Consumption Growth in a Booming Economy: Taiwan 1976-96

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Abstract

Consumption and income have both grown rapidly in Taiwan over the past forty years, with younger birth cohorts experiencing faster growth. The long upward trend in consumption presents a strong challenge to the consumption smoothing predictions of the Permanent Income Hypothesis. We investigate the extent to which consumption theory can account for this trend in an environment where a large majority of households have high savings rates. Household survey data from 1976-96 are used to estimate dynamic pseudo-panel models with inter-cohort heterogeneity. We evaluate the impacts on consumption of migration, mortality, household composition, liquidity constraints, unanticipated aggregate shocks, hyperbolic discounting, habit formation and precautionary saving. Taiwanese consumption growth is found to result from high levels of prudence, with the faster consumption growth of younger cohorts attributed to their greater participation in industries with more earnings risk. The strong precautionary motive has important implications for the effects of economic growth and population aging on aggregate saving and inequality.

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1 Introduction

The exceptional economic performance of Taiwan over the past four decades is well-known, resulting in rapid increases in lifetime incomes. Annual per capita real GNP growth and real consumption growth averaged 6.5 percent and 6.8 percent, respectively, over the 1976-96 period. At the same time, Taiwan enjoyed gross savings to GDP ratios of between 0.25 and 0.40. Together, these facts challenge simple formulations of the Permanent Income Hypothesis (PIH) in which individuals smooth their consumption over their lifetime. In particular, they pose the main question to be addressed in this paper: "Why did Taiwanese households have predictable consumption growth and high savings in the presence of rapid income growth?" The answer is not only important for understanding consumer behaviour in Taiwan, but is also of more general interest in understanding the effects of demographics, aging, and the macroeconomic environment on savings and inequality.

The main purpose of the present contribution is to systematically investigate the extent to which modern consumption theory can explain this phenomenon of consumption growth and high saving rates in a booming economy. In contrast to much of the consumption literature, the focus here is not on any one particular variant of consumption theory, such as habit formation, but rather on whether any of the many variants are consistent with the consumption growth observed. We not only offer an explanation based on precautionary saving, but are able to demonstrate that many of the other popular alternatives are not consistent with the data. Repeated cross-sections from the Taiwan Personal Income Distribution Surveys are used for the majority of our empirical work. These data are used to estimate dynamic models of consumption with inter-cohort parameter heterogeneity, using results developed in Mckenzie (2000a). We show how these methods can be used to allow pseudo-panel estimation of models with habit formation and prudence, and to test the martingale model of consumption separately for each birth cohort.

We commence by showing that the PIH can be rejected using per capita consumption. Direct tests of the martingale model at the cohort-level show that this rejection is not a result of aggregation, and find that one can reject the martingale form of the PIH in favour of models with consumption growth. Moreover, younger cohorts are found to have faster consumption growth than older cohorts. We then proceed to study the impact of migration, mortality and changes in household structure on cohort composition over time, and find that cohort selection issues are not driving the results for households with heads aged 25-65.

The consumption literature offers many extensions and alternatives to the basic permanent income model, several of which may explain consumption growth. We consider the evidence for liquidity constraints, unanticipated aggregate shocks, time-inconsistent preferences induced by a hyperbolic discount function, habit formation, and precautionary saving. Our analysis finds that the individual earnings process in Taiwan contains a strong stochastic trend for all cohorts. Over ninety percent of each cohort are observed to save. This provides strong evidence against the presence of liquidity constraints being the main cause of consumption growth, as with rapidly growing income, liquidity-constrained individuals would optimally choose to consume their entire income each period. We argue that an active informal financial sector alleviated credit restrictions in the formal sector in Taiwan.

Even if the desired consumption path is perfectly smooth over an individual's lifetime, unexpected shocks can shift the realization of this path. Consumption growth in Taiwan would therefore occur if individuals were repeatedly surprised by the high levels of income growth experienced. Over twenty years of previous high growth experience, repeated official forecasts of continued growth, evidence from Rotating Credit Associations, and individual level expectations taken from the Taiwan Social Image Surveys are used to argue that consumers did expect growth to continue. We show that individuals would have had to have repeatedly expected zero income growth for their consumption behaviour to concur with the martingale form of the PIH.

Dynamically inconsistent preferences induced by hyperbolic discounting can cause consumers to self-impose liquidity constraints to restrict their own future behaviour. Again the substantial savings made by most households each year rule out this explanation for consumption growth. We do find evidence of habit formation in Taiwan, however this is no longer significant once we allow for precautionary savings effects.

The analysis finds precautionary savings behaviour to be the main cause of rapid consumption growth in Taiwan. Taiwan's economic and political environment increases the effects of prudence, as the precautionary effect is larger when earnings shocks are highly persistent, and when there are asymmetries in the earnings distribution. The possibility of an invasion by China, an underdeveloped social security system, and a heavy reliance on external trade, all increase the uncertainty facing consumers, and the absolute amount of earnings loss in a bad state. Results from the Taiwan Social Image Surveys are used to quantify the effect of these factors on expectations. Econometric estimation finds significant evidence of a precautionary savings effect on consumption growth, and finds this to be larger for the younger cohorts. We estimate the levels of absolute and relative prudence for each cohort, and find them to be much higher than estimated levels in the United States. Birth cohorts do not differ systematically in their level of prudence. The faster consumption growth of the younger cohorts is found to be due to the greater earnings uncertainty faced by the young, due in a large part to their higher participation in riskier industries.

Our study of the determinants of Taiwanese consumption growth also enables examination of the impact of aging and demographic changes on inequality. In a series of papers, Angus Deaton and Christina Paxson have studied the effects of economic growth and of population growth on saving and inequality in Taiwan. They find that within-cohort inequality of consumption and income increases with age in Taiwan (Deaton and Paxson 1994a). A consequence is that population aging contributes to greater overall inequality, by redistributing the population towards older and therefore more unequal cohorts. For example, they estimate that with 6 percent economic growth per year, a decline in the rate of population growth from 3% to 1% would increase the Gini coefficient in Taiwan from 0.309 to 0.352 (Deaton and Paxson 1995). The effect of demographic changes on saving is found to be heavily dependent on the economic growth rate. In particular, changes in the population growth rate have only a small effect on national saving rates at the high levels of economic growth currently present in Taiwan (Deaton and Paxson 2000a, 2000b). The majority of their work is based on the life cycle model of consumption, for which they find mixed evidence. We analyze the implications of the strong precautionary motive found in this paper on changes in inequality and saving in Taiwan and conclude that the effect of aging on aggregate inequality may be even greater than that suggested by Deaton and Paxson.

The paper is organized as follows. Section 2 details income and consumption growth in Taiwan at the aggregate level. Section 3 describes the data to be used for microeconomic analysis. A brief review of dynamic pseudo-panel theory is provided in Section 4, together with direct tests of the martingale hypothesis of consumption. Section 5 examines the impact of migration, mortality, and household compositional changes on the conditions required for consistency of the pseudo-panel estimator. Sections 6 and 7 form the main body of the paper. Section 6 formally examines the evidence for liquidity constraints, unanticipated aggregate shocks, hyperbolic discount functions, habit formation and the labour/leisure trade-off, and Section 7 considers precautionary savings. Section 8 determines the implications of our results for inequality and demographic changes, while Section 9 concludes the paper. An Appendix provides the relevant econometric results needed for pseudo-panel estimation.

2 Consumption and Income at the Aggregate Level

Figure 1 plots Taiwanese real consumption per capita and real GNP per capita over the period 1952-97. Real GNP per capita grew at an average rate of 6.5 percent per annum over the 1976-96 period, while annual real consumption per capita growth averaged 6.8 percent over the same period. Figure 2 plots the annual growth rates over the 1970-97 period. Although growth rates have been high and positive, there was still sizeable variation from year to year. There is some weak evidence of consumption smoothing, with consumption tending to grow less than income in high income growth years, and growing more than income in lower income growth years.

Consumption growth per capita was positive in every single year over the period shown. This provides strong evidence against Hall's (1978) martingale hypothesis of consumption. In this model, a rational, optimizing, consumer in the absence of credit market restrictions will choose to smooth consumption over his or her life-cycle. Consumption growth in this model can only occur if the real interest rate r differs from the rate of subjective time preference δ. Hall (1978, p. 974) shows that consumption then obeys the exact regression

$$C_{t+1} = \frac{\overline{C}\,(r-\delta)}{1+r} + \frac{1+\delta}{1+r} C_t - \varepsilon_{t+1}\ , \tag{1}$$

where $\overline{C}$ is the bliss level of consumption. Estimation of an AR(1) model with drift for real consumption per capita over the period 1976-96 yields the fitted equation $C_{t+1} = 336.04 + 1.065 C_t - \widehat{\varepsilon}_{t+1}$. Real interest rates were negative in 1980-81 due to higher inflation after the second oil crisis, but were otherwise positive, averaging 2.57 percent over the 1976-96 period[1]. The fitted equation is therefore only consistent with the specification in (1) if the bliss point is negative, which violates the assumption of positive marginal utility. Unit Root tests and tests for stationarity find both income and consumption to be nonstationary, but reject the null hypothesis of a unit root in favour of explosive alternatives unless at least a quadratic deterministic trend is added. Hence at the aggregate level, the Taiwanese experience is not consistent with the permanent income hypothesis (PIH).

Even if individual consumption follows a random walk, aggregate consumption may contain a trend due to aggregation. For example, Flavin (1981) reasons that if per capita income has a positive trend, due to increasing productivity over time, then later generations will have greater lifetime wealth than earlier generations, causing aggregate consumption to trend upward over time. She therefore linearly detrends aggregate consumption in her work. Campbell and Mankiw (1989) attribute the trend to the presence of “rule-of-thumb” consumers who consume their current income. A trend may also result from the presence of liquidity constraints or from precautionary savings behaviour. Therefore uncritical detrending of consumption can remove important sources of deviation from the PIH. Examination of microeconomic data is needed to determine the cause of this trend.

3 Micro Data

The data are taken from the Personal Income Distribution Surveys (PIDS) in Taiwan, which have been collected annually since 1976. The survey design is described in Republic of China (1991) and both interviews and account-keeping are used to collect the data. The sample sizes in 1976 and 1977 are a little over 9,000 households, and are over 14,000 households from 1978 onwards, with the sample size being fixed at 16,434 households after 1983. The twenty-one surveys from 1976-96 are used in this study. Income data are available on an individual basis, but consumption data are available at the household level only. Hence one must examine whether a version of the PIH applies to consumption at the household level. This is the approach used by Deaton and Paxson (1994a) and I follow them in defining birth cohorts by the age of the household head in 1976, and restricting attention to households with heads aged between 20 and

[1] The real interest rate here is the Rediscount rate of the Central Bank of China deflated by the Consumer Price Index (source: Taiwan Statistical Databook, 1999).

75 inclusive. The number of households in a given cohort-year varies depending on both the year and the age of the household. Typical cohort-year cells contain between 300 and 400 households, but are smaller at young and old ages, which also have less time periods due to the 20-75 age restriction.

The consumption measure we use is nondurable consumption, measured as the total expenditure on all goods less expenditures on furniture and family facilities, purchases of personal transportation equipment, and purchases of recreation facilities. Nominal data were converted into 1996 NT$ using the Consumer Price Index[2]. Earnings are calculated as the household sum of compensation of employees and entrepreneurial income, and are measured before tax. Income is household after-tax income from all sources. Saving is defined as income less total consumption expenditure (including durables). Additional individual level data are obtained from the Taiwan Social Image Surveys, which have a sample size of approximately 1500 individuals. The surveys address a host of sociological, demographic, economic and public issues. We use questions from these surveys to quantify individuals' aging concerns, expectations about future income, and uncertainty about the future.

Figure 3 plots mean household consumption against the age of the household head for every fifth birth cohort in our sample. Cohort age-consumption profiles are labelled by their birth year. Consumption trends strongly upwards for all but the oldest cohorts. This demonstrates visually that the evidence against the PIH in the macro data is not merely an aggregation effect arising from different cohorts starting with different levels of lifetime wealth. However, there are noticeable differences between cohorts, with the consumption of the older cohorts appearing to grow more slowly than the consumption of the young. To formally test whether the PIH holds at the cohort-level and determine whether these inter-cohort differences are significant, we employ dynamic pseudo-panel techniques, which are explained in the next section.

4 Econometric Methods

The PIDS surveys a different sample of households every year. This prevents the use of panel data methods, which follow the same individuals over time. However, following the seminal work of Deaton (1985), we can track cohorts of individuals, where a cohort is defined by birth year and perhaps educational attainment. Mckenzie (2000a) uses this idea to study the estimation of dynamic pseudo-panel models with parameter heterogeneity and provides the results used in most of the econometric work in this paper. Here we outline how these techniques can be used to test the martingale hypothesis of consumption, and to test whether the differences between cohorts observed in Figure 3 are significant.

For the purposes of this section, let $y_{i(t)t}$ denote the consumption of individual $i(t)$ in period t and $c = 1, 2, ..., C$ denote different birth cohorts. The

[2] Source: Table 10-1, Taiwan Statistical Data Book 1998. Council for Economic Planning and Development, Republic of China.
One US dollar = 30.8 New Taiwan dollars (January 13, 2000).

famous martingale result of Hall (1978) then gives for all i, t and c:

$$y_{i(t)t} = \beta_c y_{i(t)t-1} + u_{i(t)t} \quad \text{with } \beta_c = 1 \ . \tag{2}$$

The $i\,(t)$ subscript makes explicit the fact that different individuals are observed each period. In particular, consumption for individual $i\,(t)$ in period $t-1$, $y_{i(t)t-1}$, is not observed. This precludes the use of genuine panel data methods. Summing across individuals in the same cohort c gives:

$$\overline{y}_{ct}^{i(t)} = \beta_c \overline{y}_{ct-1}^{i(t)} + \overline{u}_{ct}^{i(t)} \ . \tag{3}$$

The $i\,(t)$ superscript now indicates that the means are taken over the individuals in cohort c observed at time t. Replacing the unobserved mean consumption at time $t-1$ for individuals observed at time t, denoted $\overline{y}_{ct-1}^{i(t)}$, with the cohort mean for those individuals who were observed at time $t-1$, $\overline{y}_{ct-1}^{i(t-1)}$, gives the following model to be estimated:

$$\begin{aligned} \overline{y}_{ct}^{i(t)} &= \beta_c \overline{y}_{ct-1}^{i(t-1)} + \varepsilon_{ct} \\ \varepsilon_{ct} &= \overline{u}_{ct}^{i(t)} + \beta_c \ \overline{y}_{ct-1}^{i(t)} - \overline{y}_{ct-1}^{i(t-1)} \ . \end{aligned} \tag{4}$$

Our inability to observe the same individuals each period causes the errors to have an MA(1) structure, and to be correlated with the regressor term in finite samples. If T is the number of surveys available and n_c the number of individuals in cohort c, then Mckenzie (2000a) shows that as $n_c \to \infty$ for $T/n_c \to 0$, both OLS and instrumental variables[3] estimators of equation (4) are consistent and asymptotically normal. Consistency is shown under the following Assumption:

Assumption 1 For every cohort c, as $n_c \to \infty$:

(i) $\overline{u}_{ck}^{i(t-1)} \xrightarrow{p} 0 \ \forall k, t$

(ii) $\overline{y}_{c0}^{i(t-1)} \xrightarrow{p} E\,(y_{c0}) \neq 0 \ \forall t$

(iii) $\overline{y}_{ct-1}^{i(t)} - \overline{y}_{ct-1}^{i(s)} \xrightarrow{p} 0$ for all t,s.

Condition (i) allows for weak spatial correlation between individuals, but is violated if there is a common cohort component to individual consumption shocks. Condition (ii) is a relatively weak one, requiring convergence of the sample means to the cohort population mean. Condition (iii) is the crucial identification assumption underlying the construction of the pseudo-panel. It requires that each of the PIDS surveys is sampled from cohort populations with the same mean properties. Randomness of the sampling design is an obvious requirement, however we need to also consider the effects of mortality, international migration, and changes in household composition on the validity of this assumption.

[3] The instruments in this model are $\overline{y}_{ct-2}^{i(t-2)}$ and earlier lags. Lags of additional regressors can also be used as instruments in the more general model.

Estimation of equation (4) enables us to test whether the martingale form of the permanent income hypothesis holds separately for each cohort. We can write $\beta_c = 1 + g_c$, where g_c is the annual consumption growth rate for cohort c. Rejection of the null hypothesis that $\beta_c = 1$ in favour of $\beta_c > 1$ therefore indicates positive consumption growth. Allowance for inter-cohort parameter heterogeneity enables us to determine whether consumption growth rates differ across birth cohorts.

4.1 AR(1) Model Estimates for Birth Year Cohorts

Failure to take account of changes in household size can affect our estimation of β_c. In particular, a falling (rising) household size will cause us to understate (overstate) the true value. Therefore one needs to standardize consumption by the number of household members to approximate individual consumption levels. In the absence of equivalence scales for Taiwan, we follow Deaton and Paxson (1994a) in using consumption per adult equivalent, where the number of adult equivalents is defined as the number of household members over 17 years of age plus one half of the number aged 17 or less. Secondly we use the number of adults (members aged over 17), which Schultz (1999a) argues goes some way towards addressing the problems of endogenous family size and directly links consumption to the individuals earning the income to pay for this consumption.

Figure 4a compares the OLS estimates for total consumption, consumption per adult and consumption per adult equivalent. Figure 4b plots the OLS, GLS and IV point estimates for each β_c, using total nondurable consumption, together with pointwise 95% asymptotic confidence intervals for the OLS estimates. There are separate estimates for each of the 74 cohorts aged 1 through 74 in 1976, so for reasons of space and clarity, we tabulate only the estimates for every fifth cohort in Table 1.

Using total consumption, we see that there is a strong downward trend in the estimated β_c as one moves from younger to older cohorts. Pointwise two-sided t-tests reject the null of a unit root for all cohorts aged between 5 and 50 in 1976, with $\beta_c > 1$ for these cohorts. There is little variation between the OLS, GLS and instrumental variable estimators for the majority of cohorts, and the OLS R^2's are very close to unity. These diagnostics are suggested by Mckenzie (2000a) as indicating that large n_c, small T asymptotics are appropriate. The estimators differ dramatically for those cohorts aged 65 and above in 1976, for which we have both a small n_c and a small T. The instrumental variables estimates are a lot more variable here, reflecting the small sample behaviour suggested in the simulations in Mckenzie (2000a). This is reflected in a widening of the pointwise confidence intervals for the youngest and oldest few cohorts. The Wald test for parameter homogeneity given in Table 1 overwhelmingly rejects the null hypothesis, and furthermore, one also rejects parameter homogeneity amongst cohorts aged within five year bands. Thus using total consumption we reject the martingale hypothesis of consumption for all but the oldest cohorts, and conclude that cohorts experience significantly different growth rates of consumption. This confirms the visual findings of

Figure 5.

Standardizing by a measure of the number of household members accounts for some of the difference between cohorts, as the elder households are measured over a period where their household size is declining, whereas younger household sizes were increasing or remained constant. One can then reject the null of a unit root in favour of an explosive process additionally for cohorts aged between 50 and 60 in 1976. Again Wald Tests reject the null of parameter homogeneity, but least strongly for consumption per effective adult. Cohorts can be pooled into two-year, or perhaps five-year age groups with this measure of consumption. For comparison purposes, Table 1 also reports the pooled parameter estimate, which treats the whole population with household heads aged 20-75 as a single cohort[4]. Parameter heterogeneity is still important, and even after accounting for the effects of household size we find that younger cohorts experienced faster consumption growth than the older cohorts.

4.2 Birth Year-Education Cohort Analysis

Taiwan experienced a marked expansion in education throughout the post-World War II period. If consumption growth rates differ across education groups within birth cohorts, then differences in education levels may account for some of the differences in estimated consumption growth between birth cohorts. We investigate this proposition by using cohorts defined by both birth year and education level. Increasing the total number of cohorts reduces the number of observations within each cohort, so observations are pooled into two-year birth cohorts. These birth cohorts are then subdivided according to the education level of the household head. Three education levels are considered: Primary education, consisting of zero to six years of schooling, Secondary Education, consisting of seven to twelve years of schooling, and Tertiary Education, consisting of thirteen years or more of schooling.

Table 2 reports the slope parameter, β_c, estimates for selected Birth year-Education cohorts. Sample sizes are also reported so that the changing educational composition of birth year cohorts can be observed. As one moves from younger to older cohorts, individuals tend to have less education. Figure 5a plots the OLS estimates for each education class, using total consumption. The pattern of declining consumption growth with cohort age observed using birth cohorts is again apparent. There is more variation between the OLS and IV estimators than when birth cohorts alone are used, reflecting the smaller sample sizes. This is particularly true for cohorts aged 60 or more in 1976, and for the youngest cohort of primary educated households, where both n_c and T are small, and of similar magnitude. In such situations we know the OLS and GLS estimators will be biased downwards, while the IV estimator will be quite variable, which is reflected in the wide variation in the estimates obtained. Wald tests of homogeneity across education group, given heterogeneity across birth

[4] Note that the estimates are lower than the corresponding estimate of 1.068 using macro data on real consumption per capita over 1976-96. This reflects differences in the definitions of consumption, as well as different age populations.

year, reject the null hypothesis, indicating that there is a significant difference between educational groups. In general it appears that for a given cohort age, households with tertiary education had the fastest growth, followed by those with secondary education, with households with at most primary education having the slowest consumption growth. However this pattern is not universal, as evidenced by the lines for different education groups crossing several times in Figure 5a.

Figure 5b plots the point estimates using consumption per adult. The downward trend is weaker than in the total consumption case, with added variation resulting from small sample variations in mean household sizes. Again in general the variation is greater across age than across education group, but Wald tests reject homogeneity across education groups. All three education groups experienced positive consumption growth over the period. Although there are statistically significant differences among education groups, we find that consumption growth was higher for the younger cohorts than the older cohorts for all three education levels. Therefore educational differences between cohorts can at best account for a small portion of differences in consumption growth between cohorts.

5 Changes in the Cohort over Time

Having shown that we can reject the PIH at the per capita consumption and cohort levels, we now examine whether this is merely due to compositional changes within each cohort. Recall that consistency of the OLS and IV estimators of β_c was obtained under the conditions of Assumption 1. In particular, condition (iii) required that $\overline{y}_{ct-1}^{i(t)} - \overline{y}_{ct-1}^{i(s)} \xrightarrow{p} 0$ as $n_c \to \infty$ for all t,s. The Taiwanese PIDSs are comparable over time, so that condition (iii) is not violated by changes in survey design. The three main issues involved in examining the realism of this condition are nonrandomness in migration, mortality, and changes in household composition. If the poorer individuals in a cohort die, emigrate, or move in with relatives, then one would observe growth in the cohort consumption mean, even if there was zero growth in individual consumption for those individuals left in the cohort. The importance of each of these three factors is examined in detail in Mckenzie (2000b), and we summarize the findings here.

Strict government restrictions restricted international migration into and out of Taiwan over our sample period. Total immigration and emigration over the period 1976-96 was 545,951 and 736,037 individuals respectively, representing 2.5% and 3.4% of the 1996 population. This limited migration seems unlikely to impact strongly on our results. Annual death rates by age and sex are below 2 percent of the population until age 65, after which mortality rates increase rapidly. For individuals aged under 65, there is negligible evidence of differential mortality by education level, and hence mortality exerts little or no influence on cohort composition.

Changes in household composition provide the biggest challenge to the assumption on cohort means required for consistency. As consumption data are available at the household level only, one must define cohorts based on observable characteristics of the household which identify it through time, such as the birth year of the household head. As Schultz (1999a) emphasizes, household composition is endogenous with the fertility decision, the decision to support the elderly within the household, and the propensity for prime-aged adults to live together, all potentially responding to the income-earning opportunities open to individuals. The result is that the statistical sample of a birth cohort may change in a nonrepresentative manner as it "ages". In the Taiwanese PIDS the household head is defined as the main earner in the household, so if a father and son are both members of the same household, and from one year to the next a son's earnings overtakes his father's, then the age of the household head will drop by 20 or more years, even though household composition is unchanged (Deaton and Paxson, 1994a).

