The precaution of the rich and poor

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First draft: August 2012
This draft: September 2012

Abstract

Do households use savings to buffer against income fluctuations? Despite its common use to understand household savings decisions, the evidence for the buffer-stock model is surprisingly weak and inconsistent. This paper develops new testable implications based on a property of the model that the assets that households target for precautionary reasons should encapsulate all preferences and risks and the target should scale one for one with permanent income. I test these implications using the Survey of Consumer Finances in the United States. Those with incomes over \$60,000 fit the model predictions very well, but below \$60,000 households become increasingly precautionary. Income uncertainty is unrelated to the level of precaution. Moreover, households hold substantially weaker precautionary tendencies than standard models with yearly income shocks predict. Instead I propose and estimate a model of monthly disposable income shocks and a minimum subsistence level that can accommodate these findings.

JEL classification: E21, D91
Keywords: Buffer-stock model; Precaution; Household finance

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1 Introduction

How much do households use savings to help buffer against unexpected events? Allowing some form of short-term precautionary savings behavior has become nearly ubiquitous in recent models which incorporate household savings behavior. Precautionary behavior, whether directly from preferences or caused by liquidity constraints, is crucial to understanding the welfare effects of unemployment insurance programs or regulating consumer credit and in explanations of such diverse phenomena as why consumption tracks income over the life-cycle (Attanasio et al., 1999; Gourinchas and Parker, 2002), the varying behavior of German households following reunification (Fuchs-Schündeln, 2008), the uses of micro-credit in Thailand (Kaboski and Townsend, 2011), or the effects of banks in India (Fulford, 2011a), and in generating inequality in models with aggregate capital (Aiyagari, 1994; Krusell and Smith, 1998). The buffer-stock model of savings (Carroll, 1997; Deaton, 1991) makes all savings precautionary and so offers the clearest expression of the precautionary motive. Despite its importance, the evidence for the buffer-stock model and for the amount of precautionary savings is surprisingly sparse and often contradictory.

One approach has been to use a prediction of the model that households with a precautionary motive should save more if they face higher income risks (Huggett, 2004). Estimates of the amount of wealth held for precautionary purposes using this approach vary substantially from small (Guiso, Jappelli, and Terlizzese, 1992; Lusardi, 1998), to as much as 50% of wealth (Carroll and Samwick, 1997, 1998; Kazarosian, 1997). Hurst et al. (2010) point out that including the wealth of business owners who face higher risk has tended to overstate the amount of wealth kept for precautionary purposes. Moreover, the difficulty of finding exogenous changes in income risk, coupled with varying definitions of wealth and population leave the amount of precautionary wealth still uncertain.[1]

Jappelli, Padula, and Pistaferri (2008) suggest a more direct test of the buffer-stock model. Buffer-stock models, including the one used in this paper, predict that households that are below

[1]A different approach popular early was to rely on estimates of the Euler equation as in Dynan (1993). These approaches relied on Taylor expansions and tended to miss higher order terms (Ludvigson and Paxson, 2001) and so were incapable of capturing the correct values even from data created from the theory (Carroll, 2001).

their target buffer should save, while those who have recently had a series of good shocks and are above their target should consumer more (Carroll, 1997). Using the Italian Survey of Income and Wealth and a question which asks how much people want to save for emergencies, they find that the strength of this tendency is much too low for standard model assumptions about buffer-stock behavior. It seems that despite its widespread use, the buffer-stock model has a problem matching household level data.

This paper provides direct support for the buffer-stock model, but suggests that there are substantial problems with standard modeling assumptions of precautionary behavior. First, I develop an implication of the basic buffer-stock model which can be tested in the cross-section. Within the model there is a direct connection between income and how much households want in precautionary wealth. A household with twice as much expected income, but with the same preferences and facing the same relative risks, will target having twice as much wealth for precautionary reasons. I use this insight to develop a test for the buffer-stock model which distinguishes between income and differences in preferences or risks, and so provides an integrated way for considering how heterogeneity in preferences and risks affects precaution.

Using the Survey of Consumer Finances in the United States, I show that employed households with earning above $60,000 a year fit the model very well. A 1% increase in "normal" income brings a 1% increase in the amount a household wants "to have in savings for emergencies and other unexpected things that may come up" (Kennickell, 2009) a question which Kennickell and Lusardi (2004) and Jappelli, Padula, and Pistaferri (2008) suggest is the target precautionary wealth. Moreover, these high-income households achieve their goal and match a second prediction of the model: that liquid wealth and the target precautionary funds should also increase one for one. One might reasonably worry that the answers to such a question are pure fantasy. That it scales with income exactly as the model predicts and with the revealed preference of actual assets suggests that the question is capturing actual preferences. High-income U.S. households—the rich—fit the predictions of the buffer-stock model remarkably well.

That the rich are fairly homogeneous implies that models which assume the same preference in order to understand aggregate phenomena like capital accumulation are probably not badly distorted. Since the wealthy drive savings decisions and they appear similar across a wide range of incomes, not much is lost by assuming that everyone has the same preferences and faces the same risks (perhaps allowing for some observable heterogeneity in education and age). The same cannot be said for understanding welfare, since the poor behave very differently.

Below approximately $60,000 as incomes decline households are increasingly precautionary. Poorer households want an increasingly large amount saved for precautionary reasons compared to their incomes. Although perceived income uncertainty and lack of health insurance increase as incomes decline, these factors do not explain the increase among the poor. Moreover, the traditional explanation for why the poor are poor—that they have a high psychological discount rate as in Krusell and Smith (1998) and so do not want to accumulate much—works in exactly the opposite direction. For preferences to explain the rise in precaution the discount rate must *rise* as incomes fall. Something else must be behind it.

The test of the buffer-stock model reveals two other puzzles. First, although the high-income match the predictions of the model, they are not very precautionary. The high-income employed households want only slightly over one month of income in precautionary wealth and other groups want only slightly more. That is three to nine times less than the predictions of models which assume that households want to smooth yearly income shocks with typical parameter assumptions. The data reject these versions of the model very strongly, and so reject the model assumptions about precaution that are widely used in the macroeconomics literature. Households simply do not want as much in precautionary savings as the typical model assumes they do.[2]

Second, the amount that households want in precautionary wealth is barely responsive to perceived or actual income uncertainty. Those households who answer that they do not usually know next year's income and so face a subjectively much higher income uncertainty want precautionary

[2] I compare the estimates from the data to the theoretical predictions using parameter estimates or assumptions from three high-quality papers that approximately span the literature: Gourinchas and Parker (2002), Carroll, Dynan, and Krane (2003), (Storesletten, Telmer, and Yaron, 2004). These papers each offer their own important insights into other facets of behavior, particularly the life-cycle, and I choose them because they make important contributions, but use parameters that have counter-factual predictions about the level of precaution.

wealth that is only 6% larger from the already tiny base. Those in occupations with higher transitory income risk as calculated by Carroll and Samwick (1997) want less precautionary wealth. Whatever U.S. households are worried about, it is not yearly income uncertainty.

To explain these three observations, I propose and estimate a model which incorporates buffer-stock behavior but allows the poor to face increasingly large risks. If there is a minimum subsistence level of consumption—the amount that must be spent on food and housing to get any utility—or costs such as traffic fines which do not change with income, then those with low-incomes should be increasingly precautionary. The reason is that these minimums loom ever larger as income declines. A minor fine is an annoyance for a high-income household, but may be a serious hardship for a household below the poverty line. Households that feel well insured (or simply do not care) about income shocks may still want to buffer against shocks to disposable income or marginal utility such as fines, repair costs, or minor health emergencies. Moreover, such costs are likely to become a smaller and smaller fraction of monthly income as income increases; I show, for example, that precaution rises as housing costs become a larger fraction of income. Estimating the subsistence consumption and disposable income shocks which explain the level of precaution for the rich and the increase in the poor suggests they need not be large.

This paper concludes that while high-income households do match key predictions of the buffer-stock model, the evidence that they save to smooth income shocks at yearly frequencies is weak and a different approach is necessary to understand the poor. It is thus entirely consistent with the rejection of such models by Jappelli, Padula, and Pistaferri (2008) and low estimates of precautionary wealth. Households do face risks: car repairs, funerals, fines, unexpected taxes (or refunds) that they maintain funds to pay for and so do buffer. Such precautionary wealth is a relatively unimportant factor in aggregate wealth accumulation. Yet that does not diminish its importance for welfare especially among the poor who are particularly vulnerable to shocks.

2 Empirical implications of the buffer-stock model

This section develops the standard intertemporal consumption problem with income fluctuations when markets are incomplete and shows how the assets that household want for precautionary purposes vary with income. The basic theory is well understood (Clarida, 1987; Deaton, 1991; Schechtman and Escudero, 1977), and there are a number of variations and extensions (Carroll, 2001; Rabault, 2002) to the model in different directions. The basic idea of the model is that faced with uninsurable income shocks, the consumer has to save in order to self-insure and so develops a buffer of wealth to protect against bad shocks. Since the consumer is impatient relative to the return on savings and lives forever and so has no life-cycle considerations, she does not want to save just for the income but is induced to save by the high marginal cost of not having savings when times are bad. Consumers hit with many bad shocks will draw down their savings, attempting to smooth marginal utility, while those hit with good shocks will tend to expand their savings. With enough wealth the consumer feels sufficiently protected that she no longer feels the need to accumulate more. Above that amount she consumes more, on average, than she earns, drawing wealth down to the desired buffer. Below that amount she will attempt to save more than she earns. This precautionary target for savings is the point to which a consumer would move if each period she always earned exactly her mean income but kept behaving as if her income was risky.

The precautionary target is a function of consumer preferences and the income process; it is the point where the desire to consume more just equals the fear of the future. I show that under the assumption that preferences are iso-elastic then a multiplicative change in the income process produces the same multiplicative change in the target fund. To understand the intuition, consider someone who earns an uncertain salary of \$10 dollars a month, and wants to maintain a target emergency fund of \$60. Suppose we change the denomination: he now earns 1000 pennies a month, but faces the same risks (in pennies now). Since his preferences are iso-elastic, this change of denomination does not matter—he cares about relative risks not absolute risks—and so his target emergency fund is 6000 pennies. This basic intuition then suggests a natural and testable implication of the model in the cross-section.

2.1 The buffer-stock model

The household maximizes an infinite horizon, intertemporally additive, expected utility maximization problem with exponential discounting. The infinite horizon simplifies the analysis by allowing this year's decision to be exactly like last year's, and so abstracts from any life-cycle concerns. The household maximizes (where I suppress the household subscript i):

$$\max_{\{C_t\}_{t=0}^{\infty}} E_0 \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right], \tag{1}$$

where C_t is consumption which in period t is limited by the available assets A_t, t-measurable income Y_t and the ability to borrow: $A_t + Y_t - C_t \geq B_t$, where B_t is the borrowing constraint at time t. Assets evolve according to:

$$A_{t+1} = R(A_t + Y_t - C_t), \tag{2}$$

which is driven by the stochastic income process Y_t. The income process has a random walk component and a transitory component $Y_t = P_t U_t$ where each U_t is independent and identically distributed and of mean one and $P_t = G P_{t-1} N_t$ where G is the constant growth rate, and N_t is independent and identically distributed. Borrowing scales with permanent income: $B_t = bP_t$. In keeping with standard practice, I refer to the random walk component of income P_t as permanent income.

A solution to the problem relative to permanent income exists under fairly general conditions. It is possible to rewrite the constraints in terms of available resources at time t or "cash-at-hand:" $W_t = A_t + Y_t + B_t$ (Aiyagari, 1994; Rabault, 2002), which makes the household decision explicitly in terms of the resources it can consume today. If preferences display constant relative risk aversion $u(c) = c^{1-\gamma}/(1-\gamma)$, then it is possible to express the household problem in terms of ratios $c_t = C_t/P_t$ and $w_t = W_t/P_t$. Then as long as the household is impatient enough relative to the return on savings and the risks, a consumption function in ratios to permanent income $c_t = c(w_t)$ exists and there is an ergodic distribution of w_t.[3]

How does the ratio of available resources to permanent income change over time? Figure 1 shows the consumption function and ergodic distribution of w_t (which is what mass of identical households would hold at any one time or the wealth of an individual household far into the future). Households with high wealth eventually spend down their extra wealth; households without many resources feel insufficiently insured and try to acquire additional wealth. The dividing line w^* is where resources are neither increasing or decreasing in expectation next period. Defining $R_{t+1} = R/(GN_{t+1})$, then w^* is the fixed point of:

$$w^* = E_t[R_{t+1}(w^* - c(w^*)) + U_{t+1} - (R_{t+1} - 1)b] \tag{3}$$

or rearranging it is point where the line $((\bar{R}-1)(w-b)+\bar{U})/\bar{R}$ crosses the consumption function where the bar denotes the mean which is independent of time. Above w^* the household will on average consume more than its income that period, and w_{t+1} will decline in expectation. Since the consumption function is concave (Carroll and Kimball, 1996) the mean cash-at-hand $\bar{w}$ is higher than w^*. Rich households spend down slower than poor households accumulate and so the average wealth is greater than the dividing line.

