RENÉ GARCIA
ANNAMARIA LUSARDI
SERENA NG

Excess Sensitivity and Asymmetries in Consumption: An Empirical Investigation

Most empirical studies on liquidity constraints classify a consumer as being constrained on the basis of a single indicator such as the asset-to-income ratio. In this analysis, we model the probability that a consumer faces liquidity constraints as a function of multiple social and economic factors. This probability function is estimated simultaneously with the degree of excess sensitivity of consumption to income in a switching regressions framework. The switching regressions apply optimal weights to the densities for the Euler equations in the two states and are less susceptible to sample misclassification. Our results based on data from the CEX confirm that liquidity-constrained consumers are excessively sensitive to variables already known to economic agents. However, there is also evidence that the unconstrained consumers exhibit behavior that is inconsistent with the theoretical predictions. Further analysis suggests that such behavior could be explained by time-nonseparable preferences.

THE PREDICTION OF THE RATIONAL EXPECTATIONS permanent income model (REPIH) that consumption should be a martingale has been tested against a number of competing hypotheses. A leading alternative is the presence of liquidity constraints. Indeed, given the casual evidence for capital market imperfections, arguing that liquidity constraints are what cause rational consumers to deviate from life cycle–permanent income type behavior has a certain intuitive appeal. The evidence is, however, mixed. While Zeldes (1989) and Eberly (1994) find a statistically significant relationship between changes in consumption and lagged income and attribute this excess sensitivity to liquidity constraints, other authors, including Altonji and Siow (1987) and Runkle (1991), find no evidence of excess sensitivity measured in terms of anticipated changes in income.

In the work cited above, the criterion used to determine who is a constrained consumer is often based on an a priori chosen cutoff point on either the wealth or the asset-to-income ratio. Even when the cutoff point is chosen endogenously, the crite-

This paper was presented at the 1994 National Bureau of Economic Research Summer Institute, the University of Toulouse, CREST, and Wilfrid Laurier University. The authors thank the seminar participants, Martin Browning, Rob Alessie, Michel Normandin, Pierre Perron, Francisco Ruge-Murcia, and two anonymous referees for comments on the previous draft. Annamaria Lusardi acknowledges financial support from the Rockefeller Research Fund at Dartmouth College. The first and third authors acknowledge grants from the Social Science and Humanities Research Council of Canada and the Fonds de la Formation de Chercheurs et l'Aide à la Recherche du Québec.

RENÉ GARCIA *is assistant professor of economics at the University of Montréal and a research associate at CIRANO and CRDE.* ANNAMARIA LUSARDI *is assistant professor of economics at Dartmouth College.* SERENA NG *is associate professor of economics at Boston College and a research associate at CRDE.*

Journal of Money, Credit, and Banking, Vol. 29, No. 2 (May 1997)

ria still rely on just one economic variable to indicate whether or not a consumer faces liquidity constraints. Although the wealth- and asset-to-income ratios are natural classifiers, they cover only a narrow scope of factors affecting consumers' ability to borrow. The work of Jappelli (1990) suggests that variables other than income and financial assets also affect the degree of access consumers have to credit markets.

The first objective of our analysis is to exploit more information in the data to determine when consumers are likely to be liquidity constrained. We use social variables such as race, sex, marital status, and economic factors including income and assets to obtain the econometrician's best guess of the probability that a consumer is liquidity constrained. The probability function is estimated simultaneously with two Euler equations, one valid when the consumer is constrained and one when the consumer is not. More precisely, the analysis is carried out in a switching-regressions framework in which optimal probability weights are applied to the Euler equations to account for the fact that the econometrician has imperfect information on how consumers in the sample should be classified. Excess sensitivity is then judged in terms of whether lagged income and predicted changes in income induce statistically significant changes in consumption.

It has often been argued that the martingale hypothesis is not a general test of the REPIH because it is based on a set of restrictive assumptions about preferences. Numerous authors have attempted to relax these assumptions. These include allowing for precautionary saving motives as in Dynan (1993) and Kuehlwein (1991), nonseparability between consumption and leisure as in Attanasio (1995) and Attanasio and Browning (1995), and myopic behavior as in Hall and Mishkin (1982) and Altonji and Siow (1987). A problem that comes with the success of these extended REPIH models is that there are now many explanations for excess sensitivity, many of which have observationally equivalent implications. In addition, since most (if not all) of the studies have been set up to test the martingale hypothesis against a specific alternative, it is difficult to determine whether budget constraint considerations, nonstandard preferences, or both, are responsible for rejections of the basic REPIH.

The second objective of this paper is to disentangle some of these competing, but not necessarily independent alternatives. Our tests exploit an asymmetry in behavior between the liquidity-constrained, the myopic or the so-called rule-of-thumb consumers, and those with a certain type of time nonseparable preference. For some of these consumers, excess sensitivity should be observed only when the expected income change is either positive or negative, but not both. By allowing the response to positive and negative changes in expected income to be different, exclusion restrictions can be used to distinguish preference effects from effects due to liquidity constraints.

The evolving theme of our paper is that there are asymmetries in consumption. We first focus on the asymmetry in the response between a constrained and an unconstrained consumer to lagged income and predicted changes in income. We then consider asymmetric consumption responses to positive and negative changes in income. Using data from the Consumer Expenditure Survey (CEX), we test the hypotheses on food consumption and a measure of strictly nondurable consumption.

The rest of the paper is structured as follows: Section 1 provides a survey of the issues involved. Section 2 sets up the switching regression model and presents a description of the data. Results from the switching regressions are given in sections 3 and 4. A conclusion completes the analysis.

1. TESTING THE REPIH AGAINST THE ALTERNATIVE OF LIQUIDITY CONSTRAINTS

An implication of the REPIH is that consumption follows a martingale. Changes in consumption should be uncorrelated with anticipated changes in income and other variables that are in consumers' information set. This insight of Hall (1978) is often expressed in terms of the following Euler equation for consumer i between period t and $t + 1$:

$$\Delta c_{it+1} = \alpha + \beta Q_{it+1} + e_{it+1}, \tag{1}$$

where Δ is the first-difference operator taken with respect to time; lowercase letters denote variables in their natural logarithms. Q_{it+1} includes variables such as age and change in family size to capture shifts in tastes.

Equation (1) is what we refer to as the basic REPIH and there are several important assumptions underlying it.[1] First, it is based on an utility function that is intertemporally separable in the sense that the marginal utility of consumption in period t depends only on the level of consumption in period t. As such, it precludes behavior arising from time nonseparable utility functions such as habit persistence, catching up with the Joneses, disappointment and loss aversion, preferences that have been used with some success in explaining the equity premium puzzle in the finance literature.[2] Second, even under the assumption of constant relative risk aversion (CRRA) preferences, equation (1) is only a linear approximation of the exact Euler equation. Using a second-order Taylor series expansion on the marginal utility of consumption, it can be shown that (1) implicitly assumes that the higher-order conditional moments of the expectational error are orthogonal to variables in the information set. Third, (1) assumes separability between consumption and leisure. Therefore, labor supply variables are absent from the Euler equation for consumption. Fourth, the real interest rate is subsumed in the constant α. This is because although micro data have abundant information on consumers, the time period is rarely long enough to allow sufficient variations in the interest rate for an accurate estimate of the intertemporal elasticity of substitution. Fifth, capital markets are as-

1. See Browning and Lusardi (1995) for a review and discussion of the issues.

2. See, for example, Abel (1990) for the former two specifications, Epstein and Zin (1991) for the third.

sumed to be perfect in the sense that agents can freely transfer the desired amount of resources from one period to the next.

