongly significant. The measure of income volatility is significant as shown in the first column of Table 3a. In the second column the cross term of income volatility and expected income growth rate was added, as the theory discussed in Section 2.6 suggests that greater income uncertainty should lead to a bigger discount on expected growth. When both are included, the cross term is found to be significant while income volatility is insignificant. The change in the unemployment rate is not significant at the 5% level, probably because of its more limited variability in Japan, in contrast to its far more significant role in the UK and the US, see Muellbauer (2007). However, the sign is negative and the magnitude of the coefficient is not far below UK and US estimates.

The change in the nominal interest rate is always insignificant, unlike in the UK, but the level of the real rate has a strongly significant positive effect. This is not a disguised inflation effect as the inflation rate is insignificant when included, while the real rate remains significant. In Aron et al. (2008) and Muellbauer (2007) we find negative real interest rate effects in similar specifications estimated for the UK and the US.

Finally, the log change in income has a positive and significant effect. This is also

[11] The lower MPC for net worth reported by Horioka(1996) is consistent with the negative coefficient we estimate for the physical assets component – clearly, net worth is not the right concept.

in contrast to the UK and US findings, where this effect is not significant. The argument comes from applying the Campbell-Mankiw aggregation of credit constrained and unconstrained households to a solved out consumption function, see Muellbauer and Lattimore (1995). On this interpretation, the proportion of total income in income constrained households π is given by $(1-\beta)\pi=\beta_1$, where the coefficient on the change in log income is β_1 and β is the speed of adjustment. Given a speed of adjustment of 0.359 and β_1 estimated at 0.332 from Table 3a column 4, this suggests just over half of Japanese consumption comes from households who are, or behave as if they were, income constrained. This is not far from previous estimates of this proportion for Japan, see Hayashi (1997). However, given the somewhat unsatisfactory micro foundations for the Campbell-Mankiw story, it is probably a mistake to interpret this too literally in terms of credit constraints, see Carroll (2001) and Aron et al. (2008).

The fit of the equation over the full sample is shown in Figure A.3. The stability properties of the equations are seen in estimates over different samples in Table 3b and in the recursive betas shown in Figure A.4. These provide clear support for the long-term relevance of the model, though in short samples the real land price effect loses significance, given its lack of short-term variability.

This raises the question of whether there may have been a structural break in the coefficient on log real land price. We test for this by interacting the lagged log real land price with two step dummies, one zero up to 1980 and one from 1981; the other zero up to 1990 and one from 1991[12]. The results hardly alter when the step dummy beginning in 1991 was replaced by the one beginning in 1981. The coefficient on the step dummy

[12] To avoid a jump in the interaction effect in, for example, 1991, the 1991 step dummy is multiplied by the lagged log land price index minus its 1990 value.

interaction effect is not significant, with a t-ratio of 0.7. The point estimate is consistent with a small amelioration in the negative impact of land prices on consumption after 1991 (and indeed after 1981). But we can easily accept the hypothesis of constancy of the negative real land price effect.

In Japan's National Accounts, the series based on 93SNA are available back to 1979. Thus the series based on 93SNA and those on 68SNA were spliced with the ratio in 1980 (see also Data appendix). In order to test the possibility that the results were biased due to this method of data adjustment, the equations shown in the second column of Table 1 and the first and second columns of Table 3a were estimated up to 1998 only using the 68SNA series. The results were not statistically different from those shown in the corresponding equations estimated up to 2006.[13]

Lower income growth, and the uncertainty indicators explain some of the dramatic decline in the consumption to income ratio in the 1970s. The long-run contributions of the four I(1) explanatory variables – the net financial wealth to income ratio, the log real land price, the real interest rate and the forecast growth rate of income, are shown in Figures 8 and 9. It is clear from this figure that the rise of the consumption to income ratio is very much driven by the rise in net financial assets owned by households, only somewhat offset by the rise in real land prices. Interestingly, net financial assets relative to income shows rather little cyclical variation, as the pension fund component is not very sensitive to the stock market, though its decline in the early 1990s also contributed to the drop in the consumption ratio then.

It is a striking fact that the four demographic shares plotted in Figures 2 and 3 are

[13] We are grateful to Charles Horioka for suggesting this robustness check.

jointly and individually insignificant when included in the consumption equation.[14] This does not mean, of course, that demographic developments are irrelevant for aggregate consumption in Japan. The accumulation of financial wealth in Japan in the past has surely been, in part, driven by the ageing of the population and lengthening life-expectancy. Consumption or saving, *conditional* on such portfolio accumulations, is always less likely to be so sensitive to demographic structure.[15]

To investigate the co-integration properties of the data, on the provisional hypothesis that DLRY, the current income growth, is weakly exogenous, we set up a five-equation system with the log ratio of consumption to non-property income, LRCY, the forecast income growth, EDLRY, the real interest rate (tax adjusted), TRCR, the relative price of land, LRPLAND, and the net financial asset to income ratio, NFAY, and include DLRY and the cross term of income volatility and forecast income growth, SEDLRY, as unrestricted I(0) variables. With the constant in the cointegrating space, we find there are two cointegrating vectors, one of which can be interpreted as a

[14] Moreover the signs often make little sense. What does make more sense is the inclusion of the proportion of the adult population aged 25 to 44. These are the main savers for a housing deposit. A rise in their proportion tends to lower consumption relative to income, though the effect still only has t=-1.1. Micro evidence, see Hayashi (1997), indicates that older Japanese households tend to carry on saving until their 80s, but perhaps the 25 to 44 group are the biggest savers.

[15] We also carried out a calibration exercise based on eq (2.11) and (2.12) defining three age groups and making plausible assumptions about differences by age in the marginal propensities to consume out of income and assets. Using annual household survey data , we can then construct time varying aggregate marginal propensities $\gamma^* = (\frac{\sum \gamma_h A_h}{\sum A_h})$ and $\lambda^* = (\frac{\sum \lambda_h y_h}{\sum y_h})$. Calibrations with small age differences in the micro propensities fit better than those with larger age differences. But the results differ very little from those reported for time-invariant marginal propensities in Table 3a.

consumption function [16]:

$$LRCY=1.0432*TRCR+1.00*EDLRY-0.071511*LRPLAND+0.047680*NFAY. \quad (3.3)$$

The coefficients obtained in (3.3) were tested and found to be statistically not different from the long-run coefficients obtained in the fourth column in Table 3a, though the point estimate for the real land price effect is marginally more negative, while that for the ratio of net financial assets to income is marginally smaller. Since

[16] Unadjusted tests for the number of cointegrating vectors are marginal for the hypothesis of two cointegrating vectors vs. three. However, the inclusion of I(0) variables in the model biases up the standard test statistics, see Rahbeck and Mosconi (1999). Hence two is almost certainly correct. The significance of alpha for the second cointegrating vector ensures that the rank cannot be less than two.

eigenvalue	0.782	0.545	0.311	0.210	0.150
Hypothesis	r= 0	r<=1	r<=2	r<=3	r<=4
λmax	62.5**	32.28*	15.26	9.67	6.66
λtrace	126.4**	63.86**	31.58	16.32	6.66

Beta (co-integrating vectors):

LRCY	TRCR	LRPLAND	FNFAY	DLRY1FIA	Constant
1.0000	-1.0432	0.047680	-0.071511	-1.0000	0.18239
0.41115	1.0000	-0.016389	-0.045344	0.019226	0.069333

alpha

LRCY	-0.29342	0.00000
TRCR	0.23027	-0.16739

Standard errors of alpha

LRCY	0.046031	0.00000
TRCR	0.088052	0.042131

LR test, rank=2： Chi2(1)=1.324[0.259]

theory suggests an upper bound of 1 on the expected income growth coefficient, while the point estimate was slightly higher, this easily acceptable restriction was imposed.

In obtaining (3.3) α in the second vector, α_2, was assumed to be zero and was accepted. In addition, following Harbo et al.(1998), to check the weak exogeneity of the current income growth, DLRY, the following equation shows that DLRY is unrelated to the cointegrating vector and so passes the test (b_0 is not statistically significant):

$$DLRY = a_0 + b_0{*}ECM(-1) + b_1{*}DLRY(-1) + b_2{*}SEDLRY(-1) + b_3{*}D73(-1) + b_4{*}S73(-1) \qquad (3.4)$$

where

$$ECM = LRCY - 1.0432{*}TRCR - 1.00{*}EDLRY + 0.071511{*}LRPLAND - 0.047680{*}NFAY$$

and D73 a dummy variable with one in 1973 and zero elsewhere, and S73 a step dummy with zero up to 1972 and 1 onwards. Similarly, the cross term of income volatility and forecast income growth, SEDLRY, passes the tests using the same variables shown on the right hand side of (3.4).

The last column of Table 3b shows the results estimated by instrumental variables, further to test whether the results were biased because of possible endogeneity problems, particularly w.r.t. income and the real interest rate. The coefficients were similar to those from OLS and from the cointegration analysis, suggesting that there is no endogeneity problem, consistent with the weak exogeneity tests. The instrumenting strategy takes great care to use efficient and plausible instruments and is discussed in Appendix 2.

