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**EXCESS SENSITIVITY AND
ASYMMETRIES IN CONSUMPTION:
AN EMPIRICAL INVESTIGATION**

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Excess Sensitivity and Asymmetries in Consumption: An Empirical Investigation*

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Abstract / Résumé

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 on the two states and are less susceptible to sample misclassification. We are also able to use exclusion restrictions on the Euler equations for the constrained and the unconstrained individuals to discriminate between excess sensitivity due to liquidity constraints, from that due to myopic behaviour and a certain type of time non-separable preferences. 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 evidence that the unconstrained consumers also exhibit behaviour that is consistent with the theoretical predictions. Further analysis suggests that such behaviour could be explained by time non-separable preferences.

La plupart des études empiriques sur les contraintes de liquidité déterminent si un consommateur est contraint en fonction d'un indicateur unique comme le ratio des actifs sur le revenu. Dans la présente analyse, nous modélisons la probabilité qu'un consommateur subisse des contraintes de liquidité comme une fonction de plusieurs facteurs économiques et sociaux. Cette fonction de probabilité est estimée simultanément avec le degré de sensibilité excessive de la consommation au revenu dans un cadre de régressions à changement de régime. Les régressions à changement de régime appliquent des poids optimaux aux densités des équations d'Euler dans les deux états et sont moins susceptibles d'erreurs de classification entre les deux échantillons. Nous sommes également en mesure d'utiliser des restrictions d'exclusion dans les équations d'Euler pour les ménages contraints et non contraints afin d'établir si la sensibilité excessive provient de contraintes de liquidité ou d'un comportement myope ou encore d'un certain type de préférences non séparables dans le temps. Nos résultats, fondés sur les données de l'enquête américaine CEX, confirment que les consommateurs subissant des contraintes de liquidité réagissent excessivement à des variables dans leur ensemble d'information. Toutefois, on constate également que les consommateurs non contraints affichent aussi un comportement qui ne correspond pas aux attentes théoriques. Une analyse plus fine suggère qu'un tel comportement pourrait s'expliquer par des préférences non séparables dans le temps.

Keywords: Consumption, Liquidity Constraints, Switching Regressions, Asymmetries.

Mots clés : Consommation, Contraintes de liquidité, Régressions à changement de régime, asymétries.

JEL Classification: D12, C23

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1. Introduction

The prediction of the rational expectations life cycle-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 prevalent 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, Altonji and Siow (1987) and Runkle (1991) among others, find no evidence of excess sensitivity measured in terms of anticipated changes in income.

In the work cited above, the criteria used to determine who is a constrained consumer is often based on an *a priori* chosen cut off point on either the wealth or the asset to income ratio. See, for example, Zeldes (1989). Even when the cut off point is chosen endogenously as in Eberly (1994), the criteria still rely on just one economic variable as the indicator of whether or not a consumer was denied credit. Although the wealth and asset to income ratios are natural classifiers, they cover only a narrow scope of factors affecting households' 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 a consumer is constrained and one when he 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 on preferences. Numerous authors have attempted to relax these assumptions. These include allowing for precautionary saving motive as in Dynan (1993) and Kuehlwein (1991), non-separability between consumption

and leisure as in Attanasio (1994) and Attanasio and Browning (1992), 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. Interpretation of the evidence is especially difficult because most (if not all) of the studies have been set up to test the martingale hypothesis against a specific alternative. It is therefore difficult to determine whether budget constraint considerations, non-standard 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 behaviour between the liquidity constrained, the so-called rule-of-thumb consumers, and consumers with a certain type of time non-separable preference. For some of these consumers, excess sensitivity should be observed only when 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 identify 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. Data on food and a measure of strictly non-durable consumption constructed from the Consumer Expenditure Survey (CEX) are analyzed. The rest of the paper is structured as follows. Section 2 provides a survey of the issues involved and presents the switching regression model used to estimate Euler equations in the two states. A description of the data and results from the switching regressions are presented in Section 3. Additional tests for specific preferences are presented in Section 4. Section 5 concludes.

2. 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 the consumer's information set. This insight of Hall (1978) is often expressed in terms of the following Euler equation for household i between period t and $t + 1$:

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

where Δ is the first difference operator taken with respect to time, lower case letters denote variables in their natural logarithms, Q_{it+1} is a vector of taste shifters such as age and change in family size, and e_{it+1} is an expectational error that should be orthogonal to variables already known to consumers in period t under the null hypothesis of REPIH.

Equation (1) is what we refer to as the basic REPIH and there are several important assumptions underlying it. First, it is based on a 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 non-separable utility functions such as habit persistence, catching up with the Joneses, disappointment and loss aversion, preferences which have been used with some success in explaining the equity premium puzzle in the finance literature.¹ Second, even under the assumption of CRRA preferences, (1) is only a linear approximation to the exact Euler equation.² Estimations of (1) implicitly assume 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. Labour supply variables are therefore 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 households, 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, perfect capital markets is assumed 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 Euler equation for a forward looking consumer facing liquidity constraints. The Euler equation is a period to period arbitrage condition and therefore does not take into account the effects of future constraints on behaviour in periods when the constraint does not bind. Nevertheless, the Euler equation is still a useful analytical framework because it reveals testable predictions about economic behaviour. Specifically, the Euler equation for a consumer facing liquidity constraints can be written as:

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

¹See, for example, Abel (1990) for the former two specifications, Epstein and Zin (1991) for the third.