Almost 86 percent of all ordinary households in Taiwan are composed of relatives and a further 13 percent are one-person households. Parent-child families account for 53.9% of all ordinary households and three-generation families account for 12.1%. Approximately two-thirds of the elderly (persons aged 65 years and above) live with their children. The living arrangements of the elderly differ by their educational attainment, with the more educated individuals being more likely to live alone or with their spouse only (Census Office, 1992). This tendency will cause a violation of the condition (iii) required for consistency, and hence, in addition to the mortality effect, is another reason for restricting our study to individuals aged under 65. Table 3 is based on Schultz (1999b) and details how individuals in each age group are related to the household head. The majority of individuals aged between 25 and 65 are household heads or spouses of the head, while over 60 percent of those aged 20-24 are the child or child-in-law of the head. In terms of our econometric analysis, the main issue arising from these household composition issues concerns changes in the household head from one year to the next. This is particularly a concern with the oldest cohorts, and to a lesser extent the youngest cohorts, as the elderly (and youth) who head their own households rather than living with their children (or parents) are likely to be unrepresentative of all individuals in a particular birth cohort. In contrast, sample-selection is much less of a problem for the middle-aged households, with over 90 percent of individuals aged 35-50 being heads or spouses of heads.

The small sample size available for very young and very old heads prevents formal correction for these selection issues, and so instead we choose to focus the remainder of the paper on household heads aged between 25 and 65 years. The evidence presented here suggests that the consistency condition (iii) in Assumption 1 will hold approximately for cohorts sampled over this age range. Therefore, for cohorts of heads aged 25-65, the faster consumption growth of younger cohorts can not be attributed to selection effects and the data continue to present a strong challenge to the PIH. We therefore consider alternatives to the martingale hypothesis.

6 Alternatives to the Martingale Hypothesis

There are a multitude of possible reasons for rejecting the hypothesis that consumption is a unit root. We have already shown that this rejection is not simply an artifact of the use of cohorts rather than individuals as the unit of analysis. We now proceed to consider specific alternatives to the martingale hypothesis, and investigate the extent to which they can explain high consumption growth in an environment of rapidly growing income.

The martingale property of consumption was derived by Hall (1978) without any restrictions on the behaviour of the income process. However, other implications of the PIH, and alternatives to the PIH, are affected by the persistence properties of labour earnings and income. In particular, Deaton (1992) shows that a unit root in income has implications for tests of excess sensitivity, for the volatility of consumption, and for the behaviour of consumption under liquidity constraints. Caballero (1990) shows further that precautionary saving is of more importance the greater is the persistence in labour income. Before proceeding to investigate alternatives to the PIH, it is therefore useful to examine the stochastic properties of household earnings and income. The AR(1) model[5] in equation (4) was fitted to income and to labour earnings, allowing the parameter β_c to vary across cohorts. Both income and labour earnings were found to be explosive processes, with the estimates of β_c all greater than one[6]. Total income and total earnings growth was greater for the younger cohorts than for the elder cohorts, but much of this difference disappeared once per adult equivalent incomes were considered. The parameter estimates were close to the value of 1.059 obtained using Real GNP per capita, so that income growth rates in the macro and micro data concur with one another.

6.1 Saving and Liquidity Constraints

Rejection of the Permanent Income Hypothesis (PIH) in empirical work is often attributed to the presence of liquidity constraints. Deaton (1991) shows that even if liquidity constraints do not bind in the current period, the possibility that they may do so in the future can cause individuals to engage in 'buffer stock' saving, which can then be used to smooth consumption in the future if constraints do bind. However, when income follows a random walk, Deaton shows that the optimal strategy for liquidity-constrained households is simply to consume their income each period, as all shocks are permanent. When income is an explosive process, as the previous analysis suggests, individuals would like to borrow against their higher future incomes, and so if liquidity constrained will again optimally set consumption equal to income each period[7]. Such behaviour

[5] Deaton (1992, Chapter 4) provides a good discussion of the relative merits of modelling income as a trend-stationary versus a difference-stationary process. Deterministic trends do not seem to be appropriate for modelling much of Taiwan's income growth.

[6] The estimates were significantly greater than unity for all but the oldest cohorts, as was the case for consumption. The estimates are reported in Mckenzie (2000b).

[7] If income is the sum of a random-walk and a white-noise component, Deaton (1992, p. 206) argues that there will still be scope for buffer-stock smoothing of the white-noise innovations.

would result in a trend in consumption, but would not account for high levels of individual saving. In fact, Deaton (1997, p 369) remarks that the "buffering model does not offer any clear explanation of why consumption tracks income in Taiwan" as "Taiwanese households own very substantial assets, and are clearly not in a position where they would like to borrow but cannot."

Table 4 gives the aggregate savings rates in Taiwan over the 1976-96 period, which have been high by international standards. Asset data in the Taiwanese PIDS surveys is poor, preventing the use of Euler-equation based tests for liquidity constraints as is done in Zeldes (1989). However, one can examine saving defined as disposable income from all sources less total consumption expenditure. We use this data to examine the cross-sectional distribution of saving. Table 4 reports selected percentiles for every fifth birth-year cohort in 1976, 1982 and 1996. These years represent the beginning and end of sample, together with 1982, the year in which aggregate income growth was lowest. These figures are complemented by Figure 6, which plots the distribution of household saving rates for the entire sample in each of the three years. Between 90 and 95 percent of population are observed to be saving, with the density shifting right over time. Less than 10 percent of all cohorts dissave, while some individuals are saving over half their incomes. A vast majority of the population save, providing strong evidence against liquidity constraints being the prime cause of the trend in consumption.

Taiwan's Financial System

The institutional structure of Taiwan's financial system provides further information on whether borrowing restrictions are important. Chan and Hu (1997) describe the prevailing system as one of financial dualism, whereby the formal financial sector served primarily the needs of public enterprises and large private firms, while an extremely active informal sector served the financial needs of consumers and small and medium firms. The informal financial sector takes various forms, including Rotating credit associations (Roscas), postdated checks, "de-shia cheng chuang's" (underground money shops) and borrowing from relatives and friends. Roscas are particularly popular with a 1993 household survey finding that 49.3% of Taiwanese households are members (Kuo, 1996). Besley and Levenson (1996) find a positive association between rosca participation and durable goods acquisition, suggesting that roscas play an important role in enabling households to accumulate durable goods and make house downpayments. Biggs (1991) highlights the importance of post-dated cheques in the financing of small firms, detailing the existence of an organized market in which post-dated cheques are endorsed and sold at a discount to small private brokers who act as intermediaries. Chan and Hu (1997) suggest that a consequence of this highly active informal sector is that consumers in Taiwan are less credit-constrained than individuals in many other developing countries.

In the Taiwan case income growth was positive every year from 1976-96, so that the explosive or trend component outweighed any stationary innovations. In this scenario it is not optimal to save a buffer-stock.

The cost of home ownership is comparatively high in Taiwan, with a real estate bubble in 1987-89 pushing the average housing price to over nine times average annual income per household. House prices subsequently fell, but still average around seven times average annual household income, compared to indices of between three and four in Western Europe and North America. Despite these conditions, Table 5 shows that the home-ownership rate in Taiwan is high and quite uniform across age groups. Informal financing has alleviated credit restrictions for house purchases. Nevertheless, one may still be concerned that high levels of measured savings are due to households saving to buy a house. The lump-sum nature of housing purchases would lead borrowing-constrained households to save, so that a high level of saving would not in itself be evidence against the importance of liquidity constraints. However, Table 5 shows that saving rates do not differ greatly between households which own their own homes and households which do not. Coupled with the high rate of home ownership across all age groups, this suggests that the real estate market is not a primary cause of high saving rates in Taiwan. Ranis (1992) suggests that the reverse causation may even be true, with the excess liquidity resulting from high domestic savings fueling stock market and land speculation booms.

6.2 Unanticipated Aggregate Shocks

Ranis (1992, p.2) remarks that "the people of Taiwan, including its policy-makers, do not yet themselves believe they have "arrived"..." and adds (p.13) "they remain concerned about the durability and sustainability of their record growth with equity in an increasingly unfriendly world." The data generating process may therefore still be the unit root model, with consumption growth merely reflecting a run of unexpected positive shocks to permanent income. In a finite-life version of the PIH, Deaton and Paxson (1994a, p457) explicitly derive the relationship between the consumption innovation for individual i at time t, u_{it}, and innovations in earnings. If R is the retirement date after which earnings are zero, and r is the constant real interest rate, then they show that:

$$u_{it} = \frac{r}{1+r} \sum_{k=0}^{R-t} (1+r)^{-k} \left(E_t - E_{t-1}\right) y_{i,t+k} \; . \tag{5}$$

Marigar and Shaw (1993) suggest that $(E_t - E_{t-1}) y_{i,t+k}$, the earnings innovations, will contain a common component across individuals as a result of unanticipated macroeconomic disturbances. As an example, they note that if forecasters erroneously predict a recession at time t, then there would be a tendency for all households to underpredict income change at time t. These aggregate effects can cause condition (i) of Assumption 1 to be violated, rendering our estimators of β_c inconsistent for fixed T. Over a short number of time periods one is therefore right to be concerned that rejection of the PIH may be due to the presence of unanticipated aggregate shocks. However it is much more difficult to give credence to this hypothesis for our sample of twenty-one years of data. Provided that the aggregate effects have mean zero over time, the consistency of our estimators will continue to hold as we let T pass to infinity. Our empirical results could only be consistent with the martingale form of the PIH if the aggregate effects have positive mean, which would require Taiwanese households to be repeatedly surprised by the positive income growth experienced.

The inclusion of cohort-specific intercepts in our regressions will control directly for non-zero mean common cohort and aggregate shocks. As we will see, the consumption process may also contain an intercept due to other factors, such as precautionary savings. It is therefore important to evaluate the plausibility of consumers being repeatedly surprised by the high levels of income growth. One should first note that in the period 1955-75, Taiwan's real GNP growth was positive every year, averaging 8.7% per annum[8]. Thus, consumers had already experienced twenty years of high growth prior to our sample period of 1976-96. Furthermore, the government's four-year, six-year and ten-year plans continued to forecast high growth rates as detailed in Table 6a. This previous experience of high growth together with the official forecasts for continued growth makes it hard to believe that rational consumers repeatedly underestimated income.

A further source of evidence is the fact that rosca participation dropped significantly in 1985, a year of "recession" in Taiwan, where GNP per capita growth fell sharply to 4.2 percent from 10.0 percent in 1984. Besley and Levenson (1996, p. 43) speculate that "such a negative shock may have engendered rosca failures if individuals had taken on significant commitments in anticipation of continued growth". This would suggest that individuals were expecting the high growth rates to continue.

The extent to which official forecasts were reflected in individual expectations is of course an open question. Data from the Social Image Survey in Taiwan provide a rare opportunity to examine the expectations of individuals concerning both their own and aggregate income. Table 6b tabulates responses to the most relevant questions for assessing growth expectations. Few people anticipate a worsening economic situation for either themselves or for the country as a whole. On average, people expected the future to be better than the current period. However, sizeable proportions of the population expected their personal economic situation to remain unchanged over one-year and five-year horizons. Moreover, a significant degree of uncertainty with respect to future incomes is seen by the number of individuals replying "don't know" to the questions posed. Furthermore, self-assessed expectations of 'personal living situation' may not only reflect income growth, but also problems with the quality of life, caused by increased pollution, traffic jams, and other such factors. Chang (1990) reports on the 1985 and 1990 Social Image Surveys. He concludes that in both years people of all age groups, educational attainments, and of both genders are optimistic about their future personal living situation. Young educated males have the greatest expectations with regard to their future living situation, whereas farmers and housewives have lower expectations. It there-

[8] Author's calculations from DGBAS (1988).

fore appears that on average individuals believed that Taiwan's income growth would continue, but this was not anticipated by all individuals.

Equation (5) can be used in a thought experiment to illustrate what expectations about the earnings process would have had to have been for the realized consumption to conform to the PIH. We consider two possible models of the earnings expectations process. The first model assumes that earnings per adult equivalent follow a unit root process, while the second assumes an AR(1) process with auto-regressive parameter $\rho = 1.05$. This is approximately the realized process for earnings per adult equivalent estimated above. We then add the implied consumption shock to lagged consumption to arrive at predicted consumption under the two competing models[9]. Figure 7 plots the two predictions together with the actual value for the cohort aged 25 in 1976. The predicted consumption using a unit root process for earnings tracks consumption more closely than does predicted consumption using the more realistic AR(1) earnings process. The difference becomes more pronounced for higher interest rates of the levels prevailing in the informal financial sector, with a unit root model for earnings tracking consumption more closely than models with earnings growth. Qualitatively these results hold for other cohorts, suggesting that individuals would have had to expect zero earnings growth for their consumption behaviour to concur with the PIH.

In sum, the rapid consumption growth in Taiwan appears unlikely to have occurred as a result of individuals consistently expecting no earnings growth and then being repeatedly surprised. Over twenty years of previous high growth experience, repeated official forecasts of continued growth, and evidence from roscas suggest consumers would have anticipated some growth to occur. While the results of individual surveys do suggest that some consumers were over-pessimistic about future growth at both the aggregate and individual level, on average individuals did expect Taiwan's growth to continue.

6.3 Hyperbolic Discount Functions

Laibson (1997, 1998) suggests that hyperbolic discount functions can provide an explanation for many of the empirical anomalies which arise in standard consumption theory. Among these are the comovement of consumption and income, variation in patience over the life-cycle, asset-specific marginal propensities to consume, and declining savings rates in developed countries. We examine the extent to which this form of behavioural theory can account for consumption behaviour in Taiwan.

An individual's expected lifetime utility at time t is modeled by the 'quasi-

[9] We take the real interest rate r to be 2.57 percent, the mean real Rediscount rate of the Central Bank of China over the 1976-96 period, and the retirement age R to be 65. For the unit root model, the change in earnings is multiplied by $1 - \left(\frac{1}{1+r}\right)^{R-t+1}$ to give the shock to consumption, while for the AR(1) model the scale factor is $\frac{r}{1+r-\rho}\left[1 - \left(\frac{\rho}{1+r}\right)^{R-t+1}\right]$.

hyperbolic' form:

$$U_t = E_t \left[u(c_t) + \beta \sum_{\tau=1}^{T-t} \delta^{\tau} u(c_{t+\tau}) \right], \tag{6}$$

where $u(c)$ is the instantaneous utility and δ and β are discount parameters. In contrast to the standard exponential discount function, hyperbolic discounting induces dynamically inconsistent preferences, with a relatively high discount rate over short horizons and a relatively low discount rate over long horizons. The conflict between current period and future preferences provides a motive for consumers to constrain their future choices by saving via illiquid assets. In equilibrium, the consumer is effectively liquidity constrained at any moment in time, though the constraint is self-imposed. In the absence of alternative saving motives, equilibrium consumption is exactly equal to current labour income plus past liquid savings. The illiquid asset will be exclusively used to augment consumption in periods where income is expected to be lower. Laibson (1997) suggests that financial innovation in the U.S. during the 1980's increased access to instantaneous credit, reducing the effectiveness of illiquid assets as commitment devices, and thereby causing savings rates to fall.

Applying this theory to Taiwan, consumption growth would be explained as a consequence of (self-imposed) binding liquidity constraints combined with income growth over time. Again the presence of substantial savings each year rules this out as the main determinant of consumption growth. Furthermore, although consumers were generally limited to borrowing through the informal sector, formal financial institutions on average accounted for 87.4% of household savings over the 1965-88 period. (Chou, 1995). Government tax exemptions encouraged the use of term deposits, but the ratio of quasi-money (total time and time-savings deposits) to narrow-money (currency in circulation, checking account, passbook and passbook savings deposits) was never more than two over the 1976-90 period. (Chiu, 1992). This suggests that a significant portion of savings were in the formal sector in liquid form, contradicting the baseline hyperbolic model.

Secondly, the hyperbolic model predicts that the effective discount factor varies over the life cycle, and is positively correlated with age and financial wealth. Thus young Taiwanese who expect rising income paths are predicted to have high current marginal propensities to consume (MPCs), implying a low effective discount factor. In contrast, older consumers who can expect falling income paths are most likely to have low MPCs. The high savings rates by the young also provide evidence against this prediction.

Laibson (1997) acknowledges that the prediction of binding self-imposed liquidity constraints contradicts observed consumption choices. He suggests that this problem can be addressed by introducing precautionary savings into the model, which provides a motive for individuals to hold liquidity. The interaction of hyperbolic discounting together with precautionary savings may then be helpful in explaining some aspects of Taiwanese consumption. In particular, Chan and Hu (1997) note that the decline in Taiwan's savings rate since

1988 has coincided with financial liberalization. As was hypothesized for the United States, the increased availability of instant credit may have lowered the effectiveness of illiquid assets as a commitment device, thereby lowering savings rates.

6.4 Habit Formation

The previous models of consumption all assume preferences to be time separable. Preferences exhibiting habit formation constitute an important class of time non-separable preferences, which have received renewed attention recently. The distinguishing feature of these models is that current utility depends not only on current consumption, but also on a 'habit stock' formed from past consumption. The larger the habit, the less pleasure is received from a given amount of consumption, and the larger must be new purchases to gain the same benefit. Fuhrer (2000) shows that habit formation captures the gradual hump-shaped response of consumption spending to shocks to income, as habits cause consumers to prefer a number of small consumption changes to one larger change. Carroll, Overland and Weil (2000) find that the introduction of habit formation into a growth model can explain why high growth leads to high savings rates. Consumers in a fast-growing economy, who know they will be richer in the future than today, do not lower savings as habits make consumers more willing to postpone consumption. Deaton (1992) shows that this can lead to a desired consumption path on which consumption continually increases over the life-cycle, in order to offset the ever-increasing stock of habits. In theory, therefore, habits may be a cause of the consumption growth observed in the Taiwan data.

Deaton (1992) illustrates the effects of habit formation in the standard PIH setup of quadratic preferences with a fixed rate of interest equal to the rate of time-preference. If preferences are intertemporally additive, these assumptions give that consumption is a martingale. In the simple habit model, felicity depends positively on current consumption and negatively on lagged consumption, so that expected utility is given by Deaton's equation 1.53 (p.30):

$$u = E_t \sum_{\tau=1}^{T} \nu_\tau \left(c_\tau - \gamma c_{\tau-1} \right) . \tag{7}$$

The parameter γ measures the strength of habit formation, with positive values of γ implying habit formation. If $\gamma = 0$, there is no habit formation and the model reduces to the simple PIH. The Euler equation with habits in this simple model is:

$$\Delta c_{t+1} = \gamma \Delta c_t + u_{t+1} . \tag{8}$$

This equation demonstrates that habit formation creates a positive link between current and lagged consumption growth. Consumers now wish to smooth both the level and the growth rate of consumption. Dynan (2000) uses food consumption data from the PSID to estimate more general versions of (8), finding no evidence of habit formation at the annual level. She acknowledges that habits may be weaker in food than in consumption of other goods, limiting the extent to which her results generalize to consumption as a whole. The dynamic pseudo-panel techniques outlined earlier can be modified to allow estimation of (8) for Taiwanese non-durable consumption. This will determine whether habit formation alone can explain the rejection of the PIH for Taiwanese consumption and the finding cohort-specific consumption growth.

Taking cohort means of (8) produces the following equation to be estimated:

$$\begin{aligned}\left(\overline{c}_{c,t+1}^{i(t+1)} - \overline{c}_{c,t}^{i(t)}\right) &= \gamma \left(\overline{c}_{c,t}^{i(t)} - \overline{c}_{c,t-1}^{i(t-1)}\right) + \varepsilon_{c,t+1} \\ \varepsilon_{c,t+1} &= \overline{u}_{c,t+1}^{i(t+1)} + (1+\gamma)\left(\overline{c}_{c,t}^{i(t+1)} - \overline{c}_{c,t}^{i(t)}\right) \\ &\quad -\gamma\left(\overline{c}_{c,t-1}^{i(t+1)} - \overline{c}_{c,t-1}^{i(t-1)}\right). \end{aligned} \tag{9}$$

The error term here involves the cohort mean error from equation (8), plus two additional "measurement errors", which arise as a result of having different individuals in the sample each period. The estimated standard errors need to take this into account, requiring the extension of the sample cross-sectional variance based covariance matrix given in Mckenzie (2000a). The formulae for the correct covariance matrix estimator for equation (9) are given in Appendix A.1.

Figure 8 reports the estimates of the parameter γ for each cohort, using total, per adult, and per adult equivalent non-durable consumption. We obtain significantly positive values of γ for cohorts aged between 10 and 30 in 1976, suggesting habit formation is potentially important for these younger cohorts. This result provides one possible reason for our previous finding of faster consumption growth for younger cohorts: namely that habit formation is more important for the young. Deaton (1992, p. 34) writes "consumption becomes cheaper with age, because habits that will be engendered by consumption have less time left to do their damage". However, habit formation does not explain the positive per adult equivalent consumption growth experienced by most of the older cohorts. Moreover, the results may be spurious due to a failure to allow for precautionary savings, which we show can also cause consumption growth. Section 7.4 investigates this possibility.

6.5 Non-separability of consumption and leisure

As in much of the consumption literature, we implicitly make the assumption of additive separability of the utility function in consumption and leisure. Attanasio and Weber (1995) argue against this assumption on the grounds that job-related expenses can affect both the intertemporal allocation of expenditure and the intratemporal allocation. Their solution is to condition on labour supply variables in Euler equation estimation. Blundell, Browning and Meghir (1994) provide a two-stage sequential estimation approach which allows for the estimation of both the labour/leisure trade-off and of the consumption decision. Their work suggests that demographics and labour-supply can account for much of the life-cycle variation in consumption. Unfortunately the Taiwanese PIDS do not contain data on labour hours, preventing us from examining the influence of labour supply on the robustness of our results. If individuals work less with age, this would help account for the slower consumption growth of the older cohorts, but would not explain why there is consumption growth in the first place. The Manpower Utilization Surveys (DGBAS, various years) contain data on the average weekly working hours of employed persons by age group. Over the 1991-96 surveys, employed individuals aged 15 to 49 worked 48 hours per week on average, ages 50-54 averaged 47 hours, ages 55-59 averaged 46 hours, ages 60-64 averaged 44 hours and those aged 65 and above aged 42 hours. These figures suggest that the labour/leisure decision does not greatly impact on inter-cohort differences in consumption growth[10].

7 Precautionary saving

Models which incorporate a precautionary savings motive are one of the most popular alternatives to the martingale form of the PIH. As Deaton (1992) points out, a precautionary motive for saving is entirely consistent with the theory of intertemporal optimization, but is ruled out by the certainty equivalence assumptions made in generating the permanent income model. The appeal of precautionary saving models lies both in their a priori plausibility, and in their ability (at least in theory) to explain much of the empirical evidence against the permanent income model. In particular, precautionary savings behaviour can account for the excess sensitivity and excess smoothness of consumption to anticipated and unanticipated labour-income changes respectively; for the persistent growth of consumption, even when the real interest rate has been negative; and for consumption tracking income in the early part of the life cycle. (Caballero, 1990; Deaton, 1992). Uncertainty about future income can make young people unwilling to borrow to finance current consumption, even though they expect their incomes to rise, due to the possibility of a bad future outcome. Furthermore, uncertainty about lifespan and future health costs can make the elderly extremely cautious about running down their assets. Browning and Lusardi (1996) remark that the degree to which the certainty-equivalent model approximates models with uncertainty depends on the time path of expected income. There can be wide divergence between the two models in situations in which current period income and cash-on-hand are low relative to future expected earnings. The theory therefore suggests the precautionary motive could be a very important component of consumption in Taiwan.