2.2 Testable implications

This section develops testable implications of the buffer-stock model. For a given household i the desired precautionary target cash-at-hand is $W^*_{it} = w^*_i P_{it}$, where w^*_i combines all of the risks and preferences of that household. Permanent income enters only multiplicatively—that is why w^*_i is a fixed point.

Cash-at-hand is a useful theoretical construct, but the amount carried forward period-to-period

[3] The conditions are necessary for the value function or Euler equation to be contraction mappings and to keep the w_t from growing without bound. One set of conditions in Deaton (1991) is that the household must be sufficiently impatient so that it does not want to accumulate indefinitely $\beta RE[GN_{t+1}^{-\gamma}] < 1$ and income must be bound away from zero. Carroll (2004) and Rabault (2002) examine other specifications.

$a_i = A_{it}/P_{it}$ captures something closer to savings as it is generally defined. It is the amount people leave in wealth after they have received their income and done their consumption. Then define $a_i^* = w_i^* - \bar{U} - b_i$ as the target precautionary assets: the amount which the household wants to keep above expected income and the ability to borrow. a_i^* is the assets to permanent income ratio at which the household will consume the same amount next period as this period if it receives the mean income.[4] Subtracting out the ability to borrow means that a_i^* is the net position. The theory suggests that with a large enough b it is perfectly reasonable to have a target emergency fund that is negative. The way to think about it is with a large enough credit line, it is not necessary to keep positive assets around, only some extra ability to borrow. How consumers think about borrowing as a precautionary asset, however, may depend on whether the ability to borrow is certain (Fulford, 2011b)

The target precautionary assets then allows a testable implication of buffer-stock model. Individual households need not have the same preferences, or face the same risks. Household heterogeneity can be expressed simply as $a_i^* = a^* e^{Z_i\zeta + \epsilon_i}$ where the Z_i are observable preference or risk shifters and the ϵ_i contains unobserved factors that affect preferences or risks. Then a test of the buffer-stock model is that in a regression of the form:

$$\ln A_{it}^* - \ln P_{it} = \ln a^* + Z_i\zeta + \delta \ln P_{it} + \epsilon_i \quad (4)$$

the coefficient δ must be zero. While permanent income can vary, the difference between the target precautionary assets and permanent income should be constant. That provides a natural test for the buffer stock model: how much people want to hold for precautionary reasons should increase one for one with the log of permanent income as long as the unobserved heterogeneity is distributed the same across income groups.

The target for precautionary assets is driven by the preferences, risks, and returns of the household. a^* summarizes all of these into a single number. Increases in the risks of transitory income

[4] Note that a^* is defined in relation to w^* not as a fixed point on its own. That is because the assets that hold w^* fixed are a function of today's shock U_t. Both state variables a_t and U_t are necessary to describe the household's decision.

shocks tend to increase a^*, and so increase the accumulated assets. While much work has focused on how income risk affects precautionary savings, changes in other parameters affect it as well. A higher psychological discount rate β makes people more patient and so increases a^*, while a larger coefficient of relative risk aversion γ increases the costs of bad states and so increases a^*.

Less obviously, a higher growth rate lowers the precautionary target. That implies that younger people who expect higher income growth will tend to have lower desired precautionary savings than older people who can expect lower growth in the future.[5]

Finally, the buffer-stock model implies a relationship between actual assets A_{it}, the precautionary target A_i^*, and permanent income P_{it}, although it is a more complicated one since it depends on past shocks, not just the current income. Households have individual shocks to income whose effects die out only slowly as they save more or consume more even if the shocks themselves are transitory. So two households i and j with identical preferences and risks and permanent income $P_{it} = P_{jt}$ will have identical targets w^*, but may have a very different ratio of cash-at-hand to permanent income w_{it} because the history of past shocks matters for current wealth. Assuming an ergodic distribution in ratios then $E[w_{it}] = E[w_{jt}] = \bar{w} = \theta w^*$ where there is no t subscript on $\bar{w}$ since the mean of the ergodic distribution over households is the same as the mean for a household over time. The expectation here is unconditional and based on the ergodic distribution. Since the consumption function is concave (Carroll and Kimball, 1996), θ is larger than one. θ thus summa-

[5]To see this result consider how growth rates affects the consumer's decision. Consumption is the (functional) solution to the Euler equation: $u'(c) = \max\{u'(w), E_t[\beta R(GN_{t+1})^{-\gamma}u'(c)]\}$. Consumption is a function of the available resources and growth $c(w, G)$. Note that the consumption in the next period depends on future growth, and so the entire growth path matters (if we instead put a t subscript on G_t but make its path known). If G is larger, then in expectation marginal utility next period is lower and so consumption this period needs to increase. Higher income growth makes the future relatively better, and so one should consume more now to smooth.

The precautionary target is the fixed point solution in equation 3. Then consider a change from lower growth to higher growth $G' > G$. For all w, $c(w, G') \geq c(w, G)$ and the relationship is strict if $c(w, G) < w$ so the consumer is not just consuming all available resources. A change in G also affects the fixed point w^*. Higher G lowers the effective interest rate because a given wealth to permanent income ratio today will be smaller tomorrow since permanent income has growth. Rearranging the fixed point problem and taking expectations so $\tilde{R} = E_t[R/N_{t+1}]$ and $\bar{U} = E_t[U_{t+1}]$ gives: $c(w^*, G_t) = (1 - G/\tilde{R})w^* + G/\tilde{R}\bar{U}$. While higher growth increases consumption, the right hands side both increases in intercept and decreases in slope of the line in figure 1, so it is not immediately clear whether w^* goes up or down. For any G, however, the right hand side equals one when $w^* = \bar{U}$. So for w higher than $\bar{U}$, the right hand side is lower if G is higher. For all w, $c(w) \leq w$, and if the solution to the fixed point is $c(w^*) = w^*$ then $w^* = \bar{U}$. Then the minimum possible fixed point is $\bar{U}$ which occurs when consumers are so impatient that they are not saving anything at all. When $w^* > \bar{U}$, an increase in G means that the right hand side falls and the left hand side rises, and so w^* must fall.

rizes the concavity of the consumption function along the ergodic distribution. The more concave the slower the rich consume away their wealth while the faster the poor save up.

Turning the relationship between assets and the precautionary target into an empirical specification requires additional assumptions. Define $\bar{W}_i(P) = \bar{w}_i P = E[W_{it}|P_{it} = P]$ as the expected cash-at-hand of a household with permanent income P. The i subscript allows households with different preferences to have different expected cash-at-hand amounts, but does not take into account the different histories of shocks that different households have. Then $\bar{W}_{it} = \bar{w}_i P_{it}$ and taking logs gives a series of interlocking relationships: $\ln \bar{W}_{it} = \ln \bar{w}_i + \ln P_{it} = \ln \theta + \ln w_i^* + \ln P_{it} = \ln \theta + \ln W_{it}^*$. The relationship of cash-at-hand with assets is $\bar{w}_i = \bar{a}_i + \bar{U} + b_i$ and $w_i^* = a_i^* + \bar{U} + b_i$. Any individual household will have assets distinct from the expected assets for its income depending on its history of shocks. Writing $A_{it} = \bar{A}_{it}\epsilon_{it}^A$ then separates the mean determined by P_{it} from the deviations. Rearranging these, replacing cash-at-hand with asset and parameterizing the preference and risk heterogeneity, then across different incomes the relationship between average wealth and the target precautionary fund should be a fixed constant:

$$\ln A_{it} - \ln A_{it}^* = \ln \theta + Z_i\zeta_1 + \delta_1 \ln P_{it} + \epsilon_{it} - \epsilon_{it}^A. \tag{5}$$

where δ_1 should be zero and the constant $\ln \theta$ should be greater than zero. The ability to borrow may be included directly in A_{it} depending on whether borrowing counts as an asset in the precautionary sense. The relationship between the assets and income should also be constant:

$$\ln A_{it} - \ln P_{it} = \ln \bar{a} + Z_{it}\zeta_2 + \delta_2 \ln P_{it} + \epsilon_{it} - \epsilon_{it}^A \tag{6}$$

with δ_2 should be zero. Both of these relationships put a far higher requirement on the data since they require not just that the distribution of unobserved shifters ϵ_{it} not depend on permanent income, but also that the distribution of deviations from expected precautionary assets e_{it}^A at each income level not depend on income.

3 Tests of the buffer-stock model

This section uses survey data to test the buffer-stock model predictions. Conditional on income and demographic covariates which might shift precaution, the rich fit the model very well while the poor become increasingly precautionary.

3.1 The data

The Survey of Consumer Finances is collected every three years by the Federal Reserve Board of Governors. See Federal Reserve Board of Governors (2007) for the data and the excellent survey documentation, and Bucks et al. (2009) for a description of the 2004 and 2007 rounds. The goal of the surveys is to get a complete view of the financial holdings of a representative sample of U.S. households. In 1995, 1998, 2001, 2004, 2007, and 2010 the surveys included a question asking: "About how much do you think you (and your family) need to have in savings for emergencies and other unexpected things that may come up?" Kennickell and Lusardi (2004) argue that this question can help understand the strength of the precautionary motive and examine how many different covariates affect it. Jappelli, Padula, and Pistaferri (2008) use a similar question from the Italian SHIW. Tables 1 and 2 provide some summary statistics from the survey over income quintiles for households with an employed head which make up the large majority of households and might reasonably be described by a model of additive income shocks.

The survey oversample the rich and so still has statistical power in a part of the distribution that is rare in the population. Each survey year contains about 4,000 households weighted to be nationally representative. Partly to obfuscate incomes to protect anonymity for high income earners, and partly to allow for incomplete surveys and answer ranges, the SCF is reported with multiple imputations for each household. All of the parametric results correctly account for the multiple imputations and for the survey weighting. The non-parametric results do not use weights and use only a single imputation which understates the standard errors, but still leaves unbiased results. See Rubin (1987) and Schafer (1997) for an explanation of multiple imputation, and Kennickell (1998) for an explanation of the multiple imputation procedure in the SCF.

The survey also asks households their income in the previous year and for their "normal" income if that is different from their actual income. Since households act on what they think is their normal income and leave out swings in income that they think are one off events, normal income represents the current expectations of the household. The household may be learning what its income process is and what growth will look like as in Guvenen (2007) and normal income is its best guess, given past realizations, of the persistent part of income. Normal income is equal to income for 72% of households.

Table 1 shows how normal income and income differ across income groups. The difference between log actual income from the previous year and log normal income gives the unexpected component of income (U_t in the model). For all income quintiles log unexpected income is negative suggesting that negative income surprises are more common. The difference is stable across quintiles: the poorest do not seem to systematically overstate their normal income any more than the rich do.

Poor households seem to face greater uncertainty in their income and they know it. The variance of log unexpected income is declining with income showing that richer households are less likely to be surprised. The survey asks whether the household usually knows its income for the next year. Only 45% of households in the lowest quintile usually know their incomes, while 86% in the richest quintile do. These difference are reflected in the variances of unexpected income. The variance of the unexpected portion of income is fairly stable across income groups both for those who know usually know their incomes and those who do not. The increase in variance with income comes primarily because the proportion of households who usually know their income is changing.

Lower income households are less well connected to the financial system. They are less likely to have a checking account, and only a third of the lowest quintile have a savings account or a credit card. They are also far more likely to be living hand-to-mouth. 53% of the lowest quintile report spending equal to income in the previous year compared to 26% of the highest quintile. That close correspondence between income and spending means they are also very concerned about the near future: more than 50% percent of the poorest households are most concerned with the spending and saving within the next year, compared to only 16% of households in the top quintile. Note that does not mean that the lowest quintile is more impatient but that deviations in marginal utility dominate over a much shorter planning horizon for the poor. Indeed the poor seem particularly averse to financial risks.

Table 2 shows how the precautionary target to income ratio varies across income groups. I focus on the log difference rather than the ratio since it is less susceptible to outliers. That is evident by comparing the implied months of income from the difference in logs ($12e^{\text{ln target}-\text{ln normal income}}$) with the mean of the monthly precautionary target to income ratio (12 target/normal income) and the median of the monthly target ratio. The median and the implied months from the mean of the log differences are close, the mean ratio can be very large, and is very susceptible to a few households.

One might worry that the precautionary target is pure fantasy. That is not the case: the mean target within each income group is eminently attainable and is actually very low. Financial advisors typically suggest keeping 6-12 months of income for emergency purposes but American households say they want much less than that. I discuss this discrepancy more in section 4, and how other covariates affect the level of precaution in the next section.

3.2 Semi-parametric tests of the buffer-stock model

The first step is to examine how the precautionary target varies with income using a semi-parametric approach that allows income to enter flexibly. The basic estimating equation is:

$$\ln A_{it}^{*} - \ln P_{it} = Z_i\zeta + f(\ln P_{it}) + \epsilon_i$$

using the same shifters Z_i shown in table 3. The shifters include self-reported income risk, whether a spouse is in the household and his or her employment status, the number of children, whether the family is covered by health insurance, year level effects, indicators for race, and a cubic function of age. The function f absorbs the constant, so its level is the excluded group: white, no high school degree, age 50. Since the semi-parametric approach does not easily admit multiple imputation or survey weights, I do not present the estimates of ζ separately but instead am concerned with the general shape of f. I estimate for the employed, retired, and self-employed separately as these groups face different risks (Hurst et al., 2010). Figure 2 shows the resulting function, and the kernel density from the survey. Each of the densities are scaled to be proportional to the relative size of each group in the population, but the densities themselves are the calculated from the unweighted survey to show where the non-parametric estimates are most meaningful.