²This can be shown by a second order Taylor series expansion on the marginal utility of consumption.

³Consumers 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.

where π_{it} is associated with the shadow cost of liquidity constraint, or the Lagrange multiplier, and is positive if liquidity constraints bind and zero otherwise. Since π_{it} is non-zero only when a consumer is liquidity constrained, there is an obvious asymmetry in behaviour in the two states of the world, namely, that consumption is expected to grow faster when a consumer is constrained compared to when he is not.⁴

To analyze the empirical effects of liquidity constraints on consumption behaviour, we have to be precise about who is a constrained consumer and who is not. Unfortunately, direct information on who is liquidity constrained is rarely available. The exception is the Survey of Consumer Finances (SCF) collected by the Federal Reserve which asks households whether they have been denied credit or have received less credit than requested.⁵ One problem with using the SCF responses is that the survey is not taken every year and does not contain information on consumption. Imputation biases could arise when the credit information is matched with consumption data from other sources. For example, use of 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 non-recession years. A second problem with the survey responses 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, one would ideally 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.⁶

To determine who is a constrained consumer, most studies have used an observed variable as an indicator of the constrained status. For example, Zeldes (1989) defines liquidity constraints in terms of a lower bound on the level of assets. He then splits the sample according to whether the liquid asset or 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

⁴See Zeldes (1989) and Chapter 5 of Deaton (1992) for analyses of consumption behaviour under liquidity constraints.

⁵Treating those with affirmative responses to both questions would classify 15 per cent of the sample as constrained, which is on the low end compared to estimates from other sources.

⁶See Jappelli, Pischke and Souleles (1994) for an analysis which uses the SCF responses with data from the PSID to examine the implications of liquidity constraints.

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 cut off 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. More generally, relying on just one variable to determine whether a consumer is liquidity constrained is rather restrictive. The fraction of liquidity constrained consumers should depend on characteristics of consumers and of 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 socio-economic 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 in identifying the unconstrained consumers, they cannot adequately identify the constrained consumers. The wealth to income criteria is not without problems either, as Jappelli also finds that 8.3 percent of borrowers who are denied loans have high wealth to income ratio.

The existing evidence seems to suggest that tests for excess sensitivity are sensitive to the sample separation criteria. Indeed, Zeldes finds no evidence for excess sensitivity among the unconstrained if he splits the sample by the ratio of nonhousing wealth to income, but finds lagged income to be significant in the Euler equation for both the constrained and unconstrained households if the sample is split according to the ratio of total wealth to income.

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 in the estimation. 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.

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.

2.1 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 *unconstrained* by the following logit function:

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

where P_{it} is the econometrician's best estimate of the probability that a consumer is unconstrained, and W_{it} is a vector of social and economic variables thought to affect the ability to borrow.

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 creditor on the loan applicant. This information is available to the econometrician who estimates, for each consumer, the probability of being unconstrained by maximizing the likelihood function for consumer i in period $t + 1$:

$$f(\Delta c_{it+1}) = P_{it}f(\epsilon_{it+1}, \phi_1) + (1 - P_{it})f(\epsilon_{it+1}, \phi_2) \quad (4)$$

where ϕ_1 and ϕ_2 are parameters in the Euler equation for the unconstrained and the constrained, and $f(\epsilon_{it+1}, \phi_1)$ and $f(\epsilon_{it+1}, \phi_2)$ are the associated normal densities for changes in consumption in the two states. These are:

$$\begin{aligned} \Delta c_{it+1} &= \alpha_u + \beta Q_{it+1} + \delta_u z_{it} + \omega_u \epsilon_{it+1}^u \\ \Delta c_{it+1} &= \alpha_c + \beta Q_{it+1} + \delta_c z_{it} + \omega_c \epsilon_{it+1}^c \end{aligned} \quad (5)$$

where the subscripts c and u identify the constrained and the unconstrained respectively, and z_{it} is a parameterization of the shadow cost of liquidity constraints. 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 non-common explanatory variable to identify the two regimes. Otherwise, one can simply relabel the equations in (5) without changing the value of the likelihood function. We would not be able to tell which state P_{it} is associated to. One solution is to impose the restriction that $\delta_u = 0$. That is, the unconstrained consumers are assumed to obey REPIH. But as will be discussed later, this identification problem can also be resolved by use of extraneous information.

The idea of using switching regressions to split the sample is not new, and the econometrics of it can be found in Maddala (1986). 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” which replaces (3) by an indicator function $I_{it}^* = \theta W_{it} - u_{it}$, and sample classification in (5) is determined by whether $I_{it}^* > 0$. As shown in Maddala (1986) p. 284, the weights in the likelihood function are then cumulative normal densities associated with the parameters of both regimes.

