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# The permanent income hypothesis: Evidence from the consumer expenditure survey[1]

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**Abstract**

Consumption Euler relations are estimated with data from the 1986–1991 US Consumer Expenditure Survey *without* creating a synthetic panel. The stochastic implications of the permanent income hypothesis generally are not rejected, and there is little evidence of liquidity-constrained or rule-of-thumb behavior. The results are robust with respect to consumption category, changes in sample, and choice of instruments. 

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## 1. Introduction

The US Consumer Expenditure Survey (CEX) seems an especially promising data set for testing the permanent income/life cycle hypothesis (PILCH) at a microeconomic level. The CEX follows households for fifteen months, collecting information about expenditures on durable goods and nondurable goods and services, household assets and income, and various socioeconomic variables. There are approximately 500 types of expenditure data and 20 types of income data available for each household in the CEX. The CEX offers much more comprehensive measures of consumption than previously available data

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sets, such as the Panel Study of Income Dynamics (PSID). We use the CEX here to test consumption Euler equations.

Attanasio and Weber (1995) have used the CEX to test PILCH. They construct a synthetic panel by chaining together the underlying data to introduce a time element into data that otherwise are only cross-sectional. The chaining is done by grouping households by year of birth of the household head. These groups constitute random samples of each birth-year cohort in the population, allowing the researcher to follow the cohorts across various years of the survey. The individual households within the groups change as time passes, but, under certain identifying assumptions, the group data can be treated as panel data.[2] Attanasio and Browning (1995) and Browning et al. (1985) apply the same method to the UK. Family Expenditure Survey (FES) data, which asks households to keep a diary of expenditures on all goods over a two-week period, after which the household is replaced by a new household. Attanasio and his coauthors obtain results supporting PILCH; Browning, Deaton and Irish obtain results that support PILCH at a gross level but reject it at a finer level.

The synthetic panel approach is interesting, but its strength is also its weakness because it amounts to an aggregation procedure and thus vitiates the micro nature of the underlying data. Treating the aggregated data as if they were panel data requires identifying assumptions not obviously more appealing than those needed with other types of aggregate data.[3]

In this paper, we use the CEX to test consumption Euler equations without creating a synthetic panel. Our tests are of a similar nature to those traditionally examined with the PSID, but our estimation method emphasizes the cross-section rather than the time series element of the data. The main benefit of our approach is that we avoid the aggregation problems associated with synthetic panels. The main cost is that the time dimension of the CEX data is short (one observation per household, six years of data), so our tests are weakest in addressing the intertemporal aspects of PILCH. We regard our approach as a complement to synthetic panels rather than a competitor. The two approaches have different strengths and weaknesses and thus give different perspectives on the issues at hand. To the extent that their results agree, we gain increased confidence in those results; where the results differ, we have discovered areas for further research.

[2] See Browning et al. (1985) for details.

[3] For example, Attanasio and Weber (1995) remark that they must rely on the assumption that the underlying population is homogenous over time, an assumption that could be violated if there is a relation between mortality and wealth. An issue in the growth literature is precisely that there is such a relation between mortality (and also fertility and migration) and wealth. See Chapter 9 of Barro and Sala-i-Martin (1995) and the literature cited there. See Moffitt (1993) for a detailed discussion of identifying assumptions needed for synthetic panel data.

Our results support PILCH. The overidentifying restrictions implied by PILCH generally are not rejected, there is no significant evidence of liquidity-constrained or rule-of-thumb behavior, and the results are robust with respect to consumption category, changes in sample, and choice of instruments. Our results and those of Attanasio and Weber (1995) generally agree where they are comparable. The main differences are that we do not find the interest rate significant statistically or economically and our utility function is simpler than theirs.

## 2. Models of consumption

We first summarize the usual PILCH model and then discuss two specific alternatives to it.

### 2.1. The PILCH model

Consumer $i$ chooses the time path of consumption that solves:

$$\max E_{it_0} \sum_{t=t_0}^{T} V(C_{it}; H_{it}, t) \tag{1}$$

subject to the budget constraint

$$A_{i,\,t+1} = (1 + r_{it})A_{it} + Y_{it} - C_{it} \tag{2}$$

and the terminal condition $A_{iT} = 0$, where $E_{it}$ denotes expectation conditional on the information set $I_{it}$, $V(\cdot)$ is the utility function, $C_{it}$ is consumption, $H_{it}$ is a vector of household characteristics, $Y_{it}$ is real disposable income, $A_{it}$ is household nonhuman wealth, and $r_{it}$ is the real after-tax interest rate. This specification of the household maximization problem treats income as exogenous to consumption choice. One justification for this treatment is to suppose that utility is separable in consumption and labor so that the utility function in Eq. (1) actually is the subutility function for consumption. We discuss separability in more detail later.

We suppose that the vector of household characteristics $H_{it}$ comprises three parts: those characteristics that cause transitory consumption, those that affect the household's rate of time preference, and those that affect household choice in other ways, to be discussed presently. These three components are denoted $T_{it}$, $R_i$, and $X_{it}$, respectively:

$$H_{it} = (T_{it}, R_i, X_{it}).$$

Note that $R_i$ does not vary over time. In what follows, we treat $T_{it}$ as unobservable and thus treat transitory consumption as an unexplained residual. We suppose that the household's rate of time preference $\rho_i$ is a function $\rho(\cdot)$ of $R_i$, to be specified later, and that the remaining household characteristics $X_{it}$ affect the scale of household utility, as discussed later. We thus have the utility function

$$V(C_{it}; H_{it}, t) = U(C_{it})T_{it}X_{it}[1 + \rho(R_i)]^{-1}.$$

Finally, we suppose $U(\cdot)$ is the standard constant relative risk aversion function

$$U(C_{it}) = \frac{C^{1-\alpha} - 1}{1 - \alpha}.$$

If consumer can borrow and lend freely, optimal consumption behavior is characterized by the usual Euler relation:

$$E_{it}[(1 + r_{i,\,t+1})V'(C_{i,\,t+1}; H_{i,\,t+1}, t+1)] = V'(C_{it}; H_{it}, t),$$

or equivalently

$$(1 + r_{i,\,t+1})V'(C_{i,\,t+1}; H_{i,\,t+1}, t+1)\varepsilon_{i,\,t+1} = V'(C_{it}; H_{it}, t), \tag{3}$$

where $\varepsilon_{i,\,t+1}$ is consumer $i$'s forecast error in period $t+1$. We assume $\varepsilon$ is lognormally distributed. If expectations are rational, $\varepsilon_{i,\,t+1}$ should be uncorrelated with information known at period $t$, so that $E_{it}(\ln\varepsilon_{i,\,t+1}) = 0$. Note that the expectation is taken over time ($t$) rather than across households ($i$). Consequently, the mean of the forecast error converges to zero when the time span of the panel approaches infinity but not necessarily when the number of households included in the cross-section approaches infinity. We return to this point below.