There is a wide-spread view in the profession[17] that the Euler equation is the 'structural relationship', while solved out models are 'reduced forms'. One response to this is that solved out models defined by the life-cycle model are combinations of the Euler equations and the life-cycle budget constraint and are therefore just as structural as an Euler equation. The second response is that the Euler equation is overwhelmingly rejected by the data, while the augmented solved out model fits the data far better and has stable parameters for a 47 year period.

Our view is that therefore our consumption function is one very useful element in a system of equations, which include equations for income, portfolio allocation, asset prices, the government budget and the conventional ingredients of a macro-econometric model. On the basis of such a multi-equation model, one could examine the impact of shocks and policy changes of various types. .[18] As far as estimation bias is concerned, we have shown that there is no evidence of a bias by appropriate instrumentation. While annual income is clearly endogenous for current consumption, it is far less obvious that the current growth rate of consumption is endogenous for the log ratio of consumption to income or indeed in which direction any endogeneity bias might point. The cointegration evidence is consistent with weak exogeneity of current income growth.

4. Empirical Results for Debt.

[17] Reflected in comments by Pierre-Olivier Gourinchas at the conference.

[18] Our discussant's concerns about the endogeneity of income would be handled in such a model Such an approach is preferable to the recently fashionable New Keynesian version of a DSGE model with the consumption Euler equation at its core, given the latter's rejection by the data, and its omission of the credit channel and of any economic role for asset prices.

We argued in Section 2 that inter-temporal consumer theory can explain a positive effect of the short term real interest rate on consumption, and found strong evidence for such an effect in Japan. One alternative hypothesis that might explain a positive interest rate effect is the rise in real interest rates that can accompany credit market liberalization, as in the UK between the end of the 1970s and the mid-1980s. Since credit market liberalization raises consumption, omitting such an effect could bias the coefficient on the real interest rate upwards. Indeed, this probably explains why almost a generation of UK researchers had difficulty finding the negative interest rate effect they were expecting in UK consumption models.

The question therefore arises of whether Japan may have gone through a similar liberalization episode. We have already seen circumstantial evidence against this view. Figure 5 shows a continued rise in the ratio to income of liquid assets minus debt, unlike in the US and the UK where these declined from the 1980s. We also found stable parameter estimates for the consumption function. Had there been significant liberalization of credit markets, we would have expected at least some of the parameter shifts discussed below equation (2.17), for which UK evidence is strong.

Now we develop a model for the household debt to income ratio to see if a stable model can be found without the sorts of shifts one requires to make sense of the growth of UK household debt, see Fernandez-Corugedo and Muellbauer (2006). The answer is that we can and indeed a relatively simple and stable model explains the rise of the ratio of debt to income in Japan in terms of two asset to income ratios, the nominal interest rate, the rate of acceleration of consumer expenditure deflator [19]and the change in the

[19] One interpretation of such an effect is an indicator of risk of rises in nominal interest rates.

unemployment rate. The model includes a pre-1974 trend to reflect the earlier development of the financial system, which seems to have reached a fairly mature level by the mid-1970s. The ratios to income of physical assets and illiquid financial assets are all highly significant - as indeed they prove to be in the UK, South Africa and the US. The model shown in Table 4 was developed from a general equation also including real interest rates, income uncertainty indicators, forecast income growth, the income level and more complex dynamics. The fit as seen in Figure A.5 and the recursive stability tests in Figure A.6 are very satisfactory. While the model could probably be improved with more directly apposite interest rate measures and other sophistications, it provides strong evidence against serious structural breaks in debt growth in Japan.

A cointegration analysis for a four-variable system comprising the ratio of current debt to current income, DEBTY, the ratio of current physical wealth to current income, RAY, the ratio of current net financial wealth to current income and the nominal call rate, with the pre-1974 trend in the cointegration space, suggests there is only one cointegration vector, consistent with the long-run solution of the debt equation in Table 4, col. 1[20].

5. Conclusions

The introduction of the paper has already summarised the paper, but there are three main points regarding the role of monetary policy: theory can explain why higher real

[20] The cointegrating vector was as follows:

DEBTY=-0.750*RC+0.157*FNFAY+0.040*RAY+0.012*pre-1974Trend

where the change in unemployment rate was included as an unrestricted I(0) variable. The coefficient of Rc was restricted at -0.75, acceptable at the 5 percent level.

interest rates might have positive consumption effects in Japan and the evidence is that they do. Second, when household credit markets are underdeveloped and other institutional features are present, e.g. inheritance taxes favouring land and housing, theory suggests a negative housing 'wealth' effect and the evidence from Japan is that is negative. However, *for the economy as a whole*, our evidence is that monetary policy works in the conventional direction. Our point is that the household part of the transmission process is far weaker than in the US or the UK. Finally, there is no evidence of serious credit market liberalization for households in Japan. Between the mid-1990s and the early 2000s, the mounting bad loan problem of the banking system made such liberalization even more difficult. Our research conclusions are therefore broadly consistent with the focus on problems in the banking sector by Hoshi and Kashyap (2005).

The evidence from the income forecasting model in section 3.2 has an interesting bearing also on the role of fiscal policy in Japan's 'lost decade'. This model shows a strong negative effect from either a moving average of the government deficit to GDP ratio or from the level and change in the government debt to GDP ratio. The rises in either measure from 1995 to 2005 account, according to the model, for a cumulative loss of non-property disposable income of the order of 1 percentage point per annum, i.e. around 10 percent over 10 years. Log income has a coefficient of 1 in the long run solution for consumption, conditional on asset to income ratios etc. Hence, there was a similar long-run effect on consumption. In addition, according to the estimated consumption equations, there was also a negative short-run effect on consumption from the deterioration in the government finances.

These estimates are consistent with a 'Ricardian' element in households' perceptions of the government balance sheet, and suggest that fiscal policy also had limitations during the 'lost decade'. It is wise, however, to be aware of the possibility of some upward bias in the estimates of the size of these effects. As Comin (2009) notes, there was a significant productivity slowdown in the period, possibly connected with the survival of 'zombie' companies and/or poor investment allocation. An unexpected slowdown might well cause government revenue to deteriorate unexpectedly relative to sticky expenditure commitments, contributing to fiscal deterioration. If the underlying productivity growth rate has been omitted from the model for income, there could then be an upward bias in the size of the fiscal coefficients in the income equation.

To conclude, the evidence in this paper suggests a distinctively weak monetary transmission mechanism in Japan because of the special features of Japanese credit markets and tax institutions, the large net liquid financial asset holdings of Japanese households and perhaps their distinctive preferences. It seems likely that this was a factor contributing to Japan's 'lost decade'. In contrast, US and UK households currently hold much higher levels of debt than of liquid assets. Provided credit markets can function again, interest rate policy in the US and the UK should have far bigger effects on aggregate demand than was and is the case in Japan.

Appendix 1: Data details.

1. Producing a proxy for non-property disposable income

In the life-cycle model, the appropriate concept of income to derive human capital is non-property disposable income of the personal or household sector. However, the variable is not directly available from the National Accounts. Thus, a proxy for non-property disposable income, NPDI, is constructed by subtracting factors that are attributed to property income as well as imputed rents from disposable income.

NPDI= Disposable income

$$-\sum_{i=1}^{3}[(1-t_i)*PI_i \text{ received} - PI_i \text{ disbursements}] - (1-t_4)*PI_4$$

— *Operating surplus of which imputed service from owner-occupied dwellings*

+ Changes in pension reserves in pension funds, receivable

where PI_1 represents interest income, PI_2 dividend income and PI_3 other property income and PI_4 an estimate of the property element in proprietors' income in total property income while t_i represent corresponding tax rates. The property element in proprietors' income and its tax rate in total property income, PI_4 and t_4, are constructed as the following, following Blinder and Deaton (1985).

PI_4 = *(Operating surplus – Operating surplus of which imputed service from owner-occupied dwellings)*Property income/ Compensation of employees*

t_4= *(Income tax – Property tax) / (Compensation of employees + Operating surplus*

– Operating surplus of which imputed service from owner-occupied dwellings

– Property income).

For tax rates t_1, t_2, we used the figures estimated by Sekita (2008)[21] and t_3 was assumed to be 15 per cent.

The series based on 93SNA are available back to 1979. Thus for the period of 1960-1979 we constructed NPDI using the relevant series based on 68SNA and then the estimated figures were spliced with the ratio of 1980.

2. Data on household debt

On the 1968 SNA basis, the mortgage/non-mortgage split of debt is not available, which limits the opportunity to analyse mortgage debt separately. On the 1993 SNA basis, not only the mortgage split but also information which throws some light on the unincorporated business element of debt is available back to 1979. This poses the issue of which definition of debt we should adopt. One is total household liabilities. The data back to 1979 indicate that around 30 to 40 percent of these liabilities are loans to companies, i.e. debt of unincorporated businesses. A second definition of household debt excludes these loans. To generate the data before 1979, we subtract a fixed proportion of 0.41 of debt, the proportion in 1979.