The crucial distinction between our empirical model and an endogenous switching model is not so much that our probabilities are estimated from a logit instead of a probit equation, but rather that in an endogenous switching model, the error term u_{it} of the indicator equation can be non-zero and correlated with ϵ_{it+1}^c and ϵ_{it+1}^u of the Euler equations. The correlations are important in, for example, labour supply models in which a worker chooses whether or not to belong to a union and the hours of work simultaneously. We favour 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 an error 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, consumers 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.⁷ It is therefore less likely that the errors in the sample selection rule and those in the Euler equations will be correlated. Endogenous switching models have nevertheless been used by Hu and Schiantarelli (1994) and Jappelli et al. (1994), among others, to study the importance of liquidity constraints. We also estimated endogenous switching models as a check of robustness and found no significant difference in terms of tests for excess sensitivity and the predicted probabilities. As well, the correlations between the regression errors are not statistically significant. We therefore report results for the more parsimonious exogenous switching model only.

⁷See Lee (1978) and the references in Maddala (1986) therein.

3. The Data and Results

3.1 Data Issues

Most studies on liquidity constraints are based on food consumption reported in the PSID.⁸ However, food comprises just twenty percent of total consumption in the National Income and Product Accounts (NIPA). It is therefore useful to check for the robustness of the results against broader measures of consumption. Such data are available in the CEX. Non-durable consumption in the CEX defined as in NIPA represents approximately sixty percent of total consumption and will likely contain goods with durable and/or semi-durable content. Durable goods have different stochastic implications for the error term in the Euler equation as discussed in Mankiw (1982). To exclude durable goods from the data, we construct a measure of “strictly non-durable consumption”. It is defined as non-durable goods less apparel, expenditure on health services, and education expenses. It represents forty-seven percent of total quarterly expenditure, and is denoted SND in subsequent analysis. Readers are referred to Lusardi (1992, 1993) for details on construction of the data.

The CEX is a rotating panel; each household in the survey is being 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. The subsequent interviews use uniform questionnaires to collect expenditure data in each quarter. We use information reported in the fifth interview as the $t + 1^{th}$ observation, and information reported in the second interview as the t^{th} observation. Consumption and income growth are therefore computed as the difference between the fifth and the second interviews. After deleting ambiguous cases, we are left with a sample size of 9339 households.⁹

Some statistics of the sample are as follows. 85 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 household accounting for 24 percent of the sample. The average level of income in the sample is around 21,000 dollars. The distribution of financial assets is skewed, with a median of 1500 but a mean of over 9000 dollars. It is interesting

⁸See, for example, Hall and Mishkin (1982), Altonji and Siow (1987), Zeldes (1989), Runkle (1991), and Shea (1994-b).

⁹Self employed, and households whose head is in the farm, forestry, and fishing occupations are deleted from our sample since it is difficult to differentiate income from consumption for these occupational categories. Consumers with incomplete reports of income and/or consumption in the second and fifth interviews, those with invalid reports in checking and saving accounts or in total financial assets, outliers with consumption to income ratio in excess of 6, those with consumption growth greater than 2 percent in absolute value or income growth greater than 4 percent in absolute value, and those with financial assets greater than 250000 dollars are also excluded.

to note that eighteen percent of the sample do not hold financial assets; this statistic is roughly similar across age groups. If households choose to hold such low level of assets for reasons unrelated to liquidity constraints, then financial assets will not be a good proxy for the ability to borrow. In our sample, over sixty percent of the households have assets less than two months of income and would have been classified as being liquidity constrained according to the asset to income ratio criteria.

3.2 Results Based on Lagged Income

In this section, we follow Zeldes (1989) and parameterize the shadow cost of liquidity constraints by the level of income at time t . 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, $L = \sum_{i=1}^n \log f(\Delta c_{it+1})$, using the DFP routine in GQOPT.

In theory, there are many social and economic variables reported in the CEX which might contain information about the ability to borrow. The preferred logit equations are 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 socio-demographic factors are important in determining the ability of a consumer to borrow.

Estimates for the logit equations are given in the bottom panel of Table 1. *Ceteris paribus*, a higher level of income reduces the amount of required borrowing and therefore increases the probability of being unconstrained. However, the level of income has a non-linear effect on P_{it} and its interaction with other variables in the logit function is also significant. Home and car ownerships increase the probability of being unconstrained as they serve as tangible collateral. Among the social variables, there is statistically significant evidence that being non-white reduces P_{it} , and therefore increases the probability of being constrained. Being married has a higher probability of being unconstrained. 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. To allow the probability of being liquidity constrained to be influenced by business cycle effects, quarterly dummies are also entered to the logit equation. The 1981 recession is indeed found to increase the probability of being liquidity constrained.

