How Important Is Precautionary Saving?

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October 15, 1996

Abstract

We estimate how much of the wealth of a sample of PSID respondents is held because some households face more income uncertainty than others. We begin by solving a theoretical model of saving, which we use to develop appropriate measures of uncertainty. We then regress measures of wealth on our measures of uncertainty, and find evidence that households engage in precautionary saving. Finally, we simulate the wealth distribution that our empirical results imply would prevail if all households had the same uncertainty as the lowest-uncertainty group. We find that between 39 and 46 percent of wealth in our sample is attributable to the extra uncertainty that some consumers face compared to the lowest-uncertainty group.

Keywords: Precautionary saving, uncertainty, wealth, buffer stock saving, income distribution

JEL Classification Codes: D91, E21

We would like to thank three anonymous referees, Angus Deaton, Karen Dynan, Janice Eberly, Eric Engen, Jonathan Gruber, Jerry Hausman, Glenn Hubbard, Spencer Krane, Robin Lumsdaine, Joseph Mattey, Mark McClellan, James Poterba, Karl Scholz, James Stock, Jonathan Skinner, Stephen Zeldes, and seminar participants at the Federal Reserve Board and the North American Winter Meetings of the Econometric Society, 1993, for useful comments. The views expressed are those of the authors and do not necessarily reflect the views of the Board of Governors or the staff of the Federal Reserve System. Financial support from the National Institute of Aging and the Lynde and Harry Bradley Foundation is gratefully acknowledged.

I. Introduction

Several recent empirical papers have attempted to determine the proportion of either aggregate or household wealth attributable to precautionary saving. Unfortunately, theoretically plausible precautionary saving models are difficult to solve and have been thought to imply no well-defined relationship between wealth and any simple measure of uncertainty.[1] Empirical papers have therefore used theoretically implausible models whose chief appeal is their ability to generate a closed-form solution to serve as an econometric specification.[2] The range of results from such models is disturbingly large: Guiso, Jappelli, and Terlizzese (1992) state that “precautionary saving accounts for 2 percent of households' net worth,” while Dardanoni (1991) claims that “more than 60 percent of savings ... arise as a precaution against future income risk.”[3]

A major obstacle to empirical estimation of theoretically atttractive models has been that theory provides no analytical result that tells the researcher exactly how to specify uncertainty. In principle, optimal behavior depends upon even the minutest details of the income distribution, so that, for example, two distributions which exhibit the same mean and variance might induce quite different precautionary saving. The first contribution of this paper is to show that, in practice, if households behave according to a “buffer-stock” model of saving like that described in Deaton (1991) or Carroll (1992, 1997), there are at least two simple measures of uncertainty that are highly correlated with the “target” amount of precautionary wealth that consumers will seek to hold. The first measure is based on a theoretical construct derived by Kimball (1990a), the

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[1]By "theoretically plausible" we mean, at a minimum, models in which the consumer's utility function exhibits Decreasing Absolute Risk Aversion (DARA). See Kimball (1990b, 1991) for arguments that utility is of the DARA form. The most commonly used specific model in this class is one where the utility function is of the Constant Relative Risk Aversion (CRRA) form.

[2]The empirical papers generally assume that utility is of the Constant Absolute Risk Aversion (CARA) form. See Kimball (1990b) or Deaton (1992) for arguments that CARA utility is implausible.

Equivalent Precautionary Premium (EPP); the second is an atheoretical measure, the log of the variance of the log of income (LVARLY). We show that the buffer-stock model predicts a roughly linear relationship between the log of target wealth and either LVARLY or a normalized version of the EPP which we call the Relative Equivalent Precautionary Premium (REPP).

Armed with this specification, we next turn to empirical estimation of the relationship between wealth and uncertainty. For each household in our PSID sample, we calculate an estimate of REPP and LVARLY, and then, using instrumental variables to overcome substantial measurement error problems, we estimate the empirical relationship between log wealth and REPP and LVARLY. For our sample of consumers younger than age 50,[4] we find a statistically significant relationship between all tested measures of wealth and both measures of uncertainty.

In the final section of the paper we use our empirical estimates to answer the question in the title of the paper. We find that setting the uncertainty of every household to the smallest predicted uncertainty for *any* household would reduce total net worth of households under 50 by about 44 percent; would reduce their net worth exclusive of housing and business equity by 46 percent; and would reduce their holdings of very liquid assets by 39 percent. We also show that the fraction of wealth attributable to income uncertainty is greater at lower deciles of the permanent income distribution.