3. Estimating shares at market value for 1960-1963.

The SNA data on shares poses some problems, as before 1969 they are based on book values and are at market values only from 1969. However, quarterly Flow of

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[21] We thank Charles Yuji Horioka for his suggestion to utilise her estimates.

Funds data are available at market values back to end-1964. We therefore splice these end of year data at 1969 to take the series back to end 1964. We then adjust the earlier book values to market values. To make use of the book value information, financial asset figures were taken from the Flows of Funds in this analysis. For the period of 1960 to 1963, shares were constructed as explained below.

The market value of shares at the end of each accounting period is equal to the stock at the beginning of the accounting period, plus asset acquisitions and less disposals by transactions taking place during the period, plus the net gains accruing from holding assets through the period (i.e. capital appreciation). For book values, no revaluation takes place so that the following stock-flow identity holds:

$$BA_t = BA_{t-1} + NPA_t \tag{A. 1}$$

where BA_t is the end-of-period stock and NPA_t is the flow of net purchases of assets in the period.

To derive the corresponding market values, we have to add the net holding gains by the end of the period on the market value of the stock at the beginning of the period. The revaluation adjustment can be explained as follows. Let A_{t-1} be the market value of an asset at the end of the period, t-1. Let π_{t-1} be the corresponding price index. Let NPA_t be net purchases of the asset in the period. Then

$$A_t = A_{t-1}(\pi_t / \pi_{t-1}) + (NPA_t)(\pi_t / \widetilde{\pi}_t) \tag{A. 2}$$

where $(\pi_t / \tilde{\pi}_t)$ is the revaluation adjustment of net purchases made in period t, which would equal 1, if prices remained unchanged over the period, and $\tilde{\pi}_t$ is the average price paid during the period of purchases, since purchases are spread over the period[22]. Given an asset benchmark at some date, data on the net purchases in the period and the corresponding price indices, the revaluation adjustment in equation (A.2) can be used to convert book to market value data.

Appendix 2: Details of instrumenting equations.

Given the importance of efficient and plausible instruments in empirical work, researchers are not always careful enough in the design of instruments. In the consumption equation, we need to consider the endogeneity bias that could come from within-year feedbacks from consumption shocks back to the real interest rate and to income. Current income enters the consumption equation through the current income deflator for end of previous period net financial assets, through log y and Δlog y, through expected income growth, and through the interaction of income volatility and expected income growth.

In the IV equation shown in Table 3a column 5, the instruments were constructed as

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[22] A monthly revaluation adjustment is approximated as follows. Assume that net asset purchases, NPA_t, are evenly distributed in nominal terms in each month. With monthly price indices, the revaluation adjustment is $\frac{1}{12}\sum_{i=1}^{12}\frac{\pi_t}{\pi_{ti}} = \pi_t / H\pi_{ti}$, where $H\pi_{ti}$ is the harmonic mean of monthly prices in the year, with i representing each month of the year. Thus, π_{t1} is the index for the first month of the quarter, and $\pi_{t12} = \pi_t$ is the end-of-year index. TOPIX was used for price indices.

follows:

i) The fitted tax adjusted real interest rate was obtained from the following equation:

$$Rfit = \hat{R}c(1-t) - \Delta \log PCfit$$

where $\hat{R}c$ and $\Delta logPCfit$ were fitted values of the nominal interest rate, Rc, and the inflation rate measured by consumer expenditure deflator, obtained from the following equations estimated by OLS:

$$\Delta \text{logPC} = \underset{(0.008)}{0.060} + \underset{(0.060)}{0.454}*\Delta\text{logPC(-1)} + \underset{(0.073)}{0.278}*\text{GAP(-1)}$$
$$+\underset{(0.044)}{0.127}*\ \Delta\text{logUSWPI} - \underset{(0.051)}{0.343}*\text{MA01Openness(-1)} + \underset{(0.014)}{0.076}*\text{D74}$$
$$AdjR^2 = 0.914, \qquad D.W. = 2.36$$

This equation is a simple reduced form Phillips curve, with some persistence, in which the output gap, trade openness, foreign inflation and a dummy for the first oil shock all have significant effects in the expected direction, e.g. greater trade openness tends to reduce domestic inflation. GAP is the output gap based on log GDP constructed with an HP filter, MA01Openness is (openness + openness(-1))/2, where openness is defined as (real exports + real imports)/real GDP and logUSWPI is the log of the US wholesale price index.

The nominal interest rate equation is as follows:

$$\text{Rc} = \underset{(0.005)}{-0.013} + \underset{(0.072)}{0.397}*\text{Rc(-1)} + \underset{(0.062)}{0.288}*\ \Delta\text{logPCfit} + \underset{(0.036)}{0.174}*\text{USTB}$$
$$+\ \underset{(0.067)}{0.364}*\ \Delta\text{logC(-1)} + \underset{(0.011)}{0.038}*\text{D64}$$
$$AdjR^2 = 0.906, \qquad D.W. = 1.65$$

This can be thought of as a rough Taylor rule: nominal rates adjust with a lag to inflation, to US short term interest rates and last year’s consumption growth rate, interpretable as a proxy for demand pressure which outperforms last year's output gap. Here USTB is the US Treasury Bill rate, ΔlogC is growth rate of real consumer expenditure per capita, D64: an impulse dummy for 1964.

ii) EDLRYfit(-1): One year lag of the fitted value of forecast income growth per capita obtained in Table 1, column 2. Hence log y – log c(-1) is instrumented by log y(-1) + EDLRYfit(-1) – log c(-1). This instruments current income by last year's income plus last year's growth forecast.

iii) DLRYfitb: The fitted value of one-year ahead income growth per capita obtained in the following equation which instruments two of the variables in the Table 1 income forecasting equation, log y and the change in the nominal interest rate.

$$
\begin{aligned}
DLRY(+1) = &\underset{(0.71)}{-3.95} + \underset{(0.007)}{0.025}*trend - \underset{(0.004)}{0.024}*splittrend73 - \underset{(0.08)}{0.27}*D3Rcfit \\
&- \underset{(0.06)}{0.43}*(EDLRYfit(-1) + LRY(-1)) + \underset{(0.10)}{0.65}*(MA3Gov.ba/GDP)(-1) \\
&+ \underset{(0.09)}{0.21}*\log USGDP(-1)
\end{aligned}
$$

$$AdjR^2 = 0.849, \qquad D.W. = 2.57$$

D3Rcfit=Rcfit –Rc(-3), LRY is log non property disposable income per capita, denoted by log y in equation (2.17) and in Table 3. DLRY is the change in log y.

iv) The fitted cross term of income volatility and income forecast growth, where the fitted income forecast growth was obtained from iii) above and from income volatility, SY, which is taken as exogenous.

v) The ratio of lagged net financial assets to current income is instrumented by the ratio to lagged income.

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Table 1: Estimates of the forecasting equation for change in log y_{+1}

Dependent variable: Change in log y_{+1}	*1959–2005*				*1959–1992*		*1975–2005*		*1959–2005*	
	(1)		(2)		(3)		(4)		(5)	
Intercept	−3.814	***	−3.547	***	−4.121	***	−3.144	***	−4.440	***
	(0.693)		(0.624)		(0.726)		(0.640)		(0.669)	
Trend	0.028	**	0.024	***	0.025	**			0.026	**
	(0.010)		(0.008)		(0.011)				(0.012)	
Split trend at 1973	−0.024	***	−0.022	***	−0.023	***			−0.024	***
	(0.006)		(0.005)		(0.007)				(0.007)	
log y	−0.458	***	−0.404	***	−0.446	***	−0.356	***	−0.473	
	(0.100)		(0.068)		(0.097)		(0.068)		(0.111)	
3-year change in nominal call rate	−0.199	***	−0.212	***	−0.203	**	−0.159	**	−0.235	***
	(0.064)		(0.062)		(0.076)		(0.057)		(0.061)	
log US GDP $_{-1}$	0.174	*	0.178	*	0.223	**	0.205	***	0.246	***
	(0.088)		(0.090)		(0.100)		(0.043)		(0.089)	
(MA3Gov.ba/GDP)$_{-1}$	0.538	***	0.626	***	0.593	***	0.612	***		
	(0.102)		(0.109)		(0.135)		(0.105)			
(Gov debt/GDP)$_{-1}$	−0.032								−0.165	***
	(0.028)								(0.032)	
(Gov debt/GDP)$_{-4}$									0.108	***
									(0.018)	
Standard error*100	1.195		1.195		1.356		0.910		1.179	
Adjusted R sq.	0.873		0.873		0.840		0.603		0.876	
Durbin Watson	1.93		2.03		2.01		2.24		1.91	
AR1/MA1 (p-value)	0.828		0.877		0.899		0.475		0.789	
AR2/MA2 (p-value)	0.258		0.149		0.138		0.125		0.118	
Heteroscedasticity (p-value)	0.001		0.003		0.035		0.286		0.002	
Chow (p)	0.849		0.674		0.509		0.706		0.860	
RESET(p)	0.821		0.284		0.638		0.494		0.748	

Note: Standard errors are given in parentheses. For the equations (1), (2), (3) and (5) whose heteroscedasiticity tests have failed the robust standard errors are given in parentheses. ***, ** and * indicate the statistical significance of independent variables, at the 1 percent, 5 percent and 10 percent levels, respectively.