Although we have specified the logit equations for FOOD and SND as functions of the same set of social and economic variables, Table 1 also reveals that many of the variables in the logit equation for FOOD could have been excluded. The bulk of the explanatory power in that logit equation comes from income. Studies which used income to classify the sample

have, incidentally, focused on food consumption, and it appears that little have been lost in using income as the sole classifier. Omitting the information on the social and other economic variables would have been more severe had the analyses focused on SND. For this measure of consumption, economic variables such as home and car ownerships are statistically significant in addition to income. Furthermore, the effect of income is statistically and numerically less important than in the logit equation for FOOD. This suggests that using income as the sole variable to classify the SND sample will be more susceptible to sample misclassification.

Histograms for the predicted probability of being unconstrained are presented in Figure 1 for FOOD and SND. There are several features to note. First, all consumers face a non-zero probability of being constrained since P_{it} is bounded away from one. Second, the FOOD data imply higher probabilities of being constrained than the SND data. While one-third of the sample in SND has values of P_{it} of 0.6 and lower, two-thirds of the sample in FOOD has $P_{it} \leq 0.6$, where we recall that P_{it} is the probability of being unconstrained. Third, the probabilities associated with SND are more spread out than FOOD. In light of these results, we caution against generalizing results from FOOD to broader measures of consumption and favour the use of more information to estimate the probability that a consumer is being liquidity constrained.

Results for testing excess sensitivity to the lagged level of income are given in the top panel of Table 1. We first estimate the model imposing the null hypothesis of REPIH on the Euler equation for the unconstrained. As discussed earlier, this is the formal condition necessary for the identification of P_{it} . However, δ_u is unconstrained in the results reported in Table 1.¹⁰ The reason for this is twofold. First, there is a sense in which identification can be achieved by using extraneous information rather than by exclusion restrictions. Since Jappelli (1990) identified the relationship between the ability to borrow and variables that are included in our regressions, we can use his results to pin down whether P_{it} is the probability of being constrained or unconstrained. For example, Jappelli finds that being young or single increases the probability of being liquidity constrained. If the coefficients on these variables in our logit equation are negative and significant, we can be reasonably sure that our logit function estimates the probability of being unconstrained rather than the probability of being constrained. Indeed, 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. Second, $\hat{\delta}_u$ is statistically and numerically equal to zero for both measures of consumption in the unrestricted regressions with little change to the parameters of the logit function.

¹⁰The results for δ_u constrained to zero are available on request.

The coefficient $\hat{\delta}_c$ 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 are negative. The evidence from the CEX and the PSID both suggests that some consumers in the sample are liquidity constrained.

3.2.1 Sensitivity of the Results to Sample Classification

Most studies in the literature has 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 cut off point is endogenously estimated to maximize the likelihood function,¹¹ each data point in the likelihood function is given a weight of either zero or one given the setup of her analysis.

Lee and Porter (1984) analyzed the problem of sample classification in switching regressions when there is imperfect information on which state an observation belongs. 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).

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 which 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 $P^* = 0.4$, 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 cut off point will classify the unconstrained as constrained and will underestimate the true extent of excess sensitivity to lagged income.

¹¹Note that her model is an exogenous switching model in the sense of Maddala (1986).

Table 2 reports results for SND for three methods of sample classification. The first uses the probabilities to weigh the likelihood function,¹² 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 is therefore suboptimal relative to the first method. The results nevertheless suggest that setting P^* at 0.6 provides the minimum sum of squared residuals of the two samples, while setting the threshold income at 16000 dollars implies 58 percent of the households are unconstrained. Both criteria suggest that two-thirds of sample is unconstrained, higher than implied by the cutoff probability of .4 used in Zeldes's analysis.¹³

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 to weigh each observation in the likelihood function. These results suggest that there are efficiency gains in using more information to predict the probabilities and classify the sample.

3.3 Results Based on Predicted Changes in Income

We have shown so far that consumption is excessively sensitive to lagged income. 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 (1993) and Attanasio and Browning (1992) using data from the CEX. We denote anticipated changes in income by $\Delta\hat{y}_{it+1}$. This variable is constructed by running the following auxiliary regression:

$$\Delta y_{it+1} = c_0 + c_1 age + c_2 occupation + c_3 education + c_4 \Delta FS + c_5 occupation \times age + c_6 education \times age + c_7 sex + c_8 race + c_9 married + \sum_{j=1}^{15} d_j DT_{ij} + res_{it} \quad (6)$$

where DT are time dummies to capture the effects of macro shocks. Individual specific characteristics are captured by age, years of education, change in family size, race, marital

¹²The 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.

¹³For the FOOD model, the threshold is $P^* = 0.465$, similar to Zeldes's result. It is more difficult to compare income threshold across studies as the samples cover different years.

status, occupation, and the interaction among these variables. All the variables in the prediction equation are known to consumers at time t . Equation (6) is estimated using PSID data and the estimated coefficients are applied to the right hand side variables taken from the CEX to give $\Delta\hat{y}_{it+1}$. The imputation is used as a caution against noise in the CEX income data.¹⁴

The Euler equations defined in (5) with $z_{it} = \Delta\hat{y}_{it+1}$ are estimated along with the logit equation by maximizing the likelihood function given by (4).¹⁵ The results for FOOD and SND are reported in Table 3. There are only insignificant differences in the estimates in the logit equation compared to the results in Table 1 with lagged income entering the Euler equations. The values for $\hat{\delta}_c$ are significant at a similar statistical level as those in Table 1, reinforcing the conclusion that liquidity constraints induce excess sensitivity to changes in consumption. However, Table 3 reveals some 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. Similar results obtain when we use income data from the CEX, which are more susceptible to noise. The results therefore suggest that consumers are excessively sensitive to predicted changes in income whether or not they face liquidity constraints. The following section further investigates the source of excess sensitivity to $\Delta\hat{y}_{it+1}$.