Substituting for $V$ in Eq. (3), taking logs, using the approximation $\ln(1 + x) \approx x$ for $x$ small, and rearranging gives

$$\ln\left(\frac{C_{i,\,t+1}}{C_{it}}\right) = \frac{1}{\alpha} r_{i,\,t+1} - \frac{1}{\alpha}\rho_i + \frac{1}{\alpha}\ln\left(\frac{X_{i,\,t+1}}{X_{it}}\right) + \frac{1}{\alpha}\ln\left(\frac{T_{i,\,t+1}}{T_{it}}\right) - \frac{1}{\alpha}\ln\varepsilon_{i,\,t+1} = \frac{1}{\alpha} r_{i,\,t+1} - \frac{1}{\alpha}\rho_i + \frac{1}{\alpha}\ln\left(\frac{X_{i,\,t+1}}{X_{it}}\right) + \mu_{i,\,t+1}, \tag{4}$$

where

$$\mu_{i,\,t+1} = \frac{1}{\alpha}\left[\ln\left(\frac{T_{i,\,t+1}}{T_{it}}\right) + \ln\varepsilon_{i,\,t+1}\right].$$

Eq. (4) generalizes the usual Euler equation used for estimation in three ways. First, $r_{i,\,t+1}$ varies across households. Even if households face the same before-tax interest rates, they typically face different after-tax rates. Second, variations in family utility are allowed through the term $\ln(X_{i,\,t+1}/X_{it})$. We follow Zeldes

(1989) in assuming that $\ln(X_{i,\,t+1}/X_{it})$ takes the form

$$\ln\left(\frac{X_{i,\,t+1}}{X_{i,\,t}}\right) = \pi_i \ln\left(\frac{F_{i,\,t+1}}{F_{i,\,t}}\right) + \eta_{i,\,t+1}, \tag{5}$$

where $F_{it}$ denotes family size. This formulation assumes that household utility is the sum of individual family members' utilities, which all have the same form. Third, the rate of time preference $\rho_i$ varies across households. Lawrance (1991) argues that $\rho_i$ seems to vary substantially across household groups, so the usual practice of imposing an identical rate of time preference may be inappropriate. Following Lawrance (1991), we assume $\rho_i$ is a linear function of the average time preference rate $\bar{\rho}$, household-specific observables $R_i$, and household-specific unobservables $v_i$:

$$\rho_i = \bar{\rho} + \gamma R_i + v_i. \tag{6}$$

Substituting Eqs. (5) and (6) into Eq. (4) yields the equation for estimation:

$$\ln\left(\frac{C_{i,\,t+1}}{C_{it}}\right) = \beta_0 + \beta_1 r_{i,\,t+1} + \beta_2 \ln\left(\frac{F_{i,\,t+1}}{F_{it}}\right) + \beta_3 R_i + e_{i,\,t+1}, \tag{7}$$

where $\beta_0 = -\bar{\rho}/\alpha$, $\beta_1 = 1/\alpha$, $\beta_2 = \pi_i/\alpha$, $\beta_3 = -\gamma/\alpha$, and $e_{i,\,t+1} = \alpha^{-1}(\eta_{i,\,t+1} - v_i - \mu_{i,\,t+1})$. Eq. (7) is an expanded version of the equation Runkle (1991) estimates with the PSID data.

### *2.2. Two alternatives to PILCH*

Campbell and Mankiw (1990) argue that consumers fall into two groups, receiving shares $(1-\lambda)$ and $\lambda$ of total disposable income $Y_{it}$. Consumers in the first group behave according to PILCH as represented by Eq. (7), whereas consumers in the second group simply consume their current income ("rule-of-thumb" consumers). Combining the PILCH and rule-of-thumb consumers gives

$$\ln\left(\frac{C_{i,\,t+1}}{C_{it}}\right) = B_0 + B_1 r_{i,\,t+1} + B_2 \ln\left(\frac{F_{i,\,t+1}}{F_{it}}\right) + B_3 R_i + B_4 \ln\left(\frac{Y_{i,\,t+1}}{Y_{it}}\right) + e'_{i,\,t+1}, \tag{8}$$

where $B_j = (1-\lambda)\beta_j$ for $j = 0,\ldots,3$ and $e'_{i,\,t+1} = (1-\lambda)e_{i,\,t+1}$. The transformation to log differences implies that $B_4$ is not the fraction $\lambda$ of rule-of-thumb consumers, but as Campbell and Mankiw (1990) explain, Eq. (8) can be viewed as a log-linear approximation of the true model. Further, it can be considered as a misspecification test equation that nests the rule-of-thumb alternative. If consumers in the economy can be represented by a single forward-looking permanent-income consumer, the estimated value of $B_4$ should not differ significantly from zero.

The other major alternative to PILCH is the model of the liquidity-constrained consumer, for whom net assets can never be negative. The constraint $A_{it} \geq 0$ leads to the modified Euler relation

$$E_{it}[(1 + r_{i,\,t+1})V'(C_{i,\,t+1};H_{i,\,t+1}, t + 1)]\psi_{i,\,t+1} = V'(C_{it};H_{it}, t), \tag{9}$$

where $\psi_{i,\,t+1} \geq 1$ is the Kuhn–Tucker multiplier associated with the borrowing constraint. If the constraint does not bind, $\psi_{i,\,t+1}$ equals one and the Euler equation in (3) is satisfied. The Euler equation is

$$\ln\left(\frac{C_{i,\,t+1}}{C_{it}}\right) = \beta_0 + \beta_1 r_{i,\,t+1} + \beta_2 \ln\left(\frac{F_{i,\,t+1}}{F_{it}}\right) + \beta_3 R_i + \psi'_{i,\,t+1} + \zeta_{i,\,t+1} \tag{10}$$

where $\psi'_{i,\,t+1}$ equals $\ln(\psi_{i,\,t+1})$ divided by the left side of Eq. (9) and has the same properties as $\psi_{i,\,t+1}$. The more severe the liquidity constraint, the higher the value of $\psi'_{i,\,t+1}$ and therefore the steeper the consumption path compared with that of the unconstrained case. Also, consumption can never grow more slowly than in the unconstrained case as long as $\psi'_{i,\,t+1}$ is nonzero (Zeldes, 1989).

Because $\psi'_{i,\,t+1}$ is unobservable, we cannot test directly whether a rejection of PILCH is due to liquidity constraint. We use the same procedure as Zeldes (1989) and Runkle (1991) and group the sample households by variables that might determine whether or not households are liquidity constrained, i.e., observable variables correlated with $\psi'_{i,\,t+1}$. Zeldes and Runkle propose several possible criteria for splitting the household sample. We use two of them here: whether the ratio of total liquid assets to after-tax income is greater than 2 (similar to Zeldes) and whether a consumer owned or rented his residence (similar to Runkle).[4]

Indirect criteria to split the sample may do a bad job of separating constrained and unconstrained consumers and hence lead to low testing power (e.g., Japelli, 1990). However, as Altonji and Siow (1987) and Shea (1995) explain, liquidity-constrained consumers should respond asymmetrically to income changes because liquidity constraints bind only when consumers want to borrow, not when they want to save. Another kind of test for liquidity constraints, then, is to allow income increases to have a different coefficient on consumption than income decreases. This test also can distinguish between liquidity-constrained and rule-of-thumb behavior. Rule-of-thumb consumers, who always consumer their current income, neither borrow nor save to smooth consumption, whereas

[4] Given the asset information available in the CEX, we define liquid assets as the sum of checking and savings accounts, US Savings Bonds, and the estimated market value of stocks, bonds, mutual funds and other securities.

liquidity-constrained consumers save when current income is high even though they are constrained from borrowing when current income is low (Mariger, 1987; Zeldes, 1989; Seater, 1997). If PILCH is rejected because of rule-of-thumb consumption behavior, consumption should be equally responsive to predicted income increases and decreases, whereas if liquidity constraints cause the rejection, consumption should respond asymmetrically to income increases and decreases. In the empirical section, we allow the positive and negative predictable income growth to have different coefficients.

