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Abstract

Modern consumer theories are built upon the premise of the forward looking behavior of households. While most of the empirical studies at micro level are based on Euler equation, there have been few to estimate the household consumption function and test the implication of forward looking behavior directly. One of the main difficulties is that forward looking behavior involves such variables as human wealth and income uncertainty which are not directly observable. This paper exploits the rotating panel feature of Consumer Expenditure Survey to construct the proxies and test significance of them in the household consumption function. We fail to find evidence to support forward looking behavior over long horizon.

Key words: Consumption Function, Uncertainty, Human Wealth.

JEL classification number: D12, D91, E21.

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1 Introduction

The consumption function had received the first significant attention around 1940's after Keynes [10] emphasized the role of consumption function in his *General Theory*. He considered aggregate consumption mainly as a function of aggregate current income. This was in sharp contrast with the traditional classical point of view which treats saving (and thus consumption, since saving is defined as income minus consumption) mainly as a function of interest rate[1]. His critical assumption is that saving and investment are adjusted primarily by income, not by interest rate. Keynes also believed the average propensity to consume tends to decrease as income increases. Therefore, in the long run as economy grows, effective demand will become more and more deficient, eventually causing depression if there's no government intervention.

The arguments of Keynes on marginal propensity to consume was largely based on intuition. Given the well known impact of the theory, the subsequent controversy naturally led to the search for the empirical evidence. However, the empirical studies with cross section data as well as postwar time series data produced evidence that sometimes conflicted with assumptions of Keynes'. The new findings required explanation. The evidence of

[1]Interest rate, according to classical belief, works as an essential driving force that constantly adjusts saving and investment to be at equilibrium. Along with the flexibility of wage which equals marginal productivity, this would guarantee full employment equilibrium. The blame for the great depression which caused massive and lasting unemployment at the time, thus, was directed to the inflexibility of wage. However, Keynes thought the problem lies in deficiency of aggregate demand.

the time can be summarized as follows. First, in aggregate time series data, the average propensity to consume was found to be stable over time instead of decreasing. Second, in cross section data, the marginal propensity to consume was found to be smaller than APC which also falls as income increases. (This is in harmony with Keynes' theory, even though it was also found that the intercept, a is increasing over time.) Third, in short run time series data[2] APC was higher in recession period(and thus $MPC < APC$) than that of normal expansion period. These early stylized facts, however, are hardly a subject of discussion today. Beside the shift of interest in consumption analysis, serious statistical problems that went unnoticed in early day consumption function estimation renders such results doubtful in today's standard. See Spanos [17] and Thomas [18] for more discussion on earlier evidence. Nevertheless, the attempt to piece together these observations coherently became a major motivation for the new theories of consumption. For example, the relative income hypothesis by Duesenberry [6] attempted to explain the evidence by assuming the individual consumption as a function of not only own income but also the consumption of other people in the same social group. He also assumed that the consumption is affected by previous highest income, which is similar to the habit formation effect in today's terminology.

[2] It is important to note that the term 'long run' or 'short run' time series data used at the time is different from the same term used today which refers to the frequency of the data, i.e., quarterly, yearly, etc. The short run cyclical analysis of the time referred to the analysis of data centered around recession period. The evidence found at the time from the analysis of 'secular' trend and 'cyclical' variation which correspond to the above concepts respectively, is therefore not to be confused with today's evidence. For more on the definition of the terms, see Modigliani [12]

The major step was, however, taken by Modigliani and Brumberg [13] as well as Friedman [7]. They explicitly introduced intertemporal utility maximization framework into the consumption theory, independently coming up with "Life cycle hypothesis" and "Permanent income hypothesis". The households are assumed to allocated consumption optimally over time based on their current as well as expected future wealth. With the empirical problems of aggregate Keynesian consumption function as well as the criticism on Keynesian macroeconometric model, the empirical consumption study was divided into the two broad streams which remain to be independent from each other until now. The one is the time series modelling of aggregate consumption function which has been mainly used in large scale Keynesian macroeconometric model. It does not derive consumption function as a result of optimizing behavior of individuals, and sometimes becomes subject of criticism that it lacks of microfoundation. It has been continuously improved, especially undergoing major change in the recent adoption of Error correction model[3] which incorporates both long run equalibrium equation and short run error (or equilibrium) correction equation. The focus of this approach is the unconditional forecasting and impulse response analysis. The other is the Euler equation or the short run consumption function derived from an explicit individual intertemporal optimization model, which becomes often a basis of arguement that it has the microfoundation. The importance of this is in

[3] See the consumption function in FRB/US large scale macroeconometric model documented by Brayton and Tinsley [2]

that it provides underpinning of the currently dominant dynamic stochastic general equilibrium model through the intertemporal utility maximization of representative agent or the overlapping generations. The early empirical studies were concentrated on aggregate analysis. For example, based on the assumption of quadratic utility, the changes in aggregate consumption was derived to be martingale by Hall [8]. The empirical results of the studies on aggregate data in fact were not favorable to the theory. Attempts to explain the movement of time series variables based directly on the PI/LS hypothesis which is after all a hypothetical description of “individual” households also faced a serious logical question. The biggest problem is, of course, that there was no explicit consideration on aggregation. It was not clear why one should apply the implication of individual behavioral hypothesis directly to the aggregate data. The conditions for such “consistent aggregation” are highly unrealistic[4] . See Blundell and Stoker [1] for survey on some issues of aggregation. The aggregation problem has led many empirical studies on Euler equation to focus on household level data to recover preference parameters. See Browning and Lusardi [3] for an extensive survey on empirical Euler equation studies. But the micro level Euler equation studies have their own problems, too. The Euler equation is modeled in terms of changes in variables over time, while one can not get the changes in income