For all groups high income earners are less precautionary than low income earners. The basic precautionary model says that conditional on risk and preferences being the same, the slope should be exactly zero. For only one group—those earning over approximately \$59,000 a year (10.99 in log units) does the model prediction hold well. The higher income employed appear approximately homogeneous after allowing for observable preference shifters which are shown in table 3, with the same preferences and facing the same risks as income increases from \$59,000 (10.99 log) to \$5.4 million (15.5 log). That is a remarkable range, and suggests that the precautionary model holds very well for this group.

Since the precautionary model describes how individuals respond to additive income risks, it is not a surprise that it does not well describe the retired and self-employed whose incomes come from investments and so face primarily rate of return risk. I therefore focus on the employed.

3.3 Parametric tests of the buffer-stock model

I test for the model prediction of zero slope from equation 4 formally in table 3 using a parametric approach to properly account for the multiple imputation and survey weights. The formal test is whether the coefficient on log normal income (δ) is zero. Column one shows the unconditional test, without any possible shifters in the target amount or allowing for different slopes at different income levels. The data clearly reject the joint hypothesis of the model and preference and risk homogeneity. There is a clear negative trend as higher income households want a lower fraction of income as emergency savings. The semi-parametric approach suggests, however, that things change dramatically around $59,000 (10.99 log). Allowing for a break at this value, but no other heterogeneity, the joint hypothesis is even more strongly rejected for the poor. For the high income earners the joint hypothesis is still rejected but the coefficient is much closer to zero (these results are not shown separately). The unconditional model predictions are clearly rejected, even allowing the poor to behave differently. Employed households in the U.S. either have heterogeneous preferences and risks correlated with income, do not follow the buffer-stock model, or both.

Allowing for observable heterogeneity, however, tells a very different story. Column 2 allows for some observable preference, risk, and demographic factors that could shift the target precautionary savings. Conditional on observables, the data does not reject a slope of zero for normal income. Employed individuals with incomes ranging between $59,000 and 5.4 million want to have the same fraction of their normal income in target precautionary savings. Moreover, the standard error is small and the point estimate is close to zero, so that it is not just noisy data which cannot reject the null hypothesis, but an extremely tight estimate of zero. The population whose savings decisions matter the most for aggregates fits a key prediction of the buffer-stock model after allowing for some heterogeneity.

The model is still rejected for households with low incomes. Even with observable shifters such as income uncertainty and health insurance these households want more precautionary savings as their incomes decline. I explore potential reasons for this rejection in section 6.

The zero coefficient on normal income for the rich does not depend on what income divides the rich from the poor. Figure 3 shows the coefficients for the rich and the poor for different income divides. Each regression is the same as in column 2 of table 3 and includes all of the covariates. The dashed lines show two standard error bands, and the average R^2 if the regression is run on each imputation separately.[6] The coefficient on log normal income for the rich is statistically indistinguishable for zero when the definition of rich varies from around $40,000 to above $90,000, and

[6] Multiple imputation does not have a standard goodness of fit measure since the errors from a regression on a single imputation are themselves functions of the imputations, and so the R^2 is itself a function of the imputations. Averaging it—just as the multiple imputation coefficients are averages of the coefficients in each imputation—then creates a summary of how well the regression is doing on all of the imputations, although the statistical properties of this statistic are not the same as a traditional R^2.

the coefficient estimate is generally very close to zero, especially between $50,000 and $65,000, the interval of the best fit. The coefficient declines as the dividing line includes more of those with lower incomes who want more precautionary funds, but is stable above approximately $50,000.

3.4 Testing the relationship between assets, income, and the precautionary target

The model also specifies the relationship between the precautionary target, wealth, and income. Equations 5 and 6 relate the actual assets for precautionary reasons at any given income wealth level to the precautionary target and the income level. These relationships are complicated by observing the actual assets—which are function of past shocks—not the expected assets. These relationships thus carry the additional assumption that deviations of assets from expected assets given permanent income, preferences, and risks do not differ systematically across the population.

Starting non-parametrically, figure 4 shows the results of locally weighted regressions which allow the income to enter equations 5 and 6 flexibly and do not include any other covariates. I examine four ways of measuring assets: Savings are funds reported in the savings and checking account. Liquid financial assets include all types of transaction accounts (savings, checking and money market). Since the ability to borrow is a key asset for consumption smoothing, I also include available credit from credit cards (the credit limit minus the credit card borrowing). Financial assets are liquid financial assets plus stocks, bonds, and liquid retirement accounts.

The top chart shows how the difference between the (log) assets and precautionary target changes with income. The poor are far below their target: not only do they want more in savings for precautionary purposes, they are further from their goal for all types of assets. For those with high incomes liquid financial assets are close to the desired precautionary fund, and are comparatively constant as incomes change. The model predicts average wealth should be higher than the target and it is taking into account the ability to borrow. Above $59,000 (10.99 in logs) the survey weighted mean difference between log liquid assets and log target precautionary fund is -0.20, while the mean difference including credit as an asset is 0.82. That suggests that the ability to borrow is an important precautionary asset, at least for households close to $59,000.

The bottom chart shows how wealth and income relate. Again the poor look very different: they have substantially less in savings compared to their normal incomes than the rich. Liquid assets plus borrowing are relatively constant after log normal income of around 11. One explanation for why the poor look different is the survey may be missing some assets. Lower income households are far less likely to be part of the formal financial system as shown in table 1. If the poor hold more assets such as cash that are missed by the survey than that may explain why it appears they are so far below their target. I quantify the extent of these missing assets in the next section.

While the charts show that high income earners fit the predictions of the model reasonably well and lower income earners do not, heterogeneity in preferences or risks may change with income, just as it did examining the relationship between the precautionary target and income. In addition, since the population density is largest around log income of 11, it is difficult to tell whether the population fits the model from locally weighted regressions. To test more formally, I include other possible observable shifters as in table 3. The results are shown in table 4. I test two types of assets: liquid assets, and liquid assets plus available credit. The model predicts that mean precautionary assets should increase one for one with the precautionary target assets and with income, and so in equations 5 and 6 permanent income should have no additional effect and have a zero coefficient.

The conditional survey-weighted regression reject the hypothesis for liquid assets by themselves both for households with high and low incomes, but cannot reject when including credit. Not including borrowing, there is a strong positive effect of normal income on both the difference between log liquid assets and the log precautionary target and the gap between log liquid assets and log income. The slope is even stronger for the poor.

Including the ability to borrow the results for the rich do not reject the model. Income has no additional effect on the gap in columns 3 and 4, just as predicted by theory. For the poor there continues to be a very strong slope which is of similar magnitude to the regressions for liquid assets.

It seems that the ability to borrow, which is a key part of precautionary assets in theory, is necessary to understand savings behavior. The importance of the ability to borrow is illustrated in figure 4. Credit increases more rapidly with income than liquid assets starting around log normal income of 11 but then increases less rapidly after log income of 12 (incomes between $60,000 and 160,000 in 2010 dollars). Since the population density is the largest there (see figure 3), these households drive the parametric results, and the ability to borrow is an important asset for them.

3.5 How large are the missing assets?

The poor seem be saving substantially less than they say they want. Yet the survey is also missing important assets such as cash which are necessarily more important for the poor. For example, table 1 shows that only around 60% of the lowest quintile have a checking account with a positive balance and only 35% have a savings account. Social capital such as the ability to borrow from friends and family are also likely to be more important for the poor. How much must these missing assets be worth to account for the savings discrepancy?

The buffer-stock model gives a straightforward way to estimate the missing assets. The idea is to find the amount of missing assets that allows the relationship between assets and the precautionary target to hold across income groups. Taking equation 5 and including additional missing assets A^M but imposing the model restriction that income not matter allows a natural GMM interpretation: define $u_{it} = \ln(A_{it} + A^M) - \ln A^*_{it} - \ln\theta - Z_i\zeta_1 = \epsilon_{it} - \epsilon^A_{it}$ then the moments $E[u_{it}Z_i] = 0$ identify the ζ_1. An additional moment comes from imposing that income should not matter once the desired assets are included: $E[u_{it}P_{it}] = 0$. The additional moment allows A^M to be identified as the additional assets which make income not affect the difference between actual assets and target assets on average. Imposing that restriction then P_{it} is an exogenous instrument in the non-linear system of moments.

Some assets are observable but may not count as precautionary assets. As in figure 4 and table 4 I allow different assets to enter assets A_{it} and examine how that changes the estimates of the missing assets A^M. Table 5 shows the results, along with the estimates of $\ln\theta$ which measures how much larger assets are on average than the target (theory says θ should be greater than 1). In the first column the remaining limit on credit cards enters dollar for dollar, in the second borrowing is worth only half as much as a precautionary asset, in the third it is not included at all. The last two columns introduce a question from the survey which asks whether "In an emergency could you get financial assistance of $3,000 or more from any friends or relatives who do not live with you?" Such social assets may be particularly important for the poor.

Taken together the estimates suggest that the survey is missing some precautionary assets but that the value of the missing assets is not large. Depending on what other assets are included the missing assets per household vary from about $1,500 to $2,700. Since the missing assets are the same for all households, they become particularly important for the poor. Figure 5 shows the result of including these missing assets in the non-parametric relationship of income and the asset income ratio. It is clear that we need not have particularly large estimates of missing assets to have all households save according to their stated preferences with theoretically reasonable values of $\ln\theta$. At the same time these estimates do not show that the poor are actually holding a sizable amount of cash or other liquid assets. It seems likely given their higher propensity to spend more than their incomes in table 1 that the poor are missing their savings goals to some extent (although perhaps the knowledge of what bills can be partially defaulted on has its own precautionary value). Cash and other assets assets not picked up by surveys must be part of the answer, however, and the measure of our ignorance is A^M.

4 How precautionary are U.S. households?

While the high income employed fit the buffer-stock model well, this section shows that they are not very precautionary. Beyond predicting a slope of zero, the intercept in equation 4 summarizes the precautionary target in the population. The useful property of a^* is that if it is properly measured it takes into account all of the relevant risks and preferences and so summarizes how precautionary the population is. Moreover, the estimates of ζ show what shifts these preferences.

Households in the U.S. show very low precaution. The population average for high-income employed households is to target only slightly over one month of income for precautionary reasons.[7]

[7] That is equivalent to a difference in logs equal to -2.4 in figure 2. To put that in perspective, a household that

That figure is weighted to be nationally representative and as shown in table 3 individual demographics, particularly age, and tastes can shift this value up and down. The poor want only 1.24 months of income on average. That amount affected by the income distribution which has most of its mass where precaution is lowest close to the dividing line. The overall nationally representative mean for the self-employed is 1.9 months, and the retired target 3.2 months of income.

These preferences are very low considering the advice of the financial planners who typically suggest between six and nine months of income in emergency savings. Popular financial advice gurus often recommend that households keep some available liquid funds in case of emergency. "There's no way to predict when an emergency will strike, or to know how expensive it will be. But you can plan. An emergency cash fund is your best line of defense" writes Suze Orman (Orman, 2006), advocating having 6-8 months of income socked away. Other advisers have similar suggestions.[8] Even compared to the personal financial advise they are getting, American households want to save surprisingly little for precautionary purposes.

Moreover, these preferences are low compared to the predictions of much of the literature which embeds or estimates a precautionary motive. I examine the preferences from three papers (Carroll, Dynan, and Krane, 2003; Gourinchas and Parker, 2002; Storesletten, Telmer, and Yaron, 2004) which match up closely with the simple model presented, but they represent a larger literature which uses similar parameters. The results comparing the predictions of these papers to the data are shown in table 6. For the parameters in each paper, I find the consumption function numerically for the given the income process and preferences. The consumption function then gives the precautionary target. Then by simulating a large population with identical preferences facing the same income process, I can calculate the mean of the ergodic distribution. The table shows the corresponding values from the surveys for all US households, for high income households with an

keeps six months of income as a precautionary target will have want log target savings minus log income equal to -0.69 ($\ln(P/2) - \ln(P) = -\ln 2$ with normal income in years). In the model a^* is the ratio of target precautionary assets to income, so $1/a^*$ is the fraction of yearly income and $12/a^*$ the number of months of income. The formula used throughout this section of converting log differences to months of income is if the log precautionary target minus log income is x then the months of income target is $12/e^{-x}$.

[8] Dave Ramsey suggests building a $1000 emergency fund as step one, paying off debt as step 2, and building liquid savings of 3-6 months worth of expenses for "incidents that would have a major impact on you and your family" (Ramsey, 2010). David Bach recommends having savings worth at least three months of expenses (Bach, 2004).

employed head, and for low income households with an employed head. For easy comparison, the last two columns calculate the ratios assuming that households want six months and one month worth of permanent income.