Caballero (1990) shows that with constant absolute risk aversion (CARA), if labour income follows any ARMA process (with possibly a unit root) and the return on assets is certain, then the consumption process is a martingale

[10] Labour force participation of males aged 15-65 fell from 77.1 percent to 71.1 percent over the 1976-96 period, while female participation increased from 37.6 percent to 45.8 percent over the same period (DGBAS, 1999, p. 44). Thus, household participation rates per adult are likely to not have changed dramatically over the sample period.

with drift. The drift is increasing in riskiness of income and in the persistence of labour-income shocks. Therefore precautionary saving would be a more important determinant of consumption behaviour in countries with highly persistent income shocks, such as Taiwan. In particular, if labour income is a random walk, with $N\left(0, \sigma_\omega^2\right)$ innovations, and the instantaneous utility function is $u(C_t) = -\theta^{-1}\exp(-\theta C_t)$, then the consumption process is:

$$C_{t+1} = \left(\frac{\theta\sigma_\omega^2}{2} + \frac{(r-\delta)}{\theta}\right) + C_t + u_{t+1} \ . \tag{10}$$

Where r is the interest rate and δ the rate of time preference and $u_{t+1} \sim N\left(0, \sigma_\omega^2\right)$. Following the proof in Caballero (1990), one can show that if labour income instead follows the explosive process $y_{t+1} = \rho y_t + \omega_{t+1}$, with $1 < \rho < 1 + r^{-1}$, then equation (10) is of the same form, with only the variance of the u_{t+1} increasing[11]. Thus for a plausible labour income process for Taiwan, this specification of utility function gives consumption as a random walk with drift.

Caballero (1990) also varied the distribution of the labour income innovations, considering several Bernoulli distributions and a Uniform distribution in addition to the Normal distribution used to derive equation (10). He found that asymmetries in this distribution may have important effects. In particular, as the bad state deteriorates (preserving the expected value), the drift term becomes larger. This may be of special relevance in Taiwan, where the "bad state" involving invasion by China may be considered to have a very negative impact on incomes. An underdeveloped social security system may also mean that the "bad state" in old age is relatively worse than it would be in developed countries.

Precautionary saving in response to risk requires convexity of the marginal utility function. Kimball (1990) showed that the intensity of the precautionary saving motive can be measured by absolute prudence, defined as $-U'''/U''$; and by relative prudence, defined as $-CU'''/U''$. Dynan (1993) found that a second-order Taylor expansion of the consumer's first-order condition enables one to estimate these coefficients of prudence using panel data. Appendix A.3 derives the corresponding result for pseudo-panel data. Assuming a constant real interest rate gives the following equation:

$$\left(\overline{C}_{ct+1}^{i(t+1)} - \overline{C}_{ct}^{i(t)}\right) = \lambda + \frac{\rho^*}{2}\left(\overline{C}_{ct+1}^{i(t+1)} - \overline{C}_{ct}^{i(t)}\right)^2 + \varepsilon_{ct+1} \ , \tag{11}$$

where $\rho^* = -U'''/U''$ is the coefficient of absolute prudence. For the CARA utility function given above, $\rho^* = \theta$, a constant, and hence estimation of (11) enables one to determine the intensity of the precautionary saving motive. Note that $\rho^* = 0$ for quadratic utility, reflecting the absence of a precautionary motive when utility takes this form. Dynan (1993) notes that if ρ^* is positive, then higher expected consumption growth (reflecting higher saving) is associated with

[11] If the labour-income innovations are i.n.i.d., the drift term in equation (10) becomes $\theta E_t\left[\sigma_{\omega_{t+1}}^2\right]/2$, and is therefore stochastic. (see Caballero, 1990).

higher squared consumption growth (reflecting greater uncertainty). Similarly, letting c_{ct+1} be the mean of log non-durable consumption for individuals in cohort c, one can estimate the model $\Delta c_{ct+1} = \lambda^* + \frac{\rho}{2} (\Delta c_{ct+1})^2 + \varepsilon^*_{ct+1}$. Here $\rho = -CU'''/U''$ is the coefficient of relative prudence. The CRRA utility function $U(C) = (1-\gamma)^{-1} C^{1-\gamma}$ exhibits constant relative prudence, with coefficient $\rho = 1 + \gamma$.

Although the CARA utility function allowed Caballero (1990) to obtain tractable solutions, most empirical research has favoured constant relative risk aversion (CRRA) utility for reasons of a priori plausibility. Browning and Lusardi (1996) provide an excellent review of the empirical work, and present the derivations needed to arrive at the common empirical specification. Within-period utility is taken to be given by:

$$u(C_t, Z_t) = \frac{1}{1-\gamma} \left(\frac{C_t}{\alpha(Z_t)} \right)^{1-\gamma}, \tag{12}$$

where γ is the coefficient of relative risk aversion, and Z is a vector of utility modifiers such as "demographics". Parameterizing $\alpha(Z) = \exp(Z'\alpha)$, and letting σ^2_{t+1} denote the consumption shock variance, they show the log-linearized Euler equation is given by:

$$\ln C_{t+1} - \ln C_t = \beta + \lambda' \Delta Z_{t+1} + \phi r_t + 0.5\phi\sigma^2_{t+1} + u_{t+1}\ . \tag{13}$$

This equation captures several of the main motives for saving. The first term is a discount factor, with a lower β reflecting higher impatience and hence higher consumption in early periods. The second term allows for the influence of anticipated changes in demographics on consumption and the third term captures the intertemporal substitution motive for saving. The precautionary saving model differs from certainty-equivalence models through the fourth term. If the variance of future consumption increases, then the higher uncertainty leads consumers to increase precautionary saving and to lower current consumption. In the presence of liquidity constraints, a fifth term $\phi \ln(1+\psi_t)$ appears on the right-hand side, where the lagrange multiplier ψ_t measures how tightly liquidity constraints bind in the current period. Even though we have shown that liquidity constraints alone can not account for the observed consumption paths in Taiwan, it is important to note that the effect of the precautionary motive is strengthened by the presence of liquidity constraints. Deaton (1992) explains this by noting that the ability to borrow in bad times is an insurance device, which if not available, means consumers must accumulate a larger precautionary buffer stock.

The main empirical challenge involved in estimating (13) is that the consumption shock variance, σ^2_{t+1}, is not observed[12]. Browning and Lusardi (1996) survey the various measures used in the literature. The main approaches are to either derive an estimate of σ^2_{t+1} from the observed income process, to proxy the

[12] See Browning and Lusardi (1996) for further discussion of the estimation issues for this model. Carroll (1997) provides a powerful critique of the use of log-linearized consumption Euler equations with cross-sectional household data. The use of a long pseudo-panel may mitigate some of this criticism.

risk with the observed variance of consumption, or to estimate the equivalent precautionary premium. A major problem is in identifying exogenous sources of risk, as for example an agent's choice of occupation may be correlated with their attitude toward risk. The focus has tended to be on individual-specific sources of risk, as, for the United States at least, "most risk is idiosyncratic and averages out in the aggregate" (Dynan 1993, p. 1107). Pischke (1995) shows that individual income is much more variable than aggregate income using quarterly U.S. data, and uses this to argue that agents may simply not care about aggregate information since ignoring it is not very costly for most households. However, social insurance schemes and informal networks may enable consumers to insure against some forms of individual risk, whereas Caballero (1990, p. 124) observes that "aggregate uncertainty [is] perhaps the most uninsurable of all the risks faced by an individual". Furthermore, Pischke (1995) shows that individual income processes are generally much less persistent than aggregate income. The persistence of income shocks is seen in equation (10) to be an important determinant of the strength of precautionary savings. As we are using annual data, much of the temporary personal income shocks will average out, so that aggregate income uncertainty will be relatively more important. Finally, note that time-invariant sources of uncertainty will be captured by the constant term in (13), so that identifying time-varying sources of uncertainty will permit estimation.

7.1 Sources of uncertainty in Taiwan

Taiwan's heavy reliance on trade, its relatively underdeveloped social security system, and the precarious nature of its relations with China are all potentially strong (and mostly exogenous) sources of aggregate income risk. These factors may make aggregate uncertainty a much more important determinant of precautionary savings in Taiwan than is the case for developed nations such as the United States. We discuss the importance of each of these three factors in turn.

Openness and Susceptibility to External Shocks

Foreign trade has played a large role in the rapid growth of per capita incomes in Taiwan over the 1976-96 period. Real export growth averaged 7.7 percent per annum over this period, and the export to GNP ratio increased from .33 in 1976 to .50 in 1996[13]. While trade has undoubtedly raised the level of income, it may have also increased the variability of incomes by magnifying the impact of external fluctuations on the economy. Export growth has been highly variable, with a mean rate of 11.6 percent each year over the 1976-96 period and a standard deviation of 9.2 percent. It is therefore likely that unexpected movements in external factors constitute an important source of (uninsurable) aggregate risk for individuals in Taiwan.

Changes in the terms of trade, oil prices, and in the income growth rates in Taiwan's main trading partners can be reasonably thought of as exogenous

[13] source: Taiwan Statistical Data Book 1999.

sources of risk for Taiwanese consumers. Table 7 details these movements and their correlations with income growth in Taiwan. To determine the relationship between unexpected movements in external factors and income growth, we also consider deviations of external growth rates from a three-year moving average trend[14]. Deviations in Real GDP growth from trend have a correlation of 0.75 with detrended trade-weighted growth in Taiwan's top three export markets, a correlation of 0.23 with detrended changes in net terms of trade, and a negative correlation with oil price growth. Overall detrended export growth has a 0.87 correlation with 'unexpected' changes in the GDP growth rate. These correlations support the view that external shocks are an important source of aggregate uncertainty for Taiwanese consumers. For examining precautionary savings behaviour, it is also of interest whether the uncertainty engendered by external shocks is changing over time. A first informal check is done by comparing the standard deviations of shocks in these external factors over the sub-periods 1976-85 and 1986-96 respectively. We find that the standard deviation decreased for every one of our measures of external shocks, as did the standard deviation of Taiwanese real GDP growth. To formally test whether the variances were constant over the sample period, we employ the Lagrange-Multiplier test for an ARCH process derived in Engle (1982). For all of our measures of external shocks, and indeed for the detrended Real GDP growth rate itself, we strongly reject the null hypothesis of constant variance. Thus the degree of uncertainty changes over the sample period.

The Social Welfare System

Chang (1992, p. 229) writes that, in Taiwan, "compared with Western countries, it is astonishing how low the social and health budget and pension payments have been kept.". Social insurance programs were implemented in Taiwan in 1950, with expansion of both the available programs and their coverage over the subsequent years. Chan (1987) discusses the features of the main programs, which include Labour Insurance, Government Employees' Insurance and Farmers' Health Insurance. Labour Insurance is the most widespread program, covering all firms with 5 or more employees by 1979[15]. Labour insurance provides insurance for death, old-age, maternity, death of the contributer's parents, disability, sickness, injury, and medical care. The retirement benefit is paid as a lump-sum upon retirement, and amounts to one month's earnings for each of the first 15 years of service, plus two months' earnings for each additional year of service, up to a maximum benefit of 45 months' earnings. However, Fields (1992) reports that pensions are paid only after 15 years of service, leaving a large fraction of Taiwan's workers without pension coverage. Health insurance was also far from universal until the introduction of the National Health Insur-

[14] The qualitative results here are robust to alternative trend specifications. The MA(3) trend provides a simple specification that may match consumer's expectations more closely than an ex post fitted trend.

[15] Employees pay 20% of the premium and employers 80%, while self-employed workers can elect to join the program by paying 60% of the premium with the government subsidizing the remainder.

ance program in 1995, which insured an additional 9 million people previously without health insurance. (EIU, 1996). Social Welfare provides a minimum consumption floor for very low income households, at a level of no more than one-third[16] of average consumption expenditure. Only 7,855 households in all of Taiwan received these living relief funds in 1996, showing that this form of welfare provides a very limited form of social insurance for most Taiwanese households.

To the extent that individuals do not have private insurance and do not self-insure through family networks, the underdeveloped social welfare system is likely to have increased uncertainty about future health and income. Mckenzie (2000b) examines surveyed opinions about social welfare and aging from the Taiwan Social Image Surveys. The majority of respondents in all age groups regard unsupported elderly people and insufficient social benefits as serious or very serious social problems in Taiwan. The young worry less than the old, and men less than women, about having insufficient financial resources in old age, and about having no one to take care of them when they are old. Overall, 47 percent of males and 54 percent of females surveyed express some degree of worry about having insufficient money in old age.

Major improvements in life expectancy in Taiwan had already taken place by 1976, with a further increase of 3 to 4 years in life expectancy at birth taking place over the 1976-96 period. Hurd (1989) investigates the consequences of uncertain lifespans for utility-maximizing consumers with CRRA utility, under the assumption that there is no other source of uncertainty. He shows that mortality risk acts like an increase in the subjective time rate of discount, increasing present consumption at the expense of future consumption. The magnitude of the response depends on the degree of mortality risk aversion: if consumers are highly risk averse they will want to guard against the possibility of low consumption should they live past their life expectancy and so consumption declines more slowly than is the case with less risk aversion. Therefore uncertainty about lifespan acts to limit consumption growth by making current consumption more desirable relative to future consumption. Thus it is the uncertainty of old age income, rather than uncertainty about life expectancy itself, which is likely to be of more importance for precautionary saving.

Taiwan's Relationship with China

Taiwan maintained diplomatic relations with most non-communist nations, and was a member of the United Nations, until 1971. Following China's entry to the U.N. in 1971, Taiwan's status became less secure, especially following the United States's derecognition of Taiwan in 1979 and the cancellation of the mutual security treaty that had guaranteed Taiwan's defence. (McBeath, 1998). The timeline of major events provided in Table 8 shows that the 1976-96 sample period was one of substantial changes in Taiwan-China relations. Our main concern is the extent to which uncertainty regarding Taiwan's relation

[16] In Taipei Municipality the level was no more than 40 percent. After the 1999 Fiscal Year, the minimal living expense was increased to 60 percent of the average consumption expenditure in each locality. (DGBAS, 1999).

with China fed through into uncertainty about income. The first measure we present is the Political Risk Services (PRS) political risk rating for the risk of external conflict involving Taiwan, which is available from the start of the series in January 1984 through to June 1999[17]. The risk score is on a 1-12 scale, with a higher score indicating less risk. Unfortunately the series does not cover the 1970's, where a possible increase in risk was experienced, and is generally quite flat apart from a sharp increase in risk in early 1996, when China conducted military exercises near Taiwan's offshore islands. The series do show that some risk of external conflict was assessed by an international risk rating group. As discussed previously, a large "bad state" risk, even with small probability, can have a sizeable impact on precautionary savings.

The second piece of evidence that we present is data from the Taiwan Social Image Survey of February 1992. Individuals were asked about their beliefs concerning the likelihood of China invading Taiwan in the next few years, whether Taiwan's army was strong enough to resist such attacks, and whether they believed the U.S. would come to Taiwan's aid. The results indicate a considerable deal of uncertainty concerning Taiwan's security. For the total sample, 15 percent of individuals thought it likely or very likely that China would invade, while a further 33 percent answered "don't know". If an invasion were to occur, almost half of those surveyed did not believe that Taiwan's armed forces were strong enough to resist the invasion, nor did almost half believe that the United States would send forces to intervene. The older age groups express more uncertainty with regard to the likelihood of an attack occurring, but display more faith in the ability of Taiwan's armed forces to ward off any such attack. In contrast, a majority of those aged under 40 do not believe that Taiwan's armed forces would prevail, or that the U.S. would provide intervention forces. These results therefore demonstrate that the possibility of an invasion from Mainland China, and presumably an accompanying large negative shock to income, is found in individual's expectations.

The chance that China will invade Taiwan may give rise to a "peso problem" in the observed consumption data. Although individuals seem ex post to have saved too much, ex ante the small probability of the unrealized event of China invading may have made this behaviour rational. A second consequence is that the *observed* labour income variability may be less than the actual uncertainty, so that measures of σ_t^2 obtained from observed data will be an underestimate of the true level. Moreover, as the consequences of an invasion are likely to be severe for income, risk asymmetry may play an important role.

7.2 Estimation of Precautionary Models

The first model we estimate is given by equation (10), which for a particular individual i in cohort c at time t is:

$$C_{it} - C_{it-1} = \alpha_c + u_{it} \ . \tag{14}$$

[17] See PRS *International Country Risk Guide* (monthly) for a full description of this data.

Assume that the rate of time preference equals the real interest rate and that the term $\theta\sigma_\omega^2/2$ is the same for all individuals within a cohort. Then summing (14) over the individuals in cohort c and taking cohort means gives the following model:

$$\begin{aligned} \overline{C}_{ct}^{i(t)} - \overline{C}_{ct-1}^{i(t-1)} &= \alpha_c + \varepsilon_{ct}, \\ \varepsilon_{ct} &= \overline{u}_{ct}^{i(t)} + \overline{C}_{ct-1}^{i(t)} - \overline{C}_{ct-1}^{i(t-1)} . \end{aligned} \quad (15)$$

The precautionary savings term α_c is then predicted to be positive, and increasing in risk aversion and uncertainty. The dynamic pseudo-panel methods of Mckenzie (2000a) can be easily adapted to allow estimation of this model in differences (see Appendix A.2). Figure 9 plots the cohort-specific estimates of α_c for total, per adult, and per adult-equivalent non-durable consumption. The estimated drift term is significantly greater than zero for all but the oldest cohorts. Failure to allow for changing household size results in a very large drift term for younger cohorts, but even after appropriate scaling we find that the drift term is larger for younger cohorts than older cohorts. This again reveals the faster consumption growth experienced by younger cohorts.

If equation (10) is correct, then a larger drift term for younger cohorts reflects either greater income uncertainty for the young and/or greater risk aversion. To estimate the magnitude of the precautionary effect and the degree of risk aversion by cohort, we next estimate equation (11). The estimated coefficients of absolute prudence by cohort are given in Table 9. The estimates are all significantly positive except for the oldest cohorts, providing further evidence of a precautionary motive. Controlling for household size increases the estimated degree of absolute prudence. The estimated degree of prudence does not appear to differ across cohorts in a systematic way, but instead is high across all cohorts. Allowing for a time-varying interest rate did not have much impact on the estimates. For a CARA utility function, the coefficient of relative prudence is the same as the coefficient of relative risk aversion and is between 8 and 13 for different cohorts when evaluated at the sample mean. This would suggest that Taiwanese consumers are more precautionary and more risk averse than consumers in the United States, where the coefficient of relative risk aversion is commonly thought to lie between one and five.

The estimates of $\theta = \rho^*$ from (11) can be used together with the estimated drift term from (10) to calculate the estimated uncertainty surrounding future labour earnings shocks, σ_ω^2. The estimated standard deviations, σ_ω, are plotted in Figure 10 and for most cohorts lie between 10,000NT$ and 15,000NT$. This represents between 5 percent and 7 percent of average income for most cohorts. The younger cohorts have greater income uncertainty than most of the older cohorts, which accounts for the larger drift term estimated for the young, and hence their faster consumption growth. Thus using a CARA utility representation, one finds that Taiwanese consumers exhibited strong prudence in the face of moderate income uncertainty, leading to a large amount of precautionary saving and fast consumption growth.

Figure 11 presents the estimated coefficient of relative prudence obtained by estimating the equation $\Delta c_{ct+1} = \lambda^* + \frac{\rho}{2} (\Delta c_{ct+1})^2 + \varepsilon^*_{ct+1}$ and assuming a CRRA utility function[18]. The results are similar to those in Table 9, namely evidence of a significant and strong precautionary motive. The estimated coefficients of relative prudence generally lie between nine and sixteen, which overlaps the range estimated under a CARA specification. There does not seem to be a systematic difference between cohorts in terms of prudence. Prudence, and hence precautionary saving, is found to be stronger in Taiwan than was found by Dynan (1993) for the United States and by Merrigan and Normandin (1996) for the United Kingdom.

To illustrate the effect of different levels of prudence on consumption growth, we use the estimates of σ^2_ω shown in Figure 10 together with equation (10)[19]. Using the actual level of consumption per adult equivalent in 1976, one can then predict the 1996 level for various levels of relative prudence. Table 10 compares the actual consumption growth per adult equivalent to that predicted with relative prudence of 2, 5 and 10. Prudence is shown to have a strong effect on consumption growth: growth would only be 1-2 percent if relative prudence were two, and 3-4 percent if relative prudence were five. Thus higher levels of prudence are needed to explain the 5-8 percent growth rates observed in Taiwan.

Next we turn to estimation of equation (13). Consider the following decomposition of the consumption shock variance for individual i in cohort c:

$$\begin{aligned} \sigma^2_{it+1} &= \sigma^2_{t+1} + \varphi_c + \mu_i \\ & \mu_i \sim i.i.d. \left(0, \sigma^2_\mu\right). \end{aligned} \tag{16}$$

The individual variance is assumed to be composed of a cohort-specific constant level of uncertainty, an individual constant level of uncertainty which allows individuals to randomly have greater or less income uncertainty than the cohort average, and aggregate uncertainty. We have argued above that aggregate shocks are likely to be more persistent than individual shocks, and a substantial source of uncertainty in Taiwan. Uncertainty arising from aging and from political events appears to be relatively constant over the sample period compared to external shocks. We therefore proxy σ^2_{t+1} with the squared deviations in external factors from trend, using export growth, real GDP growth in Taiwan's major export markets, changes in Taiwan's terms of trade, and oil prices as measures of the external shock. Taking cohort means therefore gives

[18] We present results using per adult equivalent non-durable consumption. The results using per adult non-durable consumption were very similar, while using total non-durable consumption understated somewhat the degree of prudence.

[19] For a CARA utility function, the parameter $\theta = \rho/\overline{C}$, where ρ is the coefficient of relative prudence and $\overline{C}$ is mean consumption.

the following pseudo-panel estimation equation[20]:

$$\begin{aligned} \Delta c_{ct+1} &= \alpha_c + \phi r_t + \psi \mathbf{b}^2_{t+1} +_3 \varepsilon_{ct+1} , \\ \varepsilon_{ct+1} &= \overline{u}^{i(t+1)}_{ct+1} + \mu^{i(t+1)}_c + \; c^{i(t+1)}_{ct} - c^{i(t)}_{ct} \quad , \end{aligned} \tag{17}$$

where $\mathbf{b}^2_{t+1}$ is the proxy used for the aggregate shock. This equation is estimated with dynamic pseudo-panel techniques as for (15). Table 11 presents the results from estimating this equation with non-durable consumption per adult equivalent. As the dependent variable is a difference in logs, the coefficients can be interpreted as measuring the impact on consumption growth. The estimated coefficient on the interest rate is positive and significant, in accordance with theory. A one percent anticipated increase in the real interest rate increases consumption growth by approximately one-half of one percent. The cohort-specific intercepts capture both the discount factor and constant sources of uncertainty. This coefficient decreases with cohort age, suggesting that the young have either more patience or more uncertainty than the older cohorts. Anecdotal accounts in Chu (1996) suggest that, if anything, the young exhibit less willingness to delay future consumption. We therefore conclude that the younger cohorts face greater income uncertainty, in accordance with Figure 10. The proxies for aggregate uncertainty all have the correct sign, but only the squared deviation of detrended Terms of Trade (TOT) changes was significant. These measures may therefore be poor proxies for the time-varying uncertainty faced by individuals, even if they account for a significant portion of the time-invariant uncertainty.

7.3 Is income-uncertainty greater for the young?

There are several measurable differences across cohorts which may affect income uncertainty. The younger cohorts are more highly educated and less likely to live on farms and in rural regions. Figure 12 shows the average proportion of each cohort working in different industries in Taiwan. The variation over time around the mean proportions is relatively small, except for the oldest cohorts where individuals are retiring and moving into the jobless category. Individuals in the younger cohorts are much more likely to work in manufacturing, construction and commerce than individuals in older cohorts, who are more likely to work in agriculture, or to be jobless (as a result of retirement).

While traditionally agriculture is thought of as being subject to high earnings variability, most of this is of a transitory nature. In contrast, the faster growing manufacturing, construction, financial and construction industries are likely to have experienced more persistent shocks. This suggests that a major source of the differences in uncertainty across cohorts may arise from the young being more likely to work in higher uncertainty industries. Table 12 considers

[20] Note that the use of per adult or per adult equivalent consumption already accounts for two of the most common variables found in Z_{t+1} in equation (13). Age is also commonly included in Z_{t+1}, but is captured in the constant term in (17). If age^2 is also important, this would introduce a linear time trend into (17).

earnings variability by the industry of the household head. We see that workers in agriculture had lower initial earnings, and experienced slower earnings growth over the 1976-96 period, than workers in the other industries shown. Some studies of precautionary behaviour use the earnings or income variance as a measure of risk (see Table 5.2, p.1836, in Browning and Lusardi 1996). Using this measure one would conclude that the younger cohorts face more risk, due in part to working in riskier industries.