[4] Testing the implication of individual behavioral hypothesis on aggregate data without much consideration on the aggregation problem here reminds us of the empirical demand function analysis of earlier days. Researchers tested implications of the static individual utility maximization theory directly on aggregate data of commodity groups, which led to frequent rejection of the hypothesis.

and consumption together in household level data. Most of the empirical euler equation study on U.S. households uses PSID which has the record only on food consumption. Unless food consumption is representative of all non durable commodities, which is unlikely, the use of food consumption instead of total non durable consumption would introduce bias. Moreover, the precautionary motive of saving which makes individuals who face more uncertainty in future income to save more in order to build up "buffer stock", causes log linear approximation of Euler equation unsatisfactory as argued by Carroll [5].

Compared with the voluminous existing studies on individual Euler equation, those on household consumption function have been surprisingly scarce. There have been only a couple of recent papers that estimated household consumption function and tested forward looking terms. Carroll [4] estimated linear consumption function using data on U.S. households, to find out insignificance of expected future income as well as significance of labor income uncertainty in consumption decision. Miles [11] estimated logarithmic consumption function using U.K. data to come up with the significance of permanent income as well as labor income uncertainty. It seems clear that more evidence is desirable before drawing any conclusion.

There is also another important motivation for the estimation of household consumption function. Recently, Hildenbrand and Kneip [9] proposed a new method to construct short run aggregate consumption function based on disaggregate data, where we need the cross section derivatives of explanatory variables. The simple version of HK model is

$$\frac{C_t}{X_t} = \frac{C_s}{X_s} + \alpha_s log\frac{\sigma_t}{\sigma_s} + \beta_s log\frac{X_t}{X_s} + R,$$

where C_t, X_t, and σ_t are mean aggregate consumption, mean aggregate income, and standard deviation of the distribution of log income at t, respectively, and R is the residual from the first order approximation. α_s and β_s are to be estimated from the cross section consumption function at time s.

If we assume $s = t - 1$, dropping residual, we can rewrite the above equation in differenced form as follows.

$$\Delta C_t = \frac{C_{t-1}}{X_{t-1}}\Delta X_t + [log(\frac{\sigma_t}{\sigma_{t-1}})^{\alpha_{t-1}}(\frac{X_t}{X_{t-1}})^{\beta_{t-1}}] \cdot X_t.$$

This is a unique approach that aims to construct the prediction of an aggregate variable based on heterogenous behavior of individuals, thereby avoiding aggregation bias. Given C_{t-1}, X_{t-1}, and σ_{t-1}, ΔC_t depends on ΔX_t, $\Delta\sigma_t$, and the coefficients α_{t-1} and β_{t-1} which depend on marginal propensity to consume of households at time t-1.

In this paper, we are going to estimate empirical consumption function of U.S. households and examine the implication of consumer behavior which is characterized by forward looking behavior. The main difficulty is that consumption function involves unobservable components such as expected future income and income uncertainty. In this paper, we use proxies for these unobservables to estimate the consumption function.

The rest of paper is organized as follows. Section II considers the implication of LC/PI theory on consumption function and the issues related to the implementation of it. Section III discusses construction of proxies for the unobservable variables. Section IV discusses the results of estimations. Section V concludes.

2 Specification of household consumption function

The typical finite horizon model based on PI/LC hypotheses is as follows. An individual maximizes the intertemporal utility function subject to lifetime budget constraint,

$$\max_C E[\sum_{t=0}^{T}(1+\beta)^{-t}U(C_t)|I_0] \ s.t$$
$$A_{t+1} = (1+r_t)(A_t + Y_t - C_t),$$

where β is the subjective discount rate at which the individual discounts the future utilities, C_t is the consumption, I_0 is the information available to the consumer at time 0, A_t is the asset, r_t is the interest rate, T is the expected remaining life, and Y_t is the labor income. Solving for the f.o.c, we get the following Euler equation.

$$U'(C_t) = E[(1+\beta)^{-1}(1+r_t)U'(C_{t+1})|I_t].$$

Most empirical studies on household consumption behavior have been done based on this condition after assuming certain utility function. If we are going to solve for the level of consumption function, we have to make assumptions about the form of utility function. We first consider the simplest one, quadratic utility. If $U(C_t) = aC_t + bC_t^2$, then the f.o.c is

$$a + 2bC_t = (1+\beta)^{-1}E_t(1+r_t)(a + 2bC_{t+1}).$$

Solving for C_0, we get the linear consumption function,

$$C_0 = \alpha_0(\mathbf{r}, age, \beta) + \alpha_1(\mathbf{r}, age, \beta) \cdot \{E_0[\sum_{t=0}^{T-1}(1+r_t)^{-t}Y_t] + A_0\}.$$