## 3. Data and estimation issues

### 3.1. Data

The data used in this study are from the 1986–1991 US Consumer Expenditure Survey (CEX).[5] The CEX begins in 1980, but there was a change in survey methodology after 1985, making the pre- and post-1985 data not fully comparable. We therefore have restricted attention to the post-1985 data. The CEX provides detailed and extensive data on consumption expenditure, income, socioeconomic, and demographic characteristics of American households. Interviewers visit approximately 4,500 consumer units every three months for a fifteen-month period. Information collected in the first interview is not available in the public use tape, so in what follows we refer to the second interview completed by the household as the first interview. Approximately 500 types of expenditure data are collected in all the interviews, but questions on incomes are asked in the first and fourth (last) interviews only. Income values obtained in the first interview are carried over to the second and third interviews except when a household member has new employment information or has changed occupation. In such cases, the earned income history of the consumer unit is reconstructed over the intervening time period (BLS, 1990). The appendix gives more details on the CEX's definitions of consumer units and income.

To estimate Eq. (8), there must be at least two consumption and income data points for each household in the survey. The CEX data meet this requirement, and the two observations used are taken from the first and fourth quarterly interviews. Because Eq. (8) contains logarithms, we include in the sample only households with positive average income and expenditures in both interviews.

We use the following alternative definitions of consumption expenditure: nondurable goods and services, food, apparel and services, utilities, transportation, and medical care. The last five series are the main components of the first

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series. These components almost certainly are not measured equally well in the CEX, but the results are much the same across the various components, as we shall see. Nondurable goods and services are defined as in the US National Income and Product Accounts. To facilitate comparison with studies that have used the PSID, we use the PSID's definition of food expenditures as our definition of food: expenditures on food at home and away from home and on alcoholic beverages.

We measure income as disposable income, defined as before-tax income minus income taxes (federal, state and local), property taxes, deductions for retirement (social security, government, self-employed, private pensions and railroad retirement), and occupational expenses. We convert nominal quantities to real terms with the 1987 base-year CPI deflator. For regressions involving total expenditure on nondurables and services, we use the general CPI; for regressions involving a subset of expenditures, such as Apparel and Services, we use the appropriate commodity-specific CPI.

The CEX measures assets only in the last interview. We analyze consumption changes between the first and last interviews, so the right measure of assets would be the amount held in the first interview. The CEX procedure therefore injects an additional element of noise into the measure of assets. We doubt this extra measurement error is large for most households.

We calculate the real after-tax interest rate $r_{it}$ for each household using the formula

$$r_{it} = i_t(1 - \tau_{it}) - \pi_t,$$

where $i_t$ is the nominal interest rate, $\tau_{it}$ is the marginal tax rate of household $i$, and $\pi_t$ is the inflation rate. This formula reflects the fact that income tax laws generally do not index interest earnings/payments for inflation. We use the one-year Treasury bill rate for the nominal interest rate and the *ex post* growth rate of the CPI for the inflation rate. There is no information on $\tau_{it}$ in the CEX, so we approximate it for each household by dividing the household's total federal, state, and local income taxes paid by the household's total income before taxes. This average tax mismeasures the appropriate marginal tax to the extent that the household's tax is not proportional. Federal and many state income taxes are progressive rather than proportional, but even for progressive income systems, there is a high correlation between average and marginal tax rates (Seater, 1982). Also, some state income taxes and most non-income taxes, such as sales taxes, are proportional. Thus the average tax rate may not be a bad proxy for the marginal rate. Note that $r_{it}$ varies across the CEX households for three reasons: households interviewed from 1986 to 1991 are pooled, which means they face different values of $i_t$, given everything else; $\pi_t$ varies across years; and $\tau_{it}$ varies across households and years.

We restrict our sample to households with complete interviews and complete income reports. We exclude households with the reference person engaged in farming, forestry and fishing (131 households) because we cannot differentiate between their consumption and work-related expenditures. We also exclude self-employed (840 households) because income data for self-employed workers are known to be seriously underestimated and inaccurately reported. Finally, we follow previous empirical work in excluding households with extreme changes in income or consumption to limit the influence of outliers. In most of our regressions, we exclude any household with income growth over 400% or consumption growth over 300% , although we also explore the effect of making no outlier exclusions at all. Our criteria for excluding outliers are weaker than those used in previous work.[6]

After we applied these filters, 12,908 households remained in the sample, distributed approximately evenly over the six years included in the sample (i.e., about 2,150 per year). Each household is present for only one year. We thus have no panel element to our data; rather, we are doing a pooled cross-section, time series regression. The cross-section dimension is large; the time dimension is small.

### 3.2. Choice of instruments

Least squares estimation of Eq. (8) requires that $\Delta\ln Y_{i,\,t+1}$ and $r_{i,\,t+1}$ be uncorrelated with the compound error term $e'_{i,\,t+1}$. These conditions are not likely to be satisfied. The forecast error $\varepsilon$ arises from new information. Income is a decision variable, so new information that affects consumption choice also may affect income choice. The household's tax rate is effectively a choice variable, too, because it depends on the household's income. Also, the tax rate depends, through deductions, on the kind of consumption expenditures made. It seems possible – indeed, likely, given that $e'_{i,\,t+1}$ includes transitory consumption – that the composition of consumption and thus the tax rate depends on $e'_{i,\,t+1}$. Thus both $\Delta\ln Y_{i,\,t+1}$ and $r_{i,\,t+1}$ may be correlated with the error term. These problems are compounded by the fact that the CEX survey is conducted by recall, not record keeping. It seems possible that errors in recalling consumption, income, and tax payments are correlated, perhaps because households have different mind sets when answering survey questions.

[6] Altonji and Siow (1987) exclude households whose real food expenditures increase by more than 400% or decrease by more than 75% from the previous year, and those in which real family incomes increase by more than 500% or decrease by more than 80%. Zeldes (1989) excludes households whose consumption levels increase or decrease by more than a factor of 3. Runkle (1991) excludes households whose food consumption grew by more than 300% or fell by more than 75%. He also excludes farmers, self-employed heads of households, heads of households over 65 years old, and observations on any household for the year when heads of households were divorced or married.

We attempt to overcome these problems by estimating with instrumental variables. Because the choice of instruments always is somewhat arbitrary, we use four alternative sets of instrumental variables to help ensure that the test results are not sensitive to the choice of instruments. The first set Z1 comprises eight occupational variables, the interaction of occupation and age, eight earner composition variables (i.e., which household members are earners), four regional variables, and the beginning-of-sample real interest rate. The second set Z2 comprises four regional variables, eight earner composition variables, human capital variables represented by six education variables and their interaction with age, and the beginning-of-sample real interest rate. The third set Z3 comprises four types of employees, eight earner composition variables, four regional variables, and the beginning-of-sample real interest rate. The fourth set Z4 combines Z1, Z2 and Z3. Detailed descriptions of the instrument sets are in Table 1.

These instruments all are known at time $t$. It seems likely that much observed income change can be explained by human capital, occupation, and region of the country, and considerably less likely that these variables can explain much of the residual in consumption change. These instruments thus should be correlated with $\Delta \ln Y_{i,\,t+1}$ but not with $\varepsilon_{i,\,t+1}$. Also, it seems at least possible that some of the instruments, such as occupation and earner composition, reflect household tastes and thus may explain the household's choice of income level and composition of consumption. We hope that these variables thus are correlated with the tax rate component of the real interest rate but uncorrelated with $\varepsilon_{i,\,t+1}$.

Finally, there is no recall error associated with any of these variables, so they should not be correlated with household recall errors concerning consumption.