A problem with using earnings growth to measure risk is that it is only unanticipated earnings growth which is a source of risk. In Section 6.2, it was argued that consumers did not systematically underestimate earnings growth. We therefore consider four possible expectations generating mechanisms, denoted a) through d) in Table 12. Mechanism a) assumes that individuals are correct in their expectation of average growth, and so expect median earnings in their industry to be the last period's actual earnings multiplied by one plus the growth rate. Mechanisms b), c) and d) are all ex post fitted trends. For each mechanism, we calculate the difference between the fitted trend and the realization each period and report the mean of the absolute value of these deviations. Manufacturing and agriculture do not differ greatly under three of these four measures. Both industries have lower estimated uncertainty than construction, commerce and financial services. Using the proportions of each cohort in each industry, we then calculate the implied mean uncertainty by cohort. The younger cohorts do have higher measured uncertainty that the older cohorts when expectations are approximated by any one of the mechanisms a) through d)[21].

A possible concern with the use of industry is that a person's choice of industry to work in may be correlated with their attitudes towards risk. As manufacturing, commerce and construction were growing rapidly when the younger workers entered the workforce, one may argue that labour demand, rather than labour supply, is the main reason for differences in industry participation across cohorts[22]. The higher wages in the modern sector of the economy may then compensate workers for the higher uncertainty. If industry choice and risk aversion are correlated, then one would expect the older cohorts to be on average more risk averse than the young. The effect would be to reduce differences in precautionary saving and consumption growth between cohorts, as the younger cohorts would be less risk averse on average with more uncertainty, whereas the older cohorts would be more risk averse with less uncertainty. The estimation carried out above did not find systematic differences between cohorts in the degree of prudence or risk aversion. In the event that cohorts do differ in risk aversion, endogenous industry choice serves to reduce the effect of inter-cohort differences in uncertainty on consumption growth. Therefore we can be confident that our estimates of the impact of industry participation on consumption

[21] The proportions used are relative proportions for the seven industries considered. The variation in the proportions caused by retirement is the reason why the estimated uncertainty is high for the oldest cohorts.

[22] The proportions of individuals in each cohort working in particular industries do not differ greatly over time. One possible explanation is that new labour demand is age-related.

growth provide at least a lower bound of this effect.

The effect of industry can also be investigated by a variant of equation (17). Consider the following decomposition of the uncertainty for individual i in industry j at time t:

$$\sigma^2_{ijt+1} = d_{ijt+1}\sigma^2_j + \varphi_c + \mu_i \ , \tag{18}$$

where d_{ijt+1} is a dummy variable which is unity if individual i works in industry j at time $t+1$, and σ^2_j in the earnings uncertainty in industry j[23]. Averaging over individuals in the same cohort gives the following equation to be estimated:

$$\begin{aligned} \Delta c_{ct+1} &= \alpha_c + \phi r_t + \sum_{j=1}^{J} p_{cjt+1}\sigma^2_j + \varepsilon_{ct+1} \\ \varepsilon_{ct+1} &= \overline{u}^{i(t+1)}_{ct+1} + \mu^{i(t+1)}_c + \left(c^{i(t+1)}_{ct} - c^{i(t)}_{ct} \right) , \end{aligned} \tag{19}$$

where p_{cjt+1} is the proportion of individuals in cohort c working in industry j at time $t+1$, and the σ^2_j's are now parameters to estimate. The first column of Table 13 contains the results of estimating equation (19). The industry coefficients are higher for the industries identified above as being riskier, but are not significant. Column four shows that this remains the case when we set $\alpha_c = \alpha$ for all cohorts. Lack of significance is caused by severe multicollinearity between the industry variables[24]. In the second column we include only the proportion of workers in agriculture as a regressor. This is now significant and negative, showing that a higher proportion of workers in agriculture reduces consumption growth. Principal components analysis finds that one component adequately summarizes the five industries: commerce, finance, construction, manufacturing and agriculture. The industry composite variable captures this component, and is the proportion of the cohort in any of the first four industries less the proportion in agriculture. This variable has a significant and positive coefficient, so that consumption growth is higher the more workers are in manufacturing, finance, commerce and construction relative to those in agriculture. Allowing for these industry effects accounts for much of the difference among cohorts, with the α_c's varying much less across cohorts for cohorts aged under 45 in 1976. The older cohorts now have higher α_c's, indicating that their consumption growth is higher than one would expect from their industry uncertainty. These cohorts approach and reach retirement during the sample period, and it is likely that uncertainty related to aging becomes a more important source of risk for these cohorts.

[23] It is assumed that individuals work only in one industry. This is in accordance with the data.

[24] As we omit industry categories in which less than 3 percent of any cohort participates, the industry variables do not sum to exactly unity, and so are not perfectly collinear with the constant.

7.4 Habit Formation with Prudence

We have found that both habit formation and precautionary saving can help explain the rapid consumption growth experienced in Taiwan. Habits make individuals more willing to postpone consumption, reducing the level of prudence needed to explain a given consumption growth rate. Conversely, a high level of prudence will cause changes in consumption to be positively correlated, even if there is no habit formation. The omission of one of these effects may therefore cause us to erroneously conclude that there is evidence for the other, hence it is important to allow for both effects at once. The two effects may also interact. For example, being cautious to begin new habits may increase the amount of precautionary savings when income growth is rapid.

Dynan (2000) derives the log-linearized Euler equation with habit formation, arriving at a combination of equations (13) and (8):

$$\Delta \ln C_{t+1} = \alpha + \gamma \Delta \ln C_t + \lambda' \Delta Z_{t+1} + u_{t+1} \ , \tag{20}$$

where α is a function of the real interest rate, the time discount factor, and the forecast error variance. Appendix A.4 gives the pseudo-panel covariance matrix used in estimation of this equation. Dynan investigates the effect of changing the real interest rate, but assumes the forecast error variance to be constant. In the absence of habits, $\gamma = 0$ and the equation reduces to that in equation (13). Figure 13 presents the estimated drift term and habit coefficient, γ_c, for each cohort. The habit coefficient, γ_c, is insignificantly different from zero for almost every cohort, and many of the point estimates are negative. Thus after allowing for simple forms of precautionary savings, there is no evidence for habit formation. This finding was robust to the addition of the real interest rate, industry proportions, and aggregate shocks into the model, as was done in the earlier precautionary savings regressions. The results therefore concur with Dynan (2000), who finds no evidence of habit formation using data from the United States. Our earlier evidence for habit formation was therefore a spurious finding caused by the omission of precautionary effects in the model. In contrast, the evidence for precautionary behaviour still holds: the precautionary drift term is still positive, significant, and larger for the younger cohorts. Therefore we conclude that it is precautionary behaviour, rather than habit formation, which has caused the rapid consumption growth in Taiwan.

8 Implications for Inequality and Saving

Deaton and Paxson (1994a) show that an implication of the PIH is that, for any birth cohort, inequality in both consumption and income should grow with age. Although their empirical work supports this, they find that the age-inequality profile in Taiwan is convex, so that inequality increases at an increasing rate as the cohort ages. Such a finding is only consistent with the martingale form of the PIH if earnings contain a large stationary component. However, our analysis finds earnings and income to be highly non-stationary processes in Taiwan.

The simple AR(1) models estimated for earnings and income in this paper can directly give a convex age-inequality profile when inequality is measured by income. For example, if the income process is $y_{it} = \rho y_{it-1} + v_{it}$, with $\rho > 1$ and the v_{it} are i.i.d. $(0, \sigma_v^2)$, then taking cross-sectional variances gives:

$$var_i(y_{it}) = \rho^2 var_i(y_{it-1}) + \sigma_v^2 . \tag{21}$$

As $\rho^2 > 1$, the cross-sectional dispersion in income increases at an increasing rate as the population ages. The atheoretical AR(1) model estimated for consumption is also of this form, giving the same result. The precautionary savings models estimated will give similar results if we allow the drift term to be stochastic. The consequence is that an aging population will increase aggregate inequality by even more than under the PIH. The calculations in Deaton and Paxson (1995) may therefore serve as lower bounds of the impact of an aging population on aggregate inequality.

Consumption growth occurs as a result of precautionary saving behaviour, with the amount of growth depending on the level of prudence and the uncertainty surrounding labour income innovations. Any reduction in income uncertainty serves to reduce consumption growth and hence reduces the impact of an aging society on aggregate inequality. Further enlargement of the social assurance system in Taiwan, combined with resolution of the political situation with China would therefore result in lowering the level of aggregate inequality.

The high level of prudence found in Taiwan can also help explain the high savings rates experienced in Taiwan: consumers save to prepare and forearm themselves in the face of uncertainty. The external and political environment can therefore have a sizeable impact on the level of savings, through their effect on expected future uncertainty. Precautionary behaviour reduces the incentives of the young to borrow in anticipation of income growth over their lifetimes. As a result, an aging population may result in a greater fall in aggregate savings than calculated by Deaton and Paxson (1994b, 2000a) under the PIH model. Thus demographic changes may help to explain the rise in savings rates during Taiwan's initial growth period, and the fall in the aggregate savings rate since 1987.

9 Conclusions

Our analysis finds that the martingale model of consumption in Taiwan can be rejected in favour of alternatives which allow for a precautionary motive. Taiwan's rapid consumption growth is found to be largely a result of high levels of prudence coupled with uncertainty about future income. Other theories of consumption may also play a role, but are not by themselves capable of explaining the high consumption growth and high savings simultaneously experienced in Taiwan. This study has allowed for substantial amounts of inter-cohort heterogeneity, and finds that younger cohorts experienced faster consumption growth than did older cohorts. We attribute this in part to the greater riskiness of earnings in the industries in which the young are more prevalent. Future research should aim to allow for greater intra-cohort heterogeneity, as other explanations of consumption behaviour may be more important for a minority of individuals. Liquidity constraints are an obvious example.

A second area for future research is to attempt to apply quantile regression methods to dynamic pseudo-panels, in order to directly examine changes in the distribution of consumption over time. Such methods would allow us to better quantify the impact of demographic changes on aggregate and cohort level inequality.

A Appendix

A.1 Pseudo-panel estimation of the habit formation regression

Consistency of the OLS and GLS estimators applied to (9) can be shown by a simple extension of Theorem 1 in Mckenzie (2000a) for $n_c \to \infty$, T fixed asymptotics. Following the proof of Lemma 1, one can show that the covariance matrix of the standardized regression errors in equation (9) is given by:

$$\begin{aligned} var\left(\sqrt{n_c}\varepsilon_{c,t+1}\right) &= var_i\left(c_{i,t+1}\right) + (1+\gamma)^2 var_i\left(c_{i,t}\right) \\ &\quad +\gamma^2 var_i\left(c_{i,t-1}\right) \\ cov\left(\sqrt{n_c}\varepsilon_{c,t+1}, \sqrt{n_c}\varepsilon_{c,t}\right) &= -(1+\gamma)\left[var_i\left(c_{i,t}\right) + \gamma var_i\left(c_{i,t-1}\right)\right] \\ cov\left(\sqrt{n_c}\varepsilon_{c,t+1}, \sqrt{n_c}\varepsilon_{c,t-1}\right) &= \gamma var_i\left(c_{i,t-1}\right) \\ cov\left(\sqrt{n_c}\varepsilon_{c,t+1}, \sqrt{n_c}\varepsilon_{c,t-s}\right) &= 0,\ s \geq 2\ . \end{aligned}$$

A consistent estimator of this covariance matrix is then obtained by replacing the population variances with the sample cross-sectional variances, and the parameter γ with its consistent estimate.

A.2 Pseudo-panel estimation of Equation (15)

Note that the error term ε_{ct} is exactly that of the AR(1) model in Mckenzie (2000a) when the autoregressive parameter, β_c, is set to unity. Hence one can use the covariance estimator given there after imposing $\beta_c = 1$. As the cross-sectional sample size, $n_c \to \infty$ and $T/n_c \to 0$, the error term ε_{ct} converges in probability to zero. However for alternative asymptotic directions, the instrumental variables methods given in Mckenzie (2000a) will be required for consistency. These can also be applied directly after setting β_c equal to unity.

A.3 Second-order Taylor expansion of the Euler equation

The Euler equation for consumer i in the standard consumer's problem, with real interest rate r_t and rate of time preference δ, is:

$$U'(C_{it}) = \left(\frac{1+r_t}{1+\delta}\right) E_t\left(U'(C_{it+1})\right) . \tag{22}$$

Following Dynan (1993), we take a second-order Taylor expansion of $U'(C_{it+1})$ about C_{it} to get:

$$U'(C_{it+1}) = U'(C_{it}) + U''(C_{it})(C_{it+1} - C_{it}) + \frac{1}{2}U'''(C_{it})(C_{it+1} - C_{it})^2 . \tag{23}$$

Substituting (23) into (22) and rearranging gives Dynan's (1993, p. 1106) equation 4:

$$E_t\left(\frac{C_{it+1} - C_{it}}{C_{it}}\right) = \frac{1}{\xi}\left(\frac{r_t - \delta}{1+r_t}\right) + \frac{\rho}{2}E_t\left[\left(\frac{C_{it+1} - C_{it}}{C_{it}}\right)^2\right] , \tag{24}$$

where $\xi = -C_{it}U''/U'$ is the coefficient of relative risk aversion and $\rho = -C_{it}U'''/U''$ is Kimball's (1990) coefficient of relative prudence. For pseudo-panel analysis, it is more convenient to multiply through by C_{it} to obtain a variant of equation 1a in Merrigan and Normandin (1996):

$$E_t(C_{it+1} - C_{it}) = \frac{1}{\xi^*}\left(\frac{r_t - \delta}{1+r_t}\right) + \frac{\rho^*}{2}E_t\left[(C_{it+1} - C_{it})^2\right] . \tag{25}$$

Now $\xi^* = C_{it}\xi$ and $\rho^* = -U'''/U''$ is the coefficient of absolute prudence, as defined in Kimball (1990). Under rational expectations we can write $C_{it+1} = E_t(C_{it+1}) + u_{it+1}$, with $E_t(u_{it+1}) = 0$, and $E_t(C_{it+1} - C_{it})^2 = (C_{it+1} - C_{it})^2 + v_{it+1}$ where $E_t(v_{it+1}) = 0$. Then equation (25) relates the realized change in consumption to the squared change in consumption as follows:

$$(C_{it+1} - C_{it}) = \frac{1}{\xi^*}\left(\frac{r_t - \delta}{1+r_t}\right) + \frac{\rho^*}{2}(C_{it+1} - C_{it})^2 + u_{it+1} + \frac{\rho^*}{2}v_{it+1} \tag{26}$$

With genuine panel data, one could estimate this equation using instrumental variables, as in Dynan (1993). Merrigan and Normandin (1996) apply Moffitt's dynamic pseudo-panel estimator to a general version of equation, although Verbeek and Vella (2000) have since shown that this does not produce consistent estimates when there are time-varying exogenous regressors. We therefore follow the methods developed in Mckenzie (2000a), which are still consistent with time-varying exogenous regressors, and additionally allow for parameter heterogeneity across cohorts. Thus one can determine whether the degree of absolute (or relative) prudence varies across cohorts.

The first step is to take means of (26) across individuals in cohort c at time $t+1$ to get:

$$\begin{aligned}\left(\overline{C}_{ct+1}-\overline{C}_{ct}\right) &= \frac{1}{\xi^*}\left(\frac{r_t-\delta}{1+r_t}\right)+\frac{\rho^*}{2}\frac{1}{n_c}\sum_{i=1}^{n_c}\left(C_{it+1}-C_{it}\right)^2+\overline{u}_{ct+1} \\ &\quad +\frac{\rho^*}{2}\overline{v}_{ct+1}\ , \end{aligned} \tag{27}$$

where $\overline{C}_{ct+1}=\frac{1}{n_c}\sum_{i=1}^{n_c}C_{it+1}$. Let $C_{it+1}=\overline{C}_{ct+1}+\mu_i+\eta_{it+1}$, $\mu_i\sim i.i.d.\left(0,\sigma_\mu^2\right)$ and $\eta_{it+1}\sim i.i.d.\left(0,\sigma_\eta^2\right)$[25]. Then algebraic manipulation of $\frac{1}{n_c}\sum_{i=1}^{n_c}\left(C_{it+1}-C_{it}\right)^2$ gives:

$$\begin{aligned}&\frac{1}{n_c}\sum_{i=1}^{n_c}\left(C_{it+1}-C_{it}\right)^2= \\ &\left(\overline{C}_{ct+1}-\overline{C}_{ct}\right)^2+\frac{1}{n_c}\sum\left(C_{it+1}-\overline{C}_{ct+1}\right)^2 \\ &+\frac{1}{n_c}\sum\left(C_{it}-\overline{C}_{ct}\right)^2-2\frac{1}{n_c}\sum\left(C_{it+1}-\overline{C}_{ct+1}\right)\left(C_{it}-\overline{C}_{ct}\right) \\ &=\left(\overline{C}_{ct+1}-\overline{C}_{ct}\right)^2+\frac{1}{n_c}\sum\left(\mu_i+\eta_{it+1}\right)^2 \\ &+\frac{1}{n_c}\sum\left(\mu_i+\eta_{it}\right)^2-2\frac{1}{n_c}\sum\left(\mu_i+\eta_{it+1}\right)\left(\mu_i+\eta_{it}\right) \\ &=\left(\overline{C}_{ct+1}-\overline{C}_{ct}\right)^2+2\sigma_\eta^2+o_p(1)\ .\end{aligned}$$

This decomposes the average squared consumption change into a component measuring changes in the cohort mean, and a second component reflecting dispersion about the cohort mean. Substituting into (27) gives:

$$\left(\overline{C}_{ct+1}^{i(t+1)}-\overline{C}_{ct}^{i(t+1)}\right)=\frac{1}{\xi^*}\left(\frac{r_t-\delta}{1+r_t}\right)+\rho^*\sigma_\eta^2+\frac{\rho^*}{2}\left(\overline{C}_{ct+1}^{i(t+1)}-\overline{C}_{ct}^{i(t+1)}\right)^2+\overline{\omega}_{ct+1}^{i(t+1)}\ , \tag{28}$$

where $\overline{\omega}_{ct+1}^{i(t+1)}\xrightarrow{p}0$ as $n_c\to\infty$ for fixed T, and the superscript indicates that this equation applies for means taken over individuals in the sample at time $t+1$. Estimation using pseudo-panel data requires replacing the unobserved $\overline{C}_{ct}^{i(t+1)}$ with the mean over individuals in the sample at time t, $\overline{C}_{ct}^{i(t)}$. Therefore the equation to be estimated is:

$$\begin{aligned}\left(\overline{C}_{ct+1}^{i(t+1)}-\overline{C}_{ct}^{i(t)}\right) &= \frac{1}{\xi^*}\left(\frac{r_t-\delta}{1+r_t}\right)+\rho^*\sigma_\eta^2+\frac{\rho^*}{2}\left(\overline{C}_{ct+1}^{i(t+1)}-\overline{C}_{ct}^{i(t)}\right)^2+\varepsilon_{ct+1} \\ \varepsilon_{ct+1} &= \overline{\omega}_{ct+1}^{i(t+1)}+\left(1-\rho^*\overline{C}_{ct+1}^{i(t+1)}\right)\left(\overline{C}_{ct}^{i(t+1)}-\overline{C}_{ct}^{i(t)}\right) \\ &\quad+\frac{\rho^*}{2}\left(\left(\overline{C}_{ct}^{i(t+1)}\right)^2-\left(\overline{C}_{ct}^{i(t)}\right)^2\right)\ .\end{aligned} \tag{29}$$

[25] The i.i.d. assumption can be weakened to one allowing for general forms of temporal dependence and weak spatial dependence without impacting on the consistency results (see Mckenzie, 2000a).

It is clear that $\varepsilon_{ct+1} \xrightarrow{p} 0$ as $n_c \to \infty$ for fixed T, so that OLS applied to (29) will be consistent for large n_c and small T. However a finite-sample bias will result from the error term ε_{ct+1} being correlated with the regressor $\left(\overline{C}_{ct+1}^{i(t+1)} - \overline{C}_{ct}^{i(t)}\right)^2$. Instrumental variables methods can be used to achieve consistency in alternative asymptotic directions, as in Mckenzie (2000a). If we assume that the real interest rate equals the rate of time preference, then the first term drops out. The second term reflects transitory deviations of an individual's consumption from the cohort mean. If all differences are due to individual specific effects, this term will also drop out.

The variance-covariance matrix of $\sqrt{n_c}\varepsilon_{ct+1}$ reflects the measurement errors arising from sampling different individuals each period. The scaled errors are heteroskedastic and have an MA(1) structure. For the models studied in Mckenzie (2000a), the variances could be expressed as simple functions of cross-sectional covariances. Unfortunately the nonlinear structure of (29) means that the analogous expressions become much more complicated, and more reliant on ancillary assumptions. Therefore we instead use the Newey-West/Bartlett estimator using the fitted errors $\sqrt{n_c}\hat{\varepsilon}_{ct+1}$. We impose the MA(1) structure so that autocorrelations of lag greater than one are set to zero[26].

If we use the approximation $(C_{it+1} - C_{it})/C_{it} \simeq \log C_{it+1} - \log C_{it}$ in equation (25), then we get equation 1b in Merrigan and Normandin (1996). Following the same steps as were used above, we arrive at the cohort-level estimating equation:

$$\Delta c_{ct+1} = \lambda^* + \frac{\rho}{2}\left(\Delta c_{ct+1}\right)^2 + \varepsilon^*_{ct+1}\,, \tag{30}$$

here $c_{ct+1} = \frac{1}{n_c}\sum_{i=1}^{n_c} \log C_{it+1}$ is the cohort mean of log consumption and λ^* is a constant. Note that with pseudo-panel data we can calculate the mean of the logs, which would not be possible with aggregate level data. The errors ε^*_{ct+1} take an analogous form to ε_{ct+1}, and again will be heteroskedastic and have an MA(1) structure.

A.4 Estimation of Equation (20).

In terms of observed sample means, equation (20) in cohort form becomes:

$$\begin{aligned} \overline{c}_{ct+1}^{i(t+1)} - \overline{c}_{ct}^{i(t)} &= \alpha_c + \gamma_c\left(\overline{c}_{ct}^{i(t)} - \overline{c}_{ct-1}^{i(t-1)}\right) + \lambda'\Delta Z_{t+1} + \varepsilon_{ct+1} \\ \varepsilon_{ct+1} &= (1+\gamma_c)\left(\overline{c}_{ct}^{i(t+1)} - \overline{c}_{ct}^{i(t)}\right) - \gamma_c\left(\overline{c}_{ct-1}^{i(t+1)} - \overline{c}_{ct-1}^{i(t-1)}\right) + \overline{u}_{ct+1}^{i(t+1)}\,. \end{aligned}$$

It is clear that under the assumption of cross-sectional independence, the errors will have a MA(2) structure. Following the methods of Mckenzie (2000a), one

[26] The Newey-West estimator is consistent as $T \to \infty$. As we are using large n_c, small T asymptotics elsewhere, imposing the MA(1) structure on the covariance estimator is desirable.

can show that:

$$\begin{aligned} var\left(\sqrt{n_c}\varepsilon_{ct+1}\right) &= var_i\left(c_{it+1}\right) + \left(1+\gamma_c\right)^2 var_i\left(c_{it}\right) + \gamma_c^2 var_i\left(c_{it-1}\right) \\ cov\left(\sqrt{n_c}\varepsilon_{ct+1}, \sqrt{n_c}\varepsilon_{ct}\right) &= -\left(1+\gamma_c\right)\left[var_i\left(c_{it}\right) + \gamma_c var_i\left(c_{it-1}\right)\right] \\ cov\left(\sqrt{n_c}\varepsilon_{ct+1}, \sqrt{n_c}\varepsilon_{ct-1}\right) &= \gamma_c var_i\left(c_{it-1}\right) \\ cov\left(\sqrt{n_c}\varepsilon_{ct+1}, \sqrt{n_c}\varepsilon_{ct-s}\right) &= 0 \text{ for } s \geq 2 \end{aligned}$$

Sample cross-sectional variances and parameter estimates can then be substituted to give a consistent covariance matrix estimator. Note that if there are no habits, so $\gamma_c = 0$, the estimator reduces to that used for equation (13).