With the usual simplifying assumptions such as constant interest rate, known life expectancy, as well as the equality between interest rate and subjective discount rate, the consumption function becomes

$$\begin{aligned} C_0 &= \{1/E_0[\sum_{t=0}^{T-1}(1+r)^{-t}]\} \cdot TotalWealth \\ &= g(age) \cdot TotalWealth \end{aligned}$$

That is, the consumption is the annuity value(annuity is a stream of equal payment for finite time. One can convert lumpsum amount to annuity by multiplying annuity factor.) of total wealth which consists of expected future income as well as current wealth, where g(.) is the factor that annuitizes the total wealth into permanent income. Carroll [4] estimated this model after dividing the data into three age groups to control for the age effect. He finds that the expected future income is statistically insignificant and even has negative coefficient, while the uncertainty is important. He also finds that asset is insignificant. The result, however, might have been due to unsatisfactory construction of variables such as asset and disposable labor income. Multicollinearity, especially between the current and future income, might be another reason for some of the counterintuitive coefficients.

The limitation of certainty equivalence model has been well known. The model precludes the role of precautionary motive in consumption decision. The more popular model assumes the constant relative risk aversion utility. If utility function is isoelastic, $U(C_t) = \frac{C_t^{1-\gamma}}{1-\gamma}\ for\ \gamma > 0\ and\ \gamma \neq 1,\ = lnC_t\ for\ \gamma = 1$, then the first order condition is

$$C_t = [\frac{(1+r_t)(1+\nu_t)}{(1+\beta)}]^{1/\gamma} \cdot [\frac{W_t}{E_{t-1}W_t}]C_{t-1},$$

where W_t is the total wealth at time t, ν_t is the uncertainty premium. But there's no closed form solution to this problem. Skinner [16] used second order Taylor series approximation to derive the consumption function,

$$\begin{aligned} C_t &= [\sum_{j=t}^{T+t}\{\Pi_{s=t}^{j}(\frac{(1+r_s)(1+\nu_s)}{(1+\beta)})^{1/\gamma}(1+r_s)^{-1}\}] \cdot W_t \\ &= g(age,\ r,\ \beta,\gamma,\ income\ uncertainty) \cdot (X_t + A_t + H_t). \end{aligned}$$

Assuming equality of interest rate and discount factor, Miles [11] took the logarithm of the above consumption function along with Taylor series approximation to the total wealth, deriving a model for the cross section estimation,

$$\begin{aligned} \log C_i &\simeq a_0 + a_1(age_i) + a_2(age_i^2) + a_3\hat{X}_i + a_4\hat{u_i}^2 + a_5\hat{u_i}^3 \\ &\quad + a_6(\hat{u_i}^2/age_i) + a_7(\hat{u_i}^2R_{i1}) + a_8R_{i2} + a_9R_{i2}^2 + u_i, \end{aligned}$$

where $\hat{X}_i$ is predicted current labor income, R_{i1} is (Current labor income)/(Diposable income), and R_{i2} is (Asset)/(Current labor income + Expected future labor income).

He applied the model to FES data to find out the significance of uncertainty in consumption function. But the model didn't allow to test the significance of expected future income.

The above discussion suggests some common problems we face in the empirical estimation of consumption function. First, some essential components of consumption function are unobservable and thus to be constructed. Finding good proxies for them therefore is one of the most important parts of the estimation. Second, the complexity of theoretically derived consumption function makes it impractical to recover preference parameters. The log linear approximation does not change the situation either, unlike in Euler equation estimation. The goal of cross section consumption function is thus to examine the main assumption of consumption hypotheses, the significance of forward looking terms. Third, a more realistic model requires more approximation assumptions in the implementation of cross section regression. It is not clear how serious such approximation biases are. In practice, we need to check such model against simpler alternatives without such approximation.

There are two components in the consumption function that are not directly observable. They are the expected future labor income or human wealth of households and income uncertainty. We first construct the proxies for these unobservables through observable household characteristics and demographics in the following section.

3 Construction of Proxies for Unobservables

3.1 Data

The Consumer Expenditure Survey(CES) is a rotating panel in which about 5,000 households are interviewed annually for four consecutive quarters to provide information on income, asset, detailed consumption, labor supply and demographic characteristics. Each quarter, one fifth of the households are replaced by new participants. In this study, we choose households who entered the interview in 1991. Out of 5090 households who participated in the first interview, total of 3991 households completed all the interviews.

We filter the data to get complete income response[5] households for the first and last quarter, age of household head between 18 and 66, Wage and Salary bigger than 1000, Currently Employed (but not self-employed). The total of 1599 households fit into the category.

We first measure current wealth while leaving the construction of proxies for unobservables to the following sections. Current wealth can be divided into the disposable income and the level of asset. Disposable income is defined by total income - total tax paid(Federal, State, and Local) - Social Security and Pension. Asset consists of financial asset and real estate. Financial asset is measured by the balance in checking and savings account, money owed to the household by others(+/-), estimated value in stock, bond, and mutual fund. The real estate is the estimated value of house in today's market +

[5] Households whose income report are either incomplete or inconsistent are classified as incomplete income response households by BLS.

estimated value of other properties - outstanding mortgage principals - home equity loan.

3.2 Proxy for household human wealth

Household human wealth is defined as average expected future labor income of household. It is worth noting that what we measure here is "household" labor income which typically comes from multiple earners for the majority of households. The estimation is done in 2 steps which is essentially the same as that of Carroll [4] and Miles [11]. First, estimate 'Household Human Capital Earning Function'. Then add it up over age, adjusting for future growth.