The parameters used by each paper substantially overstate the desired precautionary target. Even the lowest precautionary target (from Gourinchas and Parker (2002) with its lower coefficient of relative risk aversion) is nearly three times higher than what households actually want. There appears to be a substantial disconnect between how much savings American households say they want for precautionary savings and how much models with a precautionary motive and standard parameter assumptions or estimates suggest they should have. That suggests that, even while Americans fit the precautionary model well, these models are relying too much on precautionary preferences and income shocks to generate savings. Yet it is not clear whether the explanation for the low desired savings is because US households hold very low precautionary preferences, they are not worried about income shocks but are concerned about other events, or substantially under-report the amount they want for precautionary purposes. The next section explores what it is they are worried about.

5 What are Americans (not so) worried about?

While the precautionary motive of US households is weak, there is still much heterogeneity in that motive. In the buffer-stock model, after allowing permanent income to vary in equation 4, the constant term provides a summary of the preferences and environment which make households hold precautionary motives. How that constant changes with risks and demographics thus shows what factors are important and what direction they shift the precautionary motive. I examine six factors in more detail: age, the existence of a spouse and spouse employment, health insurance, willingness to borrow, college education, and income uncertainty. These are also plausible candidates to explain the rise in precaution among the low income since most change as income changes. Yet none can explain why the poor have stronger precautionary preferences. Moreover, income uncertainty which should be the primary driver of precautionary preferences is surprisingly unimportant for all income groups.

Age. The regressions and semi-parametric approaches have all included an age cubic normalized to be zero at age 50 (approximately the mean household head age in the data). Age has a large and close to linear effect on precaution. Figure 6 plots the cubic of age from columns 2 and 4 of table 3. Column 4 allows the age function to differ by level of education. The buffer-stock model predicts that the higher expected income growth of the young should make them want a lower precautionary fund (see section 2.2). The figure suggests that age is a very important factor in precautionary motives more than doubling the precautionary target as the age of the household head goes from 25 to 75.

While the model offers a simple explanation that income growth is slowing, it seems that there must be more to the story. First, the change is approximately linear, yet income growth has largely ended by age 50 in the US, and while it may fall slightly among some education groups after that it is reasonably constant. Age-income profiles in the SCF shows a similar pattern to other work which examine age and experience in the cross-section (Murphy and Welch, 1990). That pattern suggests that if income growth explains the increase in the precautionary motive with age then the effect should taper off after age 50. Instead, it continues to grow at the same rate. Second, growth rates are higher for those with higher education, but since all groups have low income growth after 50 that means that those with higher education also have a larger deceleration in income growth. Those with college education do have a stronger precautionary motive, but figure 6 shows the effect varies little over the life-cycle. High-school and below high-school households become more precautionary as fast as the college educated, even though they have lower rates of income growth.

While differential income growth may tell some of the story of age and precaution, it is clear that there is more going on. One possible explanation is that people are biased towards saying they want the precautionary savings that they actually have in savings. Then since older households have higher wealth that pulls up the reported target with age. Alternatively, perhaps households go through a learning process about potential risks as they are hit with shocks, and so adjust their understanding about how risky the world is upwards as they age. In any case, it is clear that an assumption of constant precaution or constant risk over the life-cycle is problematic.

Changes over time. Between 1995 and 2007 US households became progressively less precautionary as shown in the second panel of figure 6. After the financial crisis of 2008, however, there was a large upturn in the target precautionary assets. One possibility for this effect may be the changing availability of credit which was consistently more available between 1995 and 2007, but became much harder to obtain after that.

Spouse in the household and spouse employment. Having an employed spouse has a large negative effect of around 20% on the precautionary target compared to having no spouse (the excluded category). Other types of spousal employment have little or no effect compared to not having a spouse. The effect is not driven by the parametric assumptions. The top left panel of figure 7 shows locally weighted regressions dividing the population between those with an employed spouse and those without. Around log income of 11, the highest population density, having an employed spouse reduces the target precautionary fund, although the effect may be smaller at very low incomes. Below an income of $450,000 (log income of 13) the fraction of the population with an employed spouse is falling since lower income households are less likely to be married. Yet the decrease in having an employed spouse does not explain why those with low incomes become increasingly precautionary since both lines in the figure start increasing below log income of 11.

Health Insurance. Being covered by health insurance has a small negative effect on the target precautionary fund. That is clear both in the regressions where if everyone is is covered that reduces the target precautionary fund by approximately 9 percent and in figure 7. Although health insurance falls with income, it is not responsible for the increase in precaution by the poor, since the increase is evident both for those with and without health insurance.

Willingness to borrow. Households that are willing to borrow to cover expenses when incomes fall want about 6% lower emergency savings. While the fraction that are willing to borrow declines slowly with income, the effect is approximately constant as shown in the bottom left of figure 7. As illustrated in figure 4 borrowing makes up a large portion of the “assets” of lower income households, and so not being willing to use borrowing for smoothing (or having a higher psychological cost of doing so) makes these households less wealthy all else equal.

Education. College education is strongly related to additional precaution, but completing high-school is not. In table 3 having finished college is associated with an increase of approximately 34% (log units) in the precautionary target. As the lower right panel of 7 makes clear, this effect is relatively constant as income changes and is responsible for the large hump visible between log income 11 and 13 in the the other panels. College and a higher precautionary target are strongly related, but the direction of causality is not clear from these results. Investments in education may be caused by unobserved higher patience or risk aversion, or college itself may encourage the development of increased precaution or patience.

5.1 Income uncertainty

The primary reason to save in the standard buffer-stock model is to self-insure against fluctuations in income. Increasing income uncertainty should therefore raise the desired precautionary target, and raise the amount saved for precautionary purposes. Figure 8 shows that the fraction of households who answer yes to the question "Do you usually have a good idea of what your next year's income will be?" increases from around 55% for the lowest incomes to 75% around log income 12.5 ($270,000) before declining slightly. Since the vast bulk of the population is between log income 9 and 13, self-reported income certainty is increasing with income for most of the population.

Yet there is not a clear relationship between income uncertainty and precaution. Examining the non-parametric effects in figure 8, income uncertainty appears to have no strong effect for the poor, although not usually having a good idea of next year's income does increase precaution for households with higher incomes. Controlling for other factors, the effect from the parametric regressions in 3 is to decrease the precautionary target by around 6%. That is surprisingly low: those with the same normal incomes and the same demographic characteristics report they want only 6% more in emergency savings than households who say they usually have a good idea of their income.

Whether a household normally knows its income captures important elements of income uncertainty. While it is binary and self-reported, it is perceived income uncertainty that should drive precaution. Moreover, any self-selection in reporting—those who care more about income uncertainty report having higher income uncertainty—should work towards finding a larger effect. In addition, table 1 shows that calculating the variance of log unexpected income (log income-log normal income) those households that do not usually know their income have much higher variance at all income levels. That such large differences in perceived and actual income uncertainty do not cause large changes in precaution suggests that income uncertainty is not an important a factor in precautionary behavior.

Evidence from other surveys supports the conclusion that income uncertainty is not an important factor in determining the precautionary target. Brobeck (2008) describes a survey of the emergency savings of low and moderate income households and finds few differences in the unreliability of income between those with high emergency savings and those with low savings.

One source of variation in income uncertainty is the industry or occupation of the household since some occupations have much higher volatility than others. Households may self-select into risky occupations so that those with lower precaution are in more risky occupations, but that should diminish any relationship rather than reverse it. Column 5 of table 3 allows the precautionary target to shift with occupation (the coefficients are on the second page). Figure 9 plots these coefficients against the transitory variance as estimated by Carroll and Samwick (1997) from the PSID.[9] Using the Carroll and Samwick (1997) estimates of permanent and transitory variances, I also simulate how much each occupation would want as its precautionary target compared to

[9] The occupations from Carroll and Samwick (1997) and the PSID do not match exactly with the SCF occupational categories, but I use the category that corresponds most closely. The differences are not important to the overall conclusions. Carroll and Samwick (1997) separately report Professional and Technical, and Managers (not self-employed) and I use their Professional and Technical in the graph. Managers (not self-employed) have a permanent variance of 0.018 and transitory of 0.0357, slightly higher than the Professional and Technical with transitory variance of 0.0331. The SCF reports Operators and a separate category for Laborers and Craftsmen, while Carroll and Samwick (1997) report categories for Operators and Laborers, and Craftsmen. I associate Operators in the SCF with Operators and Laborers, and Laborers and Craftsmen in the SCF with Craftsmen. While the permanent variance of these occupations is very different and is responsible for the differences from simulations (0.0299 for Operatives and Laborers, 0.0175 for Craftsmen), the transitory variance is close and so does not change the overall conclusion.

the Professional, Technical and Managerial occupation which is the base case for both. With the parameter assumptions Farmers and Farm Laborers would not have an ergodic distribution; their permanent income variance is so high that a psychological discount of 0.96 is not sufficient to keep even very wealthy households from wanting to save. Deaton (1991) provides a useful formula for checking stationary with log normal income processes.

The coefficients from the regression shown in figure 9 demonstrate that income uncertainty from different occupations is not a driving force of reported precautionary preferences. Moving from an occupation with lower transitory income variance to an occupation with higher variance tends to reduce the precautionary target, exactly the opposite of the model prediction. The simulations from the precautionary model, however, have a clear upward trend. The variations around the increase from the simulations result from differences in the permanent variance of income which introduces rate of return variation in the consumer decision. With only six occupations, it is difficult to say more than the trend from the data is not upward, especially since the variance of permanent incomes also changes and can also affect the precautionary target. Yet the buffer-stock model driven by variation in income risks does not predict variations in the target precautionary fund as seen in the data. Whatever US households are worried about, income uncertainty is not a large part of it.

6 Why are the poor more precautionary?

The regressions and non-parametric figures in the previous sections showed that there appears to be no simple explanation for why the precautionary target increases as incomes fall. The poor are more worried about their incomes, are less likely to have gone to college, and are less likely to have health insurance, but none of these explain why below $59,000 precaution starts increasing. This section proposes one possible explanation: the existence of a minimum or subsistence, consumption level or, equivalently, the existence of costs or risks that do not scale with income such as fines or unexpected expenses. The existence of a minimum subsistence level means that as the permanent income falls the subsistence level becomes more important in the consumption decision and so risk aversion and precaution rise.

A little theory helps explain why including costs or minimums that do not scale with permanent income makes a difference. Suppose there is a minimum consumption level H so that period utility now reads: $u(C_t) = (C_t - H)^{1-\gamma}/(1-\gamma)$. Then the entire problem can no longer be reduced to ratios of consumption to permanent income because dividing everything by P_t leaves H/P_t in the utility function. That immediately implies that the decisions of the precautionary target to income ratio will depend on permanent income now that H is involved. It also suggests a reason why those with lower permanent incomes might be more precautionary: as their permanent income declines H/P_t looms ever larger in the consumption function. For the very rich, on the other hand, H is irrelevant. In effect, households are becoming more and more precautionary as their incomes declines since they come ever closer to disaster.

To examine whether the higher precaution of the low-income can be driven by a minimum subsistence level or income shocks that do not scale with income, I modify the basic model and estimate the parameters which best allow the structural model to explain the entire distribution of precautionary targets.

Suppose that each month each household faces some probability p_L of an income shock which reduces their income to some low value $K(P_t) = k(P_t)P_t$ which is a function of permanent income. I think of this shock both as a shock to disposable income from fines or something similar, but also as a simple way to model shocks to marginal utility. For example, funerals are often unexpected and require large outlays all at once, and so may reduce disposable income for other uses. Yet funeral expenses are also mostly discretionary, and so can be thought of as a sudden desire to spend more in a given month or a shock to marginal utility. Similarly each household faces a minimum amount of consumption each month $H(P_t) = h(P_t)P_t$. Then the question becomes what functions $k(P)$ and $h(P)$ produce the precautionary target assets $a^*(P)$ which fits the data. Appendix A gives the details of the model specification of a very simple form for $k(P)$ and $h(P)$ and estimation of the parameters of model. The estimation is a non-linear least squares problem where each call must solve the different consumption problem of households with permanent incomes varying from approximately \$8,000 a year to over three million.

The resulting path of $a^*(P)$ closely matches the data and is shown in figure 2. For a household approximately at the poverty line earning \$2000 a month the estimates suggest that the minimum consumption is approximately $\$171$ and there is 12.4% chance in any given month of disposable income being only \$1,130. Such a household then wants $a^* = 0.12$ or approximately \$2,800 in savings for precautionary purposes. For households with higher incomes the minimum consumption becomes irrelevant. They face the same 12.4% chance of a having disposable income in a given month 65% of normal (the rich still hold precautionary assets, so their shocks must scale with income). The estimates suggest that $\gamma = 2.02$.