### 3.3. Aggregate components in the error term

There may be an aggregate time-specific component in $e'_{i,\,t+1}$. Such a component could arise, for example, from unanticipated macroeconomic shocks that lead all households to make common mistakes in forecasting future economic variables (Mariger and Shaw, 1993). When $e'_{i,\,t+1}$ contains an aggregate component, the mean of the forecast error converges to zero as the time series observations per household in the panel go to infinity but not necessarily as the number of households included in the cross-section goes to infinity. Ignoring such an aggregate component can lead to inefficient and perhaps even inconsistent parameter estimates, so we include period dummies in our regressions to capture the effects of aggregate shocks (Chamberlain, 1984; Hayashi, 1985). There is one dummy for each month of each year covered by our sample.

Table 1
Instrument sets

| |
|---|
| Instrument sets Z1 |
| 8 occupation variables |
| Managerial and professional specialty; Technical, sales, and administrative support; Service; Farming, forestry, and fishing; Precision production, craft, and repair; Operators, fabricators, and laborers; Armed forces; Self-employed |
| Occupation variables interacted with age |
| 8 earner composition variables |
| Reference person only; Reference person and spouse; Reference person, spouse and others; Reference person and others; Spouse only; Spouse and others; Others only; No earners |
| 4 region variables |
| Northeast; Midwest; South; West |
| Instrument set Z2 |
| 7 education variables |
| Elementary; Less than High School graduate; High School graduate; Less than College graduate; College Graduate; More than 4 years of college; Never attended school |
| Education variables interacted with age |
| 8 earner composition variables |
| Reference person only; Reference person and spouse; Reference person, spouse and others; Reference person and others; Spouse only; Spouse and others; Others only; No earners |
| 4 regional variables |
| Northeast; Midwest; South; West |
| Instrument set Z3 |
| 4 types of employees: |
| Employee of a private company, business or individual working for wages or salary; A Federal government employee; A State government employee; A Local government employee; Self-employed in own business, professional practice or farm |
| 8 earner composition variables |
| Reference person only; Reference person and spouse; Reference person, spouse and others; Reference person and others; Spouse only; Spouse and others; Others only; No earners |
| 4 region variables |
| Northeast; Midwest; South; West |
| Instrument set Z4 |
| All variables in Z1, Z2 and Z3 |

A dummy takes the value of one if a household's final interview occurred in that month and takes the value of zero otherwise.[7]

The interpretation of time dummies in a cross-sectional regression depends on the identifying restriction one imposes. The traditional identifying restriction is

[7] The CEX is a rotating panel in which households are replaced each month. Even though households are interviewed once a quarter, the quarters pertinent to households generally are not identical to quarters of a calendar year, which is why we need monthly dummies even though the data sampling intervals are three months long.

to assume that the informational error component $\varepsilon_{i,\,t+1}$ contained in $e_{i,\,t+1}$ can be additively decomposed into an aggregate part, common to all households, and a household-specific part. The time dummy then captures the aggregate part. An alternative identifying restriction is to assume complete markets. In that case, the informational error component $\varepsilon_{i,\,t+1}$ is zero, and $e_{i,\,t+1}$ consists only of transitory consumption and other specification errors. The time dummies then can be interpreted as the change in the price of contingent claims. See Altug and Miller (1990) and Miller and Sieg (1997) for discussions of these issues.

As always, choice among identifying restrictions is somewhat arbitrary. We consider the assumption of complete markets more incredible than the assumption of an additively-decomposable error, so we adopt the traditional identifying restriction. We thus interpret our time dummies as capturing the aggregate component of the error term.

An advantage of the synthetic panel approach discussed in the Introduction and used by several authors is that it avoids the issue of aggregate shocks entirely. By including many time periods, the method can suppose that aggregate shocks average out, that is, that we really are taking an expectation over time rather than just across households. To succeed, however, must be long enough for any aggregate shocks to average out. As we mentioned earlier, the CEX begins in 1980 but has a break in methodology between 1985 and 1986. Thus we have only six years of consistent data (either 1980 to 1985 or 1986 to 1991). In our judgement, such a span is much too short for one to believe that aggregate shocks have averaged out.

It is not obvious whether our identifying restrictions are more or less plausible than the identifying restrictions required for a synthetic panel (see the discussion in the Introduction). All one can say with confidence is that the restrictions are different. The two approaches thus provide different perspectives on validity of PILCH. Where they agree, the two approaches increase confidence in the results obtained; where they differ, they suggest avenues for future research.

### *3.4. Household-specific components in consumption*

Household consumption may be explained in part by variables specific to the individual household. Such household-specific influences would cause heterogeneity in the compound error term, so we attempt to capture them in Eq. (8) with the taste and time preference variables $F$ and $R$ discussed earlier. The scale variable $F$ is the logarithmic change in family size; the vector of variables $R$ determining the rate of time preference are the logarithm of age and dummies for race (white $=1$; non-white $=0$) and sex (male $=1$; female $=0$) of the household head.

### *3.5. Separability of utility*

In some of our regressions, we estimate Eq. (3) using a component of total consumption expenditure, such as transportation or food, as the dependent variable. This procedure is legitimate only if utility is separable in the various components of consumption. Testing for such separability is difficult. Varian (1982) has proposed non-statistical tests, but we do not attempt to apply them here. We thus regard our results for such regressions as tentative.

We also have assumed that utility is separable in consumption and labor so that we can analyze consumption alone. If this assumption is violated and labor supply is correlated with income, we probably would observe that consumption is excessively sensitive to changes in income (Deaton, 1987), but this apparent evidence against PILCH would reflect failure of the auxiliary separability assumption rather than of PILCH itself. We examine the adequacy of our separability assumption in the following manner. Using the utility function

$$V(C_{it}, L_{it}; H_{it}, t) = \frac{C_{it}^{(1-\alpha)}}{1-\alpha}\frac{L_{it}^{(1-\beta)}}{1-\beta}X_{it}T_{it}(1+\rho_i)^{-t}$$

in Eq. (3), where $L_{it}$ is labor supply of individual $i$ at period $t$, we can take logs and apply Taylor's approximation to obtain an estimating equation similar to Eq. (4) but with the change in labor supply as an additional regressor. We estimate a version of Eq. (4) that includes the change in the annual number of hours work of the household head to examine the sensitivity of $B_4$ to the assumption that utility is separable in consumption and labor.

## 4. Empirical results

We now turn to our estimation results.

### *4.1. Instrument adequacy*

Nelson and Startz (1990) show that IV estimation can be misleading if the instruments are weakly correlated with the original variables. In the empirical analysis, we use both the adjusted $R^2$ and $F$-statistics from the first stage regression to determine the forecasting power of the instruments. Rows 8 and 9 of Table 2 report the adjusted $R^2$ statistics from the regressions of $\Delta \ln Y_{i,t+1}$ and $r_{it}$ on the instruments; $p$-values for $F$-tests of the joint insignificance of the instruments are in brackets.[8] In the $r_{it}$ regression, the adjusted $R^2$ statistics are

[8] For the case with one right-hand side variable and one instrument, Nelson and Startz noted that the $R^2$ statistic obtained from the first-stage regression should be strictly greater than $2/N$, where $N$ is the sample size, to avoid an erroneous inference. They also noted that the $2/N$ criteria may not be directly applicable for the case of multiple explanatory and instrumental variables, as in this study. Nonetheless, it is encouraging to note that the adjusted $R^2$ we obtained are greater than $2/N$, as required in the simple one-instrument case.