3.2.1 Household Human Capital Earning Function

We start from the following household earning function. For an individual household i at time t,

$$x_{it} = f(Z_{it}, A_{it}) + u_{it}.$$

where x is the earned income by the household, Z_{it} is a vector of characteristics of household and its members that are related to earning, A_{it} is an age matrix of not only a husband but also a wife, if applicable.

We start from the following quadratic household earning function,

$$x_{it} = Z_{it}\Gamma_0 + Z_{it}A_{it}\Gamma_1 + A_{it}^2\Gamma_2 + u_{it}.$$

See table 1 for the result of OLS of the earning function with heteroskedasticity consistent covariance matrix. Variable names that end with A implies the cross product of the variable and age. Variable names that end with S implies those of spouse's. Children is the number of children under 18. Earner is the number of earners. SM1 is metropolitan residence dummy. P1 is public housing dummy. Note the significance of the age and the characteristics of spouses'. This improves the goodness of fit of household earning regression significantly. The reason is clear. About 70% of all married households have wage income from wives. Therefore unless the correlation of incomes of husbands and working wives is perfect, omission of working wives' age as well as characteristics will lead to a bias and poor fit. The concave age effects are found as usual in the age of both household heads and spouses. The return to education is also clear, the biggest return from college education. The additional increase in earning from further education is much less. More specifically, at age 45, the increase in earning for high school graduate is \$4135, that for college graduate is \$8303, and that for graduate school is \$706. It is interesting that the spouse's education makes more difference in earned income for graduate school degree level. Non earned income has significant negative effect on earning. The difference of earnings of those who have no non earned income and 3/4 quartile level which is \$1800 is \$-468. At 5% level, the non earned income is around \$11000, and according negative effect in earned income is \$11000 by -0.26 = \$-2860. Households with black earner earns considerably less income than others with same attributes. Having children under 18 also has negative effect on earning while living in urban area has positive effect.

3.2.2 The human wealth of households

Based on the household earning function, we now construct the human wealth of households as follows. If we assume expected aggregate growth rate is constant at g, the expected earning at time t+j based on the previous earning function is

$$E_t(x)_{it+j} = E_t f(Z_{it+j}, A^h_{it+j}, A^w_{it+j}) + E_t u_{it+j}$$

Also assume that the individual's expectation on the future income residual can be modelled as $u_{it+j} = \rho u_{it+j-1}$, for $j = 1...T - t$ as in Carroll, though we choose $\rho = 0.5$ to avoid high correlation between human wealth and predicted current earning[6]

Then we rewrite the above equation as

$$E_t(x)_{it+j} = [\hat{f}(Z_{it+j}, A^h_{it+j}, A^w_{it+j}) + \rho^j \hat{u}_{it}](1+g)^j.$$

Now we compute the human wealth as

$$human\ wealth = \sum_{j=1}^{T-age_{it}} (1+r)^{-j} E_t x_{it+j}$$

$$= \sum_{j=1}^{T-age_{it}} (\frac{1+g}{1+r})^j \{\hat{f}(Z_{it+j}, A^h_{it+j}, A^w_{it+j}) + \rho^j \hat{u}_{it}\}.$$

[6] Higher values of ρ were also tried but did not make qualitative differences in subsequent results.

Assuming the equality between the expected growth rate and the expected interest rate, some descriptive statistics are calculated and shown in the table 2. The quartile values of the sample are reported with respect to household human wealth, household current labor income, and predicted household current labor income. We also estimate the distribution of these values by kernel density estimator with cross validated optimal window widths. See figure 1. Compared with the current labor income, human wealth is significantly shifted to the right and more concentrated around mean. One of the interpretation can be found in concave earnings-age profile. Among those who are in the right side of the current income distribution, ther are more likely to be households around their prime age whose future income would either decline or at least not increase faster than that of the younger households who are likely to be more clustered in the left side of the distribution. Therefore the combined effect of decreasing future income of the families aroun prime age and of increasing future income of the younger family would result in the concentration of the distribution of human wealth. And if the latter effect is sufficiently strong, then the mean of human wealth will also be greater than that of current income as shown in the result. This result has some implication in welfare analysis because it shows that the inequality measure can be smaller if we consider human wealth instead of current income. The overtime change of inequality may also behave differently between the two concepts. In addition, the impact of changes in tax system such as changes in progressive tax rate may not have identical consequence as it does to the current current income distribution when we take the whole life time labor income into consideration.

