Advances in Economics and Business 1(2): 222-232, 2013 http://www.hrpub.org
DOI: 10.13189/aeb.2013.010217

Habit Formation and U.S. Household Consumption:A Semiparametric Panel Data Analysis

Chonghyun Christie Byun

Department of Economics, Wabash College, Crawfordsville, 47933, Indiana, United States
*Corresponding Author: byunc@wabash.edu

Abstract Using household panel data from the PSID, a semiparametric panel data model is estimated and examined for the presence of habit formation. Previous studies in this area were based on linear models, and the semiparametric model is an improvement over the latter in that it does not specify a particular functional form on the data generating process. Estimates of the model show evidence of habit formation for a substantial percentage of the observations. An examination of households by their demographic characteristics as well as by job status yields additional information and supporting evidence on the existence of habit formation.

Keywords Habit Formation, Semiparametric Estimation, Panel Data

1. Introduction

The starting point of relative consumption models is to postulate that consumer preferences are influenced not only by a household's own current consumption, but also by its own past consumption, or by average current and past consumption among all households in the economy. When a household's utility is affected by its own past consumption, the household is said to exhibit "habit formation". If the household's utility is affected by either average contemporaneous or average lagged consumption in the economy, then the household is "keeping up with the Joneses" or "catching up with the Joneses", respectively. My research explores the effect of habit formation on household food consumption. Much empirical work has been done on this topic, but the research has always specified a particular functional form for a utility function. One of the objectives in my paper is to examine a model of habit formation, when current and lagged consumption are nonlinearly related but without specifying a functional form for the model.Dynan (2000, *AER*) examines the presence of habit formation in a simple life-cycle consumption model using PSID household food consumption data from 3,153 households between 1974 and 1987. Specifically, current consumption is linearly related to lagged consumption via a habit formation parameter, the size of which indicates the strength of habits. Dynan finds there is no evidence in the data supporting the theory that habits affect consumer preferences.

However, current and lagged consumption could be nonlinearly related, and a linear model may not adequately capture the size of the habit formation parameter. A test for neglected nonlinearity on the same data verifies that there is a nonlinear relationship between current and lagged consumption. Therefore, without specifying a particular functional form, a semiparametric model will better represent the relationship between the variables.

2. Literature Review

The notion of relative consumption dates back as far as Adam Smith's Wealth of Nations. Competition against your neighbors in consumption was a relevant part of determining your own utility. Necessities were relevant for survival, but there was also a standard of living, below which an individual would prefer not to fall. Smith (1776) stated it as, "not only the commodities which are indispensably necessary for the support of life, but whatever the custom of the country renders it indecent for creditable people, even of the lowest order, to be without." Comparison utility was also noted by Veblen (1899) in that "the accepted standard of expenditure in the community…largely determines what his standard of living will be. It does this directly by commending itself to his common sense as right and good…".Veblen also noted that competition in consumption also exists in non-material goods, such as leisure. How much vacation time an individual consumes in comparison to their neighbors is a matter of consideration and competition.

A more recent, formalized approach was written by Duesenberry (1949), who stated that an individual's utility depends on comparing the individual's own consumption against the average consumption of her neighbors. Keeping up, or catching up with the Joneses is a relevant factor in determining utility. But the consumption level of your neighbors was not the only factor in determining utility. Duesenberry also proposed an inward looking view, where an individual considered her own past levels of consumption as well. This idea, known as habit formation, postulates that an individual's utility is also affected by how much they consumed in the past. People will exhibit habit persistence such that their consumption levels do not change much from period to period. An individual would prefer to maintain a consistent standard of living, and "it is harder for a family to reduce its expenditures from a high level than for a family to refrain from making high expenditures in the first place" (Duesenberry, 1949). Also, the human desire for status and the so called "demonstration effects in consumption behavior" were explored in Frank (1985). Goods are placed in different categories, according to what level of status they afford to a consumer. Positional goods are those whose value depends relatively strongly on how they compare to those owned by others, whereas nonpositional goods are those whose value is not strongly affected by such comparisons. Nonpositional goods include (but are not limited to) good that are not materially observable by outsiders. Some examples would be leisure time or good health. This differentiation between goods allows Frank to show that interpersonal comparisons do matter when consumers make their choices about consumption bundles. In such a framework, individuals will make consumption decisions that are suboptimal such that nonpositional goods will be underconsumed. Therefore, there is the potential for welfare improvements in such an economy.

An individual choosing her level of consumption today will be affected not only by what consumption choices her neighbors have made, but also what choices she herself has made in the recent past. In this sense, a choice of a particular consumption bundle creates an externality, in that what an individual chooses today will affect what she chooses tomorrow. It will also affect what her neighbors' choices will be both today and tomorrow. An individual's utility is positively related to current own expenditure, and negatively related to own past expenditure, as well as negatively related to average current and past expenditure for the entire economy. These inward and outward comparisons will generate a situation where individuals are not making optimal consumption choices. Their choices may be individually optimal, but collectively, they will be suboptimal.

Contemporary studies of consumption externalities have focused on the nature of the comparisons that individuals make. How exactly is utility affected by habit formation and/or keeping up or catching up with the Joneses? How strong are these factors in determining an individual's consumption choices from period to period? Can the overall welfare in the economy be improved by government intervention, and if so, what kind of intervention and how much? How can consumption externalities be incorporated into other areas of micro and macroeconomics?

One of the seminal contemporary studies is by Abel (1990) who included both habit formation and catching up with the Joneses preferences in the utility function. This utility function is applied to the Lucas (1978) asset pricing model to calculate equilibrium asset prices, which are then used to study the equity premium puzzle. Abel uses a multiplicative form for habits and catching up preferences. Utility is based on a ratio of an individuals own current consumption, against both her own past consumption and the aggregate consumption per capita. Another way in which consumption externalities are introduced into the utility function is via an additive formulation. Alonso-Carrera et al (2004) use such a form, where an individual's utility depends upon the sum of current and past own consumption, and current and past average consumption for the entire economy. The additive form is relevant in that it is applicable in reconciling theory with consumption data in many empirical studies, for instance in Heaton (1995) and Ferson and Constantinides (1991).