Table 2a Estimates of consumption Euler equations.

Dependent variable: Change in ln non -durable consumption	*1963-2006*	*1963-2006*	*1963-2006*	*1963-2006*	*1981-2006*	*1981-2006*
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.001	0.001	0.006 **	0.001	0.001 **	0.009 ***
	(0.008)	(0.004)	(0.003)	(0.004)	(0.000)	(0.003)
Change in ln y		0.641 ***	0.762 ***	0.653 ***	0.347 *	0.596 ***
		(0.078)	(0.061)	(0.079)	(0.178)	(0.171)
Real interest rate $_{-1}$ (tax adj)	0.657 ***	0.226 **		0.180 **	0.207 ***	
	(0.143)	(0.088)		(0.088)	(0.064)	
Income growth volatility $_{-2}$				0.167		
				(0.138)		
Standard error*100	2.956	1.246	1.221	1.234	0.738	0.795
Adjusted R sq.	0.227	0.790	0.798	0.782	0.523	0.441
Durbin Watson	1.04	1.74	1.59	1.61	2.52	1.83

Notes.
1. Standard errors are given in parentheses. ***, ** and * indicate the statistical significance of independent variables, at the 1percent, 5 percent and 10 percent levels, respectively.
2. The instrument used in column (1), (2), (4) and (5) is the real interest rate (tax adj) lagged two years. In columns (2) to (6) the income forecast growth lagged two years was also included as instrument. The income forecast growth equation used is Dlny (+1) = 2.05 + 0.029*Trend - 0.020*T73 -1.113*DEBTR (-1) + 0.055*DEBTR (-4) - 0.373*lny (-1) where T73 is a split time trend starting with one in 1973, DEBTR is the government debt to GDP ratio. The fitted value from this equation, lagged one year is the instrument. In columns (5) and (6), education services and semi-durables such as clothing and shoes were also excluded from the dependent variable, following Hayashi (1985) and the estimation period started in 1981 due to data availability of education services in the National Accounts.

Table 2b Estimates of consumption Euler equations for total consumer expenditure.

Dependent variable: Change in ln consumption	*1960-2006*	*1961-2006*	*1961-2006*	*1961-2006*
	(1)	(2)	(3)	(4)
Intercept	0.008	0.006	0.009	0.005
	(0.008)	(0.004)	(0.003)	(0.004)
Change in ln y		0.689 ***	0.770 ***	0.696 ***
		(0.082)	(0.062)	(0.083)
Real interest rate $_{-1}$ (tax adj)	0.614 ***	0.152		0.101
	(0.154)	(0.092)		(0.093)
Income growth volatility $_{-2}$				0.184
				(0.145)
Standard error*100	2.752	1.314	1.252	1.302
Adjusted R sq.	0.163	0.781	0.801	0.771
Durbin Watson	1.01	1.70	1.69	1.58

Notes:.as for Table 2a

Table 3a: Estimates of the solved out consumption function.

Dependent variable: Change in log c	*1961–2006*							
	(1)		(2)		(3)		(4)	
Intercept	−0.055	***	−0.057	***	−0.058	***	−0.063	***
	(0.017)		(0.016)		(0.015)		(0.015)	
log y−log c_{-1}	0.356	***	0.345	***	0.347	***	0.359	***
	(0.067)		(0.064)		(0.063)		(0.064)	
Change in log y	0.289	***	0.321	***	0.323	***	0.332	***
	(0.070)		(0.068)		(0.067)		(0.068)	
Forecast income growth rate	0.367	***	0.347	***	0.348	***	0.350	***
	(0.083)		(0.079)		(0.078)		(0.079)	
Income growth volatility	−0.225	**	−0.024					
	(0.094)		(0.128)					
Income growth volatility			−5.666	**	−6.007	***	−5.648	***
* forecast income growth rate			(2.574)		(1.782)		(1.796)	
Change in unemployment rate	−0.008		−0.007		−0.007			
	(0.005)		(0.005)		(0.004)			
Real interest rate (tax adj)	0.346	***	0.346	***	0.350	***	0.367	***
	(0.062)		(0.059)		(0.054)		(0.054)	
Net financial wealth$_{-1}$/income	0.022	***	0.022	***	0.023	***	0.024	***
	(0.006)		(0.005)		(0.005)		(0.005)	
log real land price$_{-1}$	−0.014	***	−0.015	***	−0.015	***	−0.016	***
	(0.004)		(0.004)		(0.004)		(0.004)	
Standard error*100	0.681		0.648		0.640		0.650	
Adjusted R sq.	0.941		0.947		0.948		0.946	
Durbin Watson	2.14		2.20		2.20		2.22	
AR1/MA1 (p−value)	0.621		0.386		0.417		0.396	
AR2/MA2 (p−value)	0.742		0.711		0.717		0.726	
Heteroscedasticity (p−value)	0.737		0.849		0.829		0.955	
Chow (p)	0.255		0.191		0.298		0.635	
RESET(p)	0.066		0.445		0.576		0.827	

Note: Standard errors are given in parentheses. ***, ** and * indicate the statistical significance of independent variables, at the 1percent, 5 percent and 10 percent levels, respectively.

Table 3b: Robustness check for the solved out consumption function.

Dependent variable: Change in log c	*1961–1992*		*1975–2006*		*1961–2006*		*1975–2006*		*1961–2006 (IV)*	
	(1)		(2)		(3)		(4)		(5)	
Intercept	−0.084	***	−0.087	***	−0.069	***	−0.089	***	−0.077	***
	(0.018)		(0.020)		(0.016)		(0.022)		(0.021)	
log y−log c_{-1}	0.435	***	0.483	***	0.372	***	0.476	***	0.409	***
	(0.073)		(0.094)		(0.067)		(0.098)		(0.088)	
Change in log y	0.267	***	0.269	**	0.320	***	0.276	**	0.378	***
	(0.073)		(0.126)		(0.070)		(0.131)		(0.106)	
Forecast income growth rate	0.446	***	0.129		0.354	***	0.131			
	(0.089)		(0.121)		(0.080)		(0.123)			
Change in log y_{+1}									0.309	***
									(0.117)	
Income growth volatility	−4.970	***	0.630		−5.610	***	0.991		−5.270	**
* forecast income growth rate	(1.728)		(6.277)		(1.809)		(6.521)		(2.213)	
Real interest rate (tax adj)	0.406	***	0.574	***	0.359	***	0.565	***	0.398	***
	(0.067)		(0.108)		(0.055)		(0.114)		(0.077)	
Net financial wealth_{-1}/income	0.032	***	0.033	***	0.026	***	0.034	***	0.029	***
	(0.007)		(0.007)		(0.006)		(0.008)		(0.007)	
log real land price_{-1}	−0.017	***	−0.006		−0.018	***	−0.013		−0.019	***
	(0.006)		(0.009)		(0.005)		(0.025)		(0.005)	
log real land price_{-1}					0.012		0.011			
* Step dummy with 1 since 1991					(0.018)		(0.038)			
Standard error*100	0.611		0.618		0.655		0.630		0.733	
Adjusted R sq.	0.952		0.804		0.946		0.797		0.934	
Durbin Watson	2.23		2.13		2.19		2.15		2.21	
AR1/MA1 (p-value)	0.374		0.709		0.439		0.664			
AR2/MA2 (p-value)	0.888		0.874		0.828		0.852			
Heteroscedasticity (p-value)	0.218		0.237		0.891		0.229			
Chow (p)	0.020		0.361		0.797		0.536			
RESET(p)	0.772		0.064		0.872		0.073			

Note. Standard errors are given in parentheses. ***, ** and * indicate the statistical significance of independent variables, at the 1percent, 5 percent and 10 percent levels, respectively. See Appendix 2 for the equation (5).

Table 4: Estimates of the equation for ratio of household debt to income.