3.3 Uncertainty

The uncertainty of future income of a household is difficult to measure due to its subjective and unobservable nature. To construct a proxy for it, we make the similar assumption that we made when we measured the human wealth. We construct the proxy using the household attributes related to income uncertainty. In other words, we assume that people look at the group of households who share the similar attributes as theirs to form the idea of how uncertain its own income is. We may categorize the source of income uncertainty into three levels, namely, individual, groupwise, and economy wide. The individual income risk that comes from idiosyncratic sources can not be incorporated in our model because it is hardly revealed in survey data. For example, whether a particular person faces unusual risk of losing job due to recent bad performance is not likely to be revealed in any survey. The economy wide uncertainty that affects all the households in the same way is also not a matter of concern given our current purpose, the cross section consumption regression. Our focus is therefore the income risk that is common to a group of households that shares similar identifiable attributes. How do we measure the income uncertainty common to a group? The cross section income dispersion of a group at a given time is not likely to be the proper measure since the dispersion around group mean may simply indicate the stable structure of inequality in job qualification of households within the group that is not captured by attributes. In other words, if we observe wide dispersion of income in certain group, it simply means that there are more unobserved differences among households in the group in terms of job qualification. Thus, it is not really related to income uncertainty. The distribution of the proportional change in income of the households, however, is less likely due to such structure. Say we observe 30% increase in income by a part time worker, which would put this person in the right tail of the distribution of proportional changes in income of part time workers. This is less likely to persist. It can be simply due to the unstable nature of part time working common to the group rather than due to some permanent unobserved characteristic of the worker. More dispersion in proportional changes in income of a group in general most likely reflects higher uncertainty of income of the group. We choose the following proxy,

$$Var(Proportional\ change\ in\ income) = Var(\frac{X_t - X_{t-1}}{X_t + X_{t-1}}).$$

Using this measure, we first identify the income uncertainty of different groups in some categories of households. See table 3. The result largely corresponds to our intuition. First, earner composition of households matters a lot. The variance measure for the households with at least one full time earner is about half of those with only part time earners. Second, government employee, especially those of federal government, have less variance than the private sector employee. Third, households with male primary earner have less variance than those with female primary earners. Fourth, in terms of occupation, the craftsmen have the lowest variance while those in the service have the highest variance. Fifth, as the level of education goes up, the variance tends to go down, with exception of those with graduate degree whose variance is higher than that of college graduates. Finally, the industries with high variance measure are finance and insurance, professional, and service, while the public administration and manufacturing are among the lowest[7]. In the next step, we create the following nine mutually exclusive categories which are expected to have different level of income uncertainty. Households that belong to each categories will be assigned the same level of group income uncertainty in our final consumption regression. See table 4. The result shows the dramatic difference of uncertainty measures among the groups of households. Households with only part time female earners have the largest income uncertainty while those with a full time working male earner who has high education and is either government employee or craftsman have the lowest income uncertainty. The uncertainty in general appears to have negative correlation with the level of income. Higher income group tends to be associated with less uncertainty. But the correlation is not perfect. For example, groups with government jobs, whether headed by male or female, have lower mean income but also have lower uncertainty than those with the private sector jobs. Households headed by full time working female

[7] For the definition of income uncertainty, we also tried the variance of income difference instead of the proportional change, which failed to show the intuitive result that is consistent with the findings from other studies. This is presumably due to the scale effect.

in private sector job with low education has lower income that those headed by part time working male but also has lower income uncertainty.

4 Estimation of Household Consumption function: the Results

We start with estimation of a simple model with current observables. The regression 1 in table 5 is the linear consumption function with only current observables such as disposable income(dispo), predicted current labor income($\hat{x}$) from earning regression, asset, age of household head, its square, and the size of family(fam) as explanatory variables. The dependent variable is non durable good consumption which consists of food, alcoholic beverage, tobacco, clothing, utilities, entertainment, transportation, personal care, reading, education, and miscellaneous expenditure. Since asset is likely to be measured with significant error, it is instrumented. The instrumental variables include dummies for education, race and occupation of household head and spouse, housing tenure, family type, metropolitan residence, urban/rural residence, public housing, and the type of employer for household head. These instruments are also used in the rest of the regressions that involve human wealth and uncertainty which are the proxies. As usual, potential low correlation between endogenous variables and instruments is a concern since it can cause inconsistency to the IV estimates when instruments are not perfectly exogenous and also reduces the power of hypothesis tests even in the case of perfect exogeneity. To test the instrument validity in the presence of multiple endogenous variables, we measure the "partial R square" suggested by Shea [15]. The partial R square measures for asset, human wealth, and uncertainty on the set of instruments are 0.42, 0.48, and 0.50, respectively, which indicates quite high correlation between the endogenous variables and instruments. All the variables in equation 1 are significant and the generalized R square for instrumental variable estimation is around 0.50. The result of χ^2 test of orthogonality adjusted for heteroskedasticity is reported in table 6. The null hypothesis is not rejected at 10 percent significance level. When the forward looking terms such as human wealth(human) and uncertainty(uncer) are added, none of the forward looking terms turned out to be significant. Since the human wealth bases itself on the predicted current earning to calculate the future earning, this implies that the additional information that the human wealth carries does not play a role in consumption function. This is shown in regression 2. The generalized R square of the regression 2 is around 0.50. The orthogonality test can not reject the null at 10 percent level.

We now estimate the approximation of theoretically derived model. The quadratic utility model is either estimated separately in a few age groups as in Carroll [4] or is approximated by quadratic in age multiplied by the components of total wealth. The former is in regression 6 which shows insignificant coefficient on uncertainty term even though the sign is negative as expected. The low goodness of fit, however, indicates that such specification is poor. The latter is in regression 3 which also shows the clear evidence that such approximation is not adequate. Most of the coefficients are insignificant.