In general, models that include consumption externalities can be of the form where utility can be affected by any of the following: an agent's own current and past consumption, and current and past average consumption for the entire economy. Habits can enter the utility function either additively in the following form,

$$\widetilde{\mathrm{c}}_{\mathrm{i,t}} = c_{i,t} - \alpha c_{i,t-1} \tag{1}$$

where $c_{i,t}$ is current consumption for household i in period t, $c_{i,t-1}$ is consumption in the previous period, and the parameter α represents the strength of habits. Or they can enter in a multiplicative form as in Abel (1990) where, for $\gamma \geq 0$ and $D \geq 0$

$$\widetilde{\mathrm{c}}_{\mathrm{i,t}} = [c_{i,t}^{D} c_{i,t-1}^{1-D}]^{\gamma} \tag{2}$$

The introduction of consumption externalities has a wealth of implications for many areas of economics. Among the many fields in which it has applications are basic consumer choice models, finance and asset pricing models, government fiscal and monetary policy, economic growth, savings and precautionary savings, labor and leisure choice models, the permanent income hypothesis, environmental economics, and even suicide. In the following sections I will review main contributions to the above listed areas.

There are two main categories of consumer choice models that include consumption externalities. As stated above, externalities can enter in the utility function in either a multiplicative or an additive form. Dynan (2000) studies a simple life cycle consumption model that includes habit formation in the preferences. The household's problem is to choose current consumption expenditure to maximize expected lifetime utility. Utility depends on positively on consumption today and negatively on consumption yesterday, in an additive format. Dynan uses a PSID panel data set of household food consumption from 1974 to 1987 to estimate the Euler equation based on the first order conditions of the household's problem. A household's utility is positively related to current consumption, but negatively related to its past consumption, according to the additive format as stated above. Consumption depends on today's consumption as well as a fraction of yesterday's consumption. The parameter α indicates the strength of habits. When α, is larger, habits are stronger, and a consumer receives less utility today from a given level of consumption today. With this specification, Dynan finds no evidence of habit formation on an annual frequency. Other studies, such as Dunn and Singleton (1986), Eichenbaum et al. (1988), and Heaton (1993) find little to no evidence for habit formation in US aggregate monthly consumption data. Still other studies, such as Ferson and Constantinides (1991) and Naik and Moore (1996) find large amounts of habit formation in US consumption data on the aggregate and individual levels respectively. Additionally, Braun et al. (1993) find some habit formation in aggregate Japanese consumption data. Falk and Knell (2004) use keeping up with the Joneses preferences, with a slight modification to the model. An average or reference level of consumption is included, but instead being exogenously given, they allow consumers to choose their own reference level. They find that the reference level moves positively with individuals' abilities (such as intellectual achievement), and that people compare themselves to others who are similar to themselves

Habits can also enter the story in a multiplicative form. Carroll (2000) examines the consumer's optimization problem with multiplicative habits, based on the model of Abel (1990), where a consumer's utility depends on a ratio of current and past consumption. Abel used this multiplicative form of habits in the household's utility function and examined how asset pricing can be affected by habits and catching up with the Joneses preferences.

Grinblatt et al (2004) consider a model with possible keeping up with the Joneses preferences, by examining data on automobile purchases and the associated effect on neighbors. Using data from Finnish provinces, they find that the neighborhood effects are very strong. Consumers are strongly influenced by what cars their neighbors purchase, in particular by more recent purchases of their geographically close neighbors. However, their study finds that these choices are not motivated by a competitive desires to keep up with the Joneses, but rather that there is most likely some form of information sharing between neighbors that will influence a consumer's choice. A study by Cox et al (2002) looks at intergenerational linkages in consumption behavior. Parents' consumption habits will affect their children's habits, even after controlling out for parents' income level. Parents set a reference level standard of living that their children strive to achieve or surpass. In addition, there is a strong link between consumption levels of sibling pairs. Familial links seem to be very relevant in influencing the consumption decisions of children.

The introduction of habit formation has many useful applications in savings models. Alessie and Lusardi (1997) include habits in a model of consumer savings, and they derive a closed form solution for consumption and savings for the consumer's utility maximization problem. Habits enter additively into the model, and the equilibrium level of consumption will be a weighted average of past consumption and income. Basically, the stronger the habits, the more important past consumption will be. Then, using Dutch panel data, Alessie (2003) estimates that same model and finds evidence supporting habit formation. In a study of Korean household panel data Rhee (2004) looks for evidence of precautionary savings when habit formation is included in consumer preferences. In this study, habits are additive as well. An estimate of the habit formation parameter from the first order conditions of the consumer's problem show that habit formation and precautionary savings are statistically insignificant for food consumption, but significant for nondurables and services consumption. Diaz et al (2000) expand the model of precautionary savings to include wealth distribution under habit formation. Using the multiplicative form of habits in the utility function, the results of their model calibration show a big increase in precautionary savings, as well as large reductions in income inequality.

The relation between savings rates and growth rates has long known to be positively correlated. Houthakker (1961, 1965) and Modigliani (1970), established this empirically, and many more recent studies have confirmed this fact. The standard Solow or Rebelo growth models predict that higher savings rates cause higher growth rates in the economy and the positive correlation between savings and growth has been interpreted as supportive of those models. However, recent evidence has shown that the causation may go in the other direction, i.e. growth causes savings instead. This is a contradiction of the standard growth models because forward looking agents in a fast growing economy should spend more and save less today, in anticipation of a bigger income tomorrow. To establish the causal channel from growth to savings, Carroll et al (2000) study a model of consumer behavior that includes habit formation. The consumer's utility depends on the ratio of consumption today relative to a habit stock that is based on a weighted average of past consumption. Including habits in the model gives results that support the growth to savings causal relationship. Generally speaking, habit bound consumers prefer to have smooth consumption growth rates, not jumpy ones. As a consequence, even faced with higher income growth rates, a consumer will be slow to change her spending pattern.