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Figure 1

Taiwanese Real Consumption and Income per Capita 1952–97

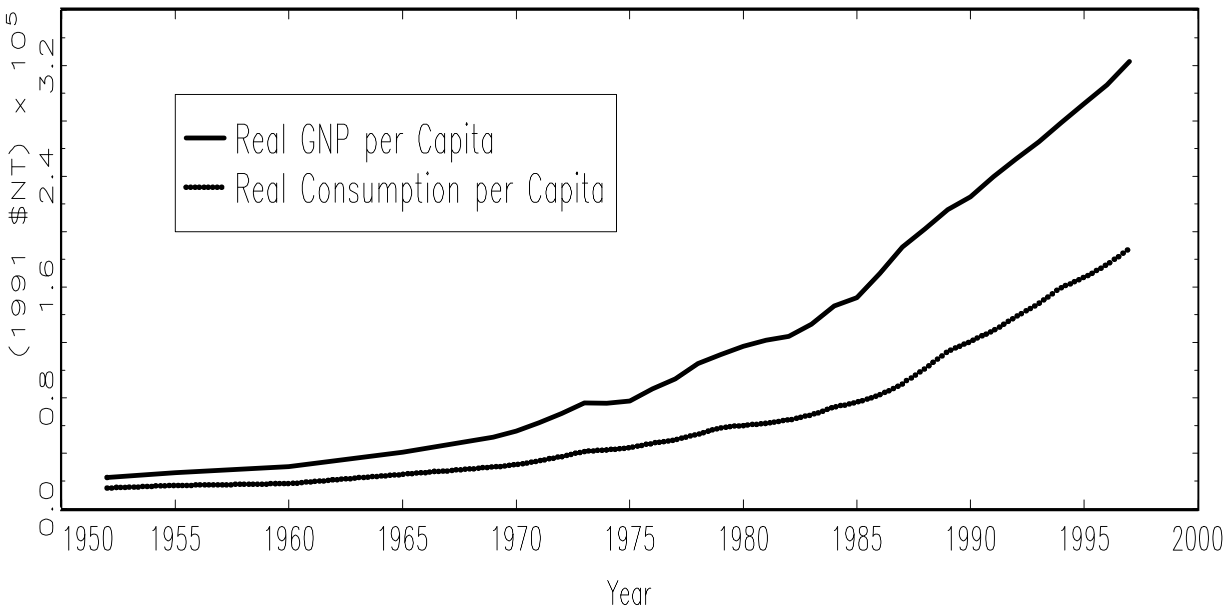
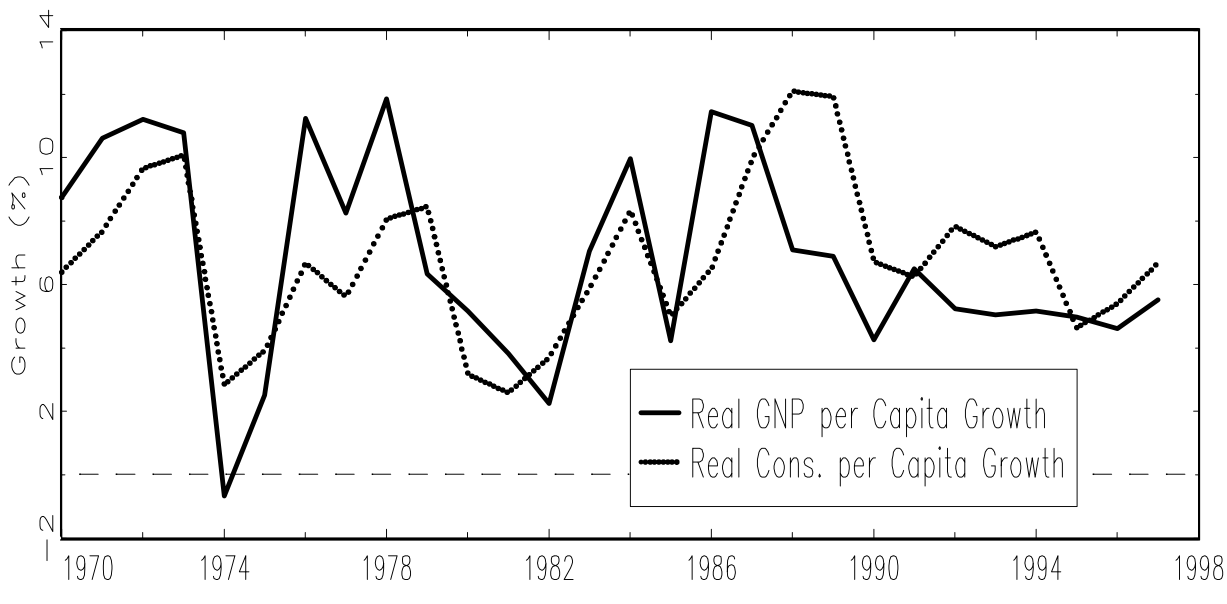
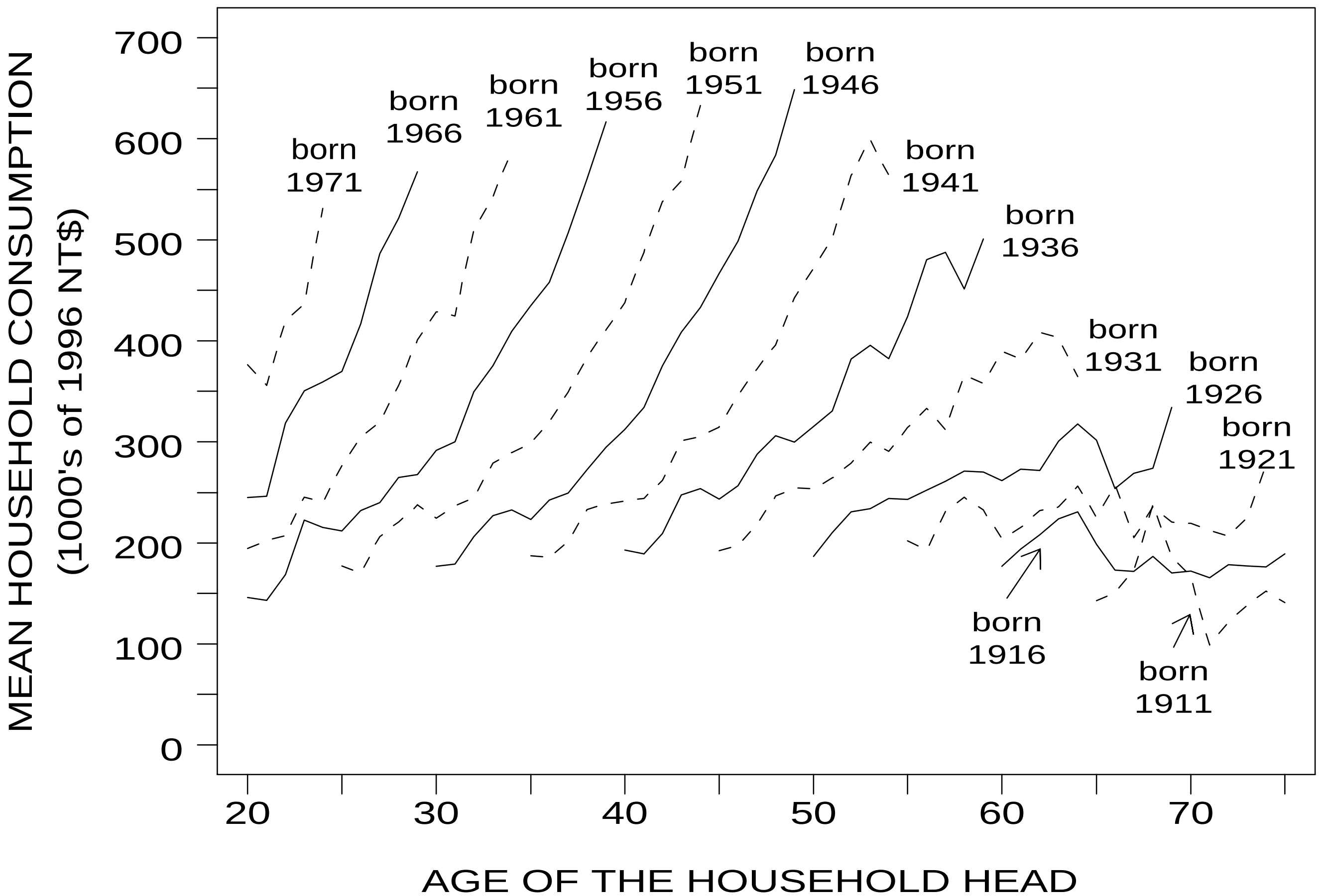


Figure 2: Taiwanese Real Consumption and Income per Capita Growth Rates 1970–97



source: Taiwan Statistical DataBook 1999

Figure 3: Taiwanese Consumption over the Life-Cycle for Cohorts



source: Survey of Personal Income Distribution in Taiwan, 1976-96

Figure 4a: Comparison of OLS estimates of Beta
AR(1) model: C(t)=b(c)C(t−1)+u(t)

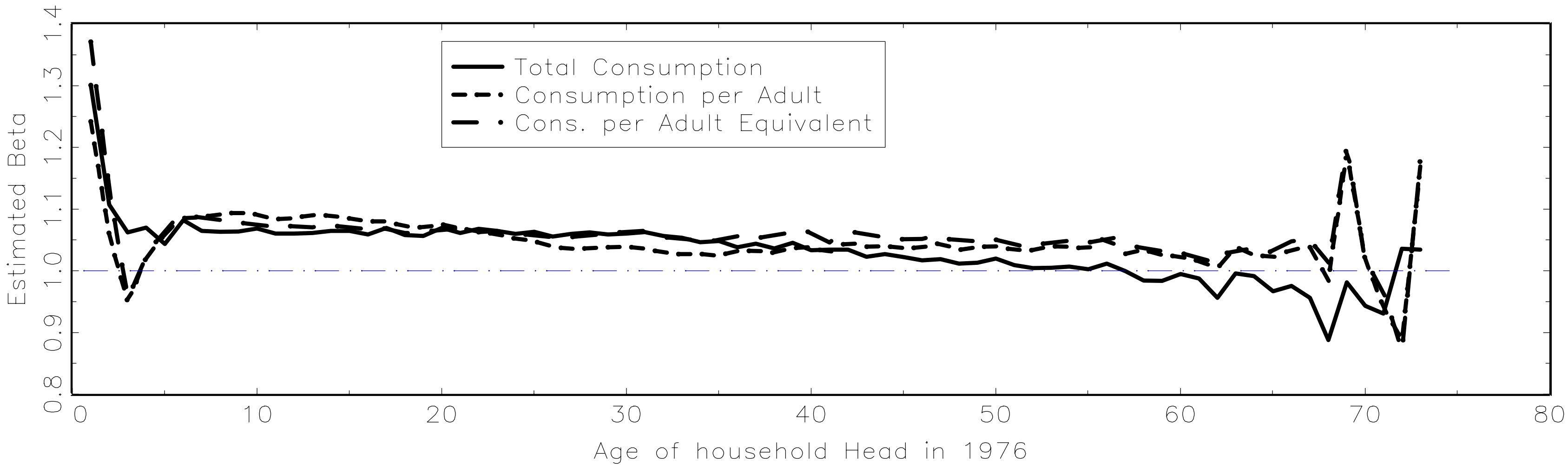


Figure 4b: Estimates of Beta
Comparison of OLS, GLS and IV

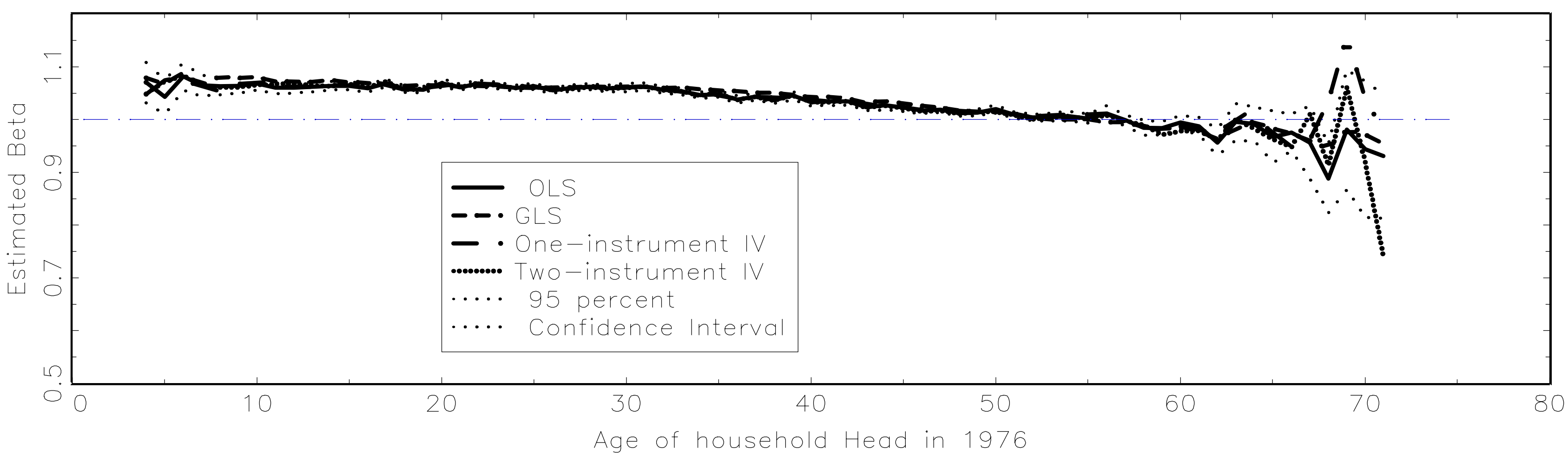


Figure 5a: Beta estimates for Birth–Education Cohorts
For AR(1) Model of Total Consumption

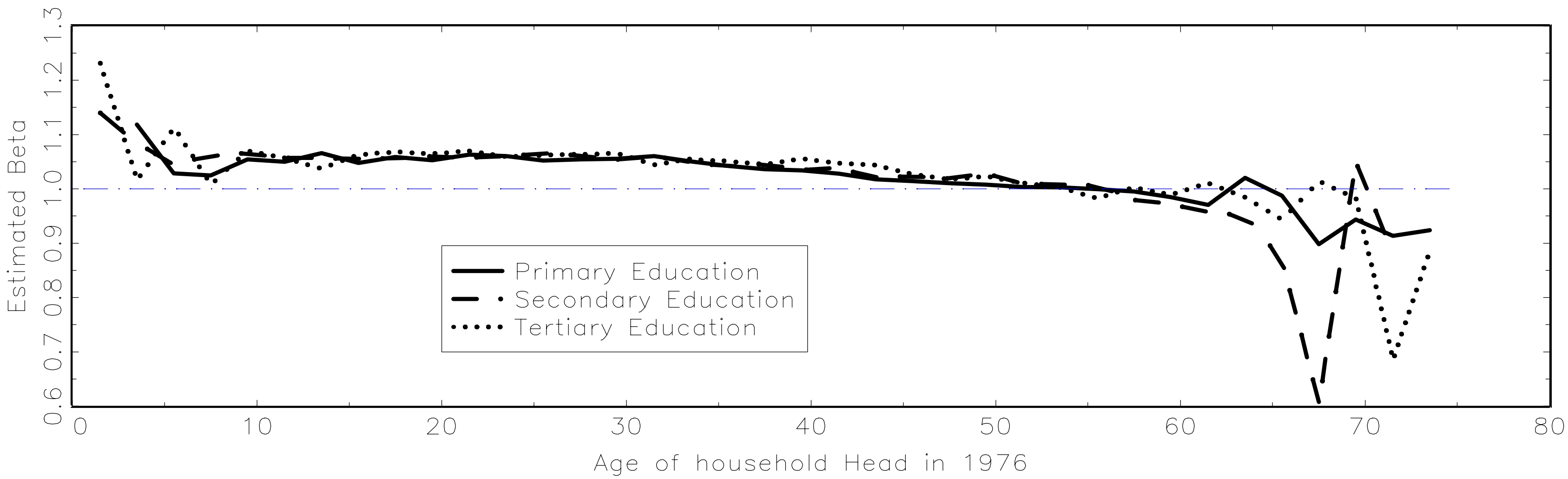


Figure 5b: Estimates using Consumption per Adult

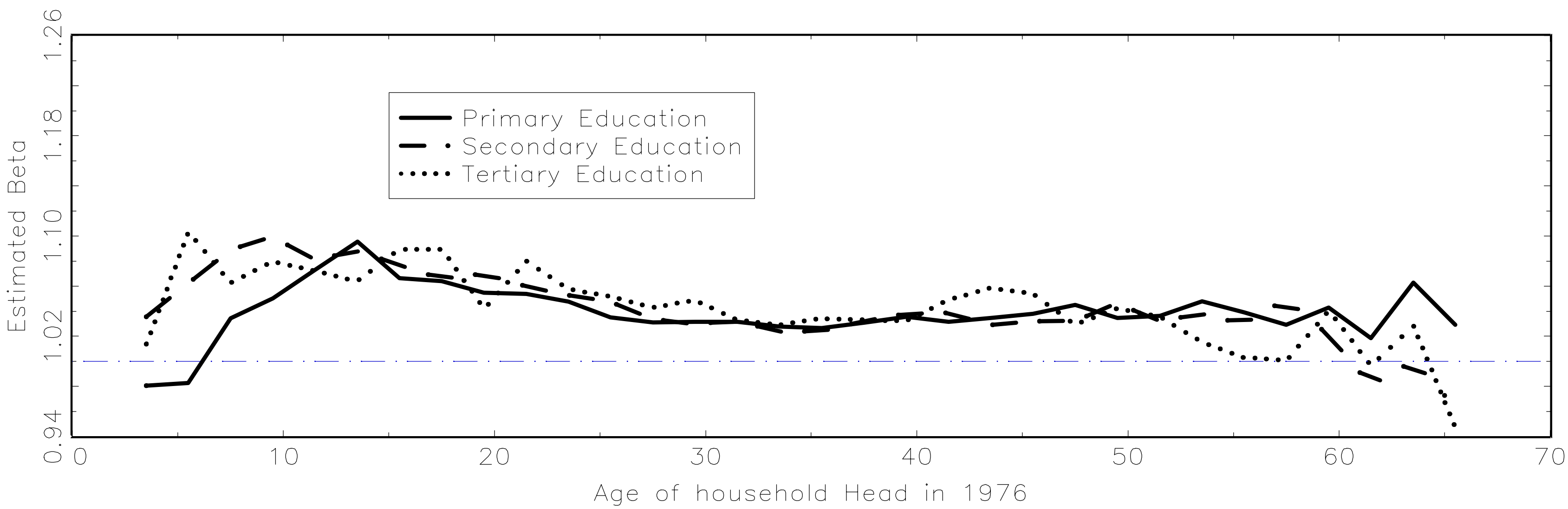


Figure 6
Distribution of Household Average Savings Ratio

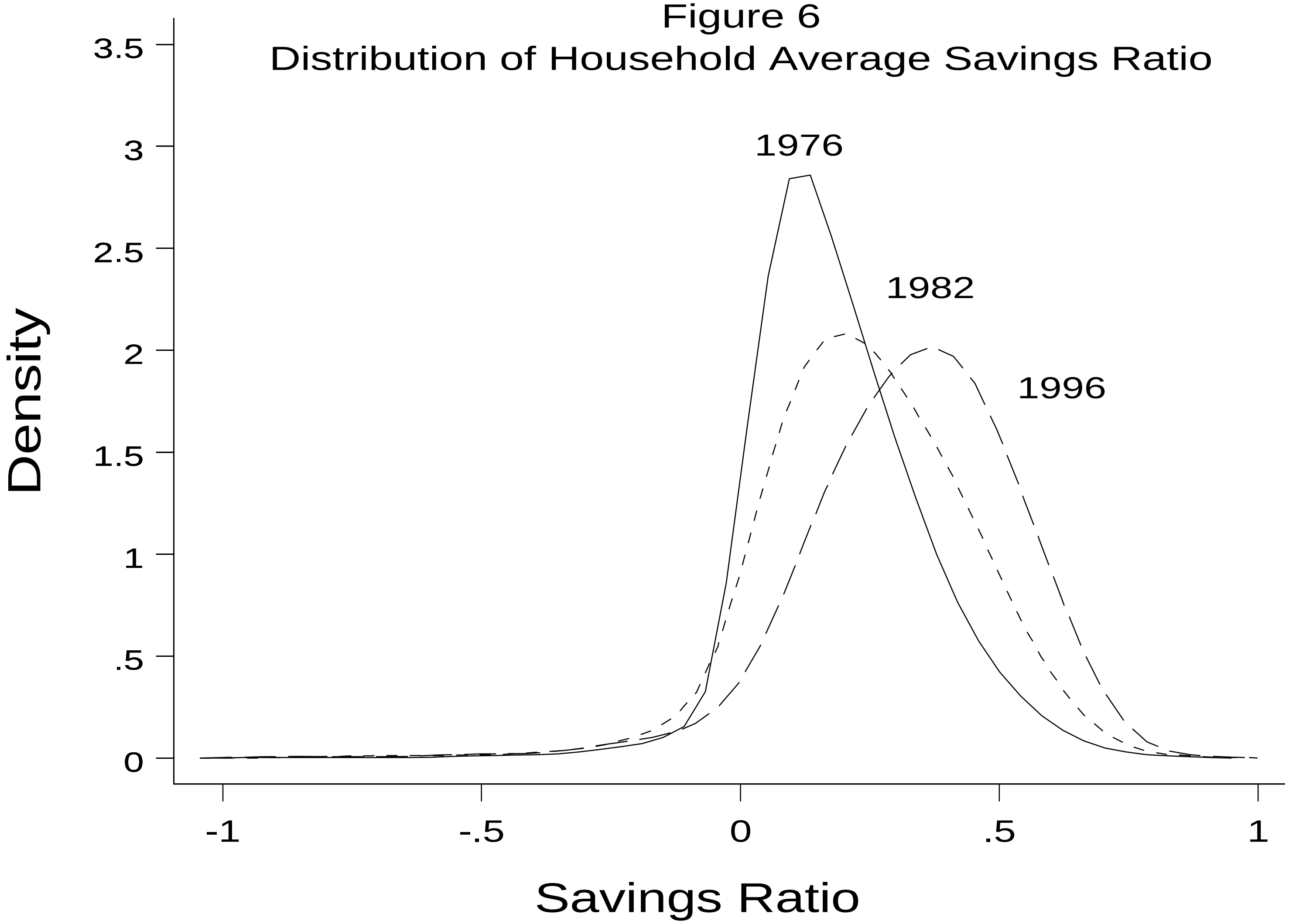


Figure 7: What would earnings expectations have had to have been for the PIH to hold?: Results for cohort aged 25 in 1976