One of the leading alternatives to the basic model is obtained by relaxing the last assumption to allow for the possibility that consumers may be liquidity constrained. This can be taken to mean that consumers are denied credit altogether or that they cannot borrow as much as desired.[3] Zeldes (1989) derived the following Euler equation for a forward-looking consumer facing liquidity constraints:

$$\Delta c_{it+1} = \alpha + \beta Q_{it+1} + \pi_{it} + e_{it+1}, \qquad (2)$$

where π_{it} is associated with the shadow cost of liquidity constraints, or the Lagrange multiplier, and is positive if liquidity constraints bind and zero otherwise. Since π_{it} is nonzero only when a consumer is liquidity constrained, there is an obvious asymmetry in behavior in the two states of the world. More specifically, consumption is expected to grow faster when a consumer is constrained compared to when he is not.

The Euler equation is a period-to-period arbitrage condition and therefore does not take into account the effects of future constraints on current behavior. As such, the Euler equation is only a minimal test of REPIH.[4] In spite of this, whether or not π_{it} is significant in (2) is still an issue of empirical importance and has been an area of much research. But, to study this issue, we have to be able to tell who is liquidity constrained. Unfortunately, there are few sources for such information. One possibility is the Survey of Consumer Finances (SCF) collected by the Federal Reserve. The survey asks consumers whether they have been denied credit or have received less credit than requested. Although the survey contains valuable information, there are problems with using it in consumption analyses.[5] One problem is that the survey is not taken every year and does not contain information on consumption, and the credit information from the survey cannot be perfectly matched with consumption data from other sources. For example, using the 1983 survey to analyze consumption data collected for the seventies may give misleading results because the 1983 information may not be representative of credit availability in nonrecession years. A second problem is that a consumer could be refused credit because of his economic and social status or because there is a credit crunch. Since a consumer takes the latter as given, ideally one would want to control for the availability of credit in predicting a consumer's ability to borrow. However, there is no way to control for supply-side effects given the information available.

The most common way of determining who is a constrained consumer is to use an observed variable to identify the constrained status. For example, Zeldes (1989) de-

3. Consumers whose cost of borrowing is higher than the return to saving can also be viewed as liquidity constrained, but this channel is not being considered here because the real interest rate is assumed constant.

4. See Deaton (1992) for analyses of consumption behavior under liquidity constraints.

5. For such an analysis, see Jappelli, Pischke, and Souleles (1994).

fines liquidity constraints in terms of a lower bound on the level of assets. He then splits the sample according to whether the liquid asset-to-income or the wealth-to-income ratio is above or below the lower bound. In his analysis, a consumer with savings or wealth less than two months worth of income would be deemed constrained. There are two problems with this approach. The first pertains to whether adequate information is being used to assess a consumer's ability to borrow. The second concerns the choice of the threshold value (the two months of income in Zeldes's case), an issue that will be taken up later.

The first problem of efficient use of information arises because assets and wealth are only crude indicators of liquidity constraints. For example, the lower the liquid asset-to-income ratio, the higher the probability that the consumer will be classified as being constrained for a given cutoff point. But consumers who have successfully borrowed would naturally have a low level of liquid assets. The criterion will classify him as a constrained consumer even though he was approved credit.

In general, it is unlikely that a single variable will serve as a sufficient statistic of consumers' ability to borrow. The fraction of liquidity constrained consumers should depend on characteristics of consumers and on the technology of financial intermediation. Jappelli (1990) examines data on people who have been denied credit and on the so-called discouraged borrowers and finds that socioeconomic characteristics such as education and marital status are relevant in explaining the probability of being liquidity constrained. He also finds that while liquid assets are a better proxy than wealth for identifying the unconstrained consumers, they cannot adequately identify the constrained consumers. The wealth to income criterion can also lead to sample misspecification. Jappelli uses Zeldes's criteria to split the sample and finds that 8.3 percent of borrowers who are denied loans actually have high wealth-to-income ratios.

Recognizing that the asset-to-income ratio is merely a noisy indicator for liquidity constraints, Hajivassiliou and Ioannides (1990) handle the issue as an econometric problem. Using the same data as Zeldes, their results show strong support for the presence of liquidity constraints. Upon further consideration, this result should not be surprising since their fundamental criterion for sample splitting still rests on the asset-to-income ratio, the same as Zeldes.

A review of the evidence suggests that tests for excess sensitivity are quite sensitive to the sample separation criteria. While Zeldes finds no evidence for excess sensitivity among the unconstrained when he splits the sample by the ratio of nonhousing wealth to income, he finds lagged income to be significant in the Euler equation for both the constrained and unconstrained consumers when the sample is split according to the ratio of total wealth to income.

All the studies cited above have used limited information to proxy for the ability to borrow. It is possible that the rather mixed evidence on liquidity constraints is due to inefficient use of available information to determine when a consumer is constrained. Our analysis overcomes this problem, to some extent, by using more information to predict when a consumer is being liquidity constrained.

1.1 Switching Regressions

The starting point of our analysis is the result of Jappelli (1990), who uses the SCF data to estimate the probability of credit denial as a function of the characteristics of consumers who face borrowing constraints. He identifies age, income, wealth, race, marital status, and family size as the primary determinants of the constrained status. This leads us to model the probability of being *constrained* (P_{it}) by the following logit function:

$$P_{it} = \frac{exp(\theta W_{it})}{1 + exp(\theta W_{it})}, \tag{3}$$

where W_{it} is a set of social and economic variables thought to affect the ability to borrow, and θ is a vector of parameters.

One way to think about the logit function is that the creditor uses a point system to decide who is going to be approved credit. The credit officer considers the social and economic background of the applicant and assigns points to each of these characteristics. These attributes and weights are the variables and parameters of the logit function. Evaluation of the logit function yields a summary assessment of the loan applicant by the creditor. The econometrician uses the same information to estimate the probability that the consumer was denied credit.

Given data on changes in consumption between period t and $t + 1$, the likelihood function for Δc_{it+1} is

$$f(\Delta c_{it+1}) = P_{it} f(\epsilon_{it+1}, \phi_c) + (1 - P_{it}) f(\epsilon_{it+1}, \phi_u), \tag{4}$$

where $f(\epsilon_{it+1}, \phi_c)$ and $f(\epsilon_{it+1} \phi_u)$ are densities associated with changes in consumption in the two states. These are given by the two Euler equations:

$$\Delta c_{it+1} = \alpha_u + \beta Q_{it+1} + \delta_u z_{it} + \omega_u \epsilon^u_{it+1},$$
$$\Delta c_{it+1} = \alpha_c + \beta Q_{it+1} + \delta_c z_{it} + \omega_c \epsilon^c_{it+1}, \tag{5}$$

where z_{it} is a parameterization of the shadow cost of liquidity constraints. Accordingly, ϕ_c and ϕ_u in (4) are the parameters in the Euler equation of the two states. Under the null hypothesis, the unconstrained consumers should not respond to variables known in the information set at time t, and thus $\delta_u = 0$. Under the liquidity constraints alternative, δ_c should be different from zero.

In general, the regressions in the two states should have at least one noncommon explanatory variable in order to identify the two regimes. Otherwise, we can simply relabel the equations in (5) without changing the value of the likelihood function and not be able to tell with which state P_{it} is associated. One solution is to impose the restriction that $\delta_u = 0$. This amounts to assuming that the unconstrained consumers obey REPIH. Although we also estimate the regressions with $\delta_u = 0$ as a cross-check, we opt to use extraneous information to achieve identification. First and foremost, economic reasoning suggests that consumers with certain attributes are more likely to be liquidity constrained. Therefore, the sign on the coefficients of these characteristics provides an informal way of identifying the regimes. Second, Jappelli (1990) has estimated the relationship between the ability to borrow and variables that are included in our regressions. For example, he finds (and economic reasoning concurs) that being young or single increases the probability of being liquidity constrained. Positive coefficients on these variables in our logit equation would be consistent with P_{it} measuring the probability of being liquidity constrained. Since we retain only those variables that conform to the sign of the estimates reported by Jappelli (1990), there is little ambiguity as to which regime the logit equation represents. As we will see later, leaving δ_u unconstrained allows us to nest other interesting hypotheses in a more general model.