Another interesting application of consumption externalities is in the area of government fiscal and monetary policy. Individual households do not take into account the externality generated when they decide upon a consumption level in each period. Therefore, the competitive equilibrium of this economy is not Pareto optimal since households do not internalize the consumption externalities. Consequently, there is room for government intervention in the form of taxes on capital and labor income. Ljungqvist and Uhlig (2000) derive optimal tax policy the associated welfare gains in an infinite-horizon representative agent model with catching up preferences. Fuhrer (2000) uses a habit formation model to study the responses of spending and inflation to government monetary policy. He finds evidence in support of the theory that monetary policy can be even more effective in controlling spending and inflation when the framework includes habit formation in the utility function.

3. Habit Formation in U.S. Household Data

The model I will consider is an extension of Dynan's (2000) model, in which households seek to solve their consumption choice problem to maximize their discounted stream of lifetime utility, with habit formation in their utility function. Previous empirical studies of habit formation have had varied results as to whether or not habits matter in consumer choice. However, as of yet, there have been no significant studies done in which a semiparametric estimation framework was used. Current and lagged consumption, which are both important in the habit formation model, could be nonlinearly related, and a linear model may not adequately capture the size of the habit formation parameter. A test for neglected nonlinearity on the same data verifies that there is a nonlinear relationship between current and lagged consumption. Therefore, without specifying a particular functional form, a semiparametric model will better represent the relationship between the variables. I will now describe Dynan's model, and then extend her work by completing a semiparametric estimation of the habit formation parameter.

3.1.The Model

Households face a simple life-cycle consumption problem in which they choose their consumption in each time period so as to maximize their lifetime expected utility as shown in equation (3).

$$E_t\left[\sum_{s=0}^{T}\beta^s U(\widetilde{c}_{i,t+s};\psi_{i,t+s}\right] \qquad (3)$$

Habits enter additively, where α measures the strength of habits, i.e. the habit formation parameter as follows.

$$\widetilde{\mathrm{c}}_{\mathrm{i,t}} = c_{i,t} - \alpha c_{i,t-1} \qquad (4)$$

The term $\psi_{i,t+s}$ represents "taste shifters", variables that change marginal utility at time t. These "taste shifters" include variables such as the age of the head of household, age-squared/1000, and growth in the number of adult male equivalents in the household. The parameter α represents habits, such that for larger value of α consumption in the past more strongly influences the consumption today. Current utility is decreased by past consumption since larger value of α indicates that the consumer receives less lifetime utility from a given amount of expenditure since current utility is diminished by past consumption. The bigger α is the more habits matter to a household. Also, a larger habit stock lowers the utility of consumption today, according to the definition of habit formation. The parameter α is restricted to be less than one because otherwise, at the steady state, utility would be negative.

Taking the first order conditions (FOC) for a household's optimization problem and simplifying the standard Euler equation, based on the methods of Hayashi (1985) gives a version of the FOC when preferences are time non-separable. If T is large and r is constant, the Euler equation can be reduced to the following.

$$E_t\left[(1+r)\beta\frac{MU_{i,t+1}}{MU_{i,t}}\right] = 1 \qquad (5)$$

This in turn implies the following.

$$(1+r)\beta\frac{MU_{i,t}}{MU_{i,t-1}} = 1+\varepsilon_{i,t} \qquad (6)$$

where $\varepsilon_{i,t}$ reflects shocks to permanent income. If households hold rational expectations, then $E_{t-1}[\varepsilon_{i,t}] = 1$ and the $\varepsilon_{i,t}$'s are serially uncorrelated.

Furthermore, simplification of the Euler equation is necessary due to the amount of measurement error in the PSID data. Given such measurement error, instrumental variables are required in order to get a consistent estimate of the habit formation parameter. However, there are a limited number of instruments in household data. This requires equation (5) to be simplified to reflect this, since the small number of instruments will not be likely to capture the nonlinearity in equation (5).Dynan then uses the standard CRRA utility function.

$$u(\widetilde{c}_{i,t},\psi_{i,t}) = \psi_{i,t}\frac{\widetilde{c}_{i,t}^{\,1-\rho}}{1-\rho} \qquad (7)$$

This implies that Equation (6) becomes

$$(1+\mathrm{r})\beta\frac{\psi_{\mathrm{i,t}}}{\psi_{\mathrm{i,t\text{-}1}}}\left(\frac{\widetilde{c}_{i,t}}{\widetilde{c}_{i,t-1}}\right)^{-\rho} = 1+\varepsilon_{i,t} \qquad (8)$$

Taking natural log and using the additive form of habits, as in equation (4), we can now apply the methodology of Muellbauer (1988) and take an approximation of $\Delta\ln(c_{i,t}-\alpha c_{i,t-1})$ by $(\Delta\ln c_{i,t}-\alpha\Delta\ln c_{i,t-1})$ and equation (5)can be rewritten as

$$\Delta\ln(c_{i,t}) = \gamma_0 + \alpha\Delta\ln(c_{i,t-1}) + \gamma_1\Delta\ln(\psi_{i,t}) + e_{i,t} \qquad (9)$$

Where γ_0 and γ_1 are constants and $e_{i,t}$ is an error term with mean zero.

Equation (9) gives us a simplified form where we can see that consumption yesterday influences consumption today. The level of this influence is captured by the habit formation parameter α. The size of α represents how important the habit stock is on household consumption. If α is large, then past consumption is more important to a household. An implication of a larger habit formation parameter is that the household adjusts slowly to shocks in income. If a household is more "habit bound", then it will be slow to change levels of consumption immediately.

4. The Data

Dynanestimates Equation (9) by using PSID data on household food consumption. This is in line with a substantial body of past literature which used food consumption data to study consumer behavior, such as Hall and Mishkin (1982), Lawrence (1991), and Zeldes (1989), under standard preferences.