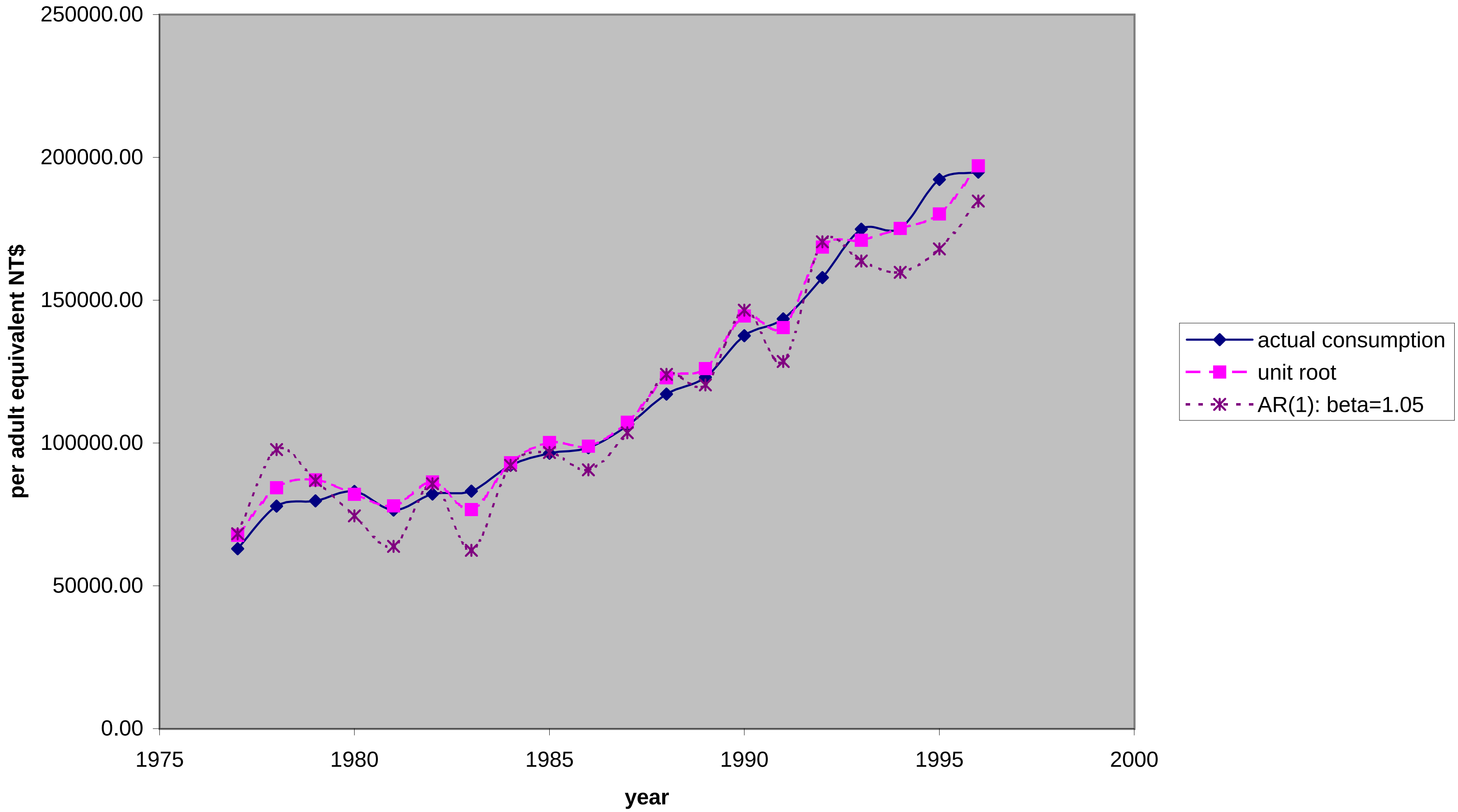
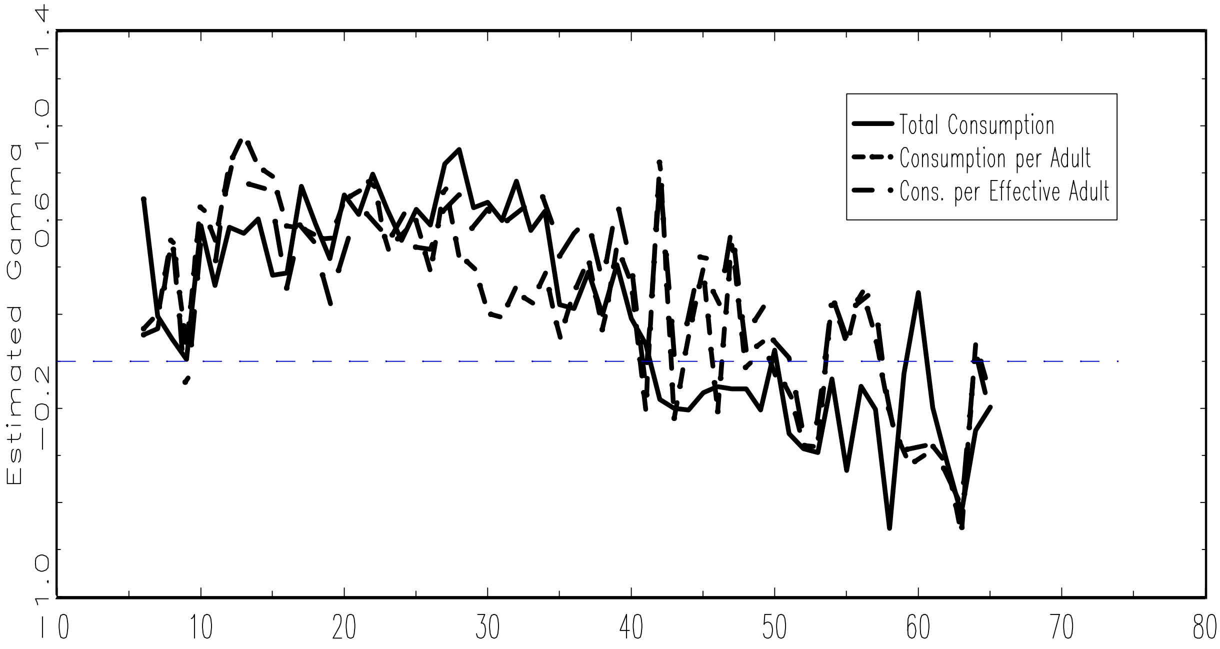


Figure 8: Estimates of Habit Persistence

Comparison of OLS Estimates



Confidence Interval for Gamma using Consumption per Adult Equivalent

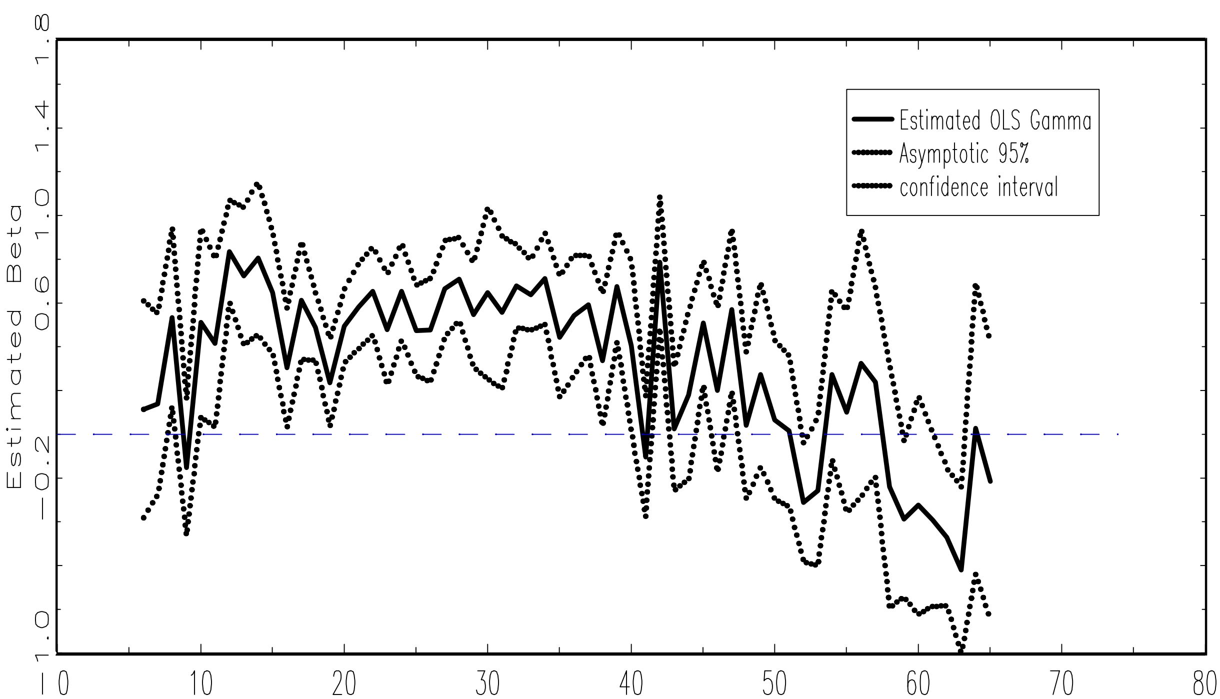
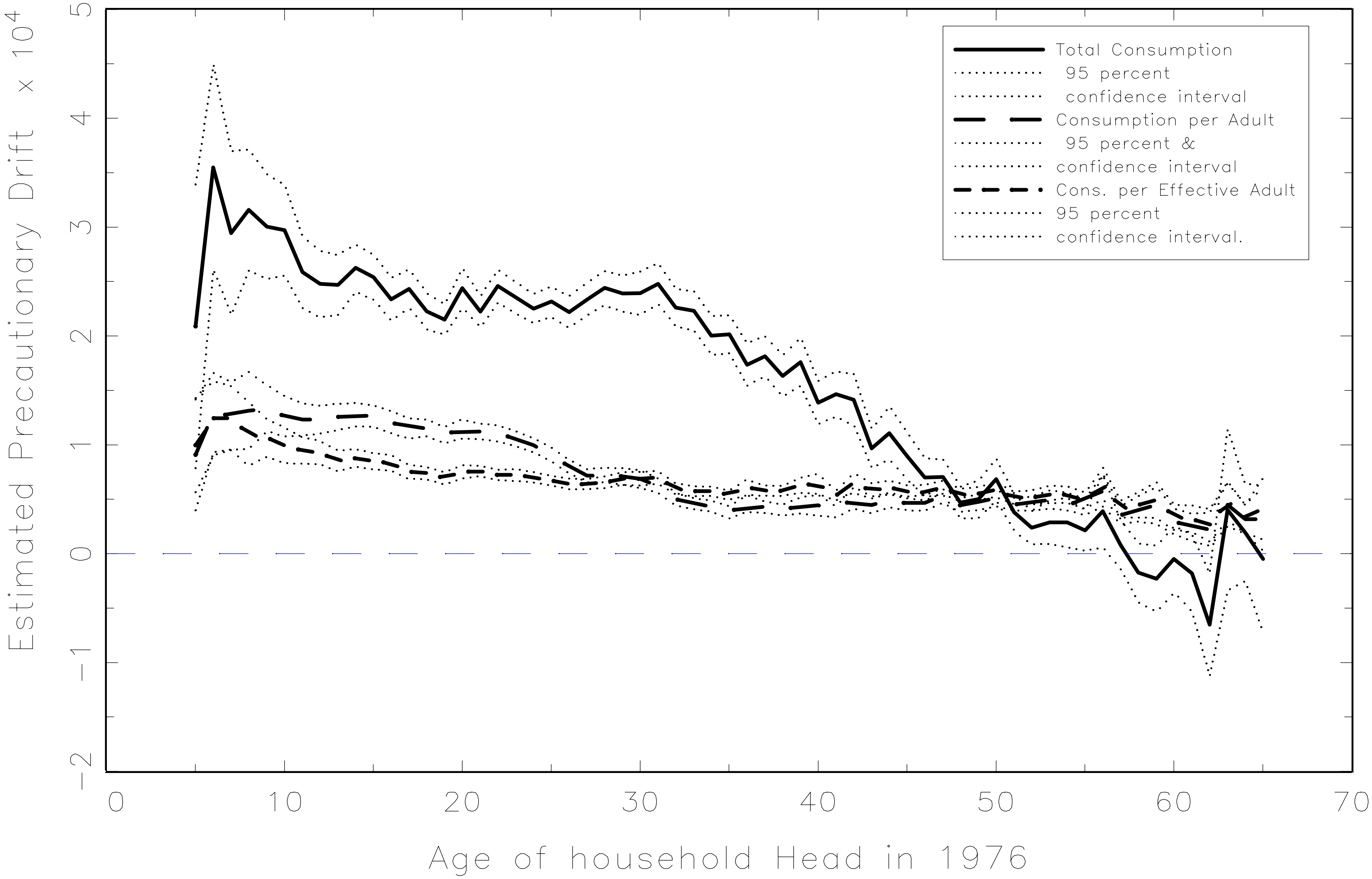


Figure 9: Estimates of the Precautionary Drift Term
Model C(c,t)−C(c,t−1)=a(c)+u(c,t)



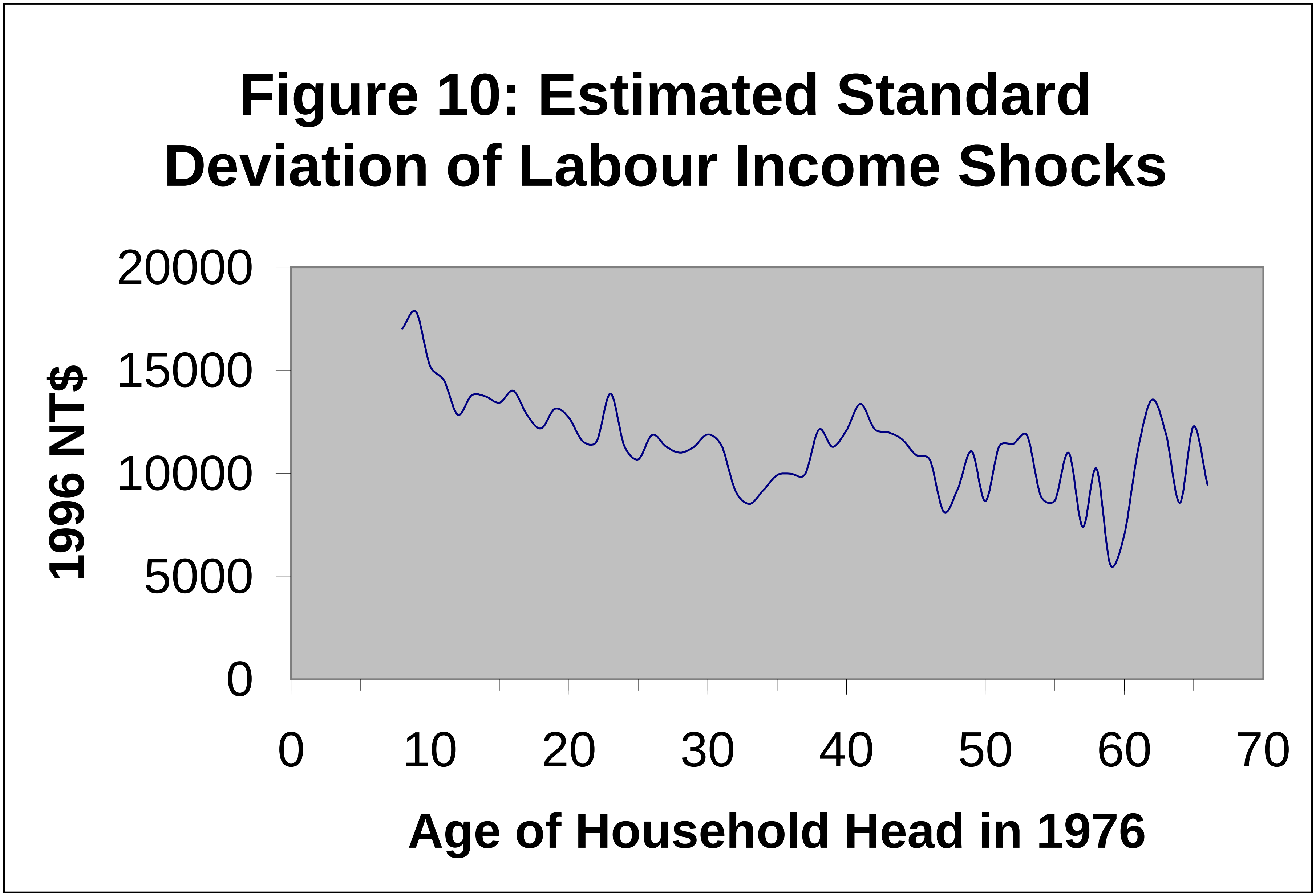


Figure 10: Estimated Standard Deviation of Labour Income Shocks
1996 NT$
20000
15000
10000
5000
0
0
10
20
30
40
50
60
70
Age of Household Head in 1976

Figure 11
Estimates of the Coefficient of Relative Prudence

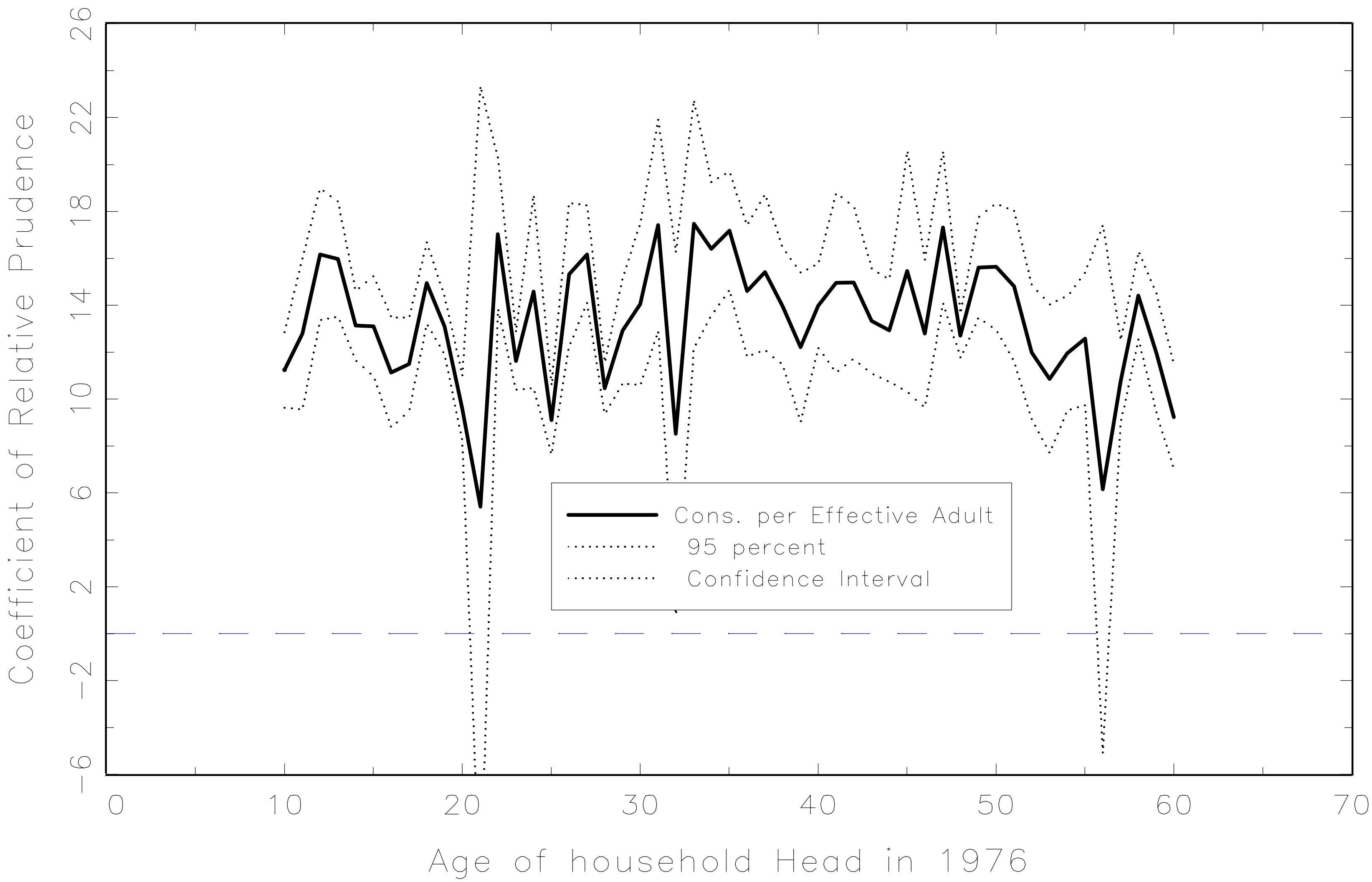


Figure 12: Percentage of Cohort Working in Each Industry

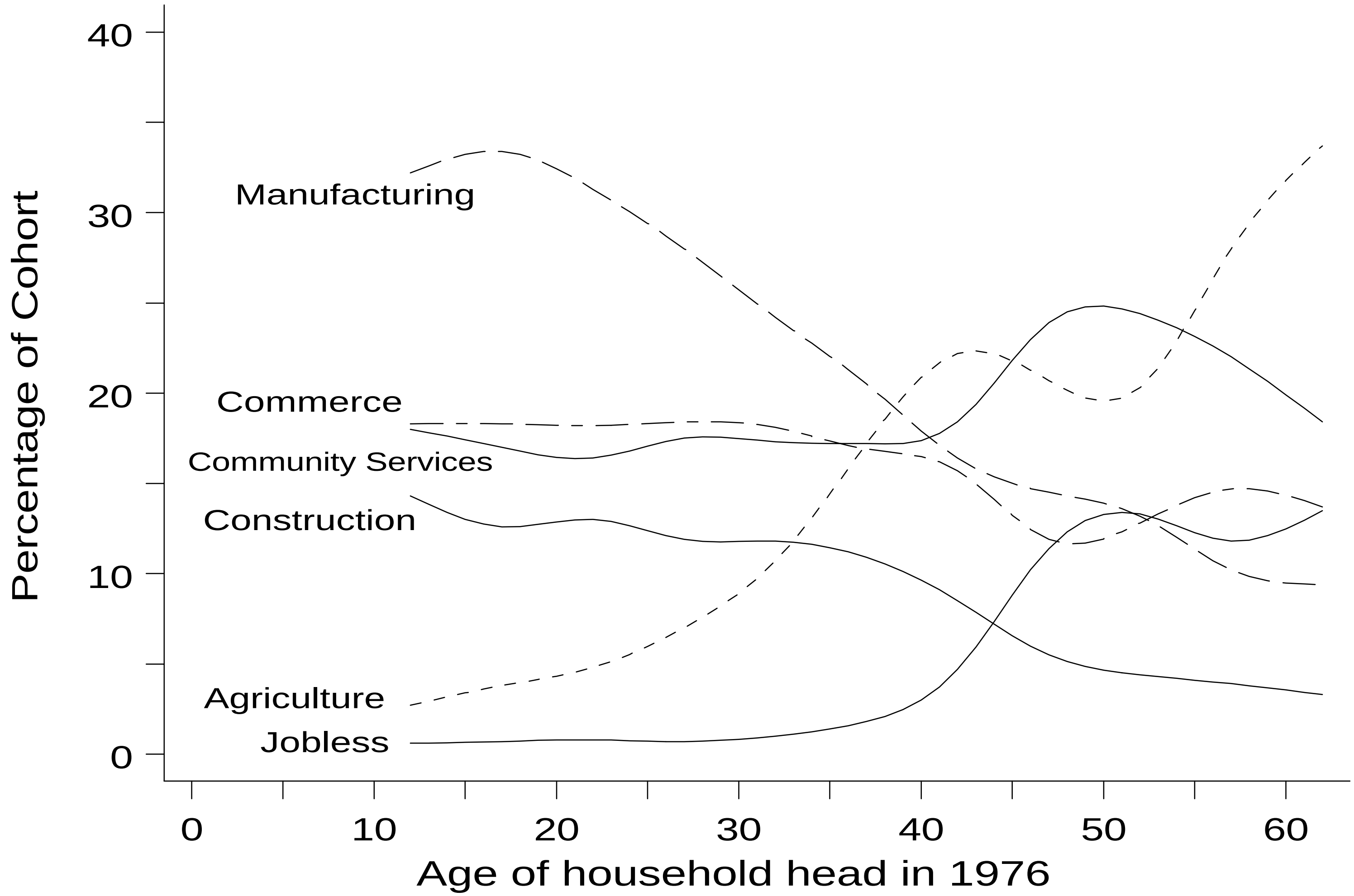
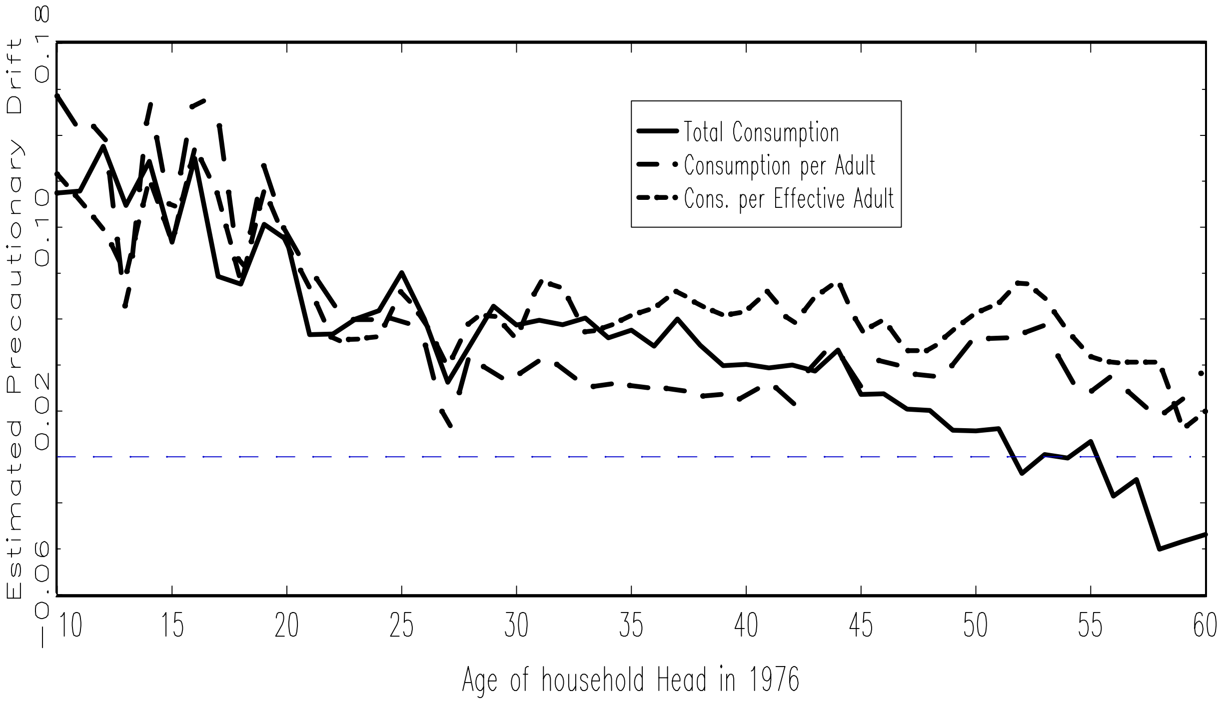