II. The Theoretical Framework

The Consumer's Intertemporal Optimization Problem

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[3] For a much more detailed discussion of the existing literature, see the working paper version of this paper, Carroll and Samwick (1995a).

[4] We restrict our sample to households under age 50 because previous work (Carroll and Samwick (1995b), Carroll (1997)) has argued that those consumers behave according to the buffer-stock model of saving which we use to derive our econometric estimating equation.

The model of precautionary saving that forms the basis of our empirical work is a variant of the "buffer-stock" models developed by Deaton (1991) and Carroll (1992, 1997). Carroll (1992, 1997) shows that these models imply that consumers will have a target wealth-to-income ratio such that if wealth is above the target, consumption will exceed income and wealth will fall, and if wealth is below the target income will exceed consumption and wealth will rise. Carroll (1992) argues that this model is consistent with a variety of characteristics of macroeconomic data on consumption and saving, and Carroll (1994, 1997), Carroll and Samwick (1995b), and Gourinchas and Parker (1996) find support for the model using microeconomic data.

The particular version of the buffer-stock model considered here imposes liquidity constraints directly, as in Deaton (1991), although similar results can be obtained in a version without liquidity constraints.[5] Specifically, the consumer is assumed to solve the following problem:

[5]We chose to impose liquidity constraints here because it simplifies the task of constructing an appropriate distribution function for the income shocks; see the discussion below of our kernel estimates of the distribution function.

$$
(1) \qquad \max_{C_s} \sum_{t=s}^{T} \beta^{t-s} u(C_t)
$$

$$
\text{s.t.} \quad \begin{aligned} Y_t &= PV_t \\ X_t &= R[X_{t-1} - C_{t-1}] + Y_t \\ W_t &\geq 0 \end{aligned}
$$

where $X_t = Y_t + W_t$ is the stock of physical resources available for spending in period t, R = (1+r) is the gross interest rate, $\beta = 1/(1+\delta)$ is the discount factor (δ is the discount rate), Y_t is the total labor income of the household in period t, P is the permanent labor income of the household (that is, the income that would be earned if there were no transitory shocks), and V_t is the multiplicative transitory shock to income in period t. The utility function is of the Constant Relative Risk Aversion (CRRA) form: $u(c) = c^{(1-\rho)}/(1-\rho)$, where ρ is the coefficient of relative risk aversion. We assume that the V_t are i.i.d. and will use empirical distribution functions calculated from the PSID data to estimate the distribution of the V_t.[6] Our choice of a CRRA utility function guarantees that the consumers in this model will engage in precautionary saving; the coefficient of relative risk aversion ρ indexes the strength of both risk aversion and prudence. The drawback of assuming CRRA utility is that there is no closed-form solution for the level of consumption, wealth, or saving as a function of uncertainty. We therefore must solve the model numerically.

The principal necessary condition for generating buffer-stock saving behavior is that, if income were certain, consumers would wish to spend more than their current income; the analytical condition which guarantees this in the continuous-time version of the model with only transitory shocks to income is $\rho^{-1}(r-\delta) < g$, where g is the expected growth rate of income (see

[6]We also discuss the consequences for our results if there is a permanent as well as a transitory component to income shocks.

Carroll (1996) for a derivation).[7] The particular values we choose for solving the model are $\rho = 3$, $\delta = 0.04$, $r = 0$, and $g = 0.02$ (drawn from Carroll (1992, 1997)), but the results of the analysis in this section are similar under a broad range of other parameter values so long as consumers are prudent ($\rho > 0$) and impatient ($\rho^{-1}(r-\delta) < g$).

Measuring Income Uncertainty

The only measure of uncertainty we know of which is based even loosely on the general theory of precautionary saving is the Equivalent Precautionary Premium (EPP) defined by Kimball (1990a). Suppose consumption is distributed randomly with a multiplicative shock X around a level $\bar{c}$, $c = \bar{c}X$. In this case, in a two period model Kimball's EPP is defined by the amount ψ such that:

$$u'(\bar{c} - \Psi) = E[u'(c)]$$

Kimball shows that the EPP is, in essence, a direct measure of the *intensity* of the precautionary saving motive *at the point of zero precautionary saving.* Under our CRRA utility function, $u'(c) = c^{-\rho}$, implying that we can solve for ψ:

$$(\bar{c} - \Psi) = [Ec^{-\rho}]^{-(1/\rho)} = [E(\bar{c}X)^{-\rho}]^{-(1/\rho)} = \bar{c}[E(X)^{-\rho}]^{-(1/\rho)}$$
$$\Psi = \bar{c}(1 - [E(X)^{-\rho}]^{-(1/\rho)})$$

For our later empirical purposes, a scaleless measure of relative uncertainty is more useful; such a measure is given by $\psi/\bar{c} = 1 - E[X^{-\rho}]^{-1/\rho}$. We will call this measure the Relative Equivalent Precautionary Premium (REPP).