Table 2
Two-stage least squares estimation results

| | Nondurable goods and services | | | | Food | | | | Transporation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instrument set | Z1 | Z2 | Z3 | Z4 | Z1 | Z2 | Z3 | Z4 | Z1 | Z2 | Z3 | Z4 |
| Constant | − 0.087 | − 0.068 | − 0.060 | − 0.059 | − 0.104** | 0.103** | − 0.081 | − 0.088 | − 0.009 | 0.001 | 0.008 | − 0.011 |
| | (0.063) | (0.055) | (0.057) | (0.053) | (0.063) | (0.061) | (0.063) | (0.061) | (0.136) | (0.127) | (0.136) | (0.126) |
| $r_{i,t}$ | 0.029 | 0.008 | 0.037 | 0.014 | 0.007 | 0.007 | 0.007 | 0.007 | 0.046 | 0.035 | 0.102 | 0.038 |
| | (0.037) | (0.028) | (0.030) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.075) | (0.058) | (0.063) | (0.049) |
| $\Delta \ln (Y_{-i,\,t+1})$ | 0.299 | 0.207 | 0.099 | 0.138 | 0.065 | 0.055 | − 0.090 | − 0.043 | 0.518 | 0.469 | 0.246 | 0.552* |
| | (0.186) | (0.138) | (0.152) | (0.118) | (0.164) | (0.137) | (0.155) | (0.119) | (0.393) | (0.304) | (0.342) | (0.265) |
| $\Delta \ln (\text{fam size}_{i,t})$ | 0.124* | 0.152* | 0.183* | 0.173* | 0.271* | 0.274* | 0.317* | 0.303* | 0.100 | 0.115 | 0.179 | 0.091 |
| | (0.060) | (0.047) | (0.051) | (0.041) | (0.055) | (0.048) | (0.053) | (0.043) | (0.128) | (0.103) | (0.114) | (0.093) |
| $\text{Age}_{i,t}$ | 0.012 | 0.008 | 0.007 | 0.007 | 0.030* | 0.030* | 0.025* | 0.027* | − 0.019 | − 0.020 | − 0.021 | − 0.018 |
| | (0.013) | (0.011) | (0.011) | (0.011) | (0.013) | (0.012) | (0.013) | (0.012) | (0.027) | (0.025) | (0.027) | (0.025) |
| $\text{White}_i$ | 0.018* | 0.018** | 0.019** | 0.018** | 0.012 | 0.012 | 0.012 | 0.012 | 0.055* | 0.054* | 0.055** | 0.055* |
| | (0.012) | (0.011) | (0.011) | (0.011) | (0.013) | (0.013) | (0.013) | (0.013) | (0.027) | (0.027) | (0.028) | (0.027) |
| $\text{Male}_i$ | 0.009 | 0.005 | 0.002 | 0.002 | − 0.013 | − 0.013 | − 0.018** | − 0.017** | 0.025 | 0.023 | 0.010 | 0.026 |
| | (0.011) | (0.009) | (0.010) | (0.009) | (0.011) | (0.010) | (0.011) | (0.010) | (0.024) | (0.022) | (0.023) | (0.021) |
| $\bar{R}^2$ of first stage | 0.013 | 0.014 | 0.013 | 0.014 | 0.013 | 0.014 | 0.013 | 0.014 | 0.013 | 0.014 | 0.013 | 0.013 |
| $\Delta \ln (Y_{i,\,t+1})$ | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] |
| $\bar{R}^2$of first stage | 0.992 | 0.994 | 0.994 | 0.994 | 0.992 | 0.994 | 0.994 | 0.994 | 0.992 | 0.994 | 0.994 | 0.994 |
| of $r_{i,\,t}$ | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] |
| Test of OI restriction | 0.57 | 0.51 | 0.42 | 0.69 | 0.12 | 0.11 | 0.12 | 0.11 | 0.44 | 0.01 | 0.02 | 0.04 |
| No. of observations | 12907 | 12907 | 12907 | 12907 | 9745 | 9745 | 9745 | 9745 | 11918 | 11918 | 11918 | 11918 |
| $\bar{R}^2$, second stage | 0.017 | 0.020 | 0.019 | 0.21 | 0.022 | 0.022 | 0.021 | 0.021 | 0.011 | 0.011 | 0.010 | 0.011 |
| Time dummy $F$-stat. | 3.19 | 4.02 | 3.75 | 3.69 | 5.57 | 3.07 | 5.29 | 2.6 | 5.74 | 7.01 | 6.23 | 6.36 |

| | Clothing | | | | Utilities | | | | Medical care | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instrument set | Z1 | Z2 | Z3 | Z4 | Z1 | Z2 | Z3 | Z4 | Z1 | Z2 | Z3 | Z4 |
| Constant | − 0.282 | − 0.277 | − 0.107 | − 0.185 | 0.182* | 0.181* | 0.170* | 0.173* | − 0.0001 | 0.026 | − 0.038 | 0.021 |
| | (0.200) | (0.179) | (0.190) | (0.171) | (0.065) | (0.063) | (0.062) | (0.060) | (0.162) | (0.157) | (0.160) | (0.153) |
| $r_{i,t}$ | 0.023 | 0.036 | − 0.042 | 0.014 | − 0.006 | − 0.029 | 0.014 | − 0.006 | − 0.015 | − 0.050 | − 0.004 | − 0.032 |
| | (0.082) | (0.060) | (0.073) | (0.051) | (0.022) | (0.031) | (0.032) | (0.025) | (0.073) | (0.058) | (0.062) | (0.048) |
| $\Delta \ln (Y_{-i,\, t+1})$ | 0.434 | 0.387 | − 0.366 | − 0.061 | − 0.032 | 0.029 | 0.013 | 0.035 | 0.163 | 0.060 | 0.472 | 0.038 |
| | (0.555) | (0.401) | (0.444) | (0.342) | (0.194) | (0.156) | (0.159) | (0.130) | (0.459) | (0.357) | (0.421) | (0.301) |
| $\Delta \ln$ (fam size$_{i,t}$) | 0.191 | 0.204 | 0.419* | 0.331* | 0.141* | 0.123* | 0.127* | 0.121* | 0.172 | 0.199** | 0.091 | 0.205* |
| | (0.171) | (0.132) | (0.144) | (0.117) | (0.063) | (0.053) | (0.054) | (0.046) | (0.135) | (0.111) | (0.127) | (0.100) |
| Age$_{i,t}$ | 0.039 | 0.038 | 0.007 | 0.022 | − 0.063* | − 0.062* | − 0.060* | − 0.061* | 0.053** | 0.048 | 0.060** | 0.050** |
| | (0.040) | (0.036) | (0.038) | (0.035) | (0.013) | (0.013) | (0.013) | (0.012) | (0.031) | (0.031) | (0.031) | (0.030) |
| White$_i$ | 0.051 | 0.050 | 0.033 | 0.041 | 0.006 | 0.005 | 0.005 | 0.006 | − 0.025 | − 0.027 | − 0.022 | − 0.026 |
| | (0.038) | (0.037) | (0.038) | (0.036) | (0.012) | (0.013) | (0.013) | (0.012) | (0.034) | (0.035) | (0.035) | (0.034) |
| Male$_i$ | 0.018 | 0.017 | − 0.005 | 0.005 | 0.015 | 0.016 | 0.018** | 0.018** | 0.004 | − 0.004 | 0.008 | − 0.003 |
| | (0.029) | (0.027) | (0.028) | (0.026) | (0.011) | (0.011) | (0.010) | (0.010) | (0.026) | (0.024) | (0.025) | (0.024) |
| $\bar{R}^2$first stage of $\Delta \ln (Y_{i,\, t+1})$ | 0.014 | 0.014 | 0.015 | 0.015 | 0.013 | 0.014 | 0.013 | 0.014 | 0.014 | 0.015 | 0.013 | 0.016 |
| | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] |
| $\bar{R}^2$ of 1st stage of $r_{i,t}$ | 0.993 | 0.995 | 0.995 | 0.995 | 0.992 | 0.994 | 0.994 | 0.994 | 0.992 | 0.994 | 0.994 | 0.994 |
| | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] | [0.0001] |
| Test of OI restriction | 0.19 | 0.14 | 0.37 | 0.28 | 0.07 | 0.06 | 0.02 | 0.08 | 0.90 | 0.20 | 0.95 | 0.52 |
| No. of observations | 9744 | 9744 | 9744 | 9744 | 12700 | 12700 | 12700 | 12700 | 9773 | 9773 | 9773 | 9773 |
| $\bar{R}^2$, second stage | 0.048 | 0.048 | 0.046 | 0.050 | 0.051 | 0.048 | 0.050 | 0.051 | 0.003 | 0.002 | 0.002 | 0.003 |
| Time dummy $F$-stat. | 14.38 | 18.46 | 17.27 | 15.26 | 14.6 | 14.42 | 11.18 | 12.89 | 0.296 | 0.2 | 0.88 | 0.02 |