Figure 13: Prudence with Habits Regression

Estimate of Drift Term



Habit Coefficient

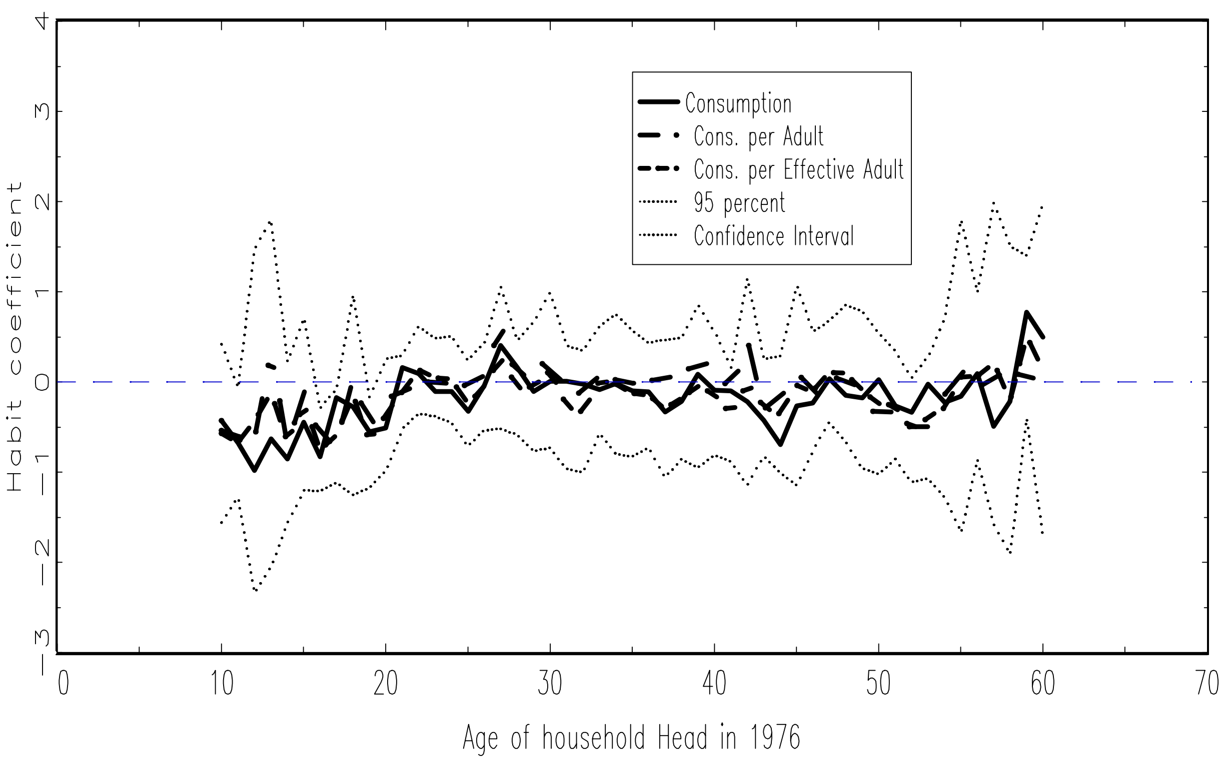


Table 1: Estimates of the slope parameter in an AR(1) Model of Consumption
Fitted Model: C(t)=b(c)C(t-1)+u(t)
Results for every fifth cohort

	Age of Household Head in 1976														*Pooled*	*Wald Tests of Parameter Homogeneity*		
	5	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*65*	*70*	*Estimator*	*All Equal*	*Five-Year Pooling*	*Two-Year Pooling*
Total Non-durable Consumption																(chi-squared dfs in parentheses)		
OLS	1.043	1.069	1.064	1.069	1.063	1.060	1.048	1.033	1.022	1.020	1.002	0.995	0.967	0.944	1.044	2243.1	100.0	62.3
	(0.017)	(0.006)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.007)	(0.025)	(0.066)		(73)	(52)	(37)
GLS	1.068	1.081	1.070	1.065	1.060	1.063	1.055	1.042	1.030	1.016	1.001	0.987	0.983	0.972		14014.5	396.0	83.6
	(0.012)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)	(0.012)	(0.044)		(73)	(52)	(37)
one instrument IV	1.075	1.074	1.067	1.070	1.065	1.061	1.050	1.034	1.023	1.017	1.010	0.988	0.971	1.040		1976.3	95.1	46.0***
	(0.021)	(0.008)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.021)	(0.069)		(69)	(52)	(37)
two instrument IV	1.072	1.065	1.068	1.069	1.063	1.060	1.049	1.033	1.021	1.015	1.001	0.978	0.962	0.918		1991.6	81.5	47.8*
	(0.023)	(0.008)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.010)	(0.027)	(0.096)		(67)	(52)	(37)
OLS R^2	0.991	0.997	0.997	0.998	0.998	0.999	0.997	0.996	0.998	0.995	0.988	0.994	0.939	0.913				
Non-durable Consumption per Adult																		
OLS	1.060	1.091	1.085	1.076	1.048	1.039	1.025	1.038	1.038	1.040	1.036	1.023	1.022	1.019	1.048	1048.0	106.3	45.1***
	(0.019)	(0.009)	(0.005)	(0.005)	(0.003)	(0.003)	(0.002)	(0.006)	(0.004)	(0.005)	(0.005)	(0.007)	(0.021)	(0.031)		(73)	(52)	(37)
GLS	1.055	1.099	1.095	1.081	1.066	1.046	1.026	1.026	1.038	1.037	1.035	1.030	1.027	1.034		18136.5	664.6	137.7
	(0.014)	(0.004)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.011)	(0.027)		(73)	(52)	(37)
one instrument IV	1.095	1.102	1.086	1.076	1.048	1.039	1.027	1.039	1.039	1.043	1.038	1.019	1.014	0.980		919.8	111.4	51.8*
	(0.021)	(0.010)	(0.005)	(0.005)	(0.003)	(0.003)	(0.002)	(0.005)	(0.004)	(0.004)	(0.004)	(0.007)	(0.023)	(0.047)		(69)	(52)	(37)
two instrument IV	1.089	1.096	1.087	1.077	1.045	1.037	1.024	1.040	1.039	1.041	1.036	1.016	0.993	1.017		916.0	101.1	47.6*
	(0.028)	(0.010)	(0.006)	(0.005)	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)	(0.004)	(0.008)	(0.026)	(0.056)		(67)	(52)	(37)
OLS R^2	0.994	0.997	0.998	0.998	0.998	0.997	0.997	0.996	0.998	0.994	0.996	0.991	0.978	0.978				
Nondurable Cons Per Adult Equivalent																		
OLS	1.071	1.078	1.070	1.069	1.059	1.062	1.048	1.063	1.051	1.051	1.044	1.028	1.031	1.017	1.057	294.6	65.5**	39.4***
	(0.017)	(0.009)	(0.005)	(0.005)	(0.003)	(0.004)	(0.003)	(0.007)	(0.004)	(0.005)	(0.005)	(0.008)	(0.023)	(0.031)		(73)	(52)	(37)
GLS	1.063	1.090	1.078	1.067	1.060	1.061	1.056	1.056	1.056	1.052	1.044	1.038	1.044	1.041		2411.8	198.0	76.5
	(0.012)	(0.004)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)	(0.010)	(0.027)		(73)	(52)	(37)
one instrument IV	1.081	1.087	1.070	1.070	1.060	1.063	1.050	1.065	1.052	1.053	1.046	1.025	1.036	0.987		291.0	74.4*	45.3***
	(0.021)	(0.009)	(0.005)	(0.005)	(0.003)	(0.004)	(0.003)	(0.007)	(0.004)	(0.004)	(0.005)	(0.008)	(0.022)	(0.051)		(69)	(52)	(37)
two instrument IV	1.075	1.079	1.070	1.070	1.058	1.062	1.048	1.053	1.042	1.050	1.044	1.022	1.008	1.034		317.7	70.5*	43.5***
	(0.027)	(0.010)	(0.005)	(0.005)	(0.003)	(0.005)	(0.003)	(0.007)	(0.004)	(0.005)	(0.005)	(0.009)	(0.029)	(0.054)		(67)	(52)	(37)
OLS R^2	0.998	0.997	0.998	0.997	0.998	0.998	0.998	0.996	0.997	0.994	0.995	0.992	0.969	0.961				

Consumption is drawn from the Taiwanese Personal Income Distribution Surveys. An AR(1) model is fitted to consumption, with standard errors in parentheses.
For the Wald Tests, *, **, and *** denote p-values above .01, .05 and .10 respectively, representing some form of parameter homogeneity

Table 2: Estimates of the slope parameter in an AR(1) Model of Consumption Using Birth Year-Education Cohorts
Fitted Model: C(t)=b(c)C(t-1)+u(t)

	Age of Household Head in 1976														*Wald Tests of Parameter Homogeneity across education groups*		
	5-6	*9-10*	*15-16*	*19-20*	*25-26*	*29-30*	*35-36*	*39-40*	*45-46*	*49-50*	*55-56*	*59-60*	*65-66*	*69-70*			
Total Consumption																	
OLS:																	
Primary Education	1.029	1.054	1.048	1.053	1.052	1.055	1.042	1.034	1.014	1.007	0.999	0.985	0.988	0.944	*For cohorts aged:*	*Wald*	*df*
	n.a.	(0.030)	(0.009)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.005)	(0.006)	(0.018)	(0.049)	age 7-66	132.14	60
Secondary Education	1.045	1.066	1.055	1.060	1.066	1.054	1.040	1.034	1.023	1.028	1.007	0.972	0.869	1.049	age 11-50	93.06	40
	(0.013)	(0.006)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)	(0.007)	(0.039)	(0.174)	age 21-40	42.24	20
Tertiary Education	1.113	1.070	1.062	1.065	1.062	1.066	1.051	1.055	1.028	1.023	0.983	0.989	0.944	0.984	age 31-40	22.54*	10.00
	(0.022)	(0.009)	(0.006)	(0.008)	(0.004)	(0.006)	(0.005)	(0.007)	(0.007)	(0.008)	(0.012)	(0.016)	(0.026)	n.a.			
One instrument IV:																	
Primary Education	1.043	1.071	1.052	1.053	1.052	1.056	1.045	1.037	1.015	1.008	1.001	0.984	0.990	1.080	*For cohorts aged:*	*Wald*	*df*
	n.a.	(0.029)	(0.008)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.006)	(0.024)	(0.041)	age 7-66	416.00	60
Secondary Education	1.063	1.056	1.056	1.059	1.068	1.056	1.039	1.037	1.031	1.029	1.017	0.962	1.077	1.308	age 11-50	221.61	40
	(0.088)	(0.033)	(0.008)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.023)	(0.075)	age 21-40	98.06	20
Tertiary Education	1.111	1.065	1.070	1.068	1.064	1.071	1.053	1.056	1.028	1.027	1.041	1.013	0.917	1.057	age 31-40	66.14	10.00
	(0.087)	(0.028)	(0.009)	(0.009)	(0.003)	(0.004)	(0.003)	(0.002)	(0.004)	(0.003)	(0.005)	(0.008)	(0.013)	n.a.			
Cons. Per Adult																	
OLS:																	
Primary Education	0.983	1.050	1.066	1.055	1.035	1.031	1.027	1.036	1.038	1.035	1.039	1.043	1.029	1.100	*For cohorts aged:*	*Wald*	*df*
	n.a.	(0.016)	(0.005)	(0.004)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.005)	(0.011)	(0.019)	(0.026)	age 7-66	261.33	60
Secondary Education	1.062	1.099	1.077	1.070	1.047	1.030	1.024	1.038	1.032	1.046	1.029	1.021	0.963	1.462	age 11-50	176.00	40
	(0.013)	(0.007)	(0.003)	(0.002)	(0.002)	(0.002)	(0.004)	(0.007)	(0.004)	(0.005)	(0.006)	(0.007)	(0.038)	(0.330)	age 21-40	93.42	20
Tertiary Education	1.103	1.079	1.089	1.042	1.052	1.049	1.034	1.032	1.054	1.042	1.003	1.040	0.947	1.007	age 31-40	5.31***	10
	(0.023)	(0.015)	(0.006)	(0.007)	(0.003)	(0.004)	(0.005)	(0.005)	(0.011)	(0.009)	(0.012)	(0.018)	(0.021)	n.a.			
One instrument IV:																	
Primary Education	1.127	1.071	1.070	1.058	1.034	1.033	1.028	1.038	1.040	1.038	1.042	1.047	1.043	1.091	*For cohorts aged:*	*Wald*	*df*
	n.a.	(0.024)	(0.006)	(0.004)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.004)	(0.011)	(0.020)	(0.029)	age 7-66	437.75	60
Secondary Education	1.105	1.097	1.077	1.072	1.047	1.029	1.025	1.039	1.036	1.049	1.037	1.026	1.111	1.640	age 11-50	293.95	40
	(0.094)	(0.032)	(0.008)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)	(0.005)	(0.020)	(0.184)	age 21-40	162.67	20
Tertiary Education	1.094	1.093	1.093	1.084	1.052	1.052	1.037	1.039	1.061	1.043	1.049	1.058	0.985	1.019	age 31-40	19.95*	10
	(0.099)	(0.039)	(0.010)	(0.008)	(0.003)	(0.003)	(0.003)	(0.002)	(0.005)	(0.004)	(0.004)	(0.010)	(0.008)	n.a.			
Sample sizes (n, T):																	
Primary	(4, 6)	(13, 10)	(70, 16)	(165, 20)	(431, 21)	(333, 21)	(428, 21)	(394, 21)	(327, 21)	(262, 21)	(157, 21)	(98, 17)	(40, 11)	(24, 7)			
Secondary	(146, 6)	(247, 10)	(456, 16)	(476, 20)	(395, 21)	(262, 21)	(181, 21)	(127, 21)	(163, 21)	(144, 21)	(54, 21)	(25, 17)	(5, 10)	(4, 7)			
Tertiary	(56, 6)	(91, 10)	(164, 16)	(193, 20)	(228, 21)	(145, 21)	(89, 21)	(58, 21)	(64, 21)	(58, 21)	(31, 21)	(19, 17)	(5, 11)	(4, 7)			

Consumption is drawn from the Taiwanese Personal Income Distribution Surveys. An AR(1) model is fitted to consumption, with standard errors in parentheses.
For the Wald Tests, *, **, and *** denote p-values above .01, .05 and .10 respectively, representing some form of parameter homogeneity across education groups.
n.a. Indicates that an estimate was not attainable as a result of insufficient observations.

TABLE 3: Household Composition and Headship

Distribution of sample surveyed by relation to household head

1976

Age	Number in Sample	Head or Spouse	Parent or Parent in-law	Child	Child-in-law	Other
		Percentage of Age Group by relation to Head				
15-19	5646	1.8	0.1	85.4	1.2	11.6
20-24	3873	24.5	0.1	53.7	7.3	14.5
25-29	3790	65.5	0.1	20.0	6.2	8.2
30-34	2920	88.6	0.0	6.0	2.2	3.2
35-39	3130	94.1	0.3	2.6	1.5	1.5
40-44	2806	95.6	2.0	0.9	0.4	1.0
45-49	2615	93.8	5.5	0.1	0.2	0.3
50-54	1910	83.6	15.2	0.2	0.1	1.0
55-59	1354	71.4	27.0	0.1	0.0	1.5
60-64	1089	51.1	46.6	0.3	0.0	2.0
65-69	609	29.6	65.7	0.3	0.0	4.4
70-74	413	21.3	71.9	0.2	0.0	6.5
75+	404	12.4	70.8	0.0	0.0	16.8

1986

Age	Number in Sample	Head or Spouse	Parent or Parent-in-law	Child or Child in-law	Other
		Percentage of Age Group by relation to Head			
15-19	7291	2.1	0.0	88.2	9.7
20-24	5547	20.0	0.0	61.8	18.2
25-29	6439	62.9	0.1	24.2	12.8
30-34	6660	87.7	0.2	6.9	5.2
35-39	5370	95.1	0.4	2.0	2.6
40-44	3597	95.0	3.0	0.7	1.3
45-49	3543	88.0	10.8	0.3	0.8
50-54	3249	74.6	24.3	0.1	0.9
55-59	3145	66.0	33.5	0.1	0.3
60-64	2505	53.1	46.2	0.0	0.6
65-69	1705	37.4	60.6	0.1	1.9
70-74	1230	28.4	67.1	0.2	4.3
75+	954	14.7	67.8	0.4	17.1

1996

Age	Number in Sample	Head or Spouse	Parent or Parent-in-law	Child	Child-in-law	Other
		Percentage of Age Group by relation to Head				
15-19	5155	1.3	0.0	92.1	0.3	6.4
20-24	3565	15.7	0.0	68.8	3.4	12.2
25-29	3826	49.8	0.0	31.8	3.9	14.5
30-34	4381	80.1	0.0	9.6	1.9	8.5
35-39	4668	93.3	0.2	2.3	0.5	3.7
40-44	4429	94.4	2.1	0.9	0.2	2.4
45-49	3386	89.5	8.3	0.4	0.1	1.7
50-54	2287	79.1	19.7	0.2	0.1	0.9
55-59	2370	62.6	36.6	0.0	0.0	0.8
60-64	2053	51.5	47.8	0.0	0.0	0.6
65-69	1875	48.7	50.3	0.0	0.1	0.9
70-74	1466	44.1	53.3	0.0	0.0	2.6
75+	1510	35.1	55.5	0.0	0.0	9.4

source: Author's calculations from Taiwan Survey of Personal Income Distribution

TABLE 4: AGGREGATE AND INDIVIDUAL SAVINGS RATES IN TAIWAN

Aggregate Savings Rates from Household and Macro data[1]

year	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*
Average propensity to save	0.18	0.20	0.21	0.20	0.18	0.21	0.21	0.22	0.23	0.25	0.29
Gross national savings/GNP (%)	0.32	0.33	0.34	0.33	0.32	0.31	0.30	0.32	0.34	0.34	0.39
	1987	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	
Average propensity to save	0.29	0.25	0.21	0.20	0.21	0.19	0.18	0.17	0.17	0.17	
Gross national savings/GNP (%)	0.39	0.35	0.31	0.29	0.29	0.28	0.28	0.26	0.25	0.25	

Cohort Percentiles for Average Propensities to Save[2]

1976 Cross-section	Percentile								
Age of Household head in 1976	1	5	10	25	50	75	90	95	99
20	-0.21	-0.14	-0.01	0.05	0.07	0.17	0.42	0.51	0.57
25	-0.10	0.04	0.05	0.10	0.19	0.30	0.38	0.43	0.54
30	-0.28	0.02	0.05	0.09	0.17	0.28	0.41	0.49	0.60
35	-1.02	0.02	0.04	0.10	0.18	0.28	0.39	0.47	0.51
40	-0.32	0.00	0.03	0.07	0.15	0.25	0.34	0.40	0.50
45	-0.08	0.02	0.04	0.09	0.18	0.28	0.41	0.45	0.55
50	-0.08	0.01	0.04	0.10	0.20	0.32	0.43	0.53	0.62
55	-0.06	0.03	0.06	0.11	0.19	0.31	0.45	0.56	0.76
60	-0.53	0.03	0.04	0.10	0.22	0.37	0.48	0.55	0.78
65	-0.03	-0.03	0.02	0.13	0.27	0.41	0.54	0.55	0.55

1982 Cross-section	Percentile								
Age of Household head in 1976	1	5	10	25	50	75	90	95	99
15	-0.34	0.00	0.03	0.09	0.21	0.34	0.44	0.49	0.50
20	-0.46	-0.06	0.04	0.14	0.25	0.37	0.49	0.53	0.68
25	-0.11	0.01	0.06	0.15	0.26	0.39	0.49	0.55	0.65
30	-0.29	-0.01	0.06	0.14	0.24	0.37	0.48	0.55	0.68
35	-0.80	-0.09	0.01	0.10	0.21	0.34	0.47	0.51	0.62
40	-0.62	-0.14	-0.04	0.09	0.23	0.37	0.47	0.55	0.62
45	-1.03	-0.10	0.03	0.13	0.26	0.41	0.51	0.56	0.66
50	-0.66	-0.02	0.06	0.14	0.28	0.41	0.51	0.58	0.70
55	-0.35	-0.03	0.06	0.16	0.32	0.47	0.59	0.64	0.67
60	-0.10	-0.07	0.03	0.11	0.26	0.44	0.55	0.59	0.64

1996 Cross-section	Percentile								
Age of Household head in 1976	1	5	10	25	50	75	90	95	99
5	-0.34	0.00	0.13	0.27	0.39	0.51	0.61	0.65	0.71
10	-0.55	0.05	0.16	0.26	0.38	0.50	0.59	0.63	0.70
15	-0.32	0.04	0.11	0.22	0.36	0.47	0.55	0.60	0.69
20	-0.54	0.00	0.08	0.21	0.33	0.44	0.54	0.60	0.67
25	-0.32	-0.04	0.10	0.19	0.34	0.45	0.55	0.60	0.70
30	-0.26	-0.02	0.09	0.24	0.36	0.49	0.59	0.65	0.72
35	-0.16	0.02	0.11	0.28	0.41	0.56	0.63	0.69	0.81
40	-0.28	-0.03	0.07	0.22	0.40	0.54	0.67	0.74	0.85
45	-1.05	-0.25	-0.03	0.13	0.32	0.51	0.67	0.83	0.89
50	-0.35	-0.12	0.00	0.09	0.24	0.37	0.49	0.55	0.60
55	-2.51	-0.09	-0.03	0.07	0.18	0.37	0.52	0.60	0.66

sources:

1. Taiwan Statistical Data Book 1999. Average Propensity to Save is defined as the ratio of Total household savings to Total Household Income.