Now, we estimate the log approximation of CRRA(isoelastic utility) model as in Miles. In regression 4, where log consumption is regressed on log predicted current earning($log\hat{x}$), uncertainty, uncertainty divided by age, asset divided by current and future labor income(the squared term is dropped because of insignificance), and uncertainty multiplied by the ratio of labor income to disposable income. The result shows the significance of uncertainty. This result, however, may be due to specification problems. The log approximation used in the derivation of Miles model required certain simplifications such as combining current and future income into a single term. Theoretically, the effect of current wealth and the expected future income should be the same, but there are many reasons why it may not be the case such as liquidity constraint and mental accounting, for example. The approximation to the log of total wealth taken at the zero value of asset could be another source of bias. He also defined income uncertainty as a squared residual of household earning regression. This amounts to assuming any difference between the actual labor income of a household and the mean income of households who belong to the same demographic group as the reference household is due to income uncertainty, even though such difference may well be the result of qualitative difference of earners unexplained by demographic data.

In fact, the terms involving future income and uncertainty become insignificant when we add simple current observables, and when we drop the forward looking terms, the goodness of fit improves a lot as one can see in regression 5. The partial R square measures of the terms x/dispo and asset/x are 0.20 and 0.19, respectively.

Now, instead of taking log approximation, one may estimate an alternative model based on quadratic approximation. But the problem is that we need the quadratic terms of the regressors as well as their cross products which are typically highly correlated, which causes multicollinearity problem. The regression using these variables indeed showed that most of those terms are insignificant.

Before concluding this section, we estimate the asset regression in which we want to test the significance of uncertainty. The buffer stock theory of saving tells that the households with more income uncertainty has the more precautionary motive of saving in order to prepare for the rainy days. Therefore, the uncertainty is expected to have a significant positive coefficient in asset regression. Table 7 shows the result of asset regression in which asset is regressed on labor income, human wealth, age, uncertainty, as well as a number of dummy variables for education, occupation, race, family type, and metropolitan residence. We choose to run simple OLS regression adjusted for the heteroskedasticity rather than to run instrumental variable estimation, because it's hard to find instruments that are highly correlated with income but not with asset. Again, the uncertainty term has positive effect but statistically insignificant. The human wealth also turned out to be insignificant and has negative effect. The $\bar{R}^2$ is 0.35.

As a summary of this section, we conclude as follows. First, whether taking log or not, empirical consumption function seems to fit quite well with linearity. Second, when tested, the human wealth, a forward looking term, is not significant in the presence of demographically predicted current income as an explanatory variable. Third, the group wise labor income uncertainty indeed has the negative coefficient, but it's not significant. In the asset regression, we also found positive, but statistically insignificant role of uncertainty.

5 Conclusion

We have estimated household consumption function with its unobservable components proxied based on the assumption that households form their idea on life cycle income as well as income uncertainty by looking at the people with similar attributes as theirs. However, we could not find the evidence of the significance of future income or human wealth constructed from the concave age earnings profile. This confirms the previous result by Carroll [4]. That is, typical households do not take such distant future as life cycle income perspective into consideration when making decisions on current non durable consumption.

The uncertainty from the common risk of a group also turned out to be mostly insignificant in estimated consumption function, even though it always had the negative coefficient as expected. It doesn't mean, however, that uncertainty does not matter in general. Uncertainty from idiosyncratic income risks, for example, may well be important but could not be tested in our model due to lack of information, as is typical in survey data.

We conclude that current disposable income is by far the most important explanatory variable in cross section consumption function. Asset, predicted current income, as well as age and family size also affect consumption.

Even though our result seems to support the traditional Keynesian consumption function or the rule of thumb behavior, it's too early to draw any general conclusion in this area. Our study indicates that the focus of future research should be more on the effect of expectation of near future income than that of entire life cycle income.

variables	estimates	sterr	t-statistic
C	-39206.7	7537.963	-5.2012
Children	-1553.09	436.8317	-3.5554
Earner	5316.276	1217.39	4.3669
OR3(African)	-9708.82	5600.945	-1.7334
OR3A	264.3514	141.9698	1.862
E1A(drop out)	41.8618	50.1642	0.8345
E2A(high school)	133.7532	45.8181	2.9192
E3A(college)	318.1801	58.4746	5.4413
E4A(graduate)	333.9228	62.4213	5.3495
OC1A	232.7334	36.1042	6.4462
OC2A	55.7352	33.8019	1.6489
OC3A	-57.5369	38.9311	-1.4779
OC4A	-91.4898	113.4294	-0.8066
OC5A	78.3099	35.6833	2.1946
QP1	2018.166	5651.952	0.3571
QP2	-1388.26	2066.213	-0.6719
QP3	1155.078	1867.363	0.6186
QP4	455.4827	1940.24	0.2348
QP5	-3727.05	1755.481	-2.1231
QP6	-890.239	2492.178	-0.3572
QP7	-6168.58	1834.361	-3.3628
QP8	-3351.3	1973.069	-1.6985
ES1	3965.174	2470.851	1.6048
ES2	8672.294	2227.073	3.894
ES3	13425.33	2941.484	4.5641
ES4	17672.69	3473.182	5.0883

variables	estimates	sterr	t-statistic
OCS1	14512.93	2449.24	5.9255
OCS2	9766.285	2292.585	4.2599
OCS3	3506.239	2685.231	1.3057
OCS4	5146.013	5469.953	0.9408
OCS5	6683.678	3458.845	1.9323
QPS1	1995.333	3839.423	0.5197
QPS2	-6203.83	4226.944	-1.4677
QPS3	1331.759	3587.246	0.3712
QPS4	3217.991	4136.424	0.778
QPS5	-9951.46	3259.699	-3.0529
QPS6	-4129.54	3876.269	-1.0653
QPS7	-7264.83	3118.072	-2.3299
QPS8	-7663.83	3809.808	-2.0116
Non Earned Income	-0.2603	0.0948	-2.7444
SM1	7317.067	1100.186	6.6508
P1	-8051.26	3241.72	-2.4836
Age	1292.519	308.8721	4.1846
Age^2	-15.3471	3.6747	-4.1765
AgeSpouse	1101.716	189.1323	5.8251
$AgeSpouse^2$	-13.9449	2.7234	-5.1204