1.2 Data Issues

Our data are taken primarily from the CEX between 1980 and 1987. We consider two measures of consumption: a constructed measure of strictly nondurables (SND), and food (FOOD). Most studies on liquidity constraints are based on food consumption reported in the PSID.[6] However, food constitutes just 20 percent of total consumption. Therefore, it is useful to check for the robustness of the results against broader measures of consumption. Nondurable consumption in the CEX defined as in NIPA (National Income and Product Accounts) represents approximately 60 percent of total consumption and contains goods with durable and/or semidurable content. Durable goods have different stochastic implications for the error term in the Euler equation as discussed by Mankiw (1982). Therefore, we construct a measure of "strictly nondurable consumption" to exclude the durable and semidurable components from consumption. The resulting variable represents 47 percent of total quarterly expenditure and is denoted SND in subsequent analysis. A summary on the construction of the data is given in the Appendix.

The CEX is a survey on consumption, but unfortunately, the quality of its data on income is not very reliable. The data on changes in income can be particularly noisy.[7] To guard against this problem when testing for excess sensitivity to predicted changes in income, we use income data from the PSID in conjunction with data from the CEX. Lusardi (1996) discusses issues pertaining to matching the PSID and the CEX data. Properties of the estimator using moment conditions from two samples are discussed in Angrist and Krueger (1992).

After deleting ambiguous cases and outliers, we have a sample of 9,339 households. Some statistics of the sample are as follows. Eighty-five percent of the sample is white, and 67 percent report male as the reference person. There are seven occupation groups. The average family size is 2.76, with one-person households

6. See Hall and Mishkin (1982), Altonji and Siow (1987), Zeldes (1989), Runkle (1991), and Shea (1995b).

7. For an analysis of measurement errors in the CEX income data, see Lusardi (1996) and Nelson (1994).

accounting for 24 percent of the sample. The average level of income in the sample is around \$21,000. The distribution of financial assets is skewed, with a median of \$1,500 but a mean of over \$9,000. It is interesting to note that 18 percent of the sample do not hold financial assets; this statistic is roughly similar across age groups. If consumers choose to hold such a low level of assets for reasons unrelated to liquidity constraints, then financial assets will not be a good proxy for the ability to borrow. Indeed, over 60 percent of the consumers in our sample have assets less than two months of income and would have been classified as being liquidity constrained according to the asset to income ratio criterion.

Our empirical analysis uses social and economic characteristics of consumers to estimate the probability of being liquidity constrained. These are associated with the characteristics of the "reference person" in the CEX, defined as the person who owns or rents the home. Thus, the consumer unit in the empirical analysis is the household.

2. EXCESS SENSITIVITY TO LAGGED INCOME

The parameters of the Euler equations in (5) and those of the logit function in (3) are obtained by jointly maximizing the log-likelihood of the whole sample, $L = \Sigma_{i=1}^{n} \log f(\Delta c_{it+1})$, where n is the sample size.[8] The t statistics are given in parentheses.

A problem can arise when estimating Euler equations using panel data. As noted by Chamberlain (1984), "a time average of forecast errors over T periods should converge to zero as $T \rightarrow \infty$. But an average of forecast errors across N individuals surely need not converge to zero as $N \rightarrow \infty$; there may be common components in those errors, due to economy-wide innovations." To guard against this problem, many studies also include a set of time dummies in the Euler equation. These are motivated in Zeldes (1989), Altonji and Siow (1987), and Runkle (1991), among others, as being necessary to control for the aggregate component of the expectational error. More recently, Altug and Miller (1990) argue that the time dummies can be reinterpreted as the undiversifiable aggregate risk facing intertemporal decisions under a complete market setting. Since this problem does not arise if the data has a long enough time dimension, time dummies are omitted in Attanasio and Weber (1995), who analyzed a longer span of panel data with synthetic cohorts. Our panel of data has a relatively short span (1980–1987). While longer than the data used in some of the earlier studies, the time dimension may still be too short, and whether or not the expectations errors are centered around zero is an empirical issue to be determined by the data. We therefore consider regressions with and without time dummies. As in Shea (1995b), we found the results to be qualitatively and quantitatively similar, whether or not the time dummies are included. We therefore only report the ones without the time dummies. The complete set of results are available on request.

8. We use the Davidson-Fletcher-Powell (DFP) routine in the Goldfeld-Quandt Optimization Package (GQOPT).

TABLE 1

LAGGED INCOME

$$\Delta c_{it+1} = \alpha_u + \beta_1 AGE + \beta_2 DIFSIZE + \delta_u \ln(y_{it}) + \omega_u \epsilon_{it+1}$$
$$\Delta c_{it+1} = \alpha_c + \beta_1 AGE + \beta_2 DIFSIZE + \delta_c \ln(y_{it}) + \omega_c \epsilon_{it+1}$$

	SND		FOOD	
	Switching Regression	Whole Sample	Switching Regression	Whole Sample
α_u	0.0139	0.1299	0.0566	0.1061
	(0.19)	(2.65)	(0.57)	(1.67)
ω_u	0.2677	0.3821	0.2878	0.4934
	(33.42)	(137.72)	(28.08)	(137.73)
α_c	0.3577	—	0.2113	—
	(3.07)		(1.79)	
ω_c	0.5315	—	0.6486	—
	(37.01)		(50.18)	
δ_u	0.0064	−0.0065	−0.0045	−0.0116
	(0.88)	(−1.41)	(−0.47)	(−1.92)
δ_c	−0.0323	—	−0.0254	—
	(−2.59)		(−2.07)	
β_1	−9.88D-04	−9.61D-04	−1.60D-04	−2.06D-04
	(−4.54)	(−4.07)	(−0.57)	(−0.67)
β_2	0.0711	0.0751	0.0788	0.0824
	(10.26)	(10.69)	(8.55)	(9.11)
	Variables Identifying Liquidity Constrained Consumers			
Const.	0.7488		0.9743	
	(2.08)		(2.65)	
Income	−0.3659		−0.4874	
	(−2.22)		(−3.03)	
Income^2	0.0222		0.0268	
	(1.63)		(1.76)	
Asset/Income	0.1939		−0.0626	
	(2.65)		(−0.78)	
Interest/Income	1.0510		−0.7416	
	(1.25)		(−0.98)	
Age	−0.0099		−0.0049	
	(−1.86)		(−0.93)	
Age × Income	0.0032		0.0046	
	(1.31)		(1.90)	
Married	−0.5649		−0.6417	
	(−4.50)		(−5.10)	
House with Mortgage	−0.3432		−0.0955	
	(−2.68)		(−0.80)	
Car	−0.4710		−0.1841	
	(−2.92)		(−0.95)	
Nonwhite	0.4296		0.6478	
	(2.60)		(3.78)	
More than 2 earners	0.4294		0.6132	
	(2.41)		(3.22)	
Recession Dummy 81:3	0.5325		0.3855	
	(2.08)		(1.55)	
Recession Dummy 81:2	0.2183		0.1322	
	(0.93)		(0.53)	
Likelihood Value	4618.44	4316.39	2313.70	1927.93

NOTE: t-statistics in parentheses.