To check for robustness of the results, Dynan estimates Equation (9) with several proxy variables for growth in nondurables and services consumption. The relationship between the growth in consumption of nondurables and services and growth of these variables (in various combinations) is estimated, using data from the 1985 *Consumer Expenditure Survey*. These estimated coefficients are used for the relevant PSID variables to create proxies for nondurables and services spending growth. The baseline sample is 3,153 households, from 1974 to 1987. There are as many as 13 observations on food expenditure growth for each household.

5. Estimation

As mentioned above, the amount of measurement error in the PSID food consumption data necessitates the use of instrumental variables to estimate the parameters of the model. This measurement error is represented by

$$\ln(c^*_{i,t}) = \ln(c_{i,t}) + v_{i,t} \tag{10A}$$

where $v_{i,t}$ represents measurement error. Thus Equation (9) becomes

$$\Delta\ln(c^*_{i,t}) = \gamma_0 + \alpha\Delta\ln(c^*_{i,t-1}) + \gamma_1\Delta\ln(\psi_{i,t}) + z_{i,t} \tag{10B}$$

Where

$$z_{i,t} = e_{i,t} + v_{i,t} - (1+\alpha)v_{i,t-1} + \alpha v_{i,t-2} \tag{11}$$

Since $\Delta\ln(c^*_{i,t-1})$ is correlated with $z_{i,t}$, equation (10) must be estimated using instruments for lagged consumption growth. Also, because of the MA(2) structure of the error $z_{i,t}$, the Generalized Method of Moments will be used to estimate it. Dynan uses a baseline set of instruments, which includes three variables, which are as follows.

1. A dummy for ranges of lagged growth in real household money income.
2. A dummy for ranges of lagged growth in total annual hours worked by family members.
3. A dummy for whether the head of household lost his/her job involuntarily during the previous period.

Additional instruments are included in some specifications to check for robustness of results (dummies for lagged hours of work missed by the head and spouse because of illness, and the lagged ratio of lump sum receipts of money incomes). The taste shifters term in the Euler equation includes the age of the head of household, age-squared, and growth in the number of adult male equivalents in the household. To prevent aggregate shocks from giving inconsistent estimates for the parameters, the specifications include dummies for time. Extra demographic variables are included in some specifications to control for possible household specific effects. Also, real after-tax interest rate is included in one specification.

5.1.Results of Dynan's Parametric Estimation

Dynan estimates the habit formation parameter, using a specification that includes the following variables: change in family size, age, age-squared scaled by 1,000, race (a dummy variable for whether the head of household is white or not) and gender (a dummy variable for whether the head of household is female or not). For this specification, the estimate for α is –0.046 with a standard error of 0.070, and is not statistically significant. Thus the results show no evidence of habit formation in the data.Dynan estimates the model with different instrument sets and an additional variable (real after-tax interest rate), but the results are qualitatively the same, with the data showing no evidence of habit formation.

6. Additional Estimation Methods

6.1 .Neglected Nonlinearity and the Fan-Ullah Test

It is possible that current and past consumption could be nonlinearly related, and a linear model may not fully capture the size of the habit formation parameter. The first order condition given by equation (5) and its subsequent simplification show a nonlinear relationship between the marginal utilities of pasts and present consumption. Although the first order condition was simplified to a linear equation for estimation purposes, a nonlinear model may be an improvement in more clearly representing the relationship between current and past consumption. There is possibility of a neglected structure between current and lagged consumption variables. To determine this, a Fan-Ullah (1999) test was conducted on the two relevant variables. The idea behind the Fan-Ullah test is the following. If the model is correctly specified, there are no neglected variables left out of the regression that could explain any significant amount of variation in the residuals. If it is incorrectly specified, then a statistically significant level of variation in the residuals could indicate model misspecification.

The Fan-Ullah test is conducted in two steps. In step one, the expectation of the residuals from the parametric estimation are taken, conditional on the variable that is thought to be nonlinearly related to the dependent variable. This conditional expectation, $\hat{E}[\hat{z}_{i,t} \mid \Delta \ln(c_{i,t-1})]$, is estimated using nonparametric techniques. In step two, the original residuals are regressed on this expected value, then a simple t-test is conducted where $\hat{\gamma}$ is the coefficient on the above expected value, where the null and alternative hypotheses are:

H_0:γ = 0 (no neglected structure)

H_1:γ ≠ 0 (neglected structure)

If the model is correctly specified, then we would expect to see that the original residuals would have no relationship with the above conditional expectation. But if it is misspecified, we should see that the original residuals are a function of the above conditional expectation. The calculated t-statistic for this hypothesis test was t=5.2102, so the null hypothesis is rejected at the 5% significance level. Obviously there is an issue of neglected structure in the original model. As stated above, the original nonlinear Euler equation was simplified into a linear form for estimation purposes. The Fan-Ullah test indicates the problem of model misspecification. Therefore, in this case, a semiparametric model may better represent the relationship between the two variables. There is obviously a nonlinear relationship that is not being captured by the linear model. The log linearization of the Euler equation may have resulted in a loss of information regarding the relationship between current and lagged consumption.

6.2. The Semiparametric Model

Equation (8) is now modified to include a semiparametric term, indicating that current and lagged consumption are nonlinearly related as follows.

$$\ln(c_{i,t}) = \eta_i + m(\ln(c_{i,t-1})) + X_{i,t}\beta + u_{i,t} \quad (12)$$

where η_i is a household specific (fixed) effect.

The remaining variables (change in family size, age, age-squared scaled, and the dummy variables for gender and race) are still linearly related to current consumption, as it was in Dynan's linear model.