*Notes*: Numbers in parentheses are standard errors; numbers in brackets are $p$-values for $F$-tests of joint insignificance of instruments. * Significance at 5% level.
** Denote significance at 10% level. The last row reports the $F$-statistic for the joint insignificance of all time dummies; all critical values $\approx$ 1.3.

high and the $F$-test of joint insignificance rejects the null for every instrument set. In the $\Delta \ln Y_{i,\,t+1}$ regression, the adjusted $R^2$ statistics are low for every instrument set but nevertheless the $F$-test for joint insignificance of the instruments rejects the null in all cases. The instrument sets therefore perform adequately, although it would be better if the adjusted $R^2$ were higher in the $\Delta \ln Y_{i,\,t+1}$ regression.

### 4.2. What to expect in the estimation

Before we proceed to the estimation results for the Euler equation, we should discuss what we can expect from them. If PILCH is correct, coefficient $B_4$ in Eq. (8) will be statistically insignificant. The other explanatory variables in Eq. (8) are the interest rate $r_{it}$, the change in the family size variable $F_{it}$, and the vector $R_i$ of possible determinants of the household rate of time preference. For the moment, ignore $F_{it}$ and $R_i$, so that only $r_{it}$ remains. Can we expect $r_{it}$ to be significant? Using the PSID, Runkle (1991) finds that it is. However, the PSID has a much longer time-series component than does the CEX. Our sample spans only six years, and for any given household, the CEX only spans four quarters. Consequently, in our regressions most of the variation in $r_{it}$ arises from cross-section differences in marginal tax rates, which are not very large. Even if $r_{it}$ really is important in household intertemporal allocations, it may be insignificant in our regressions simply for lack of variation.[9] In that case, Eq. (8) would reduce to a regression of the change in consumption on the error term, as in Hall (1978), which of course would have an $R^2$ of zero and an adjusted $R^2$ that was slightly negative. Even if there is enough intertemporal variation to make $r_{it}$ significant, most of the variation in our data is cross-sectional, so the adjusted $R^2$ still should be quite low. Finally, it seems quite possible that the family size and time preference variables $F_{it}$ and $R_i$ will explain a small part of the change in consumption even if they are statistically significant. We can expect, then, a very low adjusted $R^2$ if the PILCH model is correct. If PILCH is false and $B_4$ is significant, then the adjusted R-squared may be large. The tests of the model, however, are not the size of the adjusted $R^2$ in Eq. (8) but rather whether or not the overidentifying restrictions are satisfied and whether $B_4$ is statistically insignificant.

### 4.3. Tests of the basic model

We have estimated Eq. (8) with and without time dummies. The $F$-statistics for the hypothesis of joint insignificance of all time dummies is reported in the last line

[9] Also, as noted earlier, there is some error in our measure of marginal tax rates. One possible alternative is to use a tax-exempt interest rate, but we doubt that would be any better than what we have done because so few households own tax-exempt securities and those that do are almost entirely in the upper end of the income distribution, rendering them unrepresentative.

of Table 2. The dummies as a group are statistically significant for all instrument sets and all consumption groups except medical expenditures. The significance of the time dummies means that aggregate shocks are not negligible; however, the coefficient estimates and all other test results are much the same whether or not time dummies are included. Thus, aggregate shocks seem to be statistically but not economically significant. This result is consistent with Pischke's (1995) finding that the aggregate phenomena account for only a small part of the variation in household income.

Table 2 presents the two-stage least squares estimates of Eq. (8). The main test of PILCH is whether $B_4$, the elasticity of consumption with respect to current income, is significant. For total nondurable goods and services expenditure, the estimated values of $B_4$ range from 0.013 to 0.215 but are insignificant at the 5% level in all instrument sets, as PILCH predicts.[10] Table 2 also reports results of tests of the overidentifying restriction that the residuals obtained from the second stage regression are uncorrelated with the instruments. PILCH predicts a zero correlation. If the overidentifying restrictions are valid and the residuals are homoscedastic, then N (sample size) times the $R^2$ from a regression of the second stage residual series on the instruments is asymptotically $\chi^2$ distributed with $(k - z)$ degrees of freedom, where $k$ is the number of instruments and $z$ is the number of estimated parameters (Hansen, 1982). The $p$-values of the $\chi^2$ statistics show that the data never reject the overidentifying restrictions at the 90% level. Thus PILCH passes this test, too. The same results emerge from the regressions using subsets of consumption expenditure. The estimates of $B_4$ are statistically insignificant for all expenditure groups; they usually are of small magnitude except for transportation, for which they are of moderate magnitude.[11] Also, the overidentifying restriction never is rejected.

The estimated intertemporal substitution elasticity $B_4$ is small for all categories of consumption, never exceeding 0.03, and usually is statistically insignificant at the 5% level. These results provide no support for the hypothesis that consumers move consumption across periods as a result of changes in their expected real returns and is consistent with Hall's (1988) findings that $B_1$ is small and likely to be zero. In contrast, Shapiro (1984) and Zeldes (1989), using PSID data, report values of $B_1$ that are relatively large but often statistically insignificant, and Runkle (1991), also using the PSID, found $B_1$ to be approximately 0.50 and statistically significant. Attanasio and Weber (1995), using a synthetic panel constructed from the CEX, obtains a significant effect of the interest rate. As

[10] These estimates are within the range found in other studies, e.g., 0.17 in Japelli and Pagano (1989), 0.56 in Campbell and Mankiw (1990), 0.20 in Hall and Mishkin (1982), and 0.28 in Delong and Summers (1986).

[11] Shea (1994) found similar results using US aggregate transportation expenditure data. Our results, however, do not support his conclusion that PILCH cannot be rejected using food consumption but can be rejected using other components of consumption.

mentioned earlier, our finding of a small and insignificant coefficient may only reflect lack of enough intertemporal variation in the data to make a test of significance informative.

The results for the taste and time preference variables depend somewhat on the measure of consumption used. The coefficient on race is positive and statistically significant for total nondurables and services and for transportation but is insignificant for all other subcategories of expenditure. These results give only mixed support to Lawrance's (1991) finding that nonwhite households have higher time preference rates and thus flatter consumption profiles than white households. Age is significant for food, utilities, and medical care but not for the other categories or for total nondurables and services. The sex variable is insignificant for all categories except half the time for food. At least one time preference variable is significant for every category of expenditure except clothing. Our taste variable, change in family size, has a statistically significant positive effect at least some of the time on all categories except transportation.

One can argue that households whose incomes fluctuate the most are likely not to behave according to PILCH. Consequently, our excluding from the sample households with income or consumption changes of more than 400% or 300%, respectively, may bias our results toward PILCH. We therefore re-estimated the model without excluding households with large changes in income or consumption, but the results were virtually unchanged.