Our first set of estimates is based on parameterizing the shadow cost of liquidity constraints (z_{it}) by the level of income at time t. This allows us to compare our results with those in Zeldes based on PSID data. In theory, there are many social and economic variables reported in the CEX which might contain information about the ability to borrow. We therefore begin with a general specification for the logit equation, including a large set of regressors linearly and in the form of higher-order polynomials. Insignificant regressors are then dropped to arrive at a parsimonious representation that yields estimates that also conform to the findings of Jappelli. The preferred logit equation is specified as a function of income, assets, interest income, home and car ownership, number of earners, age, race, and marital status. Thus, both economic and sociodemographic factors are used to determine the ability of a household to borrow.

Estimates for the logit equations are given in the bottom panel of Table 1. Ceteris paribus, the lower the level of income, the larger the amount of borrowing required, and therefore the higher the probability of being constrained. Holding income constant, one would expect a high level of assets to decrease the probability of being liquidity constrained, while holding assets constant, a lower level of income will raise this probability. However, a high asset-to-income ratio can arise if assets are high, and/or the level of income is low. Therefore, the sign of the coefficient on this ratio is uncertain a priori. The finding of a positive coefficient suggests that the income effect dominates. In the same vein, a fall in the level of income raises the ratio of interest income to income and raises the probability of being liquidity constrained. Thus, the level of income has a nonlinear effect on P_{it} through its interaction with other economic variables.

A borrower who owns a house or a car can use these fixed assets as collateral. Not surprisingly, households who do not have such tangible assets have a higher probability of being liquidity constrained. Among the social variables, there is strong evidence that being nonwhite and single significantly increases the probability of being constrained. Age is also a significant variable in the logit function. The younger the consumer, the more likely that his earnings profile will rise in the future. Since consumers may not be able to borrow against higher future earnings, young consumers have a higher probability of being constrained. Quarterly dummies for the 1981 recession are also found to be significant in the logit equation. Thus, there are business cycle effects in the probability of being liquidity constrained.

Histograms for the predicted probabilities of being constrained are present in Figure 1 for FOOD and SND. According to our estimates, 16 percent of the SND sample is estimated to have a probability of being constrained greater than half, the same as predicted by the logit model of Jappelli (1990) from the SCF responses. There are several features to note. First, all consumers face a nonzero probability of being constrained since P_{it} is bounded away from zero. Second, the FOOD data suggest there are more individuals with high probabilities of being constrained than the SND data. Third, the probabilities associated with SND are more spread out than FOOD. There are evidently important differences in the predicted probabilities for FOOD and SND. Further examination reveals that although the specification of the logit equation is the same for FOOD and SND, many of the variables in the logit equation for FOOD could have been excluded. The bulk of the explanatory power in the logit equation for FOOD comes from income. By contrast, the effect of income is statistically and numerically less important in the logit equation for SND. This

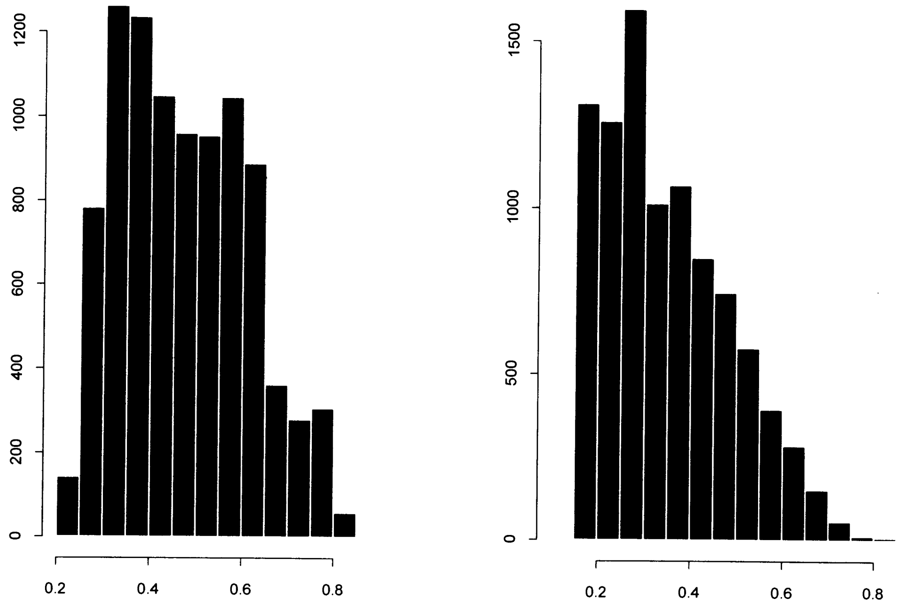

FIG. 1. Probabilities of Being Constrained. Left: Food; right: Strictly Nondurables

suggests that when analyzing broader measures of consumption, using income as the sole indicator for liquidity constraints will likely lead to more severe sample misclassification, and generalizing results from FOOD to broader measures of consumption can be misleading.

Results for testing excess sensitivity to the lagged level of income are given in the top panel of Table 1. As discussed earlier, our logit equation is such that it yields estimates that accord with our economic reasoning and the results of Jappelli. To be reassured that these prior restrictions do not bias the estimates of the parameters in the Euler equation, note that $\hat{\delta}_u$ is numerically zero in the unrestricted regressions for both measures of consumption. Thus the estimates for the remaining parameters are the same whether or not we impose the formal identification restriction of $\delta_u = 0$.

The coefficient of interest is $\hat{\delta}_c$, which measures the degree of excess sensitivity of the constrained to the lagged level of income. The coefficient is statistically significant in both the FOOD and SND equations. Consistent with the results of Zeldes (1989), the coefficient in both equations is negative. The evidence from both the CEX and PSID suggests that some consumers in the sample are liquidity constrained.

2.1 Sensitivity of the Results to Model Specification

In the switching-regressions literature, the model given by (3), (4), and (5) above is referred to as an "exogenous switching model." This is to be distinguished from an "endogenous switching model" as discussed in Maddala (1986). In those models, sample classification is determined by a variable $I_{it}^{*} = \theta W_{it} + \upsilon_{it}$, which sets an indicator I_{it} to 1 if $I_{it}^{*} > 0$ and zero otherwise. The likelihood function for consumer i in period $t + 1$ is

$$\begin{aligned} f(\Delta c_{it}) &= f(\epsilon_{it+1}^{c}, \phi_c | \theta W_{it} + \upsilon_{it} \geq 0) \cdot \text{Prob}(\theta W_{it} + \upsilon_{it} \geq 0) \\ &\quad + f(\epsilon_{it+1}^{u}, \phi_u | \theta W_{it} + \upsilon_{it} < 0)\text{Prob}(\theta W_{it} + \upsilon_{it} < 0) \\ &= f(\epsilon_{it+1}^{c}, \phi_c)\, \Phi\left(\frac{\theta W_{it} + \frac{\rho_{\upsilon c}}{\sigma_c}\epsilon_{it+1}^{c}}{(1 - \rho_{\upsilon c}^{2})^{1/2}}\right) + f(\epsilon_{it+1}^{u}, \phi_u) \\ &\quad \left[1 - \Phi\left(\frac{\theta W_{it} - \frac{\rho_{\upsilon u}}{\sigma_u}\epsilon_{it+1}^{u}}{(1 - \rho_{\upsilon u}^{2})^{1/2}}\right)\right] \end{aligned} \tag{6}$$

where $\Phi(\cdot)$ denotes the cumulative normal density, $\rho_{\upsilon c}$ and $\rho_{\upsilon u}$ are correlation coefficients between the respective error terms, and σ_{υ} is normalized to 1. Evidently, this is a switching regression of the probit type. The crucial distinction between our empirical model and an endogenous switching model is not so much that our probabilities implied by Table 1 are estimated from a logit instead of a probit equation, but rather that in an endogenous switching model, the error term υ_{it} of the indicator equation is allowed to be correlated with those of the Euler equations. The correlations can be important in, for example, labor supply models where a worker simultaneously chooses whether or not to belong to a union and the hours of work.