[7] The discrete-time version is $(R\beta)^{-(1/\rho)} < G$, where $G = 1+g$. The economic logic behind these equations is as follows. A standard result for the continuous time CRRA utility model without income uncertainty or liquidity constraints is that the desired growth rate of consumption is $\rho^{-1}(r-\delta)$. Consider a consumer with zero assets. If the desired growth rate of consumption is below the growth rate of income, then if the intertemporal budget constraint is to be satisfied it must be true

Because total consumption is not reported in the PSID, we cannot construct a measure of uncertainty that corresponds exactly to the REPP.[8] Instead, we follow Carroll (1994) in substituting permanent and actual income for average and actual consumption (respectively) in the REPP formula; strictly speaking, this is a ‘loose’ measure of the REPP and be identical to the true REPP only if the household always consumed exactly its income.[9]

Our second candidate measure of uncertainty is the variance of income. Previous work has usually assumed that utility is CARA (i.e. u(c) = -exp(-θc)/θ), and that the shock to income is additive and distributed normally with a variance of σ^2. These assumptions have been motivated by the fact that they imply an exact linear relationship between consumption and uncertainty; in particular, under these assumptions the EPP has a theoretical value of $\theta\sigma^2/2$.[10]

The final measure of uncertainty we examine is the variance of the log of income. While there is no formal theoretical justification for using this measure, we examine it because it is relatively easy to calculate and is familiar to most economists.

Estimating Alternative Distribution Functions for Income Shocks

In order to examine the model's predictions about the relationship between target wealth and income uncertainty, we must solve the model under an array of different assumptions about the distribution of shocks to income. We therefore turned to the PSID, which contains the kind

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that the level of consumption is above the level of income, and so such a consumer would be running down his net worth.

[8]Food consumption and selected other components of consumption are measured, but the quality of these data to are too poor to produce credible results about the extent of uncertainty.

[9]Because prudent households build up a "buffer-stock" of assets precisely to insure consumption against shocks to income, the random element in consumption will be less variable than $Y_{i,t}$. The relationship between the two, however, is monotonic; increases in the variability of $V_{i,t}$ will increase the variability of consumption.

[10]Because the shock is additive rather than multiplicative, there is no reason to scale the EPP by c to get the REPP. Using Kimball's notation, the EPP (ψ) is determined by the equation:

$$e^{-\theta(\bar{c}-y)} = E\,[e^{-\theta c}] = e^{-\theta(c-\theta\sigma^2/2)}$$

of panel data on income necessary to calculate distributions of shocks to income. Our method was as follows. We divided our PSID sample into subsamples corresponding to the eight occupation categories, twelve industry categories, and six education categories to which the head of household could belong, for a total of 26 different groups.[11] For each household i, we calculated $V_{i,t}$ as the ratio of observed income in year t to the mean (detrended) income over all seven years of the sample period. We treated each of these as an independent realization of V. Thus, if there are n households in a given group, this technique produces 7n observations on V for that group. The empirical CDFs of these V's for each of the 26 groups were then approximated by twenty-point kernel estimators. Using these kernel estimates of the distribution of shocks to income for each of the 26 groups, we then solved the buffer-stock model described above and calculated the model's implied target wealth-to-income ratio. We also calculated the average value of the REPP, the variance of income (VARY), and the variance of the log of income (VARLY) for each of the categories.

Target Wealth as a Function of Uncertainty

Even the theoretically preferred measure of uncertainty, the REPP, does not have a closed-form analytical relationship with the target wealth-to-income ratio, so further theoretical work is required to find an appropriate specification to characterize the relationship between uncertainty and wealth.

Define w* as the target wealth-to-income ratio predicted by the theoretical model. Figure 1a plots the log of w* for consumers facing each distribution of income against the REPP

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[11] Each consumer in our dataset thus appears in three of these groups, one corresponding to his occupation, one to his education, and one to his industry group. We could not subdivide the sample much further because in order to estimate a

calculated for that distribution. Figure 1b plots log w* against VARY, the theoretically appropriate measure of uncertainty under CARA utility. Comparison of the two figures confirms that VARY is not as closely related to target wealth as is REPP, as expected from the theoretical discussion. Figure 1c plots log w* against VARLY. Somewhat to our surprise, this atheoretical measure of uncertainty appears to perform a bit *better* than the REPP in explaining target wealth holdings; we discuss implications of this finding below.