4. Identifying Liquidity Constraints from Preference Effects

We have shown that consumption exhibits excess sensitivity and have attributed liquidity constraints as the source. However, relaxing some assumptions on preferences have also been used to explain excess sensitivity. These models are to be distinguished from each other because as Attanasio (1994) emphasized, excess sensitivity is a result of choice in the former case but is forced upon by the economic environment in the latter case.

In practice, isolating excess sensitivity due to budget constraints and that due to preference effects is rather difficult. The only restriction on z_{it} from the point of view of testing for excess sensitivity is that it is in the information set at time t . The same z_{it} can therefore be consistent with various alternatives that are not necessarily independent of one another. In consequence many of the alternatives have observationally equivalent implications. The

¹⁴For an analysis of measurement errors in the CEX income data, see Lusardi (1993) and Nelson (1994).

¹⁵We use indirect least squares instead of the instrumental variables estimator because the properties of the latter is unclear in the context of switching regressions. As well, this allows us to assess the adequacy of the instruments. See Staiger and Stock (1994) and the references therein for a discussion of problems with using instruments that have low predictive power.

objective of this section is to discriminate some of these alternatives from the liquidity constraint explanation for excess sensitivity.

4.1 Identifying the Rule-of-Thumb Consumers

One explanation for the observed excess sensitivity to anticipated changes in income is that consumers are myopic. Myopic, or “rule-of-thumb” consumers, have a constant marginal propensity to consume out of current income and therefore do not smooth consumption as predicted by the REPIH. The question is, can we identify the liquidity constrained consumers from the myopic consumers. It turns out that we can, once we take into consideration the timing of excess sensitivity. A rule-of-thumb consumer will respond to changes in income regardless 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 could save and smooth consumption when income is expected to fall. Since consumers are prohibited from borrowing only when income is expected to increase, this is the only condition under which we should observe excess sensitivity if liquidity constraints were the genuine cause for rejections of the REPIH. This asymmetry between positive and negative income changes, first noticed by Altonji and Siow (1987), forms the basis of our next test.¹⁶

Identifying the liquidity constrained from the rule-of-thumb consumers is the subject of analysis in a recent paper by Shea (1994-a). Shea’s insight is precisely that since consumption should always track income for rule-of-thumb consumers, the relation between their changes in consumption and predicted changes in income should not depend on the sign of the expected income change. He tested these predictions by allowing the responses to positive and negative income changes to be different. Our work takes Shea’s analysis one step further by separating consumers into the constrained and the unconstrained.

Let $\Delta\hat{y}_{it+1}^-$ and $\Delta\hat{y}_{it+1}^+$ denote negative and positive expected income changes respectively. Consider the following switching regressions:

$$\begin{aligned}\Delta c_{it+1} &= \alpha_u + \beta_u Q_{it+1} + \delta_u^+ \Delta\hat{y}_{it+1}^+ + \delta_u^- \Delta\hat{y}_{it+1}^- + \epsilon_{it+1}^u, \\ \Delta c_{it+1} &= \alpha_c + \beta_c Q_{it+1} + \delta_c^+ \Delta\hat{y}_{it+1}^+ + \delta_c^- \Delta\hat{y}_{it+1}^- + \epsilon_{it+1}^c,\end{aligned}\tag{7}$$

The above discussion suggests that $\hat{\delta}_c^+$ should be significant if a consumer 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.

¹⁶There is another reason why the behavior of a constrained consumer might have null or a small response to a negative income change. Suppose he is consuming close to a subsistence level but anticipates income to fall. Since the level of consumption is bounded from below by zero, the consumption response to this expected negative income change must also be of limited magnitude.

4.2 Identifying Asymmetric Preferences

Preferences that are not intertemporally separable can also give rise to behaviour that appears excessively sensitive to anticipated changes in income. If there is inertia in preferences such as due to habit formation, consumers will adjust their behaviour only slowly. Lags of marginal utility of consumption will enter the Euler equation. To the extent that lagged consumption growth is likely to be correlated with anticipated changes in income, the z_{it} appropriate for time non-separable preferences will likely be correlated with those appropriate under the liquidity constraint and the rule-of-thumb alternative.

It is, in general, difficult to test for non-separable preferences as non-separabilities can exist in many dimensions. We can, however, test for a specific type of time non-separable preference, namely, preferences that allow asymmetric responses to positive and negative predicted income changes. Loss and disappointment aversion are behaviour that can result from such preferences. Preferences that exhibit disappointment aversion have been axiomatized by Gul (1991) and used to explain the so-called Allais paradox. People with such preferences weight outcomes that are above and below the certainty equivalent differently. Loss aversion is a related concept whereby consumers treat gains and losses differently. It was proposed by Tversky and Kahneman (1991) and extended by Bowman, Minehart and Rabin (1993) into a savings model.