We favor an exogenous switching model for two reasons. First, the errors of the Euler equations are expectational errors. Under the null hypothesis of REPIH, ϵ_{it+1}^{u} should be orthogonal to any sample selection error since the latter is induced in period t. Under the alternative of liquidity constraints, the correlation of these errors will still be zero provided z_{it} correctly controls for the shadow cost of liquidity constraints. Second, households do not choose whether they want to be liquidity constrained in the same way workers choose whether or not they want to belong to a union.[9] Therefore, it is less likely that the errors in sample selection and those in the Euler equations will be correlated.

Nevertheless, endogenous switching models are appropriate for studying the importance of liquidity constraints.[10] We also estimated endogenous switching models as a check of robustness. These results are reported in Table 2. We found no significant difference, both in terms of tests for excess sensitivity and in terms of the predicted probabilities, between the logit and the probit specifications. Most importantly, the correlations between the regression errors, $\rho_{\upsilon c}$ and $\rho_{\upsilon u}$, are not statistically significant. Restricting these correlations to be zero can improve the efficiency of the parameter estimates. We also estimated exogenous switching regressions using a probit instead of a logit function to parameterize P_{it}. The estimates in the Euler equation are practically identical to those presented in Table 1. Therefore, in the rest of this

9. See Lee (1978) and the references in Maddala (1986) therein.
10. See, for example, Hu and Schiantarelli (1994).

TABLE 2

LAGGED INCOME (ENDOGENOUS SWITCHING)

$$\Delta c_{it+1} = \alpha_u + \beta_1 AGE + \beta_2 DIFSIZE + \delta_u \ln(y_{it}) + \omega_u \epsilon_{it+1}$$
$$\Delta c_{it+1} = \alpha_c + \beta_1 AGE + \beta_2 DIFSIZE + \delta_c \ln(y_{it}) + \omega_c \epsilon_{it+1}$$

	SND–Switching Regression	
	Exogenous	Endogenous
α_u	0.0134	0.0083
	(0.19)	(0.89)
ω_u	0.2677	0.2692
	(33.45)	(33.25)
α_c	0.3566	0.3435
	(3.13)	(2.73)
ω_c	0.5317	0.5318
	(36.56)	(36.21)
δ_u	0.0064	0.0015
	(0.91)	(0.18)
δ_c	−0.0322	−0.0280
	(−2.75)	(−1.72)
β_1	−9.90D-04	−9.68D-04
	(−4.60)	(−4.43)
β_2	0.0711	0.0711
	(10.11)	(10.09)
ρ_{vu}	—	−0.1608
		(−1.32)
ρ_{vc}	—	−0.0471
		(−0.41)
Variables Identifying Liquidity Constrained Consumers		
Const.	0.4493	0.4553
	(2.01)	(2.06)
Income	−0.2196	−0.2199
	(−2.25)	(−2.29)
Income^2	0.0139	0.0139
	(1.73)	(1.79)
Asset/Income	0.1174	0.1100
	(2.52)	(2.33)
Interest/Income	0.6581	0.6944
	(1.19)	(1.34)
Age	−0.0060	−0.0059
	(−1.86)	(−1.85)
Age × Income	0.0019	0.0019
	(1.28)	(1.29)
Married	−0.3434	−0.3433
	(−4.36)	(−4.37)
House with Mortgage	−0.2075	−0.2101
	(−2.67)	(−2.71)
Car	−0.2901	−0.2990
	(−2.84)	(−2.79)
Nonwhite	0.2599	0.2587
	(2.53)	(2.55)
More than 2 earners	0.2503	0.2582
	(2.25)	(2.32)
Recession Dummy 81:3	0.3234	0.3349
	(2.13)	(2.17)
Recession Dummy 81:2	0.1298	0.1270
	(0.89)	(0.88)
Likelihood Value	−3963.73	−3962.99

NOTE: t-statistics in parentheses.

analysis, we focus on results for the more parsimonious exogenous switching model based on the logit specification.

2.2 Sensitivity of the Results to Sample Classification

The problem of sample classification in switching regressions when there is imperfect information on the state to which an observation belongs was analyzed in Lee and Porter (1984). Their analysis suggests that in the absence of direct information that allows for sample classification, weighing the likelihood function for each consumer by the probability associated with the logit function is optimal in the sense of minimizing the chance of sample misclassification. This is the basis for our formulation of the likelihood function in (4).

Most studies in the literature have split the sample by comparing the value of an economic variable to some cutoff point. In the context of our switching-regression model, this means that there is just one indicator variable in the logit equation, and the weights in the likelihood function attached to the Euler equations are either one or zero. For example, Eberly (1994) classifies the sample according to whether the level of lagged income or the ratio of income to lifetime income of a consumer exceeds a trigger level. Even though the cutoff point is endogenously estimated to maximize the likelihood function, and noting that her model is an exogenous switching model in the sense of Maddala (1986), each data point in the likelihood function is given a weight of either zero or one given the setup of her analysis.

It is of interest to examine the extent to which tests for excess sensitivity are affected by the weights used in the likelihood function. To pursue such an analysis, we take the estimated probabilities from the previous subsection as given, and then perform a grid search to find the threshold probability that maximizes the joint likelihood function of the two split-sampled equations. This is in the spirit of the work of Zeldes (1989), who estimated the probability of being constrained as a logit function of multiple indicators and split the sample at $P^* = 0.6$, but his P^* is determined a priori. Our analysis is more general in that we let the threshold value be determined by the data. The choice of this threshold value is important because too low a cutoff point will classify some constrained consumers as unconstrained and will lead us to reject the REPIH even among the unconstrained. Conversely, too high a cutoff point will classify the unconstrained as constrained and will underestimate the true extent of excess sensitivity to lagged income.

Table 3 reports results for SND for three methods of sample classification. The first uses the probabilities to weight the likelihood function,[11] the second splits the sample according to a threshold probability, and the third splits the sample according to a threshold level of income. It is worth emphasizing that the latter two methods apply a weight of zero or one to each observation and are therefore suboptimal relative to the first method. Nevertheless, the results suggest that setting P^* at 0.4 provides the minimum sum of squared residuals of the two samples, while setting

11. The results are identical to those reported in Table 1 in all respects except that the β coefficients are constrained to be the same in Table 1 but can differ by groups here. Relaxing the constraint is necessary for comparison with the split sample regressions.

TABLE 3

ESTIMATES FOR VARIOUS METHODS OF SAMPLE CLASSIFICATION: SND WITH LAGGED INCOME

	Weighting by Probabilities	Optimal Splitting Based on Probabilities ($P^* = 0.400$)	Optimal Splitting Based on Income ($I^* = \$16{,}000$)
α_u	0.0575	0.1453	0.0863
	(0.53)	(2.42)	(0.73)
α_c	0.2140	0.2567	0.2190
	(1.67)	(2.01)	(2.35)
β_{1u}	−1.5529D-04	−0.9775D-03	−0.986D-03
	(−0.34)	(−3.32)	(−2.75)
β_{1c}	−2.1453D-04	−0.9088D-03	−0.9341D-03
	(−0.41)	(−2.19)	(−2.84)
β_{2u}	0.0701	0.0718	0.0676
	(3.83)	(8.32)	(7.92)
β_{2c}	0.0894	0.0825	0.0864
	(5.56)	(6.51)	(7.16)
δ_u	−0.0046	−0.0086	−0.0020
	(−0.46)	(−1.46)	(−0.18)
δ_c	−0.0254	−0.0185	−0.0171
	(−2.02)	(−1.56)	(−1.71)
		5,914 unconstrained 3,425 constrained	5,345 unconstrained 3,994 constrained

NOTE: t-statistics in parentheses.

the threshold income at $16,000 implies 42 percent of the households are constrained. Both criteria suggest that .4 of sample is constrained, lower than implied by the cutoff probability of .6 used in Zeldes's analysis.[12]

The method used to classify the sample is of empirical relevance only insofar as it affects the estimated degree of excess sensitivity. There is little difference in the parameter estimates of $\hat{\delta}_u$ across the three methods. However, the coefficient of interest, $\hat{\delta}_c$, is estimated with more precision when the optimal weighting scheme is used. When the sample is classified according to the threshold values, $\hat{\delta}_c$ is only marginally significant at conventional significance levels. The evidence for excess sensitivity is therefore much weaker when weights of zero or one are used in the likelihood function. These results suggest that there are efficiency gains in using more information to predict the probabilities and classify the sample.