Table 1: Household Earnings Equation. Total Observations:1599, Rbar-squared is 0.5025. Industry(QP): 01 Agriculture, forestry, fisheries and mining, 02 Construction, 03 Manufacturing, 04 Transportation, communications and other public utilities, 05 Wholesale, retail trade, 06 Finance, insurance, and real estate, 07 Professional and related services, 08 Other services, 09 Public administration. Occupation(OC): 01 Managerial, professional specialty, 02 Technical, sales, and administrative support, 03 Service, 04 Farming, forestry, and fishing, 05 Precision production, craft, and repair, 06 Operators, fabricators, and laborers.

Quartile	Labor Income	Predicted Labor Income	Human Wealth
25%	21177	24301	30779
50%	33720	36921	41182
75%	49983	51287	52811

Table 2: Quartile values of labor income, predicted labor income, and human wealth.

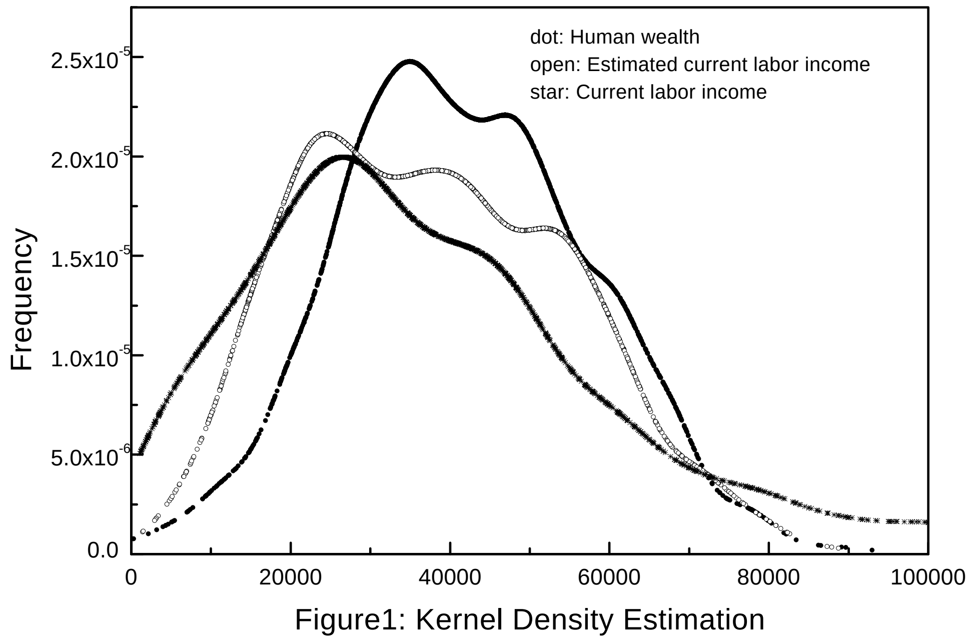

Figure 1: Kernel Density Function

Category	Groups	MEAN	VAR	Observations
All		0.0322	0.0601	1599
Earners	both full	0.0478	0.0453	382
	one full, one part	0.0227	0.0513	555
	one full	0.0319	0.0440	336
	one part	0.0302	0.1090	326
Employer	private	0.0329	0.0632	1265
	federal gov't	-0.0049	0.0387	102
	state gov't	0.0419	0.0519	84
	local gov't	0.0461	0.0527	148
Sex	male	0.0294	0.0538	1212
	female	0.0408	0.0797	387
Occupation	managerial	0.0435	0.0590	600
	technical, sales support	0.0157	0.0630	417
	service	0.0219	0.0747	132
	farming, fishing	0.0109	0.0629	15
	craftsman	0.0337	0.0405	171
	laborer, operator	0.0378	0.0633	264
Education	elementary	-0.0167	0.0859	54
	high school drop out	0.0606	0.0681	112
	high school	0.0244	0.0648	478
	less than college	0.0355	0.0568	422
	college graduate	0.0398	0.0494	293
	graduate school	0.0297	0.0601	239
Industry	agriculture, fishing	0.0498	0.0593	24
	construction	0.0048	0.0490	112
	manufacturing	0.0363	0.0403	359
	transportation	0.0203	0.0541	157
	whole sale, retail	0.0341	0.0653	261
	finace, insurance	0.0919	0.0987	82
	professional	0.0318	0.0737	329
	other service	0.0348	0.0781	131
	public administration	0.0141	0.0458	144