We also tested our auxiliary assumption that utility is separable in consumption and labor by reestimating Eq. (8) with a labor supply variable $\Delta \ln L_{i,\,t+1}$ (the change in annual number of hours worked) added. This variable is significant only in food regressions, and the estimated value of $B_4$ is affected only marginally and remains insignificant in most cases. Our separability assumption seems valid.

The results in Table 2 thus provide strong support for PILCH. Also, our results generally agree with those of Attanasio and Weber (1995), obtained with a synthetic panel constructed from the CEX. They, too, find support for PILCH and find that changes in family composition are important explanatory variables. The main differences between our results and theirs are that (i) they obtain interest rate coefficients larger than ours and sometimes significant, and (ii) we obtain agreement with PILCH using a much simpler utility function than theirs. Attanasio and Weber present evidence that they obtain significant interest rates precisely because they allow a more complicated utility function than our simple CRRA. To obtain reliable estimates of the intertemporal parameters of such a function, one almost certainly needs data with a considerably longer time dimension than ours contain. Attanasio and Weber's use of a synthetic panel provides this dimension, but as we argued earlier, it is not obvious this benefit outweighs the synthetic panel's costs.

### 4.4. Tests for liquidity-constrained behavior

Although the foregoing results show that $B_4$ is not significant for the entire sample, they do not necessarily imply that all households behave according to PILCH. Following Zeldes (1989) and Runkle (1991), this section explores the possibility that the model may be rejected for groups of households likely to be liquidity-constrained.

We divide households in the CEX into three groups: (a) those whose total liquid assets exceed their two-month after-tax income, i.e., households unlikely to be liquidity-constrained; (b) those with no total liquid assets, i.e., households likely to be liquidity-constrained; and (c) those for whom the ratio of total liquid assets to two-month after-tax income is between zero and one. We then omit households in group (c) to minimize the possibility of falsely including unconstrained households in the no-asset group or including constrained households in the high-asset group.[12]

Table 3 presents some of the characteristics of the two household groups used in our sample. There are 1,440 households with no liquid assets and 4,153 households with liquid assets greater than their two-month after-tax annual income. Households with no liquid assets have lower average annual income and are relatively younger, less educated, and more likely to be non-white. They also mostly are headed by a female, have no earners, have larger family sizes, and live in the southern part of the United States.

If liquidity/borrowing constraints are an important source of departure from PILCH, then income changes should have positive and significant effects in explaining consumption growth in the no-asset (constrained) group but not in the high-asset (unconstrained) group. Table 4 shows the estimates of $B_4$ for the two household groups and the various measures of consumption. In all cases but one, $B_4$ is statistically insignificant.

Runkle (1991) suggests dividing the sample by housing tenure on the grounds that renters are more likely than homeowners to be borrowing-constrained. Table 5 reports the estimates of $B_4$ for renters and owners; $B_4$ is significantly different from zero in only two cases.

Table 6 reports two estimates of $B_4$, $B_4^+$ and $B_4^-$, in which income growth is subdivided into increases and decreases. Under liquidity constraint, consumption should be more responsive to income increases than decreases ($B_4^+ > B_4^-$), and at least $B_4^+$ and possibly $B_4^-$ should be significantly different from zero. Under rule-of-thumb, on the other hand, consumption should be equally responsive to income increases and decreases ($B_4^+ = B_4^-$), and both $B_4^+$ and $B_4^-$ should be significantly different from zero. In fact, however, none of the estimated

[12] Also, we exclude households flagged by the survey interviewer as giving invalid responses about liquid asset information.

Table 3
Characteristics of 1986–1991 CEX households

| | | \$0 liquid asset ($N = 1{,}440$) | High liquid asset ($N = 4{,}153$) |
|---|---|---|---|
| Annual income | | \$11,127 | \$27,829 |
| Age | 25 and below | 130 (9%) | 114 (3%) |
| | 25–65 | 996 (69%) | 2840 (68%) |
| | 65 and above | 314 (22%) | 1,199 (29%) |
| Race | White | 888 (62%) | 3,922 (93%) |
| | Non-white | 552 (38%) | 274 (7%) |
| Sex | Male | 676 (47%) | 2,928 (71%) |
| | Female | 764 (53%) | 1,225 (29%) |
| Region | Northeast | 307 (24%) | 783 (21%) |
| | Midwest | 287 (22%) | 946 (25%) |
| | South | 491 (38%) | 984 (26%) |
| | West | 211 (16%) | 1,029 (27%) |
| Education | Elementary | 429 (30%) | 366 (9%) |
| | less than High School | 373 (26%) | 395 (10%) |
| | High School Graduate | 433 (30%) | 1,178 (28%) |
| | less than college | 150 (10%) | 883 (21%) |
| | College graduate | 34 (2%) | 639 (15%) |
| | More than college | 21 (2%) | 692 (17%) |
| Family size | 1 | 369 (26%) | 1,150 (27%) |
| | 2 | 329 (23%) | 1,517 (37%) |
| | 3 | 254 (18%) | 664 (16%) |
| | 4 | 196 (13%) | 522 (13%) |
| | 5 | 144 (10%) | 228 (5%) |
| | 6 and more | 148 (10%) | 72 (2%) |
| No. of earners | 0 | 530 (37%) | 1,019 (25%) |
| | 1 | 518 (36%) | 1,368 (33%) |
| | 2 | 298 (21%) | 1,335 (32%) |
| | 3 and more | 94 (6%) | 431 (10%) |

coefficients is statistically significant except $B_4^+$ for the Z4 instrument set in transportation expenditures.

We find virtually no evidence that either borrowing constraints or rule-of-thumb behavior is significant in explaining consumption.

## 5. Conclusion

We have used comprehensive US household expenditure data from the 1986–1991 Consumer Expenditure Survey (CEX) to test the permanent

Table 4
Estimates of $B_4$: Low and high asset households

| Instrument set | Categories of consumption | | | | | |
|---|---|---|---|---|---|---|
| | Nondurable goods and services | | Food | | Transportation | |
| | Low $B_4$ | High $B_4$ | Low $B_4$ | High $B_4$ | Low $B_4$ | High $B_4$ |
| Z1 | 0.355 | − 0.011 | 0.023 | − 0.089 | (0.243 | − 0.099 |
| | (0.597) | (0.607) | (0.195) | (0.234) | (0.307) | (0.523) |
| Z2 | 0.137 | 0.052 | 0.235 | 0.003 | 0.099 | − 0.050 |
| | (0.488) | (0.375) | (0.231) | (0.154) | (0.313) | (0.335) |
| Z3 | − 0.461 | − 0.023 | 0.229 | 0.119 | 0.165 | 0.183 |
| | (0.457) | (0.477) | (0.185) | (0.193) | (0.307) | (0.362) |
| Z4 | − 0.052 | − 0.102 | 0.075 | 0.071 | 0.118 | 0.109 |
| | (0.345) | (0.290) | (0.138) | (0.129) | (0.235) | (0.263) |
| Instrument set | Clothing | | Utilities | | Medical care | |
| | Low $B_4$ | High $B_4$ | Low $B_4$ | High $B_4$ | Low $B_4$ | High $B_4$ |
| Z1 | 0.426 | 0.070 | 0.606* | − 0.047 | 0.204 | 0.269 |
| | (0.576) | (0.597) | (0.265) | (0.213) | (0.316) | (0.607) |
| Z2 | 0.011 | 0.238 | 0.360 | 0.102 | 0.090 | − 0.483 |
| | (0.478) | (0.371) | (0.258) | (0.147) | (0.284) | (0.445) |
| Z3 | − 0.220 | 0.165 | 0.019 | 0.044 | − 0.172 | 0.121 |
| | (0.422) | (0.483) | (0.207) | (0.171) | (0.275) | (0.451) |
| Z4 | − 0.070 | − 0.076 | 0.141 | 0.130 | − 0.109 | 0.345 |
| | (0.344) | (0.292) | (0.160) | (0.122) | (0.236) | (0.328) |

*Notes*: The 2SLS regressions include a constant, change in family size, age, sex and race of the head of households. Standard errors are in parentheses.
* Denotes significance at 5% level. ** Denotes significance at 10% level.