Table 1 formalizes the message of the figures using univariate regressions of log w* on the various measures of income uncertainty. The first three lines of the table represent the regressions whose fitted lines are plotted in Figures 1a through 1c. The table confirms that the variance of the (detrended real) level of income is considerably less useful in explaining the model's predicted target wealth than is either REPP or VARLY.[12] The third regression confirms another apparent result of Figures 1a-c: VARLY is more closely related than is REPP to the theoretical target wealth ratio. The second set of regressions considers the relationship between log w* and the log of the same three measures of uncertainty. Based on the goodness of fit measure, the REPP performs slightly worse and the VARY measure performs slightly better than in the first set of regressions, but their relative ranking is unchanged. The striking result is that when estimated in a constant elasticity specification, the log of VARLY (henceforth LVARLY) performs even better than VARLY itself, with a t-statistic of 40.85 and an R^2 of 0.9852.

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distribution function precisely it is necessary to have a relatively large number of observations of the process.

[12] One possible objection to our procedure for constructing REPP and relating target wealth to it is that we used the same ρ in solving the model and in constructing our measure of REPP. When using REPP to analyze actual household wealth data, we do not know the "true" value of ρ; our procedure would be problematic if the relationship between REPP calculated with a given ρ were a bad indicator of the target wealth that would result from assuming a different ρ. We checked whether this was a problem by calculating REPP under several different plausible assumptions about ρ, and regressing the target wealth generated for our baseline value of ρ on the REPP calculated for non-baseline values of ρ. In all cases we found R^2's not much different from those in Table 1; in our later empirical results, we also experimented with different values of ρ and found

For simplicity, in our empirical work we wished to narrow the field of potential measures of uncertainty to two. We chose the REPP for its theoretical appeal and LVARLY because it performs better than any other measure in Table 1.[13,14]

Our conclusion from Table 1 is that the buffer-stock model implies that the relationship between income uncertainty and the wealth-to-income ratio can be well represented econometrically by an equation based on:

$$\log\left(\frac{W}{P}\right) = a_0 + a_1\omega \tag{2}$$

where ω is a measure of uncertainty, either REPP or LVARLY.

IV. Empirical Estimation of the Model

Basic Specification

Our econometric specification is based on (2). Adding log(P) to both sides and adding an error term ν gives:

$$\log(W) = a_0 + a_1\omega + \log(P) + v \tag{3}$$

Our final specification is a slightly more general version of this equation:

$$\log(W) = a_0 + a_1\omega + a_2\log(P) + a_3'Z + v \tag{4}$$

where the Z variables are demographic controls for age, race, sex, marital status, and the number of children.

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little difference in the econometric results.

[13]We also performed the analysis using all the measures of uncertainty in Table 1. We found that results for REPP, LVARLY and LVARY were approximately equally good, and the results for all of these measures were substantially better than the results for the other three measures.

[14] One way to gauge how problematic our assumption of independent shocks may be is to examine the consequences if there are both transitory and permanent shocks to income, but we nevertheless use the procedures outlined above to construct measures of uncertainty and then regress log w* on those measures of uncertainty. We report the results of this experiment

The buffer-stock model of saving presented above assumes that there is only one, perfectly liquid, asset. The model's predictions about target wealth concern total net worth held in this single asset. We therefore estimate equation (4) using total net worth (NW) as the dependent variable. In reality, of course, consumers can invest in a wide range of assets which differ, among other ways, in their degree of liquidity. Illiquid assets may be less useful as a safeguard against bad income shocks because of the extra time or money required to turn them into the cash needed to meet emergency expenses or to replace income. It would therefore not be surprising to find that holdings of more liquid assets are more sensitive to uncertainty. Consequently, we also estimate equation (4) for two progressively more liquid measures of wealth (the exact components of which are detailed in the Appendix): net worth excluding equity in the main home and in personally owned businesses (non-housing, non-business wealth, NHNBW), and very liquid assets (VLA) which can be liquidated on short notice with small transactions costs.

In the absence of a theoretical framework that explicitly incorporates liquidity, we simply note that the proposition that precautionary balances should be held in highly liquid forms is not necessarily correct. If the main motivation in holding precautionary assets is to self-insure against rare but large shocks to income (such as a prolonged spell of unemployment),[15] it may well be worthwhile to pay the transactions costs required to liquidate illiquid assets in the rare case that such an awful event actually occurs. Moreover, because our VLA measure does not

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in the working paper version of this paper, Carroll and Samwick (1995b). We find that there is still an approximately linear relationship between REPP or LVARLY and the log of the target wealth ratio.