Dependent variable: Debt/y	*1961-2006*		*1961-1992*		*1975-2006*	
	(1)		(2)		(3)	
Intercept	-0.046	**	-0.072	**	0.073	**
	(0.019)		(0.028)		(0.015)	
ratio of $debt_{-1}$ to y	0.506	***	0.407	***	0.459	***
	(0.061)		(0.084)		(0.080)	
Trend pre-1974	0.0063	***	0.0075	***		
	(0.0008)		(0.0012)			
Change in unemployment rate	-0.013	**	-0.008		-0.007	
	(0.006)		(0.015)		(0.007)	
Rate of acceleration of log Consumer expenditure deflator	-0.202	***	-0.198	***	0.033	
	(0.061)		(0.066)		(0.142)	
Nominal call $rate_{-1}$	-0.364	***	-0.352	***	-0.264	**
	(0.086)		(0.125)		(0.127)	
Physical $wealth_{-1}$/income	0.030	***	0.029	***	0.030	***
	(0.002)		(0.006)		(0.003)	
Net financial $wealth_{-1}$/income	0.059	***	0.088	***	0.070	***
	(0.014)		(0.022)		(0.017)	
Standard error*100	0.853		0.854		0.962	
Adjusted R sq.	0.998		0.998		0.996	
Durbin Watson	2.240		2.140		2.100	
AR1/MA1 (p-value)	0.220		0.582		0.439	
AR2/MA2 (p-value)	0.341		0.684		0.699	
Heteroscedasticity (p-value)	0.098		0.055		0.242	
Chow (p)	0.763		0.211		0.125	
RESET(p)	0.739		0.958		0.598	

Notes:

1. Standard errors are given in parentheses. ***, ** and * indicate the statistical significance of independent variables, at the 1 percent, 5 percent and 10 percent levels, respectively.
2. Trend pre-1974 increased by one up to 1973 and is constant from 1974.

Figure 1: Ratios of consumption to total disposable income and to non-property income, and log real land price.

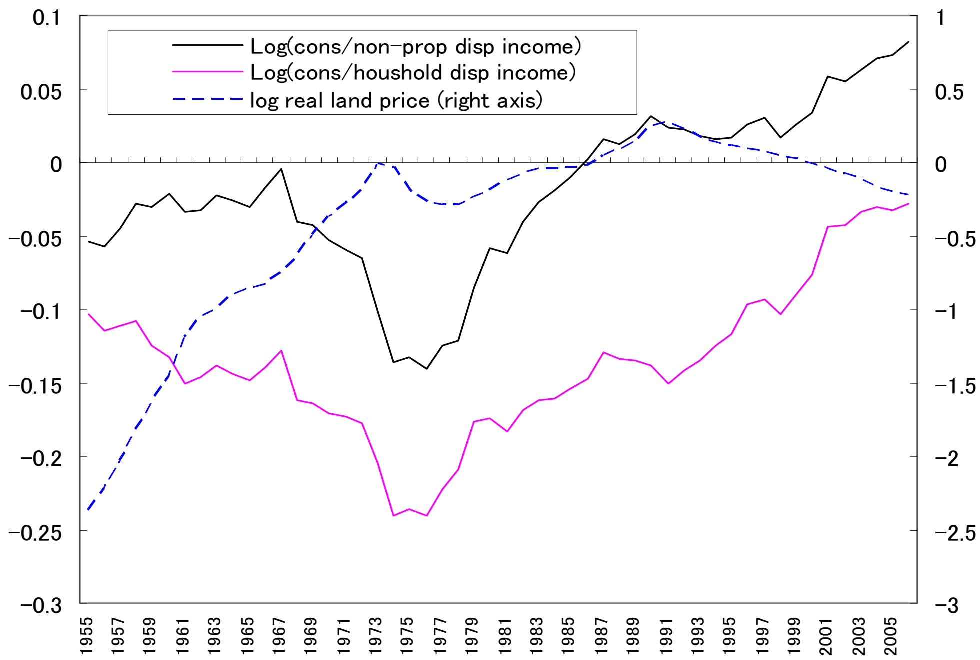


Figure 2: Population proportions of the young and the old.

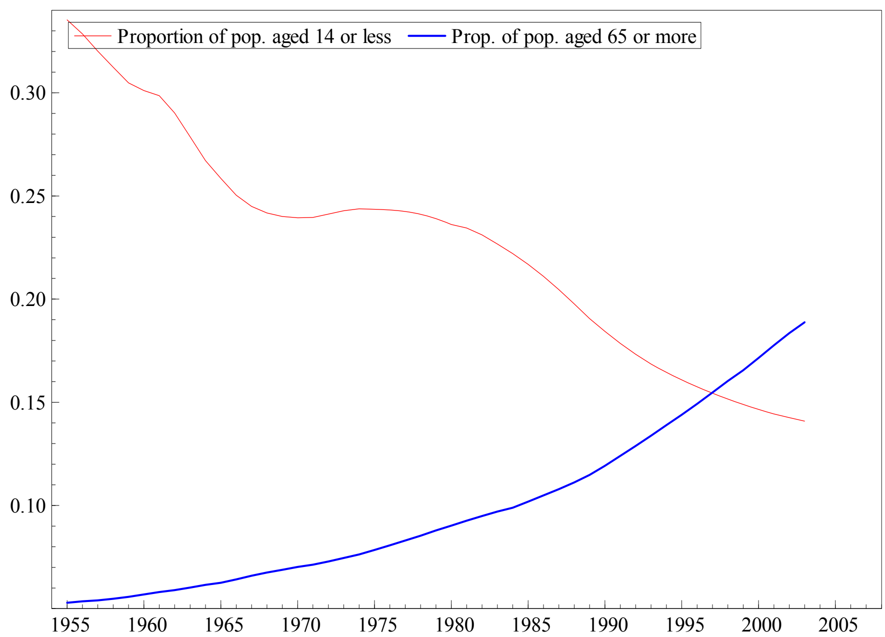


Figure 3: Middle aged population proportions.