Additional evidence that a minimum consumption level may be important comes from considering the effect of housing costs. While long term housing is a choice, in the short term rent or mortgage payments look much like a minimum consumption level. Many poor families have to choose occasionally between rent and food (Mabli et al., 2010)—a choice that must have a very high marginal utility. Table 3 includes the fraction of income going to housing. Precaution increases rapidly with the fraction. There appears to be a strong association of having no-debt or low costs of housing with high precaution, since those who pay less than 5% of their income to housing also have a higher precaution. Since the shifters are all reduced form, it is difficult to tell what is behind the non-linearity, but it is clear that housing payments are an important driver of precaution.[10]

7 Conclusion

This paper derives a new testable implication of the buffer-stock model. The rich fit the model well, but their level of precaution is far lower than the predictions from structural models based on yearly income uncertainty. The poor are increasingly precautionary and none of the usual suspects

[10]The functional form that the housing costs enter in the estimates is somewhat arbitrary, but there is a strong non-linearity close to zero. Those who owe little or nothing each month hold stronger precautionary preferences. It seems possible they owe little or nothing because of these preferences, but the reduced form cannot distinguish causality. After zero the effect appears approximately linear since additional polynomial terms do not seem to be very important.

explains the increase for the poor. Labor earnings uncertainty, which has been the key focus of most work on precautionary saving, does not appear to be a factor in determining the funds people keep for precautionary preferences.

I propose a model which can explain these facts. The model allows for a monthly subsistence level and monthly shocks to disposable income. Since neither of these is proportional to income, they become increasingly irrelevant as incomes increase. But the poor are living very close to the edge—one bad shock away from not making rent—and are very worried about such costs.

Some difficult questions still remain. Although the estimates suggest that income uncertainty is not a large part of precautionary savings, that may be because U.S. households already feel themselves reasonably well insured through unemployment insurance. That may explain the higher precaution of the self-employed who are typically not covered by unemployment insurance. While this paper focused on the employed who make up the largest fraction of households, understanding the precaution of the self-employed and retired who do not necessarily fit the standard buffer-stock model well and whose precaution appears to be falling with income is necessary to fully understand the savings behavior of the population. Perhaps most important, it is clear that age has a strong effect on precaution. While the model suggests one reason—that income growth slows over the life-cycle—the shape of the age-precaution profile and the differences by education suggest that the story is more complicated. It may actually be the case that the reason consumption tracks income early in life is that the young are willing to accept much higher risks and so do not feel much need to save.

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A Model with subsistence consumption

This section modifies the basic intertemporal consumption problem of section 2. It adds a minimum subsistence level, and low income shock, and specifies how these vary with permanent income. It then sets up the estimation problem.

Since yearly frequencies cannot explain the level of precaution with conventional parameters, the model is monthly. The household seeks to maximize each month $u(C_t) = (C_t - h(P)P)^{1-\gamma}/(1-\gamma)$. The income process $Y_t = PU_t$ fixes monthly permanent income but allows transitory income to vary. Since at a monthly frequency permanent income shocks are relatively unimportant but require a great deal of computation, doing so makes the model much more computationally tractable. The transitory portion of income has two types of shocks. There is a probability of having disposable income reduced to $k(P)P$ which occurs with probability p_L. Otherwise, each month income is distributed by a Gaussian-Hermite approximation of a log normal with variance parameter σ_U^2. I adjust the mean of the income process so that $E[U_{t+1}] = 1$ so that changing p_L and $k(P)$ affects risks, not average income. Including both a subsistence level and removing income are very closely related and the problem could be rewritten to an isomorphic problem including only one or the other.[11] They may vary with P in different ways, however, so it is useful to keep them separate.

How the subsistence and low-income shock vary with permanent income are what provides the additional curvature which allows the low-income to have a higher precautionary target. I adopt one parsimonious approach which fixes the endpoints and then allows more or less curvature in between. As P increases define $\lim_{P\to\infty} k(P) = k_H$ which is the fraction of disposable income that a very high-income person has remaining in the bad state with probability p_L. The fraction of income needed for subsistence goes to zero: $\lim_{P\to\infty} h(P) = 0$. Denote P_1 the lowest monthly

[11] Suppose that some amount H is taken from income every period so that the period budget constraint reads $C_t \leq A_t + Y_t - H$. Then by defining a new variable $\tilde{C}_t = C_t + H$, the budget constraint reads $\tilde{C}_t \leq A_t + Y_t$ and the period utility is $u(C_t) = u(\tilde{C}_t - H)$. The consumer's problem taking H from consumption is isomorphic to a problem where H is taken from income—the only difference is what gets counted as consumption. Therefore costs that reduce income or level of consumption that produces no enjoyment but must be reached before the consumer gets any utility reduce to the same type of problem.

permanent income considered (not in log units). Then with probability p_L the household receives a shock which drops disposable income to a fraction k_L. Since there must be some consumption $h(P_1) = f_L k_L$ is the subsistence to permanent income ratio for the lowest income with $f_L \in [0, 1)$. That fixes the subsistence consumption of those with monthly income P_L at $f_L k_L P_1$. Then fixing a curve through these points gives $h(P) = f_L k_L (P_1/P)^{1+\theta_H}$ and $k(P) = k_H - (k_H - k_L)(P_1/P)^{1+\theta_K}$ where θ_H and θ_K govern how fast $h(P)$ approaches zero and $k(P)$ goes to k_H.

The model then requires solving for each permanent income P the optimal precautionary target $a^*(P)$ from the solution to the intertemporal consumption problem given k_H, k_L, f_L p_L, θ_H, θ_K, the preferences γ and $\beta = 0.96^{1/12}$, the price $R = (1.04)^{1/12}$, the transitory income process variance $\sigma_U = 0.05/12$. I fix the last three since at the monthly frequency they are relatively unimportant. The transitory variance gives a yearly income variance (the sum of twelve monthly shocks) of approximately 0.05, although it is no longer log-normal. Finally, the choice of $P_1 = e^9/12 \approx$ \$675 a month gives the lowest income. There are two levels of approximation. First, I solve the household problem on a cubic spline interpolation for a grid of P ranging between P_1 and the highest P with more points at the low end. I then interpolate linearly to get an approximation of $a^*(P; k_H, k_L, f_L, p_L, \theta_H, \theta_K, \gamma)$.

Since the calculation of one solution to the non-linear function is very time consuming, I employ a two-step estimation strategy. First, I remove precautionary shifters using the same semi-parametric approach as in section 3 and shown in figure 2. I then treat the non-parametric function plus residuals for each household as the data a_i^* with normal income P_i and find the parameters which minimize the sum of squared differences between each household and the model prediction at that income level: $S = \min \sum_{i=1}^{N} (a_i^* - a^*(P_i; k_H, k_L, f_L, p_L, \theta_H, \theta_K, \gamma))^2$. I do not use survey weighting for either step. Identification of the non-linear least squares (or equivalently maximum likelihood with an assumption about the distribution of the errors) comes from several sources: the level of a^* for the high-income is from γ, p_L, and k_H which determine the risks the rich face and how much they worry about them. Approaching P_1, the parameters γ, p_L k_L, and f_L determine the precaution of the poor. θ_H, and θ_K then determine how quickly the function goes from the precaution of the poor to that of the rich. Since most of the population is in the middle, most of the fit is determined there. θ_H and θ_K are not separately well determined, so I combine them to one parameter θ. The variance-covariance matrix for the estimates is calculated by the numerical Jacobian around the optimum as $s^2(J'J)^{-1}$ where s^2 is S divided by N minus the number of parameters.

The results, with standard errors in parentheses are: k_H=0.654 (0.000397), k_L = 0.338 (0.000785), p_L = 0.124 (0.000282) θ= 0.170 (0.00102), f_L = 0.903 (0.00133) and γ = 2.02 (0.00261) with $S = 13.85$ and $N = 13,714$. The tight parameter estimates come from the large number of observations. While the estimates are the local optimum, given the multiple levels of approximation and similar effects of several of the parameters there is no guarantee it is a global optimum. The grid search I used to initialize the estimation did not suggest better starting positions, however.

Table 1: Financial status and preferences by income quintile

Quintile	1	2	3	4	5
Top income ($2010)	23,207	39,848	61,728	99,121	.
ln unexpected income	-0.032	-0.056	-0.052	-0.033	-0.030
Variance of ln unexpected income					
All	0.129	0.091	0.073	0.051	0.062
Don't usually know	0.140	0.123	0.115	0.088	0.118
Usually know income	0.117	0.076	0.062	0.045	0.057
Fraction usually know income	0.45	0.62	0.72	0.81	0.86
Have checking account?	0.61	0.77	0.89	0.93	0.92
Have savings account?	0.35	0.43	0.55	0.65	0.66
Have credit card?	0.35	0.54	0.71	0.85	0.95
Over the past year did spending exceed income?					
Spending greater	0.20	0.19	0.15	0.12	0.09
Equal	0.53	0.49	0.44	0.36	0.26
Income greater	0.26	0.32	0.41	0.53	0.65
If spending greater than income, how did you deal with shortfall?					
Borrowed money	0.47	0.45	0.49	0.42	0.41
From savings	0.22	0.31	0.33	0.43	0.53
Some form of default	0.17	0.19	0.14	0.13	0.06
Help from others	0.13	0.05	0.03	0.02	0.00
Most important time period for planning saving and spending?					
Next few months	0.33	0.27	0.21	0.15	0.08
Next year	0.18	0.17	0.16	0.12	0.09
Next few years	0.23	0.26	0.26	0.26	0.23
Next 5-10 years	0.18	0.20	0.25	0.29	0.36
Longer than 10 years	0.08	0.10	0.12	0.17	0.24
Willingness to take financial risks to get higher returns?					
Substantial risk	0.034	0.039	0.041	0.038	0.048
Above average	0.085	0.110	0.157	0.228	0.307
Average	0.275	0.315	0.369	0.457	0.514
Not willing to take risk	0.607	0.537	0.434	0.277	0.131
Spouse employment					
No spouse	0.71	0.59	0.45	0.23	0.09
Not employed	0.17	0.19	0.19	0.19	0.20
Employed	0.11	0.19	0.33	0.54	0.64
Self-employed	0.01	0.02	0.03	0.04	0.06
Employed households in survey	1,481	2,474	2,965	3,099	4,093

Notes: Includes only employed households from SCF using survey weights (standard errors from MI and survey not shown). Quintiles divisions are calculated from the full survey to be nationally representative in 2010 dollars. Unexpected income is ln income - ln normal income. When calculating the unexpected variance I exclude households with abs(ln unexpected income)>2 which reduces the sample by around 20 households in each quintile. The mean is unaffected but the variance of the lowest quintile is sensitive to the inclusion of these households. Default includes partial default (getting behind on payments, not paying bills, doing nothing) and bankruptcy. Having a savings or checking account is having an account with a non-zero balance (very few accounts have zero balances).

Table 2: Precautionary target by income quintile

Quintile	1	2	3	4	5
Top income ($2010)	23,207	39,848	61,728	99,121	.
Ln target-ln normal income	-1.90	-2.31	-2.40	-2.49	-2.44
Implied monthly target ratio	1.80	1.20	1.08	1.00	1.05
Mean target months of norm. income	3.91	2.45	2.11	1.85	1.92
Median target months of norm. inc.	2.19	1.64	1.33	1.07	1.17
Precautionary target ($2010s)	6,242	9,210	12,148	14,732	39,014
Ln target income ratio by whether usually know next year's income					
Don't usually know	-1.88	-2.30	-2.36	-2.50	-2.42
Usually know	-1.92	-2.31	-2.42	-2.49	-2.44
Fraction usually know income	0.45	0.62	0.72	0.81	0.86
Ln target income ratio by willing to borrow to cover expenses when income cut					
Not willing borrow	-1.74	-2.17	-2.35	-2.42	-2.40
Willing borrow	-1.99	-2.41	-2.45	-2.56	-2.48
Frac. willing borrow	0.61	0.57	0.52	0.48	0.46
Ln target income ratio by willingness to take financial risk					
Substantial risk	-1.47	-2.27	-2.38	-2.61	-2.61
Above average	-2.09	-2.35	-2.52	-2.47	-2.43
Average	-2.01	-2.45	-2.51	-2.52	-2.43
Not willing to take risk	-2.01	-2.44	-2.49	-2.64	-2.65
Ln target income ratio by most important time period for planning					
Next few months	-2.02	-2.35	-2.52	-2.63	-2.56
Next year	-1.90	-2.38	-2.61	-2.69	-2.66
Next few years	-1.79	-2.35	-2.34	-2.52	-2.46
Next 5-10 years	-1.83	-2.22	-2.32	-2.39	-2.38
Longer than 10 years	-1.85	-2.11	-2.26	-2.35	-2.37
Ln target income ratio by spousal employment					
No spouse	-1.85	-2.26	-2.29	-2.27	-2.18
Not employed	-2.03	-2.27	-2.37	-2.37	-2.22
Employed	-2.03	-2.53	-2.59	-2.64	-2.56
Self-employed	-1.58	-2.08	-2.23	-2.33	-2.24
Employed households in survey	1,481	2,474	2,965	3,099	4,093

Notes: Includes only employed households using survey weights from SCF (standard errors from MI and survey not shown). Quintiles divisions are calculated from the full survey to be nationally representative in 2010 dollars. The monthly target has a very long tale of outliers particularly for the lowest quintile. I calculate the mean restricting it to be less than 60 (5 years of normal income). Willingness to take financial risks is only available in 2001 and after.