3. EXCESS SENSITIVITY TO PREDICTED CHANGES IN INCOME

If the REPIH holds, no variable known in period t should have predictive power for changes in consumption. Thus, another way to test the predictions of the REPIH is to examine whether consumption is also sensitive to anticipated changes in income. This was the approach taken by Altonji and Siow (1987) and Hall and Mishkin (1982) using data from the PSID, and by Lusardi (1996) and Attanasio and Browning (1995) using data from the CEX.

12. For FOOD, the threshold is $P^* = 0.545$, closer to Zeldes's result. It is more difficult to compare income threshold across studies as the samples cover different years.

We denote anticipated changes in income by $\Delta\hat{y}_{it+1}$. This variable is taken as the predicted values from the following auxiliary regression.

$$\begin{aligned}\Delta y_{it+1} = {} & c_0 + c_1 age + c_2 occupation + c_3 education + c_4 \Delta FS \\ & + c_5 occupation \times age + c_6 education \times age + c_7 sex \\ & + c_8 race + c_8 married + res_{it}.\end{aligned} \tag{7}$$

Household-specific characteristics are captured by age, years of education, change in family size, race, marital status, occupation, and the interaction among these variables. These variables are known to consumers at time t and can be seen as instruments for changes in income. Equation (7) is estimated using PSID data, and the estimated coefficients are applied to the right-hand-side variables taken from the CEX to give $\Delta\hat{y}_{it+1}$. Reported are the results for this two-sample instrumental variable estimator.

Results for the switching regressions with $z_{it} = \Delta\hat{y}_{it+1}$ are reported in Table 4. For both FOOD and SND, the estimates for the parameters in the logit equation are similar to those in Table 1 with lagged income entering the Euler equations. The values for $\hat{\delta}_c$ are significant, reinforcing the conclusion that liquidity constraints induce excess sensitivity to changes in income. The most notable result in Table 4 is evidence of excess sensitivity even among the unconstrained. While the point estimate of $\hat{\delta}_u$ is around 0.3 for both equations and is only half the size of $\hat{\delta}_c$, the effect is nevertheless statistically significant at conventional levels. We obtain similar results when we use income data from the CEX, which are more susceptible to noise.

The finding that both constrained and unconstrained consumers are sensitive to predicted changes in income is a decisive rejection of REPIH and warrants further investigation. While the evidence of excess sensitivity is consistent with the presence of liquidity constraints, it can also be the result of invalid assumptions about preferences imposed by the basic model. The following subsection attempts to test which of these two sources of excess sensitivity is more plausible.

3.1 Excess Sensitivity to Positive and Negative Income Changes

In this subsection, we distinguish between anticipated changes in income that are positive from those that are negative, and denote them by $\Delta\hat{y}^+_{it+1}$ and $\Delta\hat{y}^-_{it+1}$. The equations in the switching regressions now take the form:

$$\begin{aligned}\Delta c_{it+1} &= \alpha_u + \beta_u Q_{it+1} + \delta_u^+ \Delta\hat{y}^+_{it+1} + \delta_u^- \Delta\hat{y}^-_{it+1} + \epsilon^u_{it+1}, \\ \Delta c_{it+1} &= \alpha_c + \beta_c Q_{it+1} + \delta_c^+ \Delta\hat{y}^+_{it+1} + \delta_c^- \Delta\hat{y}^-_{it+1} + \epsilon^c_{it+1}.\end{aligned} \tag{8}$$

This general specification allows us to test whether excess sensitivity can be explained by the following two types of preferences:

1. Rule-of-Thumb Consumers. A possible explanation for the excess sensitivity just reported is that consumers are myopic. A "rule-of-thumb" consumer has a constant marginal propensity to consume out of current income and does not smooth

TABLE 4

PREDICTED INCOME CHANGES

$$\Delta c_{it+1} = \alpha_u + \beta_1 AGE + \beta_2 DIFSIZE + \delta_u \Delta \hat{y}_{it} + \omega_u \epsilon_{it+1}$$
$$\Delta c_{it+1} = \alpha_c + \beta_1 AGE + \beta_2 DIFSIZE + \delta_c \Delta \hat{y}_{it} + \omega_c \epsilon_{it+1}$$

	SND		FOOD	
	Switching Regression	Whole Sample	Switching Regression	Whole Sample
α_u	0.0584 (4.70)	0.0408 (3.07)	−0.0122 (−0.74)	−0.0363 (−2.14)
ω_u	0.2661 (33.03)	0.3819 (136.95)	0.2882 (27.56)	0.4933 (137.02)
α_c	0.0291 (1.88)	—	−0.0556 (−2.85)	—
ω_c	0.5285 (37.12)	—	0.6489 (51.38)	—
δ_u	0.2610 (1.79)	0.4523 (3.31)	0.2884 (1.43)	0.4838 (2.77)
δ_c	0.7114 (3.37)	—	0.6069 (2.42)	—
β_1	−6.06D-04 (−2.53)	−4.57D-04 (−1.76)	3.27D-04 (1.05)	3.96D-04 (1.19)
β_2	0.0390 (3.22)	0.0397 (3.08)	0.0460 (2.88)	0.0447 (2.72)
	Variables Identifying Liquidity Constrained Consumers			
Const.	0.7958 (2.20)		0.9810 (2.64)	
Income	−0.3674 (−2.28)		−0.4927 (−3.22)	
Income^2	0.0243 (1.71)		0.0269 (2.06)	
Asset/Income	0.1970 (2.69)		−0.0634 (−0.85)	
Interest/Income	1.0107 (1.14)		−0.7551 (−0.95)	
Age	−0.0099 (−1.90)		−0.0052 (−0.99)	
Age × Income	0.0030 (1.20)		0.0048 (2.03)	
Married	−0.5759 (−4.53)		−0.6455 (−4.82)	
House with Mortgage	−0.3457 (−2.69)		−0.0930 (−0.76)	
Car	−0.4599 (−2.79)		−0.1817 (−1.16)	
Nonwhite	0.4301 (2.56)		0.6395 (3.81)	
More than 2 earners	0.4089 (2.22)		0.6116 (3.34)	
Recession Dummy 81:3	0.5374 (2.09)		0.3975 (1.46)	
Recession Dummy 81:2	0.2236 (0.94)		0.1360 (0.65)	
Likelihood Value	4620.89	4320.86	2314.55	1929.86

NOTE: t-statistics in parentheses.

consumption as predicted by the REPIH. Therefore, like liquidity-constrained consumers, myopic consumers will also be excessively sensitive to variables known in the information set. However, there is an important difference between the two types of consumers. A rule-of-thumb consumer will respond to changes in income regardless of whether the income change is expected to be positive or negative. On the other hand, liquidity constraints impede borrowing but do not inhibit saving. Consumers can save and smooth consumption when income is expected to fall. Thus, if liquidity constraints were the genuine cause for rejections of the REPIH, we should observe excess sensitivity only when consumers expect increases in income but are prohibited from borrowing. This asymmetry between positive and negative income changes was first discussed in Altonji and Siow (1987) and recently analyzed by Shea (1995a, b).