Table 3: Groupwise Labor Income Uncertainty

	Groups	$E(\frac{Y_t+Y_{t-1}}{2})$	$E(\frac{Y_t-Y_{t-1}}{Y_t+Y_{t-1}})$	Var	Observations
1	part, female	20457	0.0544	0.1218	100
2	part, male	28865	0.0196	0.1036	226
3	full, female, private, low ed	23486	-0.0012	0.0883	84
4	full, male, pri, low	33428	0.0395	0.0709	77
5	full, female, private, high ed	34777	0.0447	0.0592	124
6	full, female, gov't	28665	0.0622	0.0503	79
7	full, male, pri, high, others	44388	0.036	0.0452	614
8	full, male, gov't	43480	0.0102	0.03	192
9	full, male, pri, high, craftsman	40442	0.0402	0.0288	103

Table 4: Labor Income Uncertainty of 9 Disjoint Groups

variables	estimates	st.err	t-statistic
Equation 1			
C	-2962.07	2359.6364	-1.26
Dispo	0.1774	0.0183	9.71
$\hat{x}$	0.1183	0.0170	6.94
Asset	0.0069	0.0033	2.11
Age	305.4233	124.1961	2.46
Age^2	-2.7937	1.4806	-1.89
Fam	1106.6585	121.5356	9.11
Equation 2			
C	-1828.44	2987.328	-0.61
Dispo	0.1763	0.0185	9.51
Asset	0.0069	0.0033	2.11
$\hat{x}$	0.1227	0.0382	3.21
Human	-0.0087	0.039	-0.22
Uncer	-8.8297	16.6634	-0.53
Age	292.3218	123.8315	2.36
Age^2	-2.6649	1.4862	-1.79
Fam	1086.694	168.2211	6.46
Equation 3			
C	28514.86	38382.11	0.74
Dispo	1.0203	0.8299	1.23
Asset	-0.138	0.1655	-0.83
Human	-1.425	1.4614	-0.98
Age*Dispo	-0.0406	0.0415	-0.98
Age*Asset	0.005	0.0078	0.65
Age*Human	0.0803	0.0726	1.11
Age*$Dispo^2$	0.0005	0.0005	0.93
Age*$Human^2$	-0.001	0.0009	-1.16
Age*$Asset^2$	0	0.0001	-0.37
Age	-1299.7532	1796.772	-0.72
Age^2	15.6862	19.9662	0.79
Fam	1496.419	154.6907	9.67

Table 5: Household Consumption Functions. Total observations: 1558.

Equation 4			
C	0.5747	1.3522	0.42
$\log \hat{x}$	0.678	0.0358	18.94
Age	0.0903	0.0461	1.96
Age^2	-0.0009	0.0004	-2.48
Uncer	0.0118	0.0092	1.29
Uncer/Age	0.3954	0.3519	1.12
Uncer(x/Dispo)	-0.0238	0.0034	-6.97
Asset/(x + Human)	0.064	0.0113	5.64
Equation 5			
C	3.1862	0.2226	14.32
$\log \hat{x}$	0.2384	0.0321	7.42
Age	0.0238	0.0074	3.23
Age^2	-0.0003	0.0001	-3.22
$\log Dispo$	0.3957	0.0232	17.03
x/Dispo	-0.705	0.2424	-2.91
Asset/x	0.0101	0.0038	2.66
Fam	0.0536	0.0068	7.94
Equation 6			
C	7579.792	2658.486	2.85
Asset	0.0129	0.0043	3.03
Uncer	-8.4988	21.6578	-0.39
Human	-0.0261	0.0554	-0.47
$\hat{x}$	0.225	0.0527	4.27
Fam	967.9019	316.9839	3.05

Equation	χ^2	d.f	Generalized R^2
Eq 1	30.9	33	0.508.
Eq 2	30.5	31	0.508.
Eq 3	36.5	28	0.507.
Eq 4	43.6	31	0.468.
Eq 5	32.1	32	0.578.
Eq 6	36.7	31	0.365.

Table 6: The χ^2 test of orthogonality and the generalized R square for IV estimation for the consumption functions.

variables	coefficients	st.error	t-statistic
C	-182488.7348	43558.0048	-4.1896
Age	6470.3768	2050.6474	3.1553
Age^2	-56.1168	24.5587	-2.2850
x	2.6217	0.2451	10.6960
Uncer	161.8299	111.5640	1.4506
Human	-0.4438	0.3982	-1.1145
E1	-9183.8558	14713.6342	-0.6242
E2	11861.6976	14096.1823	0.8415
E3	44007.7304	17635.6626	2.4954
E4	47586.4122	18441.1619	2.5804
F1	32518.1948	10311.0712	3.1537
F2	31740.1390	7449.0812	4.2609
F3	31303.8448	12042.3039	2.5995
OC1	33462.4512	9405.9140	3.5576
OC2	19556.6516	8402.9557	2.3274
OC3	7563.0637	10240.5002	0.7385
OC4	-13782.3852	16010.2412	-0.8608
OC5	3243.4740	10523.5793	0.3082
OR1	3219.1435	6341.0179	0.5077
OR2	1606.0966	13845.5595	0.1160
OR3	-44092.2243	8213.8409	-5.3680

Table 7: Asset Regression. Dependant variable is total asset. Total observations: 1558. $\bar{R}^2$ is 0.35. F1, F2, and F3 are married couple, married couple with children, and single households, respectively. OR1, OR2, and OR3 are european, spanish, and afro-american origin.

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