Table 3: Parametric tests of the buffer-stock model

	Log precautionary target-log normal income				
	[1]	[2]	[3]	[4]	[5]
Log normal income	-0.163***	-0.0101	-0.000882	-0.0136	-0.0307
	(0.0155)	(0.0314)	(0.0445)	(0.0200)	(0.0317)
Low income		-0.290***	-0.327***	-0.304***	-0.267***
× log normal income		(0.0541)	(0.0716)	(0.0484)	(0.0539)
Usually know next		-0.0633**	-0.0229	-0.0558**	-0.0701**
year's income?		(0.0282)	(0.0418)	(0.0252)	(0.0283)
Everyone in household		-0.0859***	-0.0859*	-0.0668**	-0.0871***
has health ins.		(0.0332)	(0.0487)	(0.0304)	(0.0334)
High School		0.0680	0.0247	0.0690	0.0531
		(0.0455)	(0.0670)	(0.0541)	(0.0459)
College		0.339***	0.303***	0.311***	0.280***
		(0.0494)	(0.0735)	(0.0577)	(0.0516)
Fraction income		0.309***	0.275***	0.293***	0.313***
housing < 0.05		(0.0410)	(0.0575)	(0.0345)	(0.0409)
Fraction income		0.712***	0.788***	0.682***	0.705***
housing		(0.101)	(0.135)	(0.0841)	(0.101)
Willing to borrow		-0.0553**	-0.0948***	-0.0553**	-0.0563**
when income cut		(0.0228)	(0.0321)	(0.0219)	(0.0228)
Willing to accept fin. risk			-0.0372*		
(1 Substantial-4 None)			(0.0209)		
Not-Employed Spouse		-0.0262	-0.0271	0.00923	-0.00449
		(0.0354)	(0.0509)	(0.0327)	(0.0358)
Employed Spouse		-0.190***	-0.156***	-0.199***	-0.168***
		(0.0300)	(0.0429)	(0.0287)	(0.0305)
Self-Employed Spouse		0.0448	-0.0404	0.0520	0.0622
		(0.0601)	(0.0849)	(0.0524)	(0.0600)
Race: Black		-0.0199	-0.0972*	-0.0506	-0.0176
		(0.0371)	(0.0533)	(0.0340)	(0.0370)
Race: Hispanic		0.0610	0.0889	0.0524	0.0599
		(0.0399)	(0.0584)	(0.0384)	(0.0399)
Race: Other		0.309***	0.294***	0.261***	0.305***
		(0.0650)	(0.0948)	(0.0566)	(0.0649)
Number of kids		-0.0386***	-0.0309**	-0.0290***	-0.0402***
		(0.0103)	(0.0148)	(0.00985)	(0.0103)

(continued)

(continued)

	Log precautionary target-log normal income				
	[1]	[2]	[3]	[4]	[5]
Age		0.834***	0.708***	0.748***	0.827***
		(0.0994)	(0.135)	(0.263)	(0.0993)
Age^2		0.00162	0.532*	-0.466	-0.0217
		(0.234)	(0.308)	(0.445)	(0.235)
Age^3		0.616	1.801***	0.828	0.626
		(0.536)	(0.681)	(1.186)	(0.539)
H.S $\times$Age				1.115***	
				(0.123)	
H.S $\times Age^2$				-0.209	
				(0.267)	
H.S $\times Age^3$				-0.806	
				(0.602)	
College $\times$Age				0.682***	
				(0.144)	
College $\times Age^2$				0.0818	
				(0.272)	
College $\times Age^3$				0.617	
				(0.814)	
Clerical and sales					-0.0698**
					(0.0336)
Services					-0.0499
					(0.0415)
Laborers					-0.0924**
and Craftsmen					(0.0400)
Operators					-0.173***
					(0.0407)
Farmers and					0.0325
farm laborers					(0.121)
Low income intercept		3.195***	3.601***	3.315***	2.945***
		(0.582)	(0.776)	(0.514)	(0.581)
High income intercept	-0.578***	-2.070***	-2.223***	-2.002***	-1.749***
	(0.173)	(0.364)	(0.526)	(0.237)	(0.370)
Obs	13886	13886	6547	13886	13886
Imputations	5	5	5	5	5
Year effects	YES	YES	YES	YES	YES

Notes: The excluded year effect is 1995. The excluded spouse employment is no spouse in household. The excluded education is less than a high school degree. Age is normalized to be 0 at 50 by: (Age-50)/50. All regressions account for multiple imputation by the SCF and are survey weighted to be nationally representative. The income dividing high from low is 10.99 or $59,278.

Table 4: Parametric tests of the buffer-stock model: savings

	ln liq. assets - ln target [1]	ln liq. assets - ln income [2]	ln liq. + credit - ln target [3]	ln liq. + credit - ln income [4]
Log normal income	0.296***	0.273***	0.0455	0.0112
	(0.0467)	(0.0467)	(0.0447)	(0.0429)
Low income	0.951***	0.608***	1.362***	1.024***
$\times$ log normal income	(0.0999)	(0.0974)	(0.107)	(0.101)
Usually know next	0.435***	0.436***	0.483***	0.481***
year's income?	(0.0574)	(0.0538)	(0.0592)	(0.0561)
Everyone in household	0.948***	0.968***	1.035***	1.055***
has health ins.	(0.0718)	(0.0686)	(0.0758)	(0.0741)
High School	0.906***	0.990***	1.160***	1.247***
	(0.0970)	(0.0924)	(0.105)	(0.100)
College	1.255***	1.616***	1.607***	1.986***
	(0.102)	(0.0967)	(0.109)	(0.104)
Fraction income	0.221***	0.544***	0.136*	0.463***
housing < 0.05	(0.0827)	(0.0817)	(0.0815)	(0.0805)
Fraction income	0.769***	1.606***	0.871***	1.709***
housing	(0.193)	(0.194)	(0.203)	(0.209)
Willing to borrow	-0.134***	-0.206***	-0.0749*	-0.141***
when income cut	(0.0433)	(0.0409)	(0.0447)	(0.0426)
Employed Spouse	-0.289***	-0.253***	-0.223***	-0.181**
	(0.0715)	(0.0685)	(0.0741)	(0.0716)
Self-Employed Spouse	0.121**	0.00808	0.186***	0.0834
	(0.0600)	(0.0566)	(0.0615)	(0.0587)
Not-Employed Spouse	0.00486	0.121	0.102	0.223**
	(0.112)	(0.103)	(0.109)	(0.0950)
Race: Black	-0.724***	-0.765***	-0.947***	-1.005***
	(0.0770)	(0.0733)	(0.0793)	(0.0754)
Race: Hispanic	-0.542***	-0.510***	-0.613***	-0.566***
	(0.0905)	(0.0883)	(0.0962)	(0.0942)
Race: Other	-0.390***	-0.124	-0.400***	-0.128
	(0.110)	(0.106)	(0.117)	(0.112)
Number of kids	-0.0792***	-0.114***	-0.0884***	-0.123***
	(0.0212)	(0.0199)	(0.0222)	(0.0209)
Low income intercept	-10.72***	-6.934***	-15.20***	-11.47***
	(1.089)	(1.062)	(1.161)	(1.095)
High income intercept	-6.314***	-8.514***	-2.603***	-4.676***
	(0.555)	(0.546)	(0.533)	(0.505)
Obs	13912	14004	13507	13598

Notes: All regressions include an age cubic and year effects. Estimates are based on five imputations from the SCF. The divide between high and low income is 10.99.

Table 5: GMM estimates of missing assets

	[1]	[2]	[3]	[4]	[5]
Missing assets A^M	2,730***	2,330***	1,940***	1,572***	1,728***
	-398.3	-324.9	-245.7	-402.4	-354.7
$\ln\theta$	0.286**	0.0547	-0.328***	0.470***	0.277**
	-0.117	-0.115	-0.118	-0.132	-0.126
Usually know next	0.147***	0.129***	0.0794***	0.155***	0.131***
year's income?	-0.0321	-0.0311	-0.0307	-0.0378	-0.0362
Everyone in household	0.306***	0.278***	0.201***	0.329***	0.286***
has health ins.	-0.0405	-0.0392	-0.0381	-0.049	-0.0462
High School	0.144***	0.111**	0.0346	0.198***	0.148**
	-0.0526	-0.051	-0.05	-0.0617	-0.0579
College	0.236***	0.176***	0.0292	0.301***	0.219***
	-0.0667	-0.0639	-0.0604	-0.0807	-0.0752
Fraction income	-0.0838**	-0.0514	0.033	-0.0704	-0.0425
housing < 0.05	-0.0403	-0.0397	-0.0412	-0.0475	-0.0464
Fraction income	-0.318***	-0.316***	-0.312***	-0.419***	-0.420***
housing	-0.0875	-0.0857	-0.0874	-0.102	-0.0984
Willing to borrow	0.0143	0.00602	-0.0266	0.0465	0.0377
when income cut	-0.0252	-0.0245	-0.0248	-0.0295	-0.0284
Employed Spouse	-0.0186	-0.0284	-0.0507	-0.0438	-0.0542
	-0.0393	-0.0383	-0.0391	-0.0448	-0.0431
Self-Employed Spouse	0.113***	0.0933***	0.0502	0.113***	0.0856**
	-0.0341	-0.0332	-0.0329	-0.0412	-0.0393
Not-Employed Spouse	0.0188	-0.00096	-0.0597	0.0976	0.0683
	-0.0714	-0.0688	-0.0665	-0.0874	-0.0842
Race: Black	-0.293***	-0.235***	-0.0873**	-0.335***	-0.246***
	-0.0437	-0.0422	-0.0405	-0.056	-0.052
Race: Hispanic	-0.241***	-0.213***	-0.146***	-0.302***	-0.267***
	-0.0443	-0.0429	-0.043	-0.0505	-0.0483
Race: Other	-0.221***	-0.225***	-0.251***	-0.193**	-0.187**
	-0.0677	-0.0662	-0.0675	-0.0789	-0.0768
Number of kids	-0.0277**	-0.0207*	-0.00665	-0.0265*	-0.0192
	-0.0119	-0.0115	-0.0114	-0.014	-0.0133
Borrow	1	0.5	0	1	0.5
Family	0	0	0	1	0.5
Obs	13020	13020	12904	9416	9416
Imputations	5	5	5	5	5

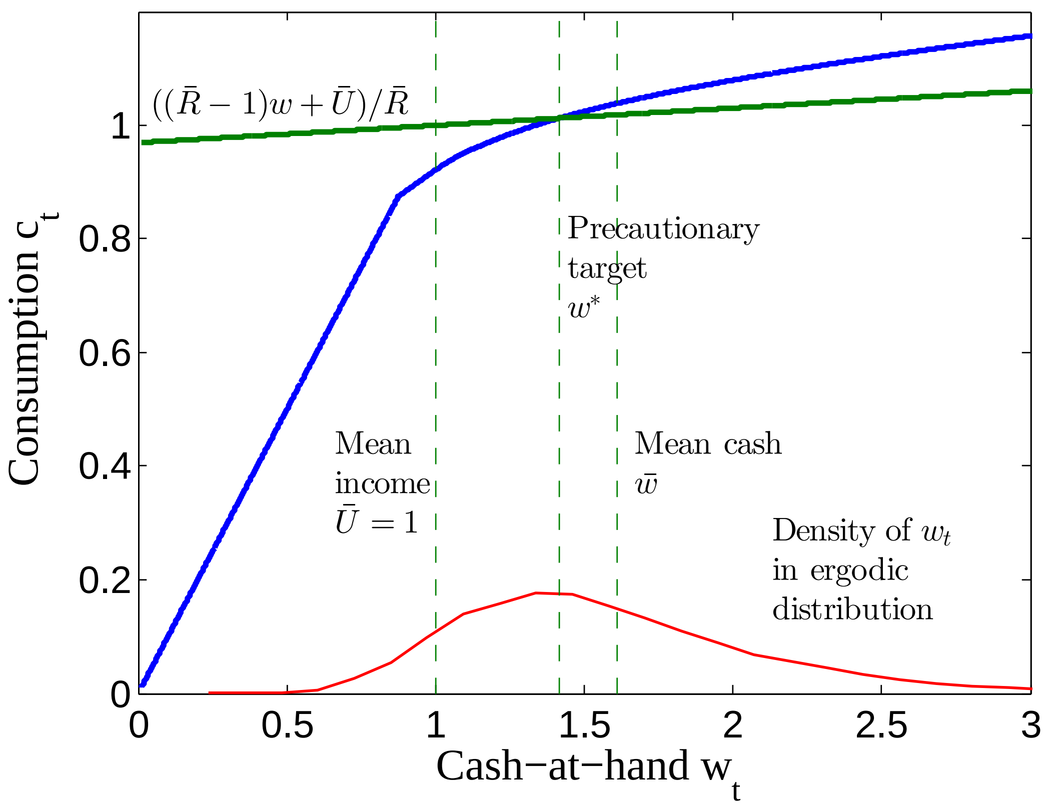
Notes: All regressions includes age cubic and year effects. Estimates are based on five imputations from SCF.