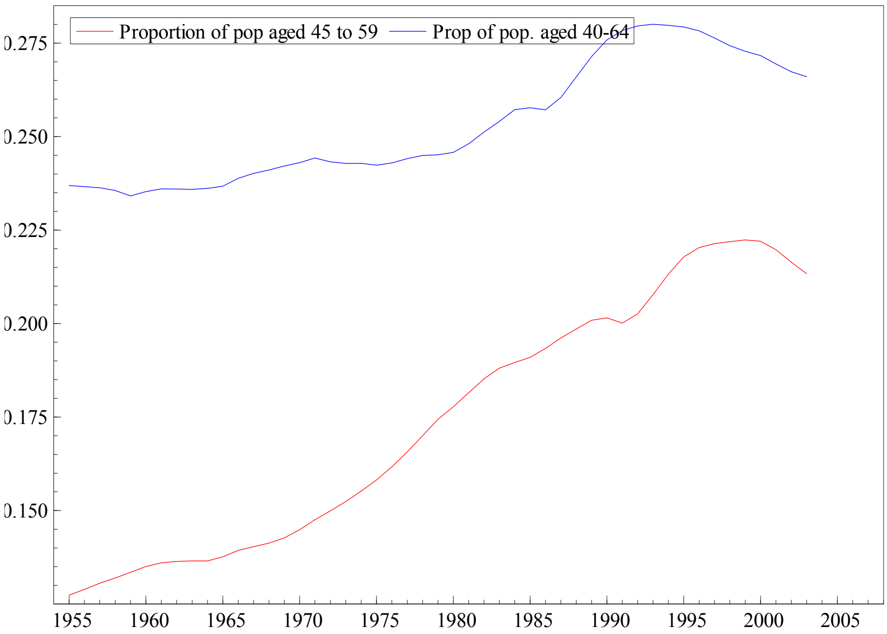


Figure 4: Life expectancies in Japan

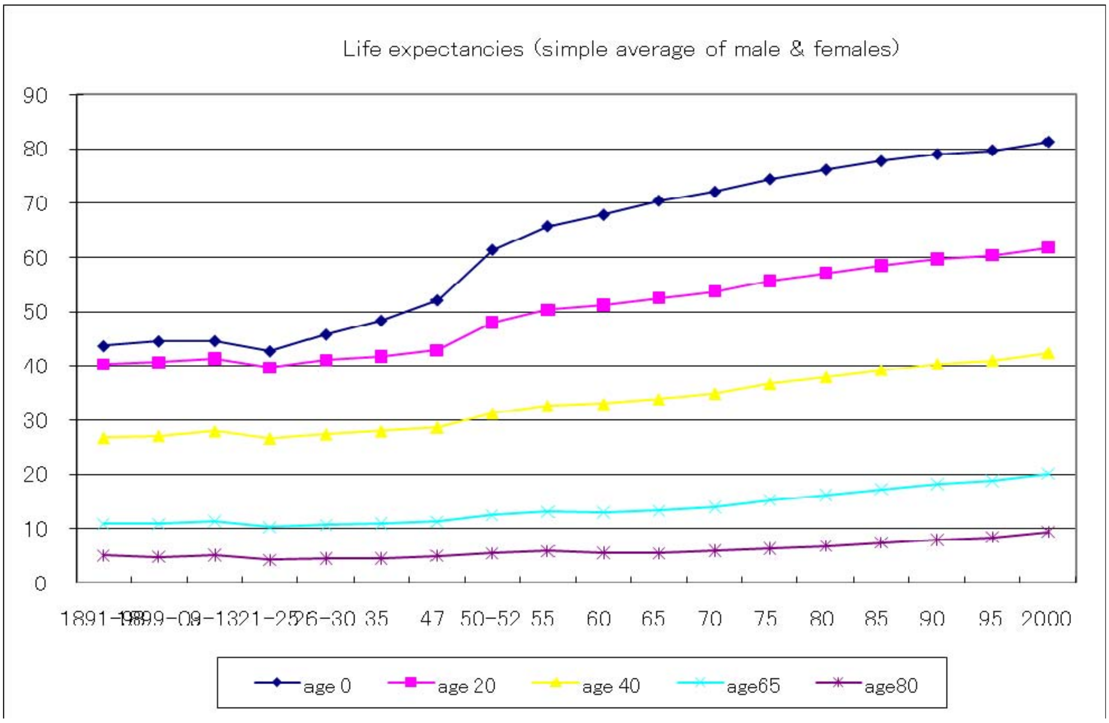
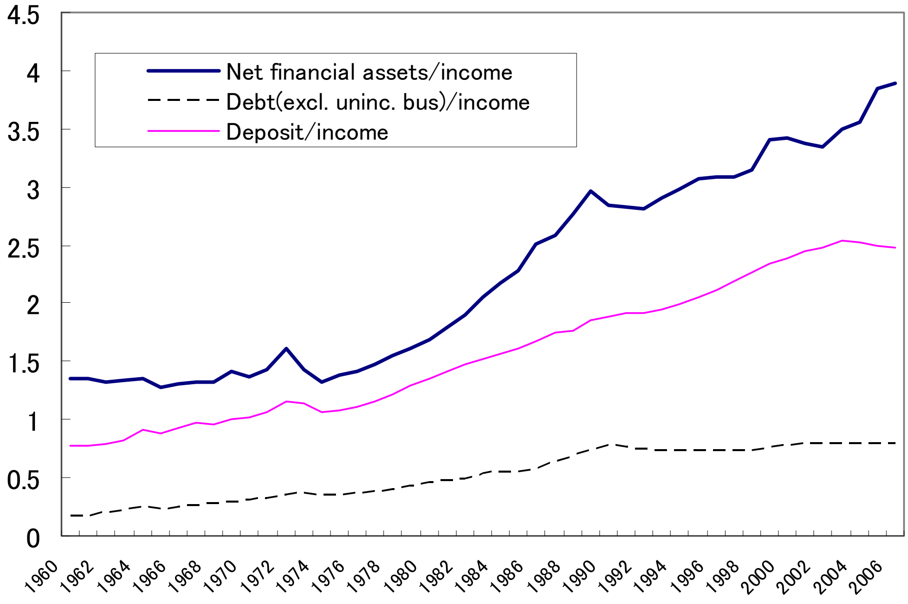


Figure 5: Ratios to income of household deposits, debt excluding unincorporated enterprises, and net liquid assets.



Note: Income means non-property disposable income.

Figure 6: Ratios to non-property income of illiquid financial assets, physical assets, and the log real price of land.

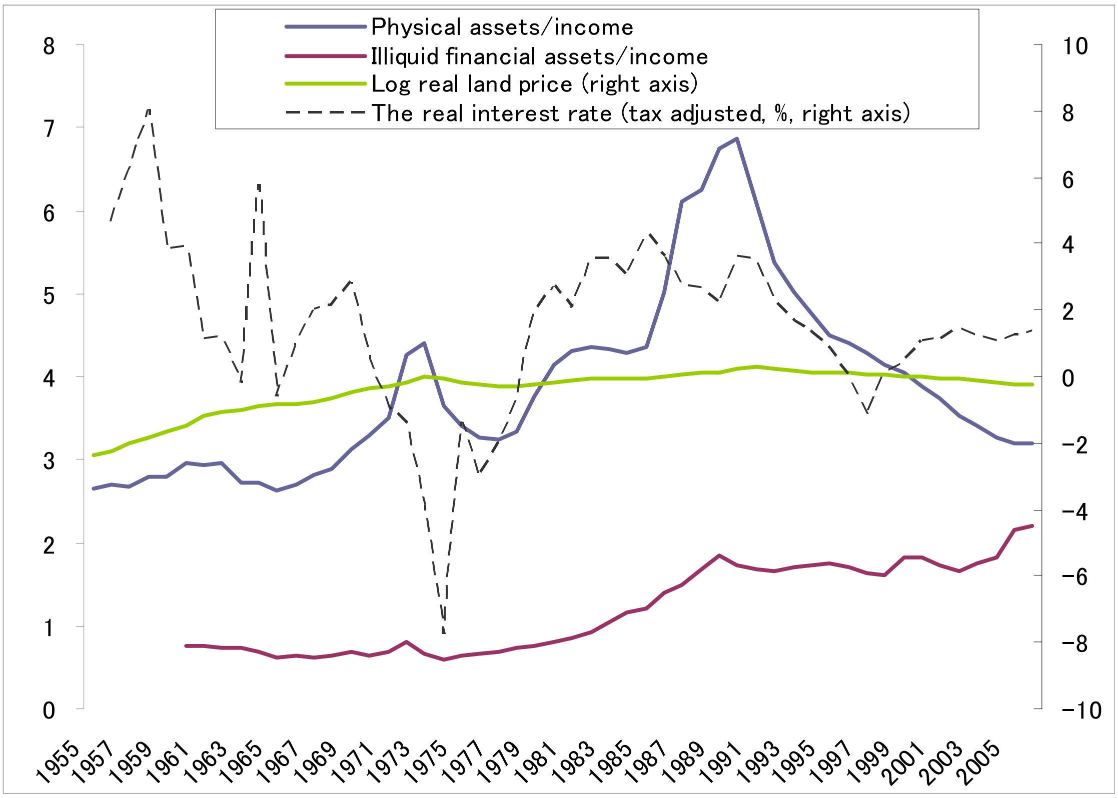
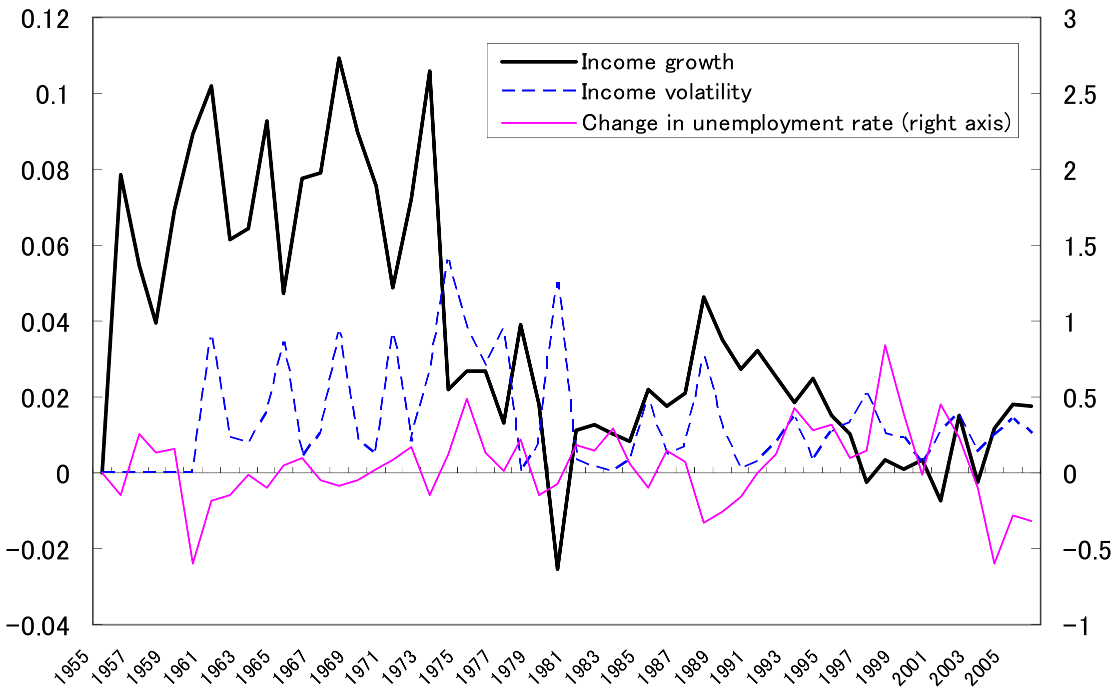


Figure 7: Income growth, income volatility, and the change in the unemployment rate.



Note: income is real per capita non-property.

Figure 8: long-run contribution to log consumption/income of net financial assets/income and log real land price.