The above discussion suggests that $\hat{\delta}_c^+$ should be significant if a household is genuinely liquidity constrained, but $\hat{\delta}_c^-$ should be insignificant. By contrast, both $\hat{\delta}^+$ and $\hat{\delta}^-$ should be significant and of similar magnitudes if a consumer is myopic.

2. *Asymmetric Preferences.* One plausible explanation for the excess sensitivity to $\Delta\hat{y}_{it+1}$ is that households do not have time-separable preferences as assumed. If there is inertia in preferences as in the case of habit formation, households will adjust their behavior slowly. Omitting lags of marginal utility of consumption from the Euler equation may be the reason why the coefficients on $\Delta\hat{y}_{it+1}$ are significant.

There are many ways to model time nonseparabilities in preferences, and we shall concentrate on those that induce asymmetric responses to positive and negative predicted income changes. Such behavior could arise if individuals weigh outcomes that are above and below the certainty equivalent differently, or treat gains and losses differently.[13]

While forward-looking consumers with time-separable preferences respond to new information about future events as the information arrives, consumers with asymmetric preferences do not behave in the same way. Suppose such a consumer anticipates a negative income change in $t + 1$. Since the consumer is averse to negative changes, he will not revise c_t downward in anticipation of the negative shock, but will gamble that the negative shock will not occur. This consumer will adjust c_{t+1} downward only when the shock is realized. A small reduction in c_t and a large negative change in c_{it+1} can therefore translate into a large negative Δc_{it+1} for a given $\Delta\hat{y}_{it+1}^-$. However, when the consumer anticipates a future but positive income change in period *t,* he will revise c_t upward immediately just like any expected utility maximizer would. This implies that Δc_{it+1} will be small in response to a $\Delta\hat{y}_{it+1}^+$. Thus, if households have these asymmetric preferences, we should observe excess sensitivity to $\Delta\hat{y}_{it+1}^-$ but not to $\Delta\hat{y}_{it+1}^+$.

The above two hypotheses can be nested in equation (8). If the REPIH holds, all the $\hat{\delta}$ coefficients should be statistically insignificant. If households are myopic, $\hat{\delta}^+$ and $\hat{\delta}^-$ should be both significant and of the same magnitudes. If $\hat{\delta}^+$ is significant only among the constrained, liquidity constraints would be the primary source of excess sensitivity. A significant $\hat{\delta}^-$, on the other hand, is consistent with asymmetric preferences.

The estimation results are presented in Table 5. The estimates with all the δs uncon-

13. Examples include "disappointment aversion," axiomatized by Gul (1991) and used to explain the so-called Allais paradox, and "loss aversion," proposed by Tversky and Kahneman (1991) and extended by Bowman, Minehart, and Rabin (1993) into a savings model.

TABLE 5

EXCESS SENSITIVITY TO PREDICTED INCOME CHANGES

	Unconstrained Estimates		Myopia		Asymmetric Preferences	
	SND	FOOD	SND	FOOD	SND	FOOD
δ_u^-	0.800	1.243	0.824	1.213	0.799	1.238
	(3.02)	(3.57)	(3.28)	(3.58)	(3.02)	(3.47)
δ_u^+	−0.036	−0.120	−0.052	−0.092	—	—
	(−0.19)	(−0.50)	(−0.29)	(−0.40)		
δ_c^-	0.117	−0.144	—	—	0.145	−0.064
	(0.30)	(−0.34)			(0.39)	(−0.16)
δ_c^+	1.067	0.926	1.081	0.915	1.056	0.903
	(3.43)	(3.21)	(3.75)	(2.80)	(3.42)	(3.17)
L	4624.44	2318.90	4624.40	2318.84	4624.42	2318.76

NOTE: t-statistics in parentheses.

strained provide a useful reference and are given in the first column. The coefficients $\hat{\delta}_u^+$ and $\hat{\delta}_c^-$ are statistically insignificant. These coefficients are then constrained to zero to increase the power of tests on the remaining coefficients of the model.

The estimates in the second column are based on regressions with $\delta_c^- = 0$. The estimates reject the null hypothesis that the unconstrained obey REPIH. The rejections, for both FOOD and SND, can be traced to excess sensitivity to negative income changes. Note that the estimates are inconsistent with rule-of-thumb behavior. This is because $\hat{\delta}_u^+$ and $\hat{\delta}_u^-$ are of rather different magnitudes. If the unconstrained consumers are indeed rule-of-thumb consumers, they should have responded to positive and negative income changes in the same way.

The estimates in the third column are based on regressions with δ_u^+ constrained to zero. This allows the unconstrained consumers to treat gains and losses differently but assumes that they should otherwise obey the REPIH. Our results indeed find $\hat{\delta}_u^-$ to be strongly significant. However, there is no evidence of asymmetric preferences among the constrained. For these consumers, liquidity constraints appear to be the sole source of excess sensitivity.

Looking at the overall evidence, liquidity constraints appear to be the most important source of excess sensitivity among the constrained; the unconstrained also respond to anticipated changes in income, but only in anticipation of negative shocks. Admittedly, we are testing a narrow aspect of time nonseparable preferences. However, using different data and methodology, Shea (1995a, b) also finds consumption to be more sensitive to predictable income declines than to predictable income increases. Our results provide further evidence for such asymmetries in consumption behavior.

4. CONCLUSION

This study is motivated by the need to use more information to classify who is a liquidity-constrained consumer and to discriminate between the many alternatives to the REPIH. Our analysis suggests that in addition to the level of assets and income, other economic and social factors determine the likelihood that a consumer will be denied credit. We also find the logit equations that predict the probability of being constrained to be different across measures of consumption. While using income as the sole variable to split the sample might be adequate for food, this might lead to substantial sample misclassification for strictly nondurables. Results from the switching regressions find evidence for excess sensitivity among the liquidity constrained. More surprising is the evidence for excess sensitivity to predicted changes in income among the unconstrained. Further analysis on this last result suggests a role for time-nonseparable preferences but finds no role for rule-of-thumb behavior as an explanation for rejections of the REPIH. Attanasio (1995) has made the argument that evidence of excess sensitivity in a standard model can be due to preferences or to liquidity constraints. The latter are forced upon by the economic environment, while the former are not. Our results suggest that both factors play a role in explaining excess sensitivity.

DATA APPENDIX

Description of the CEX

The CEX is a rotating sample. Each household in the survey is interviewed once per quarter for five consecutive quarters. In the initial interview, information is collected on demographics, family characteristics, and the inventory of major durable goods. Wages, salary, and other information on the employment of each household member are collected in the second and fifth interviews. In the fifth and final interview, an annual supplement is used to obtain a financial profile of the household. Given this structure of the data, consumption growth is defined as the difference between the second and the fifth interviews. We merge households being interviewed in the first quarter of 1981 (their second interviews happen in the second quarter of 1980) with consumers being interviewed in the second, third, and fourth quarter of 1981. Due to changes in the data collection, we consider other waves of consumers from the first quarter of 1983 to the fourth quarter of 1983, from the first quarter of 1985 to the fourth quarter of 1985, and from the first quarter of 1987 until the fourth quarter of 1987, for a total of sixteen quarters of data.

The consumer unit is the "reference person" in the CEX, defined as the person who owns or rents the home. If there is joint ownership, the reference person is the one whose name appears first when asked "start with the name of the person or one of the persons who owns or rents the home."