6.3. Estimation

This new model is estimated using the methodology in Robinson (1988), where the estimation procedure is as follows. Take the expectation of equation (12), conditional on the lagged consumption variable, which is

$$\begin{aligned} &E[\ln(c_{i,t})|\ln(c_{i,t-1})] \\ &= E[\eta_i|\ln(c_{i,t-1})] + m(\ln(c_{i,t-1})) \\ &+E[X_{i,t}|\ln(c_{i,t-1})]\beta \end{aligned} \quad (13)$$

where $E(u_{i,t} \mid X_{i,t}, c_{i,t-1}) = 0$. Then equation (13) is subtracted from (12), giving

$$c_{i,t}^{\ *} = \eta_i^* + X_{i,t}^*\beta + u_{i,t} \quad (14)$$

The "star" superscripts denote the differences from the conditional means. Now (14) can be estimated consistently using Least Squares, giving the solution:

$$(\hat{\eta}\ \hat{\beta}) = (X^{*'}X^{*})^{-1}X^{*'}c^{*} \quad (15)$$

Now using equation (15) and the estimates for β, the following equation is obtained.

$$c_{i,t}{**} = c_{i,t} - \hat{\eta} - X_{i,t}\hat{\beta} = m(c_{i,t-1}) + w_{i,t} \quad (16)$$

Using nonparametric methodology, Equation (16) can be estimated by solving the following problem

$$\min_{n,\alpha} \sum_{i=1}^{n}\sum_{t=1}^{T}\left[\left(c_{i,t}^{\ **} - n - \alpha\cdot c\right)^2 \cdot K\left(\frac{c_{i,t-1}-c}{h}\right)\right] \quad (17)$$

where

$$K\left(\frac{c_{i,t-1}-c}{h}\right) = \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}\left(\frac{c_{i,t-1}-c}{h}\right)\right) \quad (18)$$

and h is the window width, also known as bandwidth which is given by $h = 1.06\sigma n^{-1/5}$, which gives the optimal window width that will minimize the approximate integrated mean squared error, as stated in Silverman (1986). The solution to the above minimization problem is given by

$$(\hat{n}\ \hat{\alpha})' = (\Pi'\vec{K}\Pi)^{-1}\Pi'\vec{K}\cdot c_{i,t}^{\ **} \quad (19)$$

where $\Pi = (1\ \ c)$ and

$$\vec{K} = \mathrm{diag}\left(K\left(\frac{c_{11}-c}{h}\right) \ \ldots\ K\left(\frac{c_{nT}-c}{h}\right)\right) \quad (20)$$

Then the Local Linear Least Squares estimate of this is calculated by $\hat{m}(c_{i,t-1}) = \hat{n} + \hat{\alpha}\cdot c$.

To estimate the 95% confidence bounds of the habit formation parameter, I used the wild bootstrapping procedure from Rodriguez-Campos and Cao-Abad (1993).

6.4. Coefficient Estimation Results

Dynan's point estimates of the habit formation parameter for the parametric model ranged between -0.038 and -0.046, depending on which model specification she used. None of these values were statistically significant. In comparison, the mean value of the estimated semiparametric habit formation parameter is -0.116. One thing I would like to focus on here is the existence of positive, nonzero habit formation parameter in my estimates. Based on the current literature, the habit formation parameter has been restricted to be between zero and one, as this upper bound is necessary to ensure positive utility in the steady state. Dynan uses a CRRA utility function, thus it is necessary to place an upper bound on the value of the habit formation parameter. However, this constraint on habits is only necessary when a specific functional form is used for a household utility function. In my semiparametric estimation, a functional form is not required; the main idea is to investigate is the relationship between past and current consumption. The structure of habits in Dynan's and other authors' models is that there is either an additive or multiplicative relationship between consumption yesterday and today, with the size of the habit formation parameter α indicating the strength of habits. But regardless of the type of habits used in the model, the key element is the connection between a household's consumption yesterday versus today. If there is a strong connection between these two events, then habits do exist. Therefore, in the semiparametric model, the restriction on the upper bound of the habit formation parameter is not necessary.

Given the wild boostrapped 95% confidence intervals, 23,957 observations, or 88% of the estimated habit formation parameters are nonzero, and within this subset, 7,531 are positive. Thus, 28% of all the total observations show evidence that is consistent with the theory of habit formation. I will focus on only these observations that had positive, nonzero estimates of the habit formation parameter for my subsequent discussion.

It is possible that certain characteristics of households could be affecting their consumption levels and their habits from period to period. In particular, I will examine households based on demographic characteristics such as age, gender, and race of the head of the household. Job loss could also affect consumption levels, so I will look at the estimated habit formation parameter for those households whose heads have involuntarily lost their jobs in a prior time period. I will also be including descriptive statistics on the average growth of money income for each category, since income levels from period to period will also affect consumption levels.

6.4.1. Households by Age Ranges

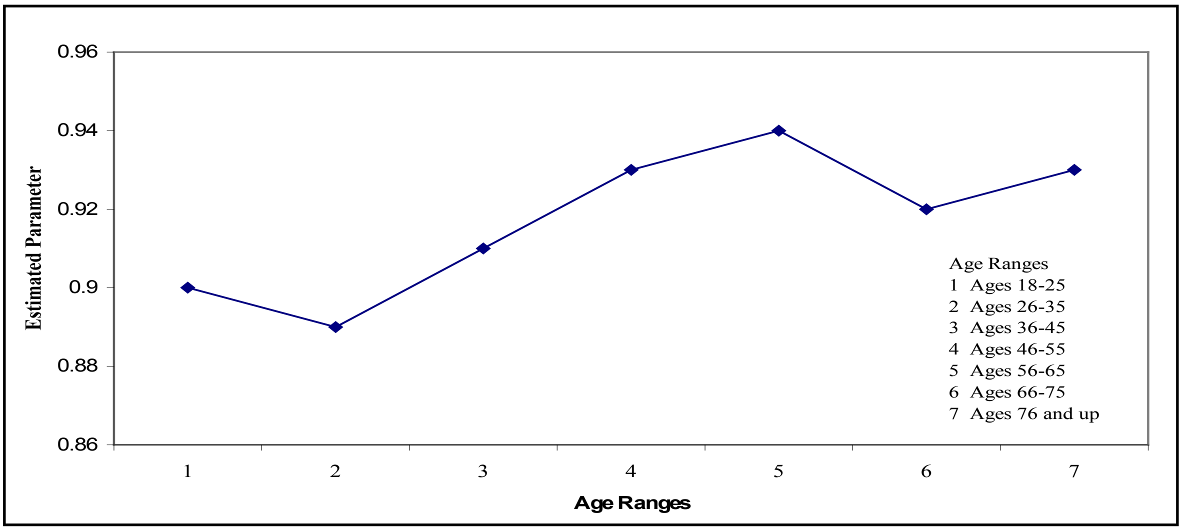
Table 1 lists the average habit formation parameter for households according to age ranges of the head of households. The second column in the table lists the number of observations for which the estimated habit formation parameter is positive. The third column lists the total number of observations with nonzero habit formation parameters for each age group. As column 4 shows, quite a high percentage of each age range demonstrates positive habits. For the age ranges 26 to 35 and 36 to 45, the average habit formation parameters are quite close, at 0.89 and 0.91. This corresponds with the growth in money income, which is similar for both these age ranges. Habits in these two groups are similar, due to the fact that growth in income is similar as well. It is also interesting to note that the strength of habits rises over the main years of employment, from age 26 to 65. After retirement, the parameter decreases and is approximately the same for both the age ranges 66 to 75, and 75 and up. This corresponds with the fact that average growth of money income falls after retirement age. Older aged households have to be more restrictive about their spending, and must be more habit bound than other households. This information is also shown in Figure 1, which is a representation of the average habit formation parameter for each age group, which indicates that habits do change by age.