Forward looking consumers are supposed to make behavioural changes in response to new information about future events. Suppose a consumer is not liquidity constrained but has asymmetric preference for desirable and undesirable events, and he anticipates a negative income change in $t + 1$. Because of such an asymmetric preference, he will not make a downward revision in c_t in anticipation of the negative shock. The household is willing to take a gamble that the negative shock will not be realized. However, in period $t + 1$ when the negative shock arrives, he has no choice but to adjust c_{t+1} downwards. A small reduction in c_t and a large negative change in c_{t+1} therefore translates into a large negative Δc_{it+1} for a given $\Delta \hat{y}_{it+1}^-$. However, when this consumer anticipates a positive income change, he will revise c_t upwards when the news arrive as any expected utility maximizer would. This implies that Δc_{it+1} will be small in response to a $\Delta \hat{y}_{it+1}^+$. For this reason, excess sensitivity should be larger with $\Delta \hat{y}_{it+1}^-$ than $\Delta \hat{y}_{it+1}^+$ for such a consumer. On the other hand, liquidity constrained consumers would respond to $\Delta \hat{y}_{it+1}^+$ only. These effects can be tested from the coefficients in (7).

4.3 Results

All the hypotheses that we have considered above can be nested in equation (7), which treats positive and negative expected changes in income as different variables. If the REPIH holds, all the $\hat{\delta}$ coefficients should be statistically insignificant. Myopic behaviour implies that $\hat{\delta}^+$ and $\hat{\delta}^-$ are both significant and of the same magnitude across states. A $\hat{\delta}^+$ that is significant among the constrained only would be evidence in favour of liquidity constraints. A significant $\hat{\delta}^-$, on the other hand, can be seen as evidence in favour of asymmetric preferences.

The estimation results are presented in Table 4. The unconstrained estimates provide a useful reference and are given in the first column. The coefficients $\hat{\delta}_u^+$ and $\hat{\delta}_c^-$ are statistically insignificant, suggesting no loss in imposing them to be zero for testing the hypothesis of interest.

The estimates in the second column are based on regressions with δ_c^- constrained to zero. This presupposes that the liquidity constrained consumers are excessively sensitive to positive but not to negative changes in income. This constraint is valid given that $\hat{\delta}_c^-$ is insignificant in the unconstrained regression, but imposing it gives more power to tests of the remaining coefficients in the model. The estimates reject the null hypothesis of insensitivity to anticipated changes in income among the unconstrained. The rejections, for both FOOD and SND, can be traced to excess sensitivity to negative income changes. However, the results are also inconsistent with the rule-of-thumb alternative since $\hat{\delta}_u^+$ 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 preference among the constrained. Rather, the evidence is consistent with liquidity constraints being the sole source of excess sensitivity for consumers in that group.

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. Zeldes (1989) also finds excess sensitivity among the unconstrained, and his results could also have been due to asymmetric preferences of the type considered here. Using different data and methodology, Shea (1994a,b) also finds consumption to be more sensitive to predictable income *declines* than to predictable income increases. Our results provide further evidence for this asym-

metry, but we do not attribute asymmetric preferences as the sole explanation for excess sensitivity of consumption. Liquidity constraints continue to play a role that cannot be overlooked.

5. 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 also determine the likelihood that a consumer will be denied credit. We also find the logit equations which 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 non-durables. 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 non-separable preferences, but finds no role for rule-of-thumb behaviour as an explanation for rejections of the REPIH.

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Table 1: LAGGED INCOME $\Delta c_{it+1} = \alpha_u + \beta_1 AGE + \beta_2 DIFSIZE + \delta_u \ln(y_{it}) + \gamma TIME + \omega_u \epsilon_{it+1}$ $\Delta c_{it+1} = \alpha_c + \beta_1 AGE + \beta_2 DIFSIZE + \delta_c \ln(y_{it}) + \gamma TIME + \omega_c \epsilon_{it+1}$				
	SND		FOOD	
	Switching Regression	Whole Sample	Switching Regression	Whole Sample
α_u	-0.0093 (-0.12)	0.0969 (1.79)	0.0494 (0.49)	0.0985 (1.41)
ω_u	0.2674 (34.60)	0.3790 (267.28)	0.2817 (28.28)	0.4876 (430.41)
α_c	0.3305 (3.12)	-	0.1938 (1.76)	-
ω_c	0.5306 (36.37)	-	0.6444 (50.90)	-
δ_u	0.0072 (1.02)	-0.0049 (-0.97)	-0.0053 (-0.54)	-0.0117 (-1.92)
δ_c	-0.0310 (-2.83)	-	-0.0254 (-2.26)	-
β_1	-9.81D-04 (-4.72)	-9.87D-04 (-1.86)	-2.06D-04 (-0.76)	-2.28D-04 (-0.59)
β_2	0.0724 (10.30)	0.0747 (7.41)	0.0771 (8.92)	0.0807 (5.55)
Variables Identifying Liquidity Constrained Consumers				
Const.	-0.3034 (-0.88)		-0.8625 (-2.48)	
Income	0.3820 (2.29)		0.5078 (3.03)	
Income ²	-0.0232 (-1.73)		-0.0304 (-2.14)	
Asset/Income	-0.1981 (-2.72)		0.0483 (0.68)	
Interest/Income	-1.0149 (-1.24)		0.7066 (1.00)	
Age	0.0102 (1.97)		0.0054 (1.01)	
Age x Income	-0.0034 (-1.33)		-0.0045 (-1.79)	
Married	0.5541 (4.40)		0.6222 (4.92)	
Mortgage	0.3475 (2.75)		0.0790 (0.65)	
Nocar	-0.4737 (-2.95)		-0.1777 (-1.04)	
Non-White	-0.4354 (-2.65)		-0.6533 (-3.35)	
More than 2 earners	-0.4258 (-2.37)		-0.6024 (-3.44)	
Recession Dummy 81:3	-0.5194 (-2.08)		-0.4087 (-1.54)	
Recession Dummy 81:2	-0.2277 (-0.97)		-0.1372 (-0.61)	
Likelihood Value	4632.44	4330.96	2341.70	1948.19