Description of the Variables

All variables have been deflated using the corresponding Consumer Price Index (which is derived by the Bureau of Labor Statistics using CEX data) and expressed in 1982 dollars. Readers are referred to Lusardi (1992, 1996) for further details on the variables and comparison with other data sets.

1. Consumption. The consumption measure referred to as "strictly nondurable consumption" is the sum of the quarterly expenditure on food, alcoholic beverages, tobacco, utilities, personal care, household operations, public transportation, gas and motor oil, and miscellaneous expenses. It differs from the NIPA definition of nondurables by excluding apparel and services, expenditure on health, education, and reading. The consumption measure referred to as "food consumption" is the sum of food and alcoholic beverages at home and outside home. This definition corresponds to the food consumption measure reported in the PSID.

2. Income. The income variable in the CEX corresponds to total disposable income, net of all taxes. It includes labor income, unemployment compensation, retirement pension and Social Security benefits. We then subtract from net disposable income the amount received as interest, dividend and rent payment. This gives a measure of total noncapital income. The income variable in the PSID matches the definition in the CEX.

3. Assets. In the fifth interview, the CEX provides data both on financial assets and the change in the stock of assets during the last twelve months. Therefore, it is possible to construct a measure of financial assets held by households at the beginning of the second interview. The asset variable is obtained by summing the amount invested in savings and checking accounts, in U.S. savings bonds, and in stocks, bonds, mutual funds, and other such securities.

Sample Selection

The final sample has 9,339 observations. We exclude from the CEX sample those households whose heads are in the farm, forestry, and fishing occupations since it is difficult to differentiate between income and consumption in these cases. We also delete self-employed workers since their income is heavily underestimated or not reported correctly. In addition, we exclude consumers with incomplete reports of income in the second and fifth interviews because in many cases the reported income is zero. To eliminate extreme outliers, we delete households whose income growth (in absolute terms) is greater than 400 percent, and households with absolute consumption growth greater than 200 percent. Consumers with a consumption-to-income ratio greater than 6 are excluded as well. We also delete households with invalid reports on both checking and saving accounts (only a limited proportion of households reported assets in stocks and bonds and in U.S. savings bonds). Those whose change in assets during the year is greater than the final stock of assets are excluded from the sample since their assets in the second interview are less than zero. Finally, we exclude consumers with financial assets greater than $250,000.

LITERATURE CITED

Abel, Andy B. "Asset Prices under Habit Formation and Catching Up with the Joneses." *American Economic Review Papers and Proceedings* 80 (1990), 38–42.

Altonji, Joseph G., and Aloysius Siow. "Testing the Response of Consumption to Income Changes with (Noisy) Panel Data." *Quarterly Journal of Economics* 102 (1987), 293–328.

Altug, Sumru, and Robert A. Miller. "Household Choices in Equilibrium." *Econometrica* 58 (1990), 543–71.

Angrist, Joshua, and Alan Krueger. "The Effect of Age at School Entry on Educational Attainment: An Application of Instrumental Variables with Moments from Two Samples." *Journal of the Americal Statistical Association* 87 (1992), 328–36.

Attanasio, Orazio P. "The Intertemporal Allocation of Consumption: Theory and Evidence." *Carnegie Rochester Conference Series on Public Policy* 42 (1995), 39–89.

Attanasio, Orazio P., and Martin Browning. "Consumption over the Life Cycle and over the Business Cycle." *American Economic Review* 85 (1995), 1118–37.

Attanasio, Orazio P., and Guglielmo Weber. "Is Consumption Growth Consistent with Intertemporal Optimization? Evidence from the Consumer Expenditure Survey." *Journal of Political Economy* 103 (1995), 1121–57.

Bowman, David, Debby Minehart, and Matthew Rabin. "Loss Aversion in a Savings Model." Mimeo, University of California-Berkeley, 1993.

Browning, Martin, and Annamaria Lusardi. "Household Saving: Micro Theories and Micro Facts." *Journal of Economic Literature* 34 (1996), 1797–1855.

Chamberlain, Gary. "Panel Data." In *Handbook of Econometrics,* vol. 2, pp. 1247–1318. North Holland, 1984.

Deaton, Angus S. *Understanding Consumption.* Oxford: Oxford University Press, 1992.

Dynan, Karen. "How Prudent Are Consumers." *Journal of Political Economy* 101:6 (1993), 1104–12.

Eberly, Janice C. "Adjustment of Consumers' Durables Stocks: Evidence from Automobile Purchases." *Journal of Political Economy* 102:3 (1994), 403–36.

Epstein, Larry, and Stanley Zin. "The Independence Axiom and Asset Returns." National Bureau of Economic Research Technical Working Paper 109, 1991.

Gul, Faruk. "A Theory of Disappointment Aversion." *Econometrica* 59 (1991), 667–86.

Hajivassiliou, Vassilis A., and Yannis Ioannides. "Dynamic Switching Regression Models of the Euler Equation; Labor Supply, Food Consumption, and Liquidity Constraints." Mimeo, Yale University, 1990.

Hall, Robert E. "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence." *Journal of Political Economy* 86 (1978), 971–87.

Hall, Robert E., and Frederic Mishkin. "The Sensitivity of Consumption to Transitory Income: Estimation from Panel Data on Households." *Econometrica* 50 (1982), 461–81.

Hu, Xiaoqiang, and Fabio Schiantarelli. "Investment and Financing Constraints: A Switching Regression Approach Using U.S. Firms Panel Data." Mimeo, Boston College, 1994.

Jappelli, Tullio. "Who Is Credit Constrained in the U.S. Economy." *Quarterly Journal of Economics* CVI (1990), 219–34.

Jappelli, Tullio, Steve Pischke, and Nicholas Souleles. "Testing for Liquidity Constraints in Euler Equations with Complementary Data Sources." Mimeo, M.I.T., 1994.

Kuehlwein, Michael. "A Test of the Presence of Precautionary Saving." *Economic Letters* 37 (1991), 471–75.

Lee, Lung Fei. "Unionism and Wage Rates: A Simultaneous Equation Model with Qualitative and Limited Dependent Variables." *International Economic Review* 19 (1978), 415–33.

Lee, Lung Fei, and Robert Porter. "Switching-Regression Models with Imperfect Sample Separation Information with an Application on Cartel Stability." *Econometrica* 52:2 (1984), 391–419.

Lusardi, Annamaria. "Permanent Income, Consumption, and Precautionary Saving: An Empirical Investigation." Ph.D. dissertation, Princeton University, 1992.

———. "Permanent Income, Current Income, and Consumption: Evidence from Two Panel Data Sets." *Journal of Business and Economic Statistics* 14 (1996), 81–90.

Maddala, George S. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press, 1986.

Mankiw, Gregory N. "Hall's Consumption Hypothesis and Durable Goods." *Journal of Monetary Economics* 10 (1982), 417–25.

Nelson, Julie A. "On Testing for Full Insurance Using Consumer Expenditure Survey Data." *Journal of Political Economy* 102 (1994), 384–94.

Runkle, David. "Liquidity Constraints and the Permanent Income Hypothesis: Evidence from Panel Data." *Journal of Monetary Economics* 27 (1991), 73–98.

Shea, John. "Myopia, Liquidity Constraints, and Aggregate Consumption: A Simple Test." *Journal of Money, Credit, and Banking* 27 (August 1995), 798–805. (a)

———. "Union Contracts and the Life Cycle-Permanent Income Hypothesis." *American Economic Review* 85 (1995), 186–200. (b)

Tversky, Amos, and Daniel Kahneman. "Loss Aversion in Riskless Choice: A Reference-Dependent Model." *Quarterly Journal of Economics* 106:4 (1991), 1039–61.

Zeldes, Stephen P. "Consumption and Liquidity Constraints: An Empirical Investigation." *Journal of Political Economy* 97 (1989), 305–46.