Table 5
Estimates of $B_4$: Renter and homeowner households

| Instrument set | Categories of consumption | | | | | |
|---|---|---|---|---|---|---|
| | Nondurable goods and services | | Food | | Transportation | |
| | Renter $B_4$ | Homeowner $B_4$ | Renter $B_4$ | Homeowner $B_4$ | Renter $B_4$ | Homeowner $B_4$ |
| Z1 | 0.021 | 0.233 | – 0.032 | – 0.069 | – 0.393 | 0.533 |
| | (0.377) | (0.445) | (0.183) | (0.210) | (0.372) | (0.408) |
| Z2 | 0.010 | – 0.457 | – 0.105 | – 0.069 | – 0.274 | 0.373 |
| | (0.368) | (0.403) | (0.161) | (0.186) | (0.324) | (0.361) |
| Z3 | – 0.119 | – 0.269 | – 0.139 | – 0.028 | – 0.077 | 0.828* |
| | (0.351) | (0.474) | (0.164) | (0.199) | (0.301) | (0.394) |
| Z4 | – 0.095 | – 0.012 | – 0.019 | – 0.141 | 0.048 | 0.394 |
| | (0.277) | (0.291) | (0.117) | (0.141) | (0.213) | (0.261) |
| Instrument set | Clothing | | Utilities | | Medical care | |
| | Renter $B_4$ | Homeowner $B_4$ | Renter $B_4$ | Homeowner $B_4$ | Renter $B_4$ | Homeowner $B_4$ |
| Z1 | 0.438 | 0.043 | – 0.178 | 0.0005 | 0.973* | – 0.100 |
| | (0.322) | (0.448) | (0.234) | (0.184) | (0.480) | (0.400) |
| Z2 | 0.315 | – 0.420 | 0.094 | – 0.103 | 0.133 | – 0.191 |
| | (0.313) | (0.390) | (0.178) | (0.164) | (0.396) | (0.348) |
| Z3 | 0.334 | – 0.237 | – 0.107 | – 0.209 | 0.338 | – 0.074 |
| | (0.297) | (0.471) | (0.183) | (0.178) | (0.383) | (0.330) |
| Z4 | 0.193 | – 0.110 | 0.072 | – 0.005 | 0.046 | – 0.118 |
| | (0.247) | (0.285) | (0.130) | (0.115) | (0.297) | (0.255) |

*Notes*: The 2SLS regressions include a constant, change in family size, age, sex and race of the head of households. Standard errors are in parentheses. * Denotes significance at 5% level. ** Denotes significance at 10% level.

Table 6
Estimates of $B_4^-$ and $B_4^+$

| Instrument set | Nondurable goods and services | | Food | | Transportation | |
|---|---|---|---|---|---|---|
| | $B_4^-$ | $B_4^+$ | $B_4^-$ | $B_4^+$ | $B_4^-$ | $B_4^+$ |
| Z1 | 0.159 | 0.393 | 0.244 | 0.008 | 0.653 | 0.289 |
| | (0.672) | (0.456) | (0.218) | (0.171) | (0.410) | (0.336) |
| Z2 | 0.017 | 0.225 | 0.145 | – 0.006 | 0.423 | 0.361 |
| | (0.474) | (0.386) | (0.162) | (0.149) | (0.301) | (0.289) |
| Z3 | – 0.587 | – 0.294 | 0.012 | – 0.139 | 0.124 | – 0.048 |
| | (0.467) | (0.401) | (0.186) | (0.162) | (0.315) | (0.323) |
| Z4 | – 0.324 | – 0.128 | 0.031 | – 0.094 | 0.404 | 0.509* |
| | (0.374) | (0.329) | (0.139) | (0.129) | (0.251) | (0.257) |
| **Instrument set** | **Clothing** | | **Utilities** | | **Medical care** | |
| | $B_4^-$ | $B_4^+$ | $B_4^-$ | $B_4^+$ | $B_4^-$ | $B_4^+$ |
| Z1 | 0.096 | 0.310 | – 0.156 | 0.049 | 0.214 | (0.224 |
| | (0.671) | (0.448) | (0.220) | (0.168) | (0.501) | (0.387) |
| Z2 | 0.110 | 0.317 | 0.143 | 0.097 | – 0.188 | 0.414 |
| | (0.471) | (0.375) | (0.162) | (0.142) | (0.388) | (0.329) |
| Z3 | – 0.484 | – 0.133 | 0.016 | – 0.008 | 0.388 | 0.543 |
| | (0.451) | (0.385) | (0.177) | (1.47) | (0.451) | (0.415) |
| Z4 | – 0.278 | – 0.042 | 0.104 | 0.033 | – 0.054 | 0.229 |
| | (0.366) | (0.322) | (0.136) | (0.121) | 0.328) | (0.279) |

Categories of consumption.

*Notes*: The instrument lists are presented in Table 1. The 2SLS regressions include a constant, change in family size, age, sex and race of the head of households, whose coefficients are omitted to save space. Standard errors are in parentheses. * Denotes significance at 5% level.

income/life-cycle hypothesis (PILCH) against the alternative hypotheses of rule-of-thumb and liquidity-constrained consumers. Because the raw CEX data have a time dimension, the CEX has elements of a panel data set. We thus have conducted our test without having to resort to construction of a synthetic panel.

Our principal finding is that consumption behavior is consistent with PILCH. In particular, we find no evidence that current income movements cause changes in total consumption of nondurable goods and services or in several subcategories of consumption. Also, the results offer no support for the hypothesis that liquidity constraints affect consumption significantly. These results confirm and complement the findings of several previous studies that used micro data, but our results also are an advance in that our data set is much more comprehensive than the often-used PSID and because we have not had to rely on the identifying assumptions necessary for the validity of the synthetic panels that some studies have used.

## Appendix A. Some details of the CEX data

A ‘consumer unit’ in the CEX consists of either (i) two or more people, usually living together, who are related by blood, marriage, adoption, or some other legal arrangement, and who pool their income to make joint expenditure decisions, or (ii) a person living alone, sharing a household with others, or living as a roomer in a private home, lodging home, or hotel, and who is financially independent. In each such unit, a reference person is identified as the person identified by the respondent when asked to start “with the name of the person or one of the persons who owns or rents the home” (US BLS, 1990). We have used the term ‘household’ to mean ‘consumer unit’.

The CEX defines household income before-tax as the sum of regular income (wages and salaries, income/loss from farm and nonfarm business, social security, railroad retirement, pensions, workmen’s compensation, interest on savings accounts and other assets, rental income and income from roomers, and regular support from alimony), value of in-kind benefits (unemployment compensation, food stamps, and public assistance or welfare payments), and other income (money received from care of foster children, cash scholarships and fellowships, and stipends not based on working). To protect the confidentiality of survey participants, a topcoding procedure is used in which all incomes over $100,000 are lumped together and reported as $100,000. This topcoding procedure seems unlikely to affect our estimation results because few households earn more than $100,000.

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