Table 2: Estimates for Various Methods of Sample Classification
SND with Lagged Income

	Weigthing by Probabilities	Optimal Splitting Based on Probabilities (P'=0.603)	Optimal Splitting Based on Income (I'=\$16,000)
α_u	0.0105 (0.12)	0.0726 (0.93)	0.0682 (0.57)
α_c	0.2852 (2.80)	0.2123 (2.22)	0.1979 (2.04)
β_{1u}	-1.1734D-03 (-3.06)	-0.8720D-03 (-2.83)	-0.9902D-03 (-2.78)
β_{1c}	-5.6192D-04 (-1.00)	-0.0010 (-2.65)	-0.9230D-03 (-2.80)
β_{2u}	0.0577 (4.73)	0.0560 (6.96)	0.0684 (8.02)
β_{2c}	0.1011 (5.35)	0.1152 (8.41)	0.0872 (7.22)
δ_u	0.0061 (0.78)	-0.0034 (-0.48)	-0.0026 (-0.23)
δ_c	-0.0285 (-2.93)	-0.0170 (-1.83)	-0.0163 (-1.63)
		6189 unconstrained 3150 constrained	5345 unconstrained 3994 constrained

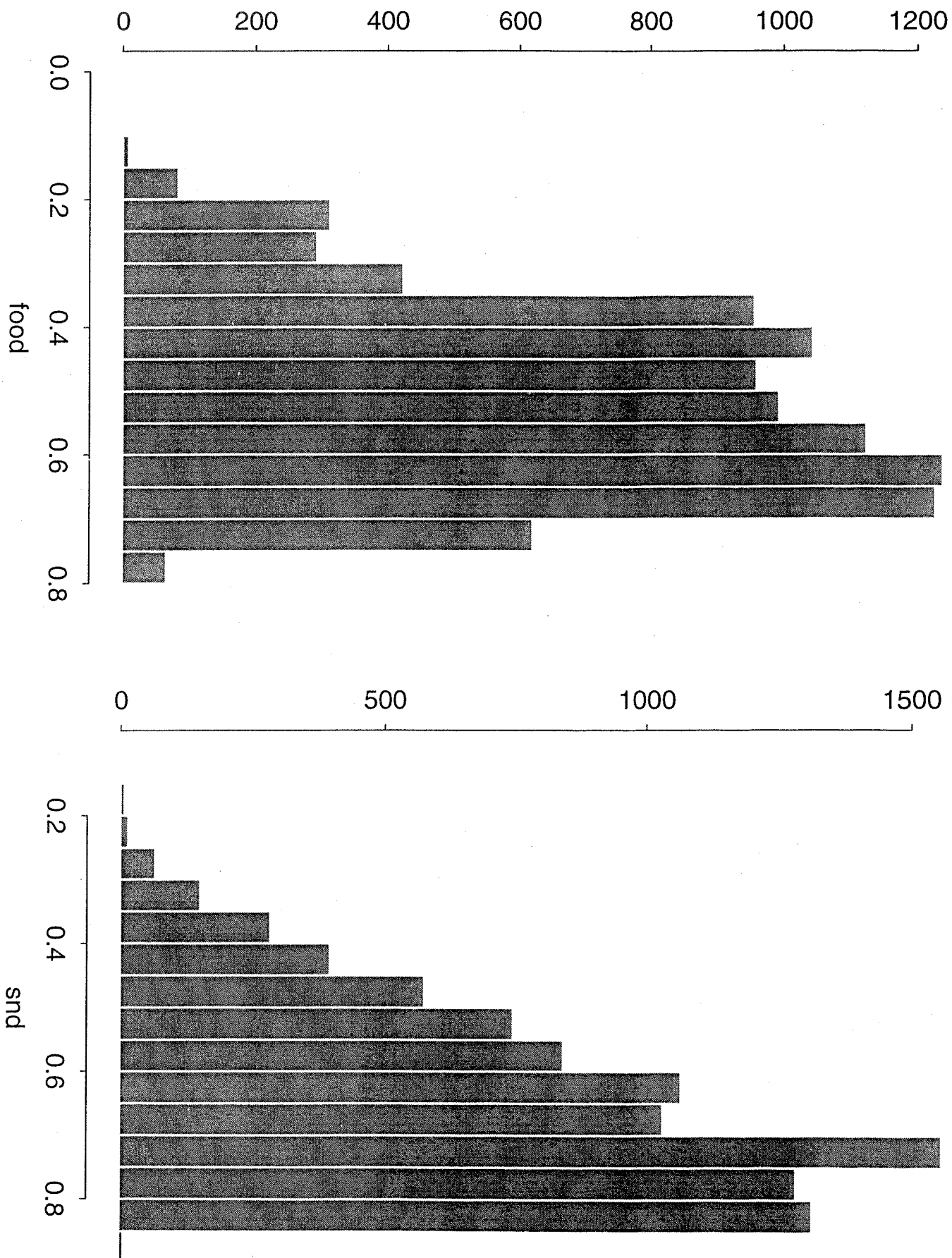
Table 3: PREDICTED INCOME CHANGES
 $\Delta c_{it+1} = \alpha_u + \beta_1 \text{AGE} + \beta_2 \text{DIFSIZE} + \delta_u \Delta \hat{y}_{it} + \gamma \text{TIME} + \omega_u \epsilon_{it+1}$
 $\Delta c_{it+1} = \alpha_c + \beta_1 \text{AGE} + \beta_2 \text{DIFSIZE} + \delta_c \Delta \hat{y}_{it} + \gamma \text{TIME} + \omega_c \epsilon_{it+1}$