Table 1. Habit Formation Parameter: Average Value by Age Ranges

Age Range[1]	Number of Observations	Total Number of Observations	% of Total Observations for the Age Range	Average Habit Formation Parameter	Average Growth of Money Income (GMY)*	σ_{GMY}
18-25	501	1588	31.5%	0.90	4.48	65.58
26-35	2220	6954	31.9%	0.89	1.20	72.10
36-45	1397	4567	30.6%	0.91	1.27	57.52
46-55	1156	3639	31.8%	0.93	-0.45	65.18
56-65	1024	3232	31.7%	0.94	-1.88	70.69
66-75	793	2489	31.9%	0.92	0.69	37.68
76-up	440	1488	29.6%	0.93	-1.09	43.17
Total	7531	23957				

*Values in logs

[1]Age range of head of household



Note: Average positive habit formation parameter, for age ranges.

Figure 1. Average Habit Formation, by Age Ranges

Table 2. Habit Formation Parameter: Average Value by Gender

Gender[2]	Number of Observations	Total Number of Observations	% of Total Observations for the Gender	Average Habit Formation Parameter	Average Growth of Money Income (GMY)*	σ_{GMY}
Male	6156	19582	31.4%	0.91	1.41	64.78
Female	1375	4375	31.4%	0.92	-3.25	56.59
Total	7531	23957				

*Values in logs

[2]Gender of head of household

Table 3. Habit Formation Parameter: Average Value by Race

Race[3]	Number of Observations	Total Number of Observations	% of Total Observations for the Race	Average Habit Formation Parameter	Average Growth of Money Income (GMY)*	σ_{GMY}
White	6912	21934	31.5%	0.91	0.89	63.71
Nonwhite	619	2023	30.6%	0.88	-2.98	59.70
Total	7531	23957				

*Values in logs

[3]Race of head of household

Table 4. Habit Formation Parameter: Average Value by Job Loss

Job Status[4]	Number of Observations	Total Number of Observations	% of Total Observations for Job Status	Average Habit Formation Parameter	Average Growth of Money Income (GMY)*	σ_{GMY}
Lost Job	48	202	23.8%	0.69	1.46	31.18
Didn't Lose Job	6615	21115	31.3%	0.91	0.52	63.62
Total	6663	21317				

*Values in logs

[4]Job status is a dummy variable for whether the head of the household lost his/her job involuntarily in the previous period

6.4.2. Households by Gender

Table 2 shows the data categorized by the gender of the head of the household. The second column lists the number of observations with positive estimated habits, and column 3 lists the total number of observations with nonzero habit formation parameters for each gender. About one third of each group shows evidence of habit formation, with the average parameter being quite high at 0.91 for male headed households and 0.92 for female headed households. A look at the average growth rate of money income in column 6 shows that female headed households have a substantially lower average growth rate of income; in fact it is negative, at –0.425. It is quite low, compared to male headed households, which have an average growth rate of income at 0.730. This difference in income growth rate could account for the female group being slightly more bound by habits than the male group.

6.4.3. Households by Race

Another factor, which could contribute to different habits between households is race. Table 3 shows a breakdown of the data, by white and nonwhite headed households. Column 2 lists the number of observations that have an estimated positive habit formation parameter, and column 3 lists the total number of observations with nonzero estimated parameters. Here also, about a third of each subgroup shows habit formation. Data on average growth of money income is listed in column 6. Here, nonwhite households have substantially lower growth in money income, at –0.529, compared to white households with an average growth of money income at 0.618. This factor could be quite relevant in explaining the difference in habits between the two groups.

6.4.4 .Households by Job Status

Table 4 lists the data, categorized by job loss, that is, whether the head of the household involuntarily lost his/her job in the previous period. For the positive estimates of the habit formation parameter, there are 48 observations that show job loss in a previous period, with an average habit formation parameter of 0.69 as indicated in columns 2 and 5. In this case, the average habit formation parameters are quite different between the two groups. The households with no job loss have a substantially higher estimated parameter, at 0.91.

7. Conclusion

As an extension to Dynan's paper, I considered an alternative method of estimating the parameters of habit formation. In the original parametric panel data model, there was no evidence of habit formation in household food consumption. However, this may be because of a neglected structure in the model. For estimation purposes, Dynan simplifies of the Euler equation from the first order condition of the household's problem into a log linear form, but this simplification may result in a loss of information that results in a weaker result for the evidence of habit formation. The Fan-Ullah test confirms that past and present consumption are actually nonlinearly related, thus there is a neglected structure that is not being accounted for in the parametric model. Therefore, a semiparametric estimation of the model may give more accurate results. After estimating the habit formation parameter via semiparametric methodology, I examined the results, and based on the wild boostrapped confidence bounds, I found that a large percentage of these estimates were nonzero, and a third of the nonzero estimates to be positive. In addition, breakdowns of the data by demographic characteristics, such as age, gender, and race were useful in making comparisons of the strength of habit formation by these different groups. These demographic categories, as well as a category for the status of job loss for the head of the household, yielded interesting and varying results for the estimates of the habit formation parameter. Including data on average growth of money income for all these different categories provided additional information regarding the different households and the possible reasons for their consumption patterns. Minority headed households, as well has female headed households, had average income growth rates which were substantially lower than those for white and/or male headed households. Differences in income growth rates, as well as demographic characteristics, could also be key in understanding the strength of habit formation for various households.