Table 6: Comparison of precautionary model predictions to the preferences of US households

	Paper or population								
	STY (2004)	CDK (2003)	JPP (2008)	GP (2002)	US Pop	High Income Employ.	Low Income Employ.	Keep 6 months income	Keep 1 month of income
log precautionary target - log permanent income	-0.274	-0.610	-0.749	-1.750	-1.994	-2.358	-2.265	-0.693	-2.485
Precautionary target assets to income ratio (months)	9.123	6.518	3.420	2.085	1.633	1.135	1.245	6	1
log mean assets - log permanent income	-0.067	-0.698		-1.344	-2.137	-1.581	-3.439		
log mean assets - log precautionary target	0.207	-0.088		0.406	-0.103	0.783	-1.112		
Parameters:									
CRRA γ	2.000	2.000	2.000	0.514					
Discount β	0.962	0.962	0.910	0.960					
Interest rate R	1.040	1.040	1.040	1.034					
Growth rate G	1.015	1.030	1.030	1.020					
Transitory σ_U^2	0.050	0.010	0.010	0.044					
Permanent σ_N^2	0.013	0.010	0.010	0.021					
Probality low income p_l	0.000	0.030	0.005	0.003					
Low-income		0.010		0.010					

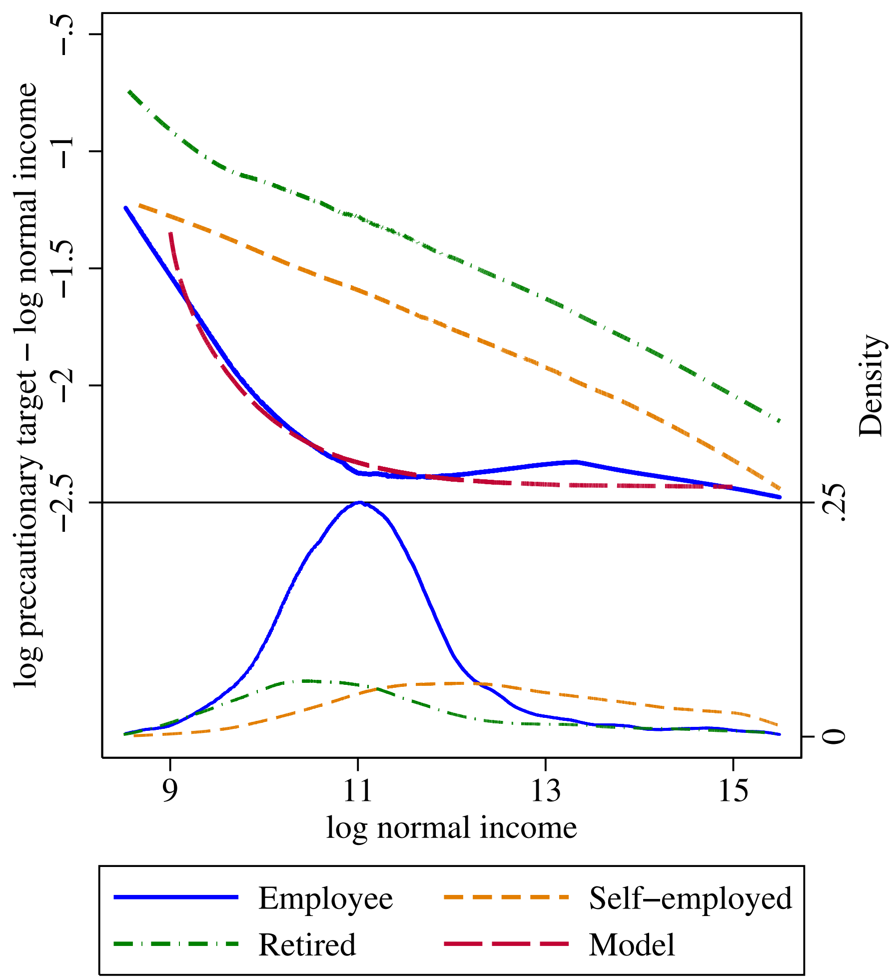
Notes: STY (2004): Storesletten, Telmer, and Yaron (2004); CDK (2003): Carroll, Dynan, and Krane (2003); JPP (2008): Jappelli, Padula, and Pistaferri (2008); GP (2002): Gourinchas and Parker (2002). Given the preferences and income process each column calculates the precautionary target and the mean of the ergodic distribution of assets implied by those preferences and income. For JPP (2008) I report the target wealth from their figure 1 with discount factor 0.91. My simulations produce nearly the same target using their parameters but it is useful to show robustness to programming error. When there is a discrete probability of low income with probability p_L the transitory shock U_{t+1} is the low income fraction. Otherwise the transitory shock is approximated with a 5 point Gaussian quadrature of a lognormal with location parameter zero and variance parameter σ_U^2. N_{t+1} is a 5 point Gaussian quadrature approximation of a lognormal with variance parameter σ_N^2 and the mean of $\ln N_{t+1} = 0$. Different assumptions about approximating the income distribution do affect the calculated a^* and $\bar{a}$ but tend to increase the target assets. The calculations from the SCF are survey weighted to be nationally representative. The income dividing high from low is 10.99 or \$59,278.

Figure 1: The consumption function



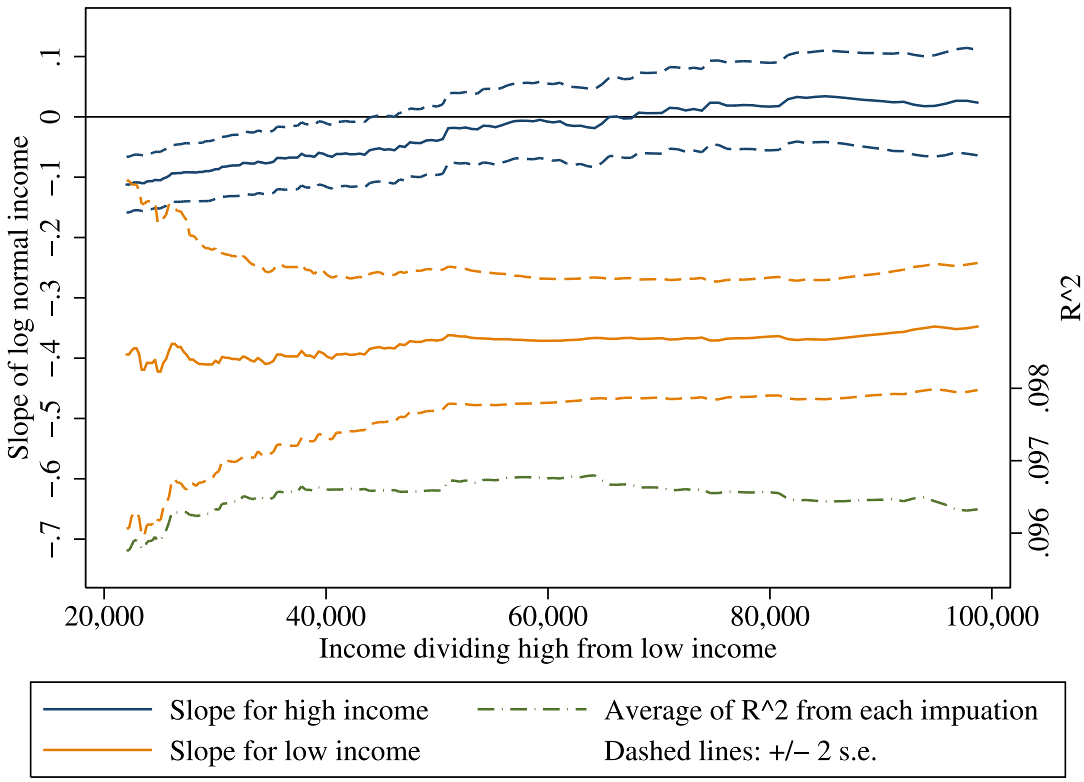
Notes: The outside income process U_{t+1} is a 5 point Gaussian quadrature of a log normal distribution with mean $\bar{U} = 1$, and variance parameter 0.0212, N_{t+1} is lognormal with mean one and variance parameter 0.0440 (as calculated from the PSID by Carroll and Samwick (1997)). Preferences are CRRA with $\gamma = 2$, and $\beta = 0.96$, and the interest rate is $R = 1.03$ and $G = 1.02$. The cash-at-hand distribution is taken after letting the wealth of 10,000 individuals evolve for 100 years, and is smoothed using a kernel density with bandwidth 0.1 (it is not to scale with the y-axis which is consumption). The value function is approximated using a cubic spline with routines from Miranda and Fackler (2002).

Figure 2: Semi-parametric relationship of income and emergency savings



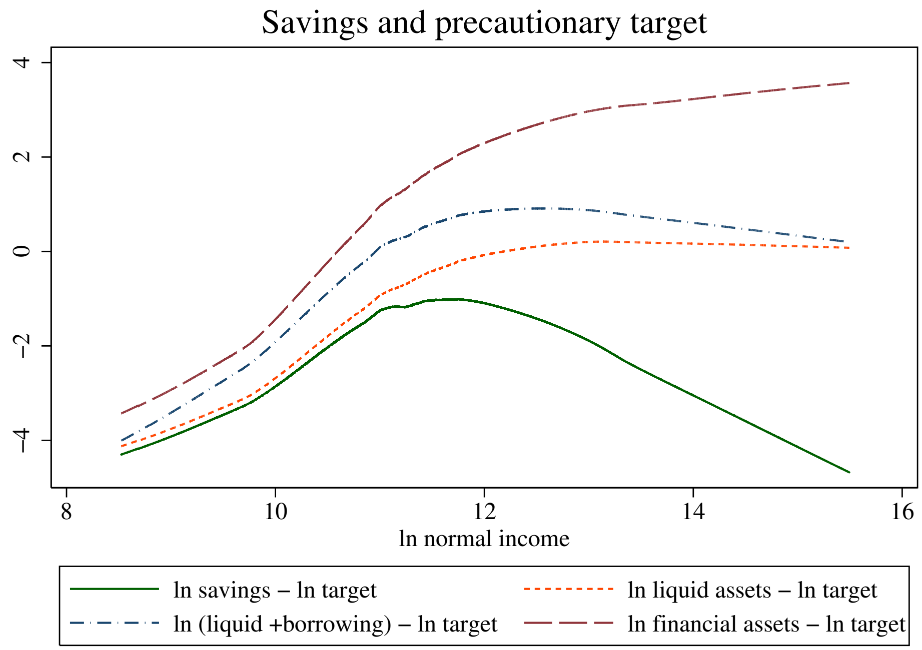
Notes: Shows the function f in $\ln \hat{A}_{it} - \ln P + it = Z_i\beta_i + f(\ln P_{it}) + \epsilon_i$ estimated using the Z_i shown in table 3. The locally weighted regression to estimate f and β are implement by Lokshin (2006) following Yatchew (1998). Survey weights are not included, and uses only one imputation.

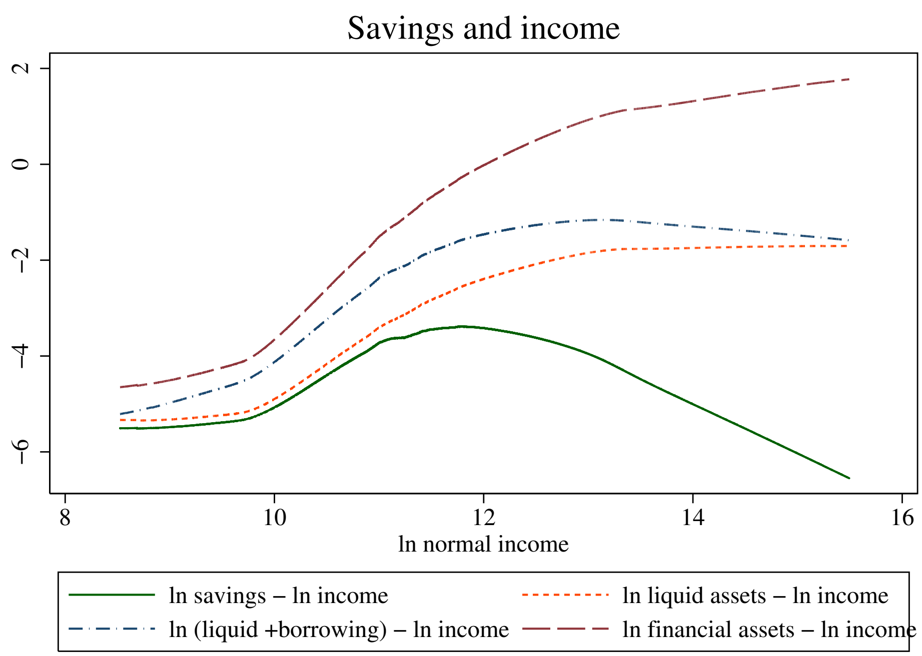
Figure 3: Coefficient on log income as income divide changes



Notes: Shows the coefficients on ln normal income and ln normal income × low income from regressions in column 3 of table 3 allowing the dividing income between high and low income to vary. All other covariates are the same. The dashed lines show plus or minus two standard errors for each coefficient. The bottom line shows the average R^2 from the regression on each imputation.