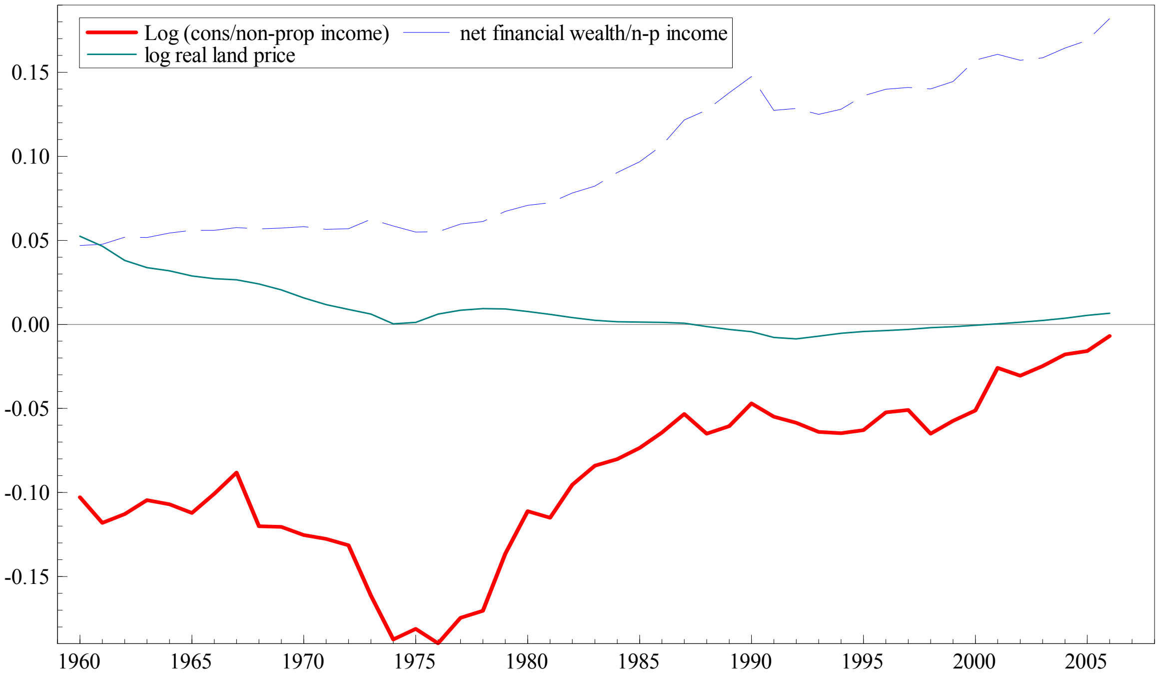
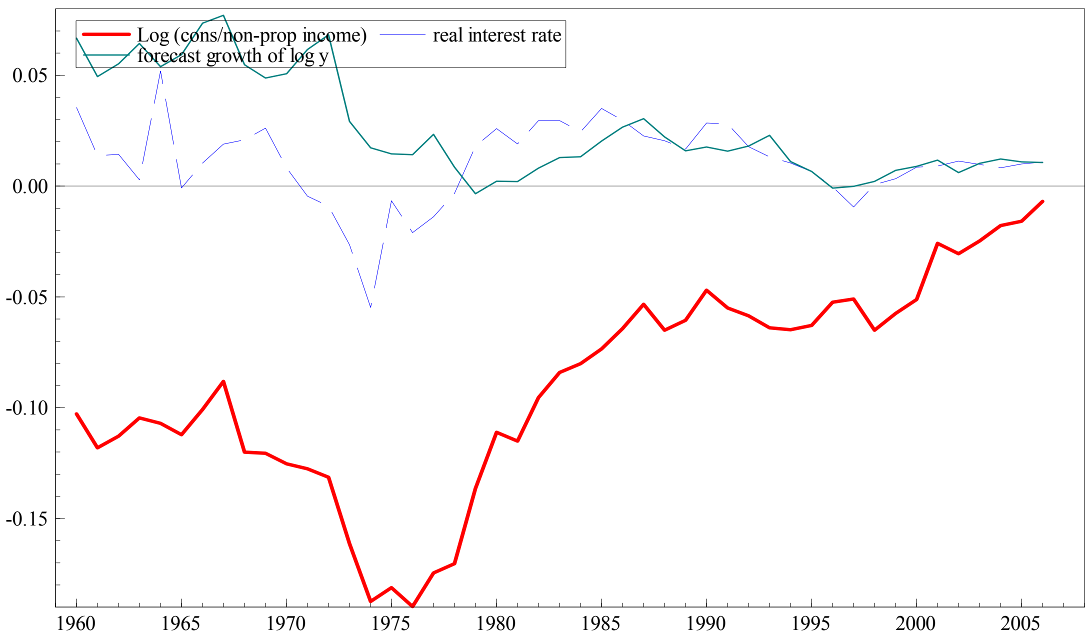


Figure 9: Long-run contribution to log consumption/income of real interest rate and forecast income growth



Appendix Charts: Goodness of Fit and Parameter Stability

Figure A1: Fitted and actual values and scaled residuals for next year's growth rate of income.

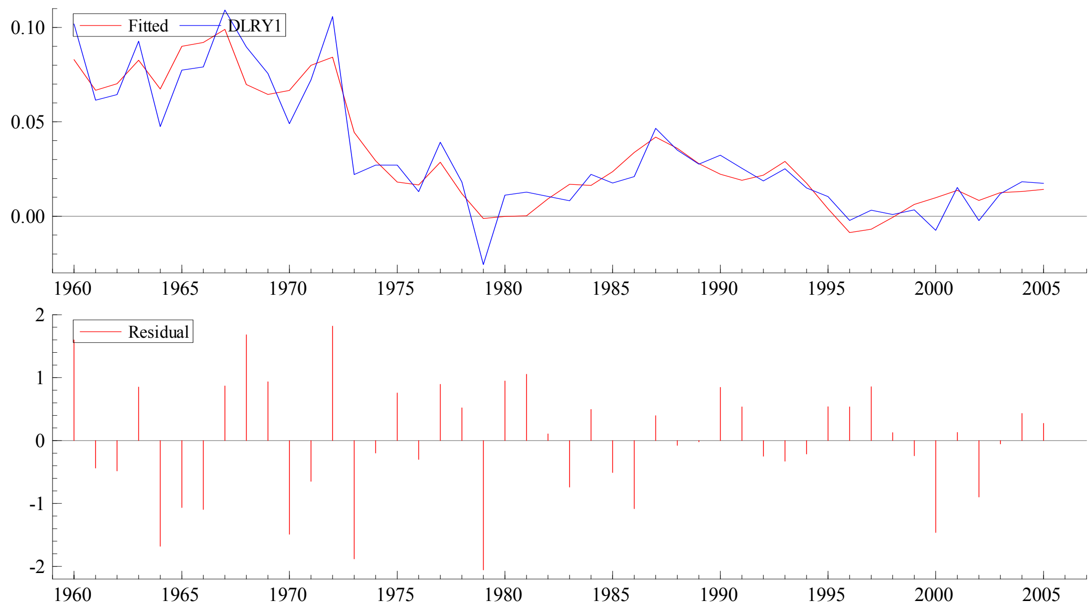


Figure A2: recursive stability tests for income growth forecasting equation.

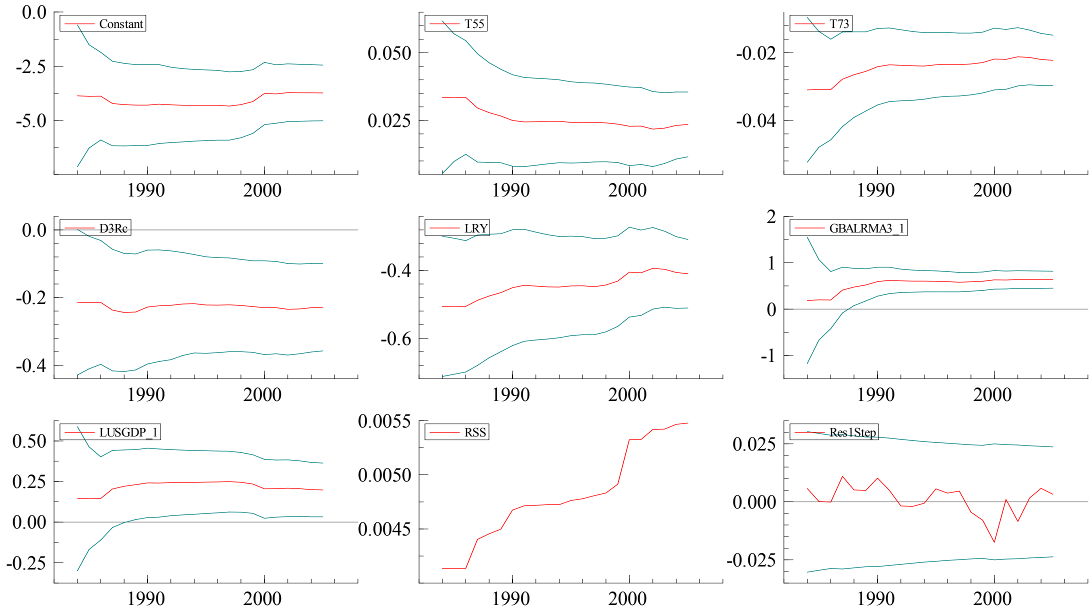


Figure A3: fitted and actual values and scaled residuals for the consumption equation, Table 3a, col 4.