REFERENCES

[1] Abel, Andrew B., "Asset Prices Under Habit Formation and Catching Up with the Joneses," American Economic Review, May 1990, vol. 80, no. 2, pp. 38-42.

[2] Abel, Andrew B., "Risk Premia and Term Premia in General Equilibrium," Journal of Monetary Economics, 1999, 43, pp. 3-33.

[3] Alessie, Rob, "Savings and Habit Formation: Evidence from Dutch Panel Data," Working Paper, February 2003.

[4] Alessie, Rob and Lusardi, Annamaria, "Consumption, Savings, and Habit Formation," Economics Letters, February 1997, 55, pp. 103-108.

[5] Alonso-Carerra, Jaime; Caballé and Raurich, Xavier, "Consumption Externalities, Habit Formation, and Equilibrium Efficiency," Working Paper, October 5, 2001.

[6] Berg, M. Douglas, Li, Qi, and Ullah, Aman, "Instrumental Variable Estimation of Semiparametric Dynamic Panel Data Models: Monte Carlo Results on Several New and Existing Estimators," Nonstationary Panels, Panel Cointegration and Dynamic Panels, vol. 15, pp. 297-315, Elsevier Science, Inc., 2000.

[7] Boskin, Michael J. and Sheshinski, Eytan, "Optimal Redistributive Taxation when Individual Welfare Depends Upon Relative Income," Quarterly Journal of Economics, November 1978.

[8] Campbell, John Y. and Cochrane, John H., "A Consumption Based Explanation of Aggregate Stock Market Behavior," Journal of Political Economy, April 1999, vol. 107 (2), pp. 205-251.

[9] "Explaining the Poor Performance of Consumption-based Asset Pricing Models," Journal of Finance, vol. LV, no. 6, 2000.

[10] Campbell, John Y. and Deaton, Angus S., "Why is Consumption so Smooth?" Review of Economic Studies, July 1989, 56(3), pp. 357-73.

[11] Campbell, John Y. and Cochrane, John H., "By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior," Journal of Political Economy, April 1999, vol. 107 (2), pp. 205-251.

[12] Carroll, Christopher D., "Solving Consumption Models with Multiplicative Habits," Economics Letters, 2000, vol. 68, pp. 67-77.

[13] Carroll, Christopher D. and Weil, David N., "Saving and Growth: A Reinterpretation," Carnegie-Rochester Conference Series on Public Policy, June 1994, 40, pp. 133-192.

[14] Carroll, Christopher D.; Overland, Jody and Weil, David N., "Savings and Growth with Habit Formation," American Economic Review, June 2000, vol. 90, no. 3, pp. 341-355.

[15] "Comparison Utility in a Growth Model," Journal of Economic Growth, 1997, vol. 2, pp. 339-367.

[16] Chetty, Raj, and Szeidl, Adam, "Consumption Commitments: Neoclassical Foundations for Habit Formation," Working Paper, November 2004.

[17] Constantinides, George M., "Habit Formation: A Resolution of the Equity Premium Puzzle," Journal of Political Economy, June 1990, 98(3), pp. 519-543.

[18] Cox, Donald, Ng, Serena, and Waldkirch, Andreas, "Intergenerational Linkages in Consumption Behavior," Working Paper, September 2002.

[19] Duesenberry, James S., "Income, Saving, and the Theory of Consumer Behavior," Cambridge: Harvard University Press, 1952.

[20] Dupor, Bill and Liu, Wen-Fang, "Jealousy and Equilibrium Overconsumption," Working Paper, April 2001.

[21] Dynan, Karen, "Habit Formation in Consumer Preferences: Evidence from Panel Data," American Economic Review, June 2000, vol. 90, no. 3, pp. 391-406.

[22] Falk, Armin and Knell, Markus, "Choosing the Joneses: Endogenous Goals and Reference Standards," Scandinavian Journal of Economics, 2004, vol. 106, no. 3, pp. 417-435

[23] Fan, Y., and AmanUllah, "Asymptotic Normality of a Combined Regression Estimator," Journal of Multivariate Analysis, 1999.

[24] Faria, Joao R., "Growth and Labor Supply in the Presence of Habit Formation in Consumption," Economics Bulletin, 2002, vol. 4, no. 5, pp. 1-5.

[25] Ferson, Wayne, and Constantinides, George, "Habit Persistence and Durability in Aggregate Consumption," Journal of Financial Economics, 1991, vol. 29, pp. 199-240.

[26] Fisher, Walter H. and Hof, Franz X., "Relative Consumption, Economic Growth, and Taxation," Journal of Economics, March 2000, vol. 72, no. 3, pp. 241-262.

[27] Frank, Robert, "The Demand for Unobservables and Other Nonpositional Goods," American Economic Review, March 1985, vol. 75, no. 1, pp. 101-116.

[28] Fuhrer, Jeffrey C., "Habit Formation in Consumption and its Implications for Monetary-Policy Models," American Economic Review, June 2000, vol. 90, no. 3, pp. 367-390.

[29] Gali, Jordi, "Keeping Up with the Joneses: Consumption Externalities, Portfolio Choice, and Asset Prices," Journal of Money, Credit, and Banking, February 1994, vol. 26, no. 1.

[30] Greene, William H., Econometric Analysis, MacMillan Publishing Company, 1990.