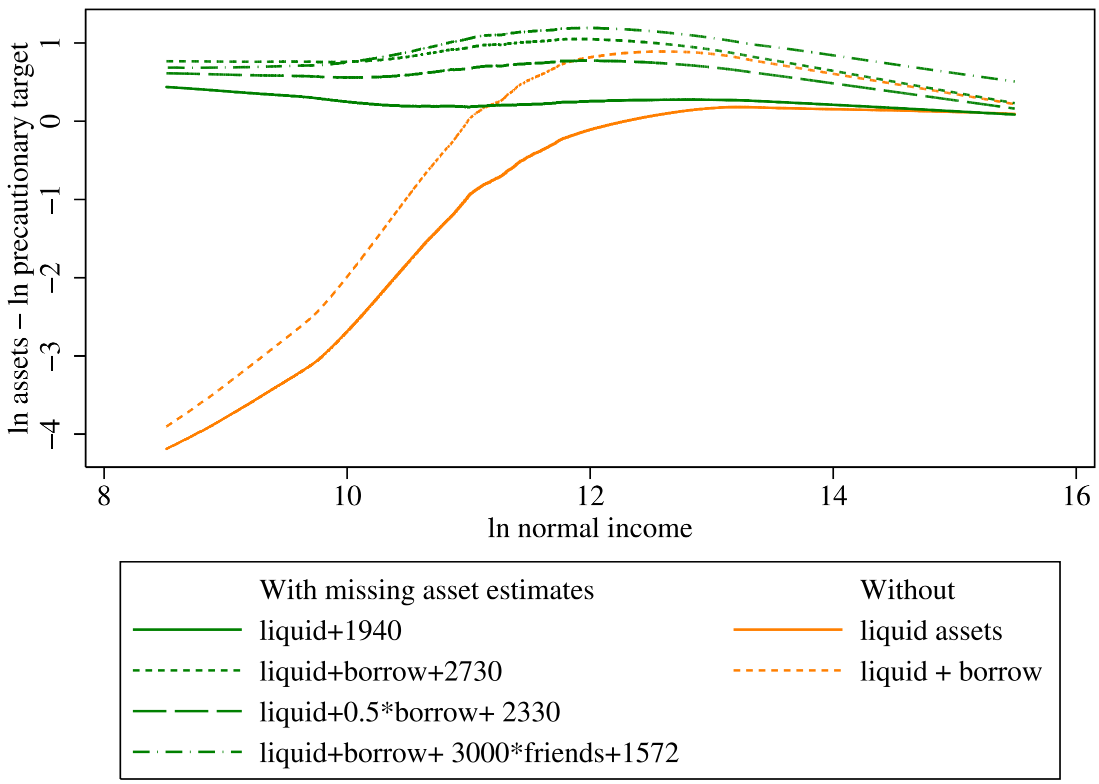
Figure 4: Relationship between target precautionary fund, assets, and income





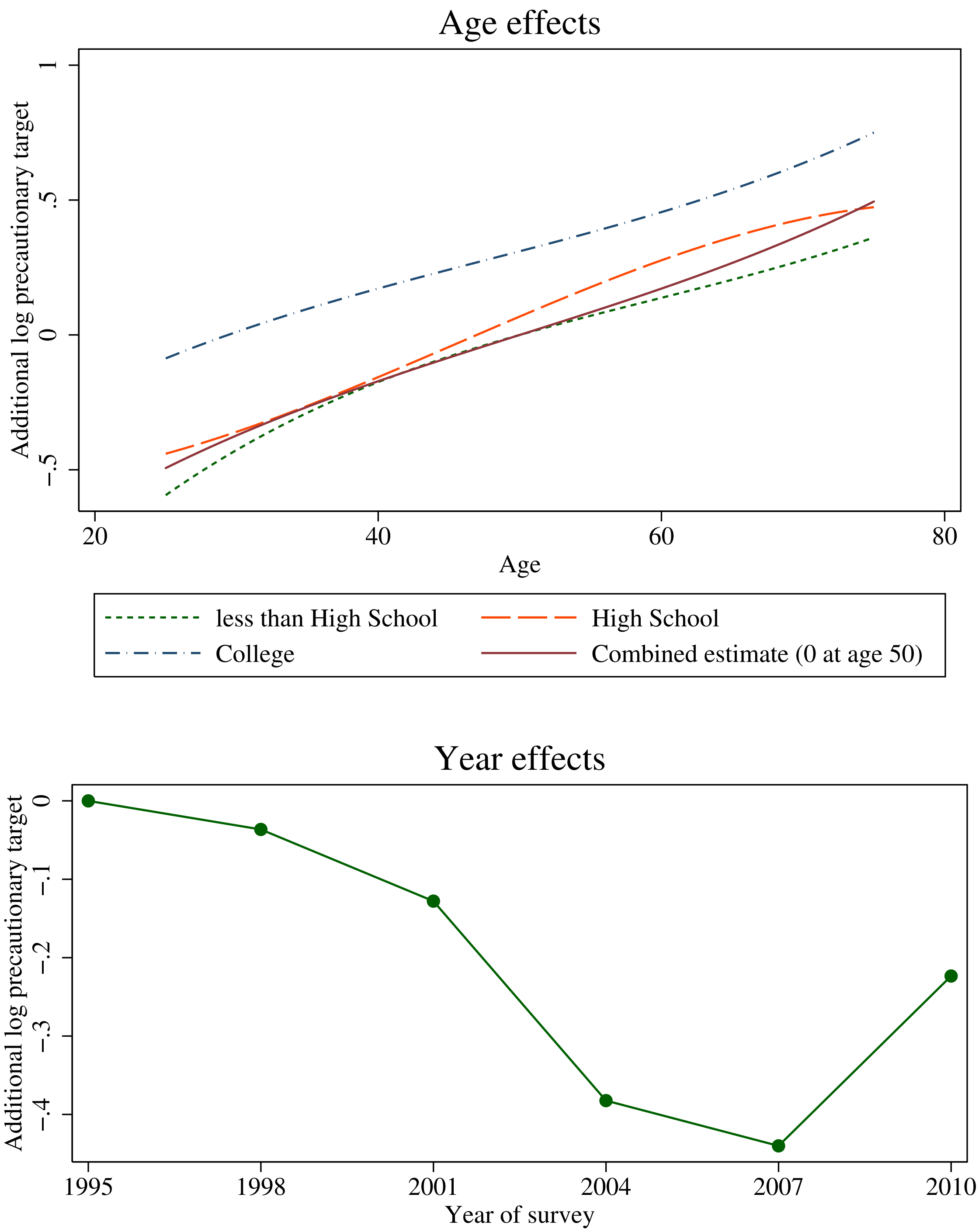
Notes: Local polynomial smoother. Borrowing is the available credit on credit cards (credit limit-current balance). Savings are funds reported in the savings and checking account. Liquid financial include all types of transactions accounts (savings, checking and money market). Financial assets are liquid financial assets plus stocks, bonds and liquid retirement accounts.

Figure 5: Accounting for missing assets



Notes: Missing assets are calculated by GMM in table 5. Local polynomial smoother. Borrowing is the available credit on credit cards (credit limit-current balance). Savings are funds reported in the savings and checking account. Liquid financial include all types of transactions accounts (savings, checking and money market).

Figure 6: Age and year effects on the precautionary target

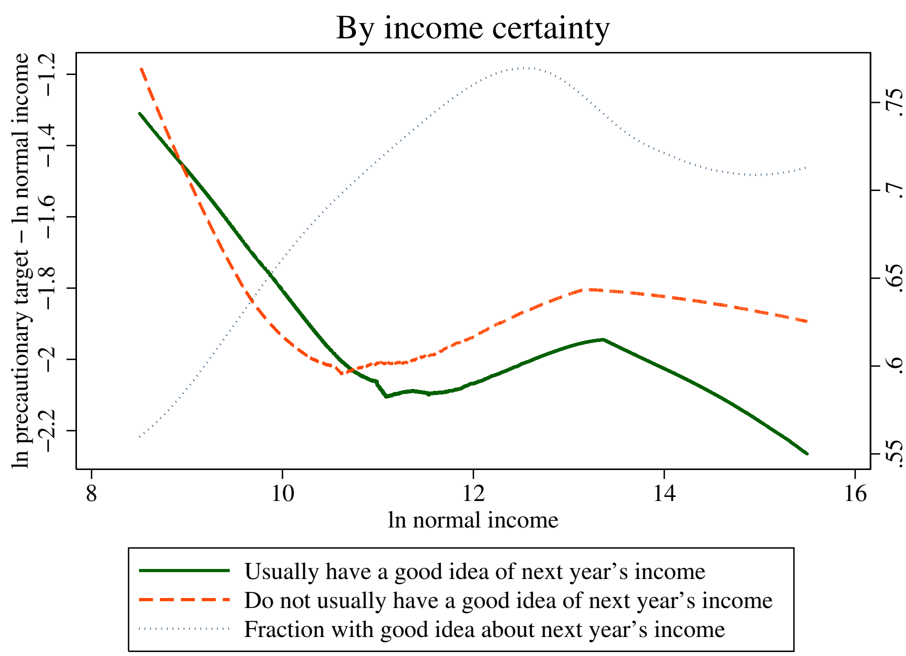


Notes: Shows the age and year effects from regressions in column 3 (Combined estimate) and column 5 (by education) in table 3. The effects with education include the level effect of education. The level of the combined effect is the below HS effect. Year effects are 0 in 1995 (the excluded year).

Figure 7: Non-parametric effects on the precautionary fund

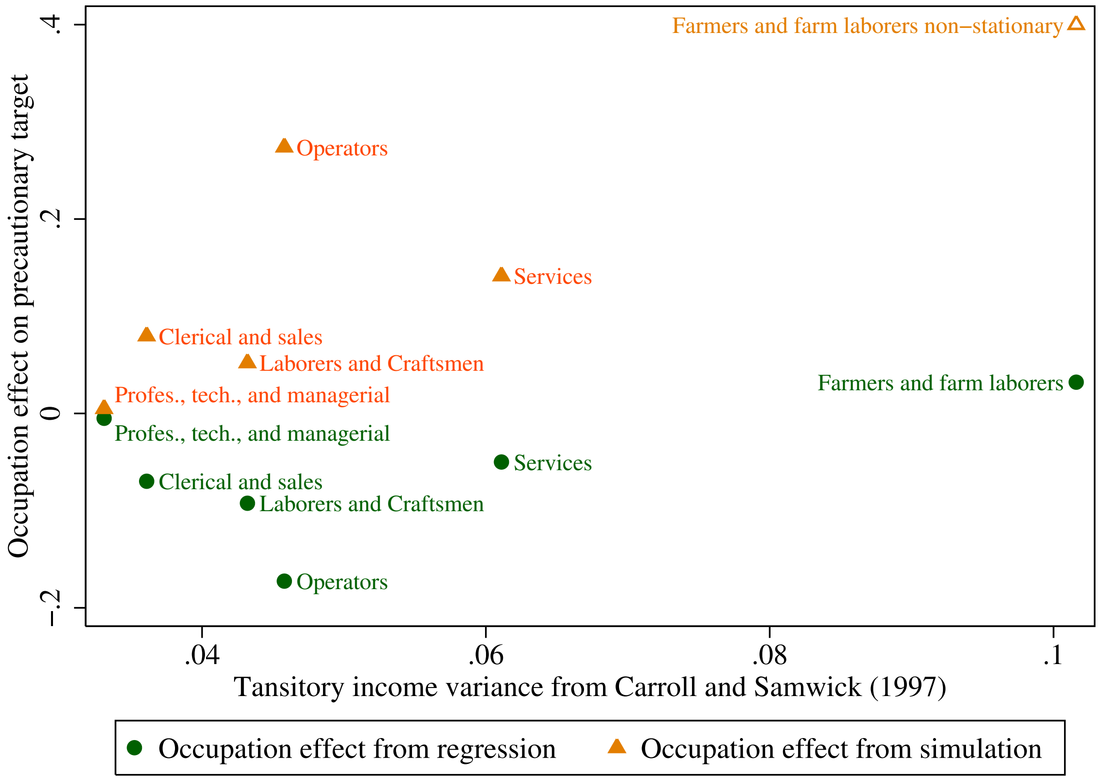
Notes: Shows the raw effect of dividing the population by each category on the desired precautionary fund. No other variables are included in the locally weighted regressions. The fraction of households in each category is on the right axis. The income density in the survey which is centered at about 10.7 is shown in figure 2.

Figure 8: Non-parametric effect of income certainty on precautionary fund



Notes: Shows the raw effect of dividing the population into those who are generally certain about income next year, and those who are not. No other variables are included in the locally weighted regressions. The fraction of households in each category is on the right axis. The income density in the survey which is centered at about 10.7 is shown in figure 2.

Figure 9: Occupation, income variance, and the precautionary target



Notes: The regression effects are the occupation effects from column 6 of table 3. The x-axis gives the transitory variance of income for that occupation as calculated by Carroll and Samwick (1997) from the PSID. The occupation categories available in the public version of the SCF do not coincide exactly with the Carroll and Samwick (1997) categories, but are very close. See text. The simulation effects show the effect of changing the permanent and transitory income for each occupation, and calculated relative to Professional, Technical and Managerial to match the regression effects. The other simulation parameters are: $\gamma = 2$, $\beta = .96$, $R = 1.03$, $G = 1.02$ a nine node Gaussian approximation of the income process. Given these parameters Farmers and farm laborers do not have an ergodic distribution: they want to accumulate indefinitely. The simulations use code from Miranda and Fackler (2002).