	SND		FOOD	
	Switching Regression	Whole Sample	Switching Regression	Whole Sample
α_u	0.0618 (3.23)	0.0432 (0.93)	-0.0084 (-0.36)	-0.0197 (-0.74)
ω_u	0.2663 (31.44)	0.3805 (305.71)	0.2821 (28.99)	0.4922 (137.56)
α_c	0.0334 (1.50)	-	-0.0529 (-2.12)	-
ω_c	0.5284 (36.40)	-	0.6449 (50.10)	-
δ_u	0.2837 (1.92)	0.4300 (2.65)	0.3531 (1.92)	0.4815 (2.67)
δ_c	0.5616 (2.71)	-	0.4938 (2.52)	-
β_1	-6.13D-04 (-2.52)	-4.52D-04 (-0.44)	3.26D-04 (1.13)	3.88D-04 (1.14)
β_2	0.0429 (3.46)	0.0417 (2.44)	0.0455 (3.00)	0.0443 (2.63)
Variables Identifying Liquidity Constrained Consumers				
Const.	-0.3635 (-1.06)		-0.8675 (-2.49)	
Income	0.3943 (2.40)		0.5143 (3.14)	
Income ²	-0.0253 (-1.72)		-0.0306 (-2.16)	
Asset/Income	-0.2003 (-2.80)		0.0488 (0.71)	
Interest/Income	-0.9495 (-1.14)		0.7350 (1.01)	
Age	0.0104 (2.06)		0.0056 (1.06)	
Age x Income	-0.0034 (-1.33)		-0.0046 (-1.87)	
Married	0.5642 (4.48)		0.6227 (5.13)	
Mortgage	0.3454 (2.70)		0.0769 (0.67)	
Nocar	-0.4614 (-2.89)		-0.1732 (-1.01)	
Non-White	-0.4386 (-2.67)		-0.6420 (-3.77)	
More than 2 earners	-0.4010 (-2.21)		-0.6037 (-3.52)	
Recession Dummy 81:3	-0.5189 (-2.06)		-0.4082 (-1.62)	
Recession Dummy 81:2	-0.2257 (-0.96)		-0.1358 (-0.64)	
Likelihood Value	4633.65	4335.36	2341.82	1950.70

Table 4: Excess Sensitivity to Predicted Income Changes

	Unconstrained Estimates		Myopia		Asymmetric Preferences	
	SND	FOOD	SND	FOOD	SND	FOOD
δ_u^-	0.894 (3.63)	0.990 (2.92)	0.908 (3.80)	1.042 (3.31)	0.898 (3.65)	0.997 (2.71)
δ_u^+	-0.039 (-0.22)	0.083 (0.35)	-0.066 (-0.40)	-0.003 (-0.01)	—	—
δ_c^-	0.155 (0.46)	0.340 (1.00)	—	—	0.184 (0.59)	0.281 (0.90)
δ_c^+	0.922 (3.15)	0.618 (2.15)	0.941 (3.24)	0.642 (2.14)	0.912 (3.10)	0.630 (2.24)
L	4638.71	2344.13	4638.62	2343.72	4638.69	2344.06

Figure 1 : Histograms of the Probability of Being Unconstrained



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