[31] Grinblatt, Mark, Keloharju, Matti, and Ikaheimo, Seppo, "Interpersonal Effects in Consumption: Evidence from the Automobile Purchases of Neighbors," Working Paper, January 2004.

[32] Hall, Robert E., "Stochastic Implications of the Life-Cycle/Permanent Income Hypothesis: Theory and Evidence," Journal of Political Economy, December 1978, 86(6), pp. 971-87.

[33] Harbaugh, Richmond, "Falling Behind the Joneses: Relative Consumption and the Growth-Savings Paradox," Economics Letters, September 1996, 53, pp. 297-304.

[34] Hayashi, Fumio, "The Permanent Income Hypothesis and Consumption Durability: Analysis Based on Japanese Panel Data," Quarterly Journal of Economics, November 1985, 100(4), pp. 1083-113.

[35] Heaton, John "On Some Determinants of Saving in Developed and Underdeveloped Countries," Problems in Economic Development, E.A.G. Robinson, ed., London: Macmillan, 1965.

[36] Heaton, John, "An Empirical Estimation of Asset Pricing with Temporally Dependent Preference Specifications," Econometrica, May 1995, vol. 63, no. 3, pp.681-717.

[37] Houthakker, Hendrik S., "An Intertemporal Comparison of Personal Savings," Bulletin of the International Statistical Institute, 1961, 38, pp. 55-70.

[38] Hsiao, Cheng, Analysis of Panel Data, Cambridge University Press, 1986.

[39] Kocherlakota, Narayana R., "The Equity Premium: It's Still a Puzzle," Journal of Economic Literature, vol. XXXIV, pp. 42-71, 1996.

[40] Kumar, Subodh and AmanUllah, "Semiparametric Varying Parameter Panel Data Models: An Application to Estimation of Speed of Convergence," Advances in Econometrics, vol. 14, pp.109-128, JAI Press, 2000.

[41] Lettau, Martin and Uhlig, Harald, "Can Habit Formation Be Reconciled with Business Cycle Facts?",Review of Economic Dynamics, 2000, vol. 3, pp. 79-99.

[42] Lettau, Martin and Uhlig, Harald, "Can Habit Formation Be Reconciled with Business Cycle Facts?",Review of Economic Dynamics, 2000, vol. 3, pp. 79-99.

[43] Ljungqvist, Lars and Uhlig, Harald, "Tax Policy and

Aggregate Demand Management Under Catching Up with the Joneses," American Economic Review, June 2000, vol. 90, no. 3, pp. 356-366.

[44] Lofgren, Asa, "Habit Formation in the Environmental Quality: Dynamic Optimal Environmental Taxation," Working Papers in Economics no. 92, 2003.

[45] Lucas, Robert E., Jr., "Asset Prices in an Exchange Economy," Econometrica, November 1978, 46, 1429-45.

[46] Mehra, Rajnish and Prescott, Edward C., "The Equity Premium: A Puzzle," Journal of Monetary Economics, March 1985, 15, pp. 145-161.

[47] Modigliani, F "Life Cycle, Individual Thrift, and the Wealth of Nations," American Economic Review, June 1986, 3(76), pp. 297-313.

[48] Modigliani, F., "The Life Cycle Hypothesis of Saving and Inter-Country Differences in the Saving Ratio," Induction, Growth, and Trade: Essays in Honor of Sir Roy Harrod, W.A. Eltis et al., eds., London: Clarendon Press, 1970.

[49] Muellbauer, John, "Habits, Rationality, and Myopia in the Life Cycle Consumption Function," Annalesd'Economieet de Statistique, January-March 1988, (9), pp. 47-70.

[50] Mundlak, Y., "Empirical Production Function Free of Management Bias," Journal of Farm Economics, 1961, 43, pp. 44-56.

[51] Pagan, Adrian and AmanUllah, Nonparametric Econometrics, Cambridge University Press, 1999.

[52] Pierdzioch, Christian, and Yener, Serkan, "On the Hump-Shaped Output Effect of Monetary Policy in an Open Economy," Institute for World Economics, Working Paper, 2003.

[53] Rauscher, M., "Conspicuous Consumption, Economic Growth, and Taxation," Journal of Economics/Zeitschrift für National ökonomie, 66, pp. 35-42.

[54] Rhee, Wooheon, "Habit Formation and Precautionary Savings: Evidence from Korean Panel Data Studies," Journal of Economic Development, v. 29, n. 2, 2004

[55] Robinson, P.M., "Root-N-Consistent Semiparametric Regression," Econometrica, 1988a, 56, 931-954.

[56] Robinson, P.M., "Semiparametric Econometrics: A Survey," Journal of Applied Econometrics, 1988c, 3, pp. 35-51.

[57] Ryder, Harl E., and Heal, Geoffrey M., "Optimal Growth with Intertemporally Dependent Preferences," Review of Economic Studies, 1972.

[58] Seckin, Aylin, "Consumption-Leisure Choice with Habit Formation," Economics Letters, 2001, 70, pp. 115-120.

[59] Shao, Jun and DongshengTu, The Jackknife and the Bootstrap, Springer Verlag, 1995.

[60] Shao, Jun and DongshengTu, The Jackknife and the Bootstrap, Springer Verlag, 1995.

[61] Siegel, Jeremy J., and Thaler, Richard H., "Anomalies: The Equity Premium Puzzle," Journal of Economic Perspectives, 1997, vol. 11, n. 1, pp. 191-200.

[62] Skinner, Jonathan, "A Superior Measure of Consumption from the Panel Study of Income Dynamics," Economics Letters, 1987, 23(2), pp. 213-16.

[63] Toche, Patrick, "Savings and Growth with Habit Formation: A Comment," Working Paper, May 2004.

[64] Wendner, Ronald, "Capital Accumulation and Habit Formation," Economics Bulletin, vol. 4, no. 7, pp. 1-10, 2002

[65] Wendner, Ronald, "An Overlapping Generations Model of Habit Formation and Tax Policy," Working Paper, May 2000.

[66] Wooldridge, Jeffrey M., Econometric Analysis of Cross Section and Panel Data, MIT Press, 2002.