[15]Carroll (1992) solves a buffer stock model with lognormal shocks to annual transitory and permanent income and with a small probability that income goes to zero for the entire year, which he interprets as long spells of unemployment. Despite the assumption that such events are very rare, he finds that a large fraction of the buffer is attributable to the fear of

subtract any debts from the measured assets, it is only weakly related to the concept of net worth in our model. As a result, the case for preferring one measure of wealth over the other two is not particularly strong.

Because our econometric specification was derived from a model in which all consumers engage in buffer-stock saving, our estimating equation is justified only for a data sample in which households can plausibly be expected to be buffer-stock savers. Carroll (1992, 1997), Samwick (1994), and Carroll and Samwick (1995) argue that a variety of empirical evidence is consistent with the view that households engage in buffer-stock saving behavior until roughly age 50, but behave differently in the years immediately preceding retirement. In order to obtain a sample in which theory suggests consumers might conform to the model, we initially limit our sample to households in which the head is no older than 50 during the sample period.

The final issue to be addressed before presenting the estimation results is the nature and justification of the instrumenting procedure used. Because at the level of the individual household both uncertainty and permanent income are unquestionably measured with considerable error, they must be instrumented if we are to obtain consistent coefficient estimates. Our instrument set contains dummies for the occupation, education, and industry of the head of household in 1981, along with the demographic variables already contained in Z. We also interacted the occupation and education variables with the age and age^2 terms in order to allow for different lifetime profiles of income and uncertainty for different occupation and educational groups. (The set of instruments is described fully in the Appendix).

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these zero income events rather than to the annual transitory and permanent shocks.

Results for our estimates of equation (4) for all three measures of wealth, and for both measures of uncertainty, are presented in Table 2.[16] The coefficients on the REPP and LVARLY terms are highly significant for all three measures of wealth, with VLA receiving a somewhat lower coefficient than NHNBW or NW.[17] The statistical significance of the uncertainty terms increases as the measure of wealth becomes more comprehensive, and for a given wealth measure, the coefficients on the REPP and LVARLY terms are of approximately equal statistical significance.[18] Although the coefficient estimates on REPP are larger than predicted in Table 1, they are not statistically significantly larger. On the other hand, the coefficients on LVARLY are significantly lower than predicted in Table 1; however they are not significantly different from coefficients the model regressions will produce under alternative assumptions about the income process (see Carroll and Samwick (1995a), Table 2 for details).

Our instrumental variables specification is econometrically identified by the exclusion of occupation, education, and industry variables from the regression of wealth on uncertainty. We test this assumption by performing the standard heteroskedasticity-robust overidentification test from Hansen (1982); results are reported in the last column of the table. In no case does the OID test reject the model at the 5 percent level, but when total net worth is the dependent variable the model is rejected at the 10 percent level for both measures of uncertainty.

This exclusion restriction assumes that these variables have no predictive power for wealth other than through their correlations with permanent income and with uncertainty.

[16]In constructing REPP, we assumed a coefficient of relative risk aversion of three, for consistency with the simulation results in Table 1. We also tried coefficients of 2 and 5; the empirical results were not materially different.

[17]Heteroskedasticity tests rejected the null hypothesis of homoskedasticity at the 5 percent level, so all standard errors are heteroskedasticity-robust.

[18]These variables are also highly correlated with each other, and regressions (not reported) in which both measures are

Carroll (1997) shows that in buffer-stock models the target wealth-to-income ratio is indeed determined largely by the degree of uncertainty and the coefficient of relative risk aversion, and is comparatively insensitive to the growth rate of income, the interest rate, and other variables which may also differ systematically across the industry-occupation-education groups in our sample. In this framework it would therefore not be surprising to find that instruments have little explanatory power for wealth beyond the information they contain about uncertainty.

As a robustness check of the results in Table 2, Table 3 reports the coefficient estimate on REPP and the standard error and t-statistic when we make a variety of changes in our sample and specification (results were similar when LVARLY was the measure of uncertainty). Results for all tests are first presented for the case where the measure of wealth is VLA, then for NHNBW then for total net worth NW.

When we extend the sample to include consumers who were over age 50 (but still younger than 63) during our sample period the coefficient estimates increase (for all three measures of wealth), although the standard errors increase even more, resulting in lower t-statistics. This is consistent with the theoretical predictions of the buffer-stock model; Carroll and Samwick (1995b) show that a buffer-stock model implies that wealth is considerably more responsive to uncertainty in the immediate preretirement period than during