2. Authors calculations from Taiwanese Personal Income Distribution Surveys

TABLE 5: Home Ownership and Liquidity Constraints

Proportion of Households Owning Home by Year and Age Group

	Total	*Age Group of Household Head*								
Year	*Population*	*20-24*	*25-29*	*30-34*	*35-39*	*40-44*	*45-49*	*50-54*	*55-59*	*60-64*
1976	0.67	0.58	0.55	0.61	0.71	0.73	0.68	0.68	0.70	0.71
1981	0.73	0.71	0.65	0.69	0.75	0.79	0.81	0.74	0.73	0.72
1986	0.78	0.75	0.72	0.72	0.77	0.81	0.85	0.88	0.81	0.73
1991	0.81	0.80	0.78	0.78	0.79	0.82	0.83	0.86	0.87	0.81
1996	0.84	0.77	0.82	0.82	0.83	0.84	0.86	0.88	0.91	0.90

source: Author's calculations from Taiwan Personal Income Distribution Surveys.

Mean Savings Rates by Age and Home-Ownership

	Age Group of Household Head								
Year	*20-24*	*25-29*	*30-34*	*35-39*	*40-44*	*45-49*	*50-54*	*55-59*	*60-64*
Home-Owners									
1976	0.18	0.19	0.19	0.17	0.13	0.18	0.20	0.22	0.21
1981	0.25	0.27	0.25	0.23	0.22	0.25	0.26	0.28	0.27
1986	0.27	0.28	0.26	0.24	0.22	0.28	0.29	0.28	0.27
1991	0.32	0.36	0.32	0.32	0.29	0.30	0.34	0.40	0.35
1996	0.32	0.36	0.35	0.34	0.30	0.32	0.36	0.38	0.33
Non-Home-Owners									
1976	0.18	0.20	0.19	0.18	0.17	0.17	0.20	0.22	0.23
1981	0.28	0.27	0.26	0.23	0.21	0.27	0.31	0.27	0.26
1986	0.28	0.26	0.26	0.24	0.22	0.23	0.28	0.29	0.30
1991	0.36	0.35	0.33	0.30	0.25	0.32	0.35	0.38	0.39
1996	0.36	0.35	0.34	0.31	0.30	0.34	0.40	0.36	0.37

source: Author's calculations from Taiwan Personal Income Distribution Surveys

TABLE 6: Were Consumers Systematically Surprised by High Income Growth?

Table 6a: Official Forecasts of Taiwanese Real GNP Growths per annum

Plan	Forecast Period	Growth forecast (%)	Actual growth (%)
Six-Year Plan 1976-81	1976-81	6.5	9.1
Ten-Year Plan 1980-89	1980-84	8	7.5
	1985-89	7.8	10.3
Four-Year Plan 1982-85	1982-85	8	8.6
Four-Year Plan 1986-89	1986-89	6.5	9.5
Four-Year Plan 1990-93	1990-93	7	6.6
Six-Year Plan 1991-96	1991-96	7	5.9

sources: Actual Rates calculated from *Taiwan Statistical Data Book 1999, CEPD, R.O.C.*
Forecasts reported in *The Economist Intelligence Unit Country Profile: Taiwa* n (various years).

Table 6b: Individual Expectations of Personal and Aggregate Growth

1990-08 Social Image Survey in Taiwan: First Regular Survey

	Age of Respondent				
	15-19	20-29	30-39	40-49	50-59
Personal Changes in Welfare					
How does your personal living situation compare to that of 5 years ago?					
	Percentage of Respondents				
Better	46.2	50.0	51.1	58.2	63.2
The same	40.9	38.4	38.0	30.0	23.1
Worse	12.9	11.6	10.9	11.8	13.7
How do you expect your personal living situation in 5 years time to compare to that of today?					
	Percentage of Respondents				
Better	34.9	42.8	55.9	64.0	74.8
The same	55.4	45.9	37.9	32.7	21.9
Worse	9.6	11.3	6.3	3.4	3.3
Number in Survey:	97	225	285	493	437

1992-02 Social Image Survey in Taiwan: The Regular Survey on February of 1992

	Age of Respondent in 1990				
	20-29	30-39	40-49	50-59	60+
Aggregate Economy					
What is your opinion of the general economic situation in the past year?					
	Percentage of Respondents				
Very Satisfied or Satisfied	52.3	55.5	56.7	65.1	72.9
Dissatisfied or very dissatisfied	28.6	25.5	26.4	15.6	12.1
No opinion/don't know	19.1	19.0	17.3	19.3	15.0
What is your opinion of the general economic situation in the coming year?					
	Percentage of Respondents				
Very Satisfied or Satisfied	59.1	58.4	48.1	45.5	47.9
Dissatisfied or very dissatisfied	21.8	21.0	25.4	21.3	17.1
No opinion/don't know	19.1	20.6	26.5	33.2	35.1
Number in Survey:	369	575	365	212	117

1992-06 Social Image Survey in Taiwan: the Special Essay on June of 1992

	Age of Respondent in 1992				
	20-29	30-39	40-49	50-59	60+
Personal Economic Situation					
Compared with your present situation, what will your personal economic situation in one year be?					
	Percentage of Respondents				
Improved a lot	7.0	4.5	4.1	2.3	2.4
Improved	42.7	36.6	25.0	13.9	11.1
About the same	31.2	38.1	44.2	49.3	57.1
Worse	5.1	9.2	11.6	12.4	9.5
A lot worse	1.6	1.3	2.1	4.5	1.6
Don't know	10.8	10.2	12.0	17.7	17.5
Number in Survey:	373	470	292	266	126

source: Social Image Survey in Taiwan, The Office of Survey Research of the Academia Sinica, Taiwan

Table 7: Uncertainty arising from movements in External Factors

year	Percentage of Total Exports going to: U.S.A.	Hong Kong	Japan	Real GDP growth rate (%) in: U.S.A.	Hong Kong	Japan	Trade-weighted Average growth in top 3 markets:	Deviation of TWA from trend	Change in Net Terms of Trade (%)	Deviation of TOT growth from trend	Change in Oil Prices (%)	Deviation of Oil price growth from trend	Taiwanese Export growth (%)	Deviation of Export growth from trend	Real GDP Growth in Taiwan (%)	Deviation from Trend
1976	37.2	7.5	13.4	4.88	17.20	3.98	6.26	3.93	4.23	8.85	11.59	-76.62	36.26	30.00	13.9	7.6
1981	36.1	8.4	11.0	1.69	9.37	3.17	3.14	-0.73	-1.78	3.16	-3.84	-53.13	9.42	-2.82	6.2	-3.5
1986	47.7	7.3	11.4	2.91	11.09	2.90	3.81	-0.43	6.46	4.07	-48.23	-42.74	28.22	15.71	11.6	3.6
1991	29.3	16.3	12.1	-1.00	5.06	3.80	1.72	-1.94	0.80	-1.25	-15.75	-26.01	12.82	9.21	7.6	0.5
1996	23.2	23.1	11.8	3.57	5.01	3.92	4.21	0.86	0.82	2.10	18.43	21.42	7.07	-1.40	5.7	-0.6
mean	36.2	11.8	11.9	2.7	7.5	3.5	3.7	0.2	0.6	0.5	6.8	-7.1	11.6	0.6	8.2	0.1
std. dev.	7.8	6.3	1.3	2.0	4.2	1.6	1.6	2.1	4.0	4.1	32.6	44.3	9.2	10.9	2.9	-0.3
Std. devs. over sub-intervals:																
1976-85	5.3	0.7	1.3	2.5	4.9	1.0	**2.1**	**2.8**	**4.1**	**4.4**	**40.4**	**57.4**	**10.5**	**13.3**	**3.4**	**4.4**
1986-96	8.2	6.5	1.2	1.4	3.2	2.0	**0.9**	**1.1**	**3.7**	**3.7**	**23.6**	**27.1**	**7.9**	**8.7**	**2.4**	**3.8**
Correlation with Taiwanese Real GDP growth:				0.56	0.78	0.30	0.72	**0.55**	0.09	**0.11**	0.00	**-0.10**	0.86	**0.61**		
Correlation with detrended Real GDP growth:				0.60	0.59	-0.04	0.65	**0.75**	0.17	**0.23**	-0.33	**-0.36**	0.88	**0.87**		

sources:

Taiwan Statistical Databook 1999, World Development Indicators 1999, Statistical Yearbook of the Republic of China 1999.
International Financial Statistics 2000.

Testing for an ARCH process in the deviations from trend
Test statistic is distributed chi-squared (m) under null hypothesis of constant variance

	Number of ARCH terms (m)					
Detrended series:	1	2	3	4	5	6
TWA growth in export markets:	7.29	7.94	8.47	8.52	8.76	8.61
	(0.007)	(0.019)	(0.037)	(0.074)	(0.119)	(0.197)
Net TOT	9.23	9.97	10.63	10.66	10.57	9.82
	(0.002)	(0.007)	(0.014)	(0.031)	(0.061)	(0.132)
Oil Prices	4.48	5.94	8.92	11.25	10.89	10.56
	(0.034)	(0.051)	(0.030)	(0.024)	(0.054)	(0.103)
Export growth	9.11	8.95	12.62	8.86	8.99	9.45
	(0.003)	(0.011)	(0.006)	(0.065)	(0.109)	(0.150)
Real GDP growth	13.10	13.41	14.04	12.88	11.89	11.00
	(0.000)	(0.001)	(0.003)	(0.012)	(0.036)	(0.088)

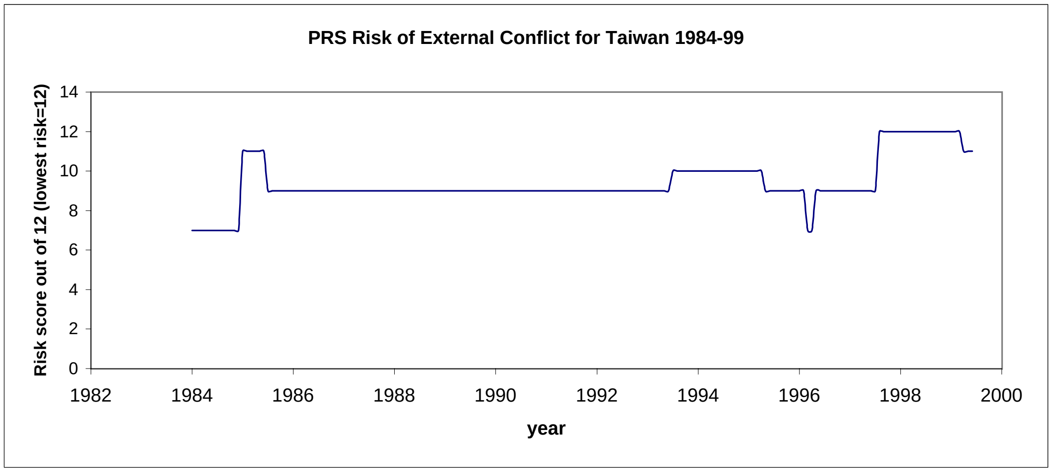
p-value given in parentheses

TABLE 8: POLITICAL UNCERTAINTY DUE TO RELATIONS WITH CHINA.

Timeline of Major Events in Taiwan's Relationship with China 1971-98

1971 Taiwan withdraws from the United Nations, in the face of certain expulsion following China's entry.
1972 Japan derecognizes Taiwan
Jan 1, 1979: U.S.A. recognises Peking government, abrogating mutual defence treaty with Taiwan.
1981 China initiates process of peaceful reunification with Taiwan offering one-country, two-systems policy
Aug 1982: U.S.A. and China reach agreement calling for eventual phasing out of U.S. arms supplies to Taiwan
Sept 1986: Democratic Progressive Party (DPP) formed, with announced goal of seeking independence for Taiwan
March 1987 Announcement of China-Macau deal, putting pressure on Taiwan to follow
July 1987: martial law lifted in Taiwan, allowing opposition political parties
July 1987 "suspension" of foreign exchange controls put into effect, reflecting reduction of siege mentality.
1987-88 first weakening in the KMT "no contact" policy, with visits to mainland through Hong Kong allowed.
April 15, 1989: Chinese students take over Tiananmen square, calling for more democratic government.
June 4, 1989 troops retake Tiananmen Square from prodemocracy protesters and fire at crowds
1990 indirect investment in China now permitted
July 1990 Saudi Arabia severs diplomatic relations with Taiwan
Aug 1992 South Korea severs diplomatic relations with Taiwan
June 1995: China breaks off bilateral talks following a private visit by Taiwan's president Lee Teng-hui, to the U.S.
July, Aug 1995: China initiates military exercises near Taiwan's offshore islands
Mar 96: Chinese miltary exercises before Taiwan's first freely contested election - U.S. sends two aircraft carrier groups.
1997: only 29 nations formally recognize Taiwan.
April 1998. Bilateral contact with China resumes.

sources: EIU (various years); McBeath (1998).



source: Political Risk Services *International Country Risk Guide* (various years)
External conflict is an assessment of the risk to both the incumbent government and to inward investment. It ranges from trade restrictions and embargoes, through geopolitical disputes, armed threats, border fire and incursions, to full-scale warfare.

Expectations about China: Survey Results from the 1992-02 Taiwan Social Image

	Age of Respondent in 1990					All
	20-30	30-40	40-50	50-60	60+	Respondents
How likely is it that China will invade Taiwan in the next few years?						
	Percentage of Respondents					
Very Likely/Likely	19.4	15.7	10.5	11.0	14.8	14.7
Not likely/Impossible	54.4	54.5	56.0	45.7	41.7	52.7
Don't Know	26.2	29.8	33.5	43.3	43.5	32.6
Do you believe that Taiwan's Armed Services are currently strong enough to protect Taiwan's safety?						
	Percentage of Respondents					
Strongly agree/Agree	24.7	26.4	29.2	35.2	49.6	29.4
Disagree/Strongly Disagree	61.4	51.6	43.3	30.0	20.9	47.0
No opinion/Don't Know	14.0	22.0	27.5	34.8	29.6	23.6
If China does attack, do you believe the U.S.A. will send forces to intervene?						
	Percentage of Respondents					
Strongly agree/Agree	18.6	16.9	12.8	14.3	20.7	16.3
Disagree/Strongly Disagree	51.4	52.0	46.9	37.1	35.3	47.6
No opinion/Don't Know	30.1	31.1	40.3	48.6	44.0	36.1

source: author's calculations from the 1992-02 Taiwan Social Image Survey

Table 9: Estimates of the Coefficient of Absolute Prudence

Cohort	Total Consumption Coefficient	Total Consumption Implied RRA	Cons. per Adult Coefficient	Cons. per Adult Implied RRA	Cons. per Adult Equivalent Coefficient	Cons. per Adult Equivalent Implied RRA
10	1.99E-05	10.0	5.74E-05	10.5	8.19E-05	12.9
	(1.62E-07)	(0.2)	(3.73E-06)	(0.7)	(7.99E-06)	(1.3)
15	2.29E-05	10.4	5.61E-05	10.3	9.26E-05	13.1
	(2.29E-06)	(1.1)	(6.35E-06)	(1.2)	(1.02E-05)	(1.5)
20	3.48E-05	14.5	5.90E-05	10.5	9.43E-05	11.9
	(2.53E-06)	(1.1)	(2.78E-06)	(0.6)	(8.85E-06)	(1.1)
25	3.10E-05	12.1	9.90E-05	16.4	1.12E-04	12.9
	(3.78E-06)	(1.5)	(8.73E-06)	(1.5)	(4.88E-06)	(0.6)
30	2.70E-05	10.9	1.00E-04	16.2	9.93E-05	11.4
	(3.75E-06)	(1.5)	(1.14E-05)	(1.9)	(1.01E-05)	(1.2)
35	1.59E-05	6.4	1.39E-04	19.7	1.24E-04	13.3
	(1.10E-05)	(4.4)	(1.57E-05)	(2.2)	(1.91E-05)	(2.1)
40	3.53E-05	13.4	7.37E-05	9.5	7.31E-05	7.8
	(5.67E-06)	(2.2)	(1.60E-05)	(2.1)	(8.84E-06)	(1.0)
45	5.01E-05	17.5	1.17E-04	14.6	9.48E-05	10.3
	(8.02E-06)	(2.8)	(1.54E-05)	(1.9)	(1.05E-05)	(1.1)
50	6.15E-05	18.2	1.17E-04	13.2	1.38E-04	13.2
	(1.35E-05)	(4.0)	(1.37E-05)	(1.5)	(2.04E-05)	(2.0)
55	-1.83E-06	-0.5	1.85E-04	17.8	1.71E-04	14.5
	(3.71E-05)	(9.8)	(2.48E-05)	(2.4)	(1.57E-05)	(1.3)

Cohorts are described by the age of the household head in 1976. Standard errors in parentheses.

The implied coefficient of Relative Risk Aversion is calculated at the Cohort sample mean consumption level. It is also a measure of the coefficient of Relative Prudence with an exponential utility function.

TABLE 10: What difference does prudence make?

Cohort age in 76	Actual growth	Consumption per adult equivalent Predicted growth, Relative Prudence 10	5	2
10	7.8	6.8	3.9	1.7
12	8.6	6.8	3.9	1.7
14	8.0	6.3	3.6	1.6
16	7.7	5.8	3.3	1.4
18	7.2	5.9	3.3	1.5
20	7.0	6.1	3.8	1.9
22	6.5	7.0	4.6	2.3
24	6.6	5.3	3.3	1.6
26	5.6	5.0	3.1	1.5
28	5.6	5.0	3.0	1.4
30	6.1	5.4	3.3	1.6
32	5.6	3.7	2.2	1.0
34	5.5	4.7	2.9	1.3
36	6.0	5.0	3.1	1.4
38	5.7	5.9	3.7	1.8
40	5.9	7.0	4.5	2.3
42	6.1	6.4	4.1	2.0
44	5.8	5.4	3.4	1.6
46	5.6	3.7	2.2	1.0
48	5.3	5.4	3.4	1.6
50	5.6	5.5	3.4	1.6
52	5.1	5.9	3.7	1.8
54	5.1	3.8	2.2	1.0

Results for every second cohort are shown.

Consumption growth for Cohorts aged 20-55 is over the 1976-96 period.

For cohorts aged 10-19 in 1976, growth is over the 1986-96 period.

Prediction method is described in text.

Table 11: Estimation of the log Precautionary Savings Equation

Dependent variable: change in log non-durable consumption per adult equivalent

cohort 5-9	0.074	0.074	0.062	0.074	0.074
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)
cohort 10-14	0.057	0.058	0.047	0.058	0.057
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)
cohort 15-19	0.054	0.056	0.042	0.056	0.053
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
cohort 20-24	0.045	0.047	0.034	0.048	0.043
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)
cohort 25-29	0.042	0.043	0.030	0.045	0.039
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
cohort 30-34	0.042	0.043	0.030	0.044	0.039
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
cohort 35-39	0.041	0.042	0.028	0.043	0.038
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
cohort 40-44	0.040	0.041	0.027	0.042	0.037
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
cohort 45-49	0.037	0.038	0.024	0.039	0.034
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
cohort 50-54	0.035	0.037	0.022	0.039	0.031
	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)
cohort 55-59	0.038	0.039	0.025	0.041	0.033
	(0.008)	(0.010)	(0.008)	(0.009)	(0.010)
cohort 60-64	0.063	0.062	0.046	0.066	0.057
	(0.015)	(0.018)	(0.016)	(0.015)	(0.016)
interest rate	0.394	0.441	0.485	0.436	0.435
	(0.133)	(0.120)	(0.111)	(0.115)	(0.116)
Export shock variance	5.33E-05				
	(7.09E-05)				
Oil shock variance		8.58E-07			
		(2.10E-06)			
TOT shock variance			1.09E-03		
			(3.93E-04)		
GDP in export markets shock variance				8.16E-05	
				(1.06E-03)	
Taiwan GDP shock variance					6.52E-04
					(5.58E-04)
R^2	0.619	0.617	0.663	0.615	0.618

Notes:

Dynamic pseudo-panel standard errors given in parentheses.

Table 12: Measures of Uncertainty by Industry of Household Head

	agriculture	manufacturing	commerce	construction	finance[1]	transport[2]	other services[3]
median earnings per adult equivalent (1996 NT$)							
1976	43734	65156	67909	59421	92912	70817	70975
1996	119046	222844	221520	196961	325305	248000	270976
Geometric mean annual growth rates:							
in median earnings	5.1	6.3	6.1	6.2	6.5	6.5	6.9
in mean earnings	5.3	6.2	6.1	6.1	6.3	6.5	7.1
Mean absolute deviation from trend in median earnings:							
a). using realized geometric growth rate	3552	3768	4824	5114	8189	4085	5690
b). using fitted quadratic time trend	3390	5619	6574	8272	7922	5141	7586
c). using unit root and fitted quadratic trend	3473	3486	4516	5016	7739	4039	5847
d). using fitted AR(2) with quadratic trend	2809	2697	3653	3671	7274	3292	5380
Implied mean uncertainty for cohorts under measure:	a).	b).	c).	d).			
Cohort aged 10-14 in 1976	4807	6601	4638	3839			
Cohort aged 20-24 in 1976	4661	6424	4500	3699			
Cohort aged 30-34 in 1976	4637	6249	4494	3714			
Cohort aged 40-44 in 1976	4550	5909	4434	3687			
Cohort aged 50-54 in 1976	4638	5958	4554	3860			

Notes:

1. Finance includes finance, insurance, real estate and business services
2. Transport includes transport, storage and communication
3. Other services are community, social and personal services, which include environmental services, health and medical, publishing, arts and entertainment, hotelling, vehicle repairs, cleaning, barber and beauty shops, and others.

Industries listed are those in which more than 3 percent of household heads in at least one cohort work.
Results are for household heads aged between 25 and 65 years.
source: author's calculations from Personal Income Distribution Surveys, Taiwan, Republic of China.

Table 13: Estimation of the log Precautionary Savings Equation using Industry of household head as a measure of earnings risk.

Dependent variable: change in log non-durable consumption per adult equivalent

cohort 5-9	-0.266	0.078	-0.001			
	(0.330)	(0.009)	(0.037)			
cohort 10-14	-0.269	0.065	-0.015			
	(0.331)	(0.006)	(0.035)			
cohort 15-19	-0.263	0.066	-0.012			
	(0.329)	(0.007)	(0.033)			
cohort 20-24	-0.268	0.060	-0.017			
	(0.327)	(0.008)	(0.032)			
cohort 25-29	-0.270	0.062	-0.013			
	(0.324)	(0.009)	(0.028)			
cohort 30-34	-0.261	0.070	-0.005			
	(0.321)	(0.013)	(0.024)			
cohort 35-39	-0.244	0.084	0.008			
	(0.317)	(0.021)	(0.017)			
cohort 40-44	-0.235	0.095	0.021			
	(0.315)	(0.026)	(0.010)			
cohort 45-49	-0.249	0.089	0.026			
	(0.317)	(0.024)	(0.007)			
cohort 50-54	-0.252	0.087	0.026			
	(0.318)	(0.024)	(0.007)			
cohort 55-59	-0.230	0.107	0.039			
	(0.320)	(0.033)	(0.004)			
cohort 60-64	-0.182	0.144	0.071			
	(0.319)	(0.040)	(0.013)			
constant				-0.237	0.055	0.037
				(0.269)	(0.004)	(0.003)
interest rate	0.454	0.400	0.405	0.473	0.425	0.428
	(0.124)	(0.120)	(0.118)	(0.120)	(0.114)	(0.113)
jobless	0.224			0.180		
	(0.309)			(0.257)		
agriculture	0.096	-0.235		0.221	-0.065	
	(0.345)	(0.114)		(0.306)	(0.018)	
construction	0.280			0.260		
	(0.374)			(0.330)		
commerce	0.313			0.339		
	(0.365)			(0.301)		
transportation	0.465			0.309		
	(0.431)			(0.389)		
finance	0.505			0.489		
	(0.462)			(0.353)		
other services	0.488			0.427		
	(0.336)			(0.274)		
manufacturing	0.241			0.193		
	(0.362)			(0.271)		
industry composite[1]			0.108			0.024
			(0.053)			(0.005)

Notes:

Dynamic pseudo-panel standard errors for the general model in Mckenzie(2000a) are given in parentheses.

1. Industry composite is the proportion in manufacturing, finance, construction and commerce less the proportion in agriculture