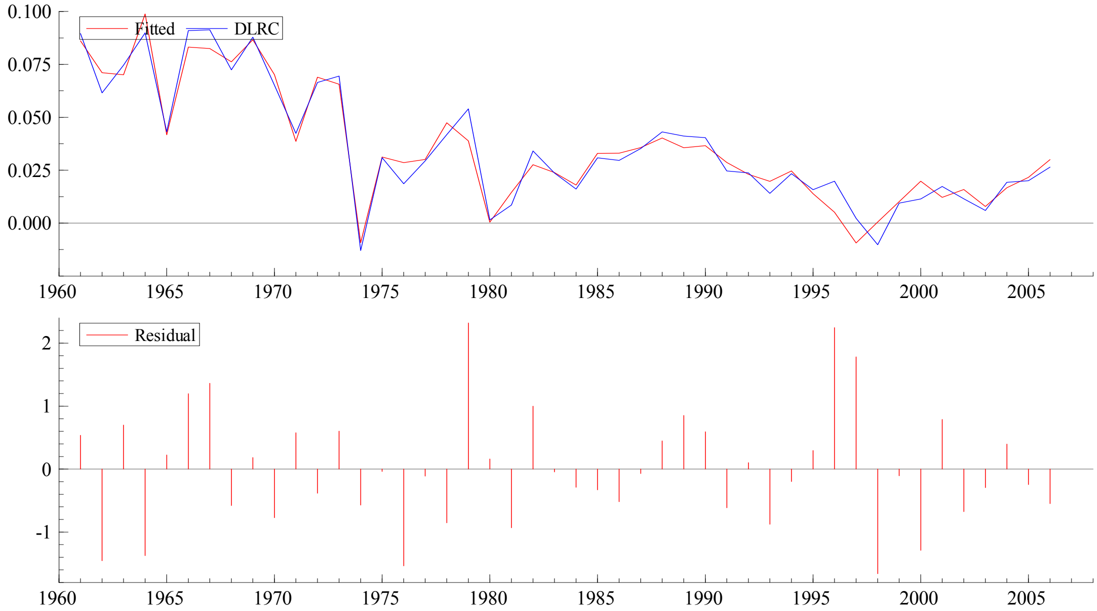
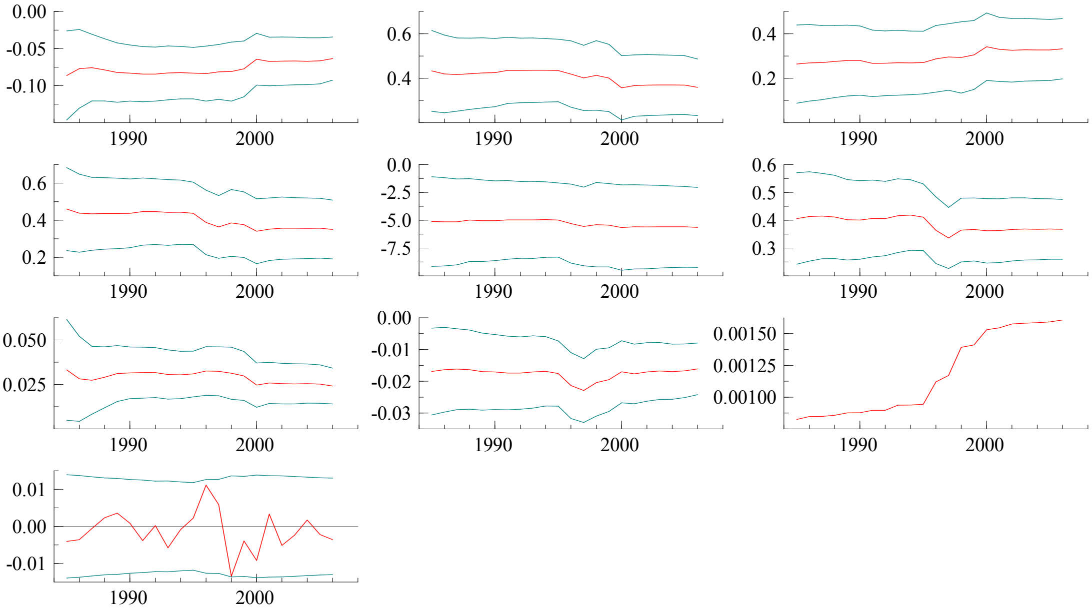


Figure A4: Recursive stability tests for the equation, Table2, col. 4.



Note: order of variables is constant, logy-logc$_{-1}$, log change in y, forecast income growth, interaction between forecast income growth and income volatility, real interest rate ,net financial assets$_{-1}$/income, log real land price$_{-1}$. The cumulative sum of squared residuals and a recursive Chow-test for structural breaks are shown last.

Figure A5: Fitted and actual values and scaled residuals from the debt equation

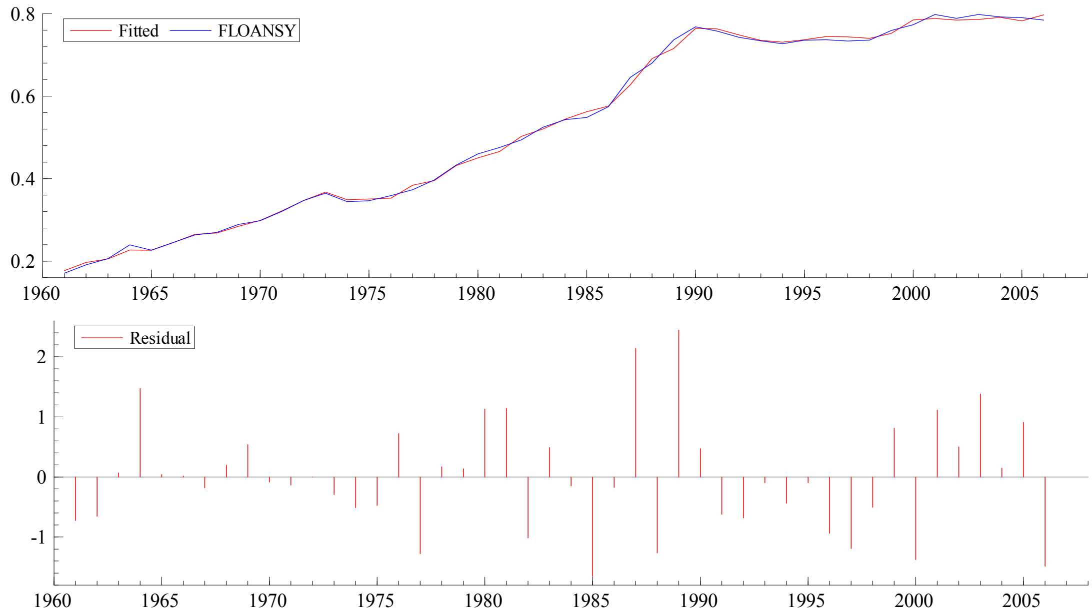
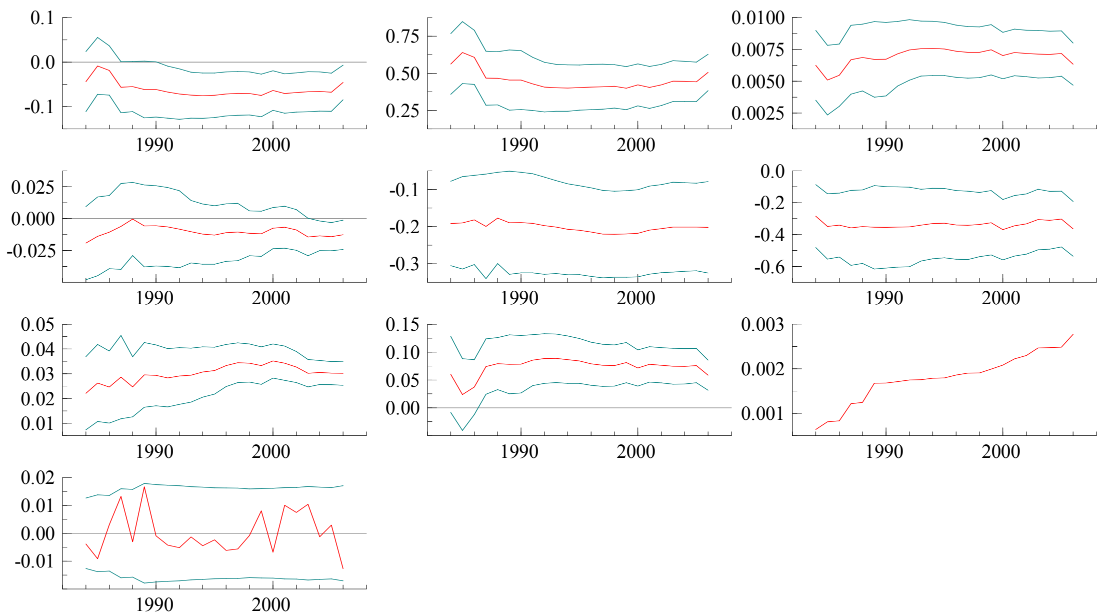


Figure A6: recursive stability tests for debt model, Table 4, col. 1



Note: order of variables is in the order shown in Table A6, i.e. constant, lagged debt/income, split trend, change in the unemployment rate, acceleration of the log price level, the nominal interest rate, net financial wealth/income and physical wealth/income. The cumulative sum of squared residuals and a recursive Chow-test for structural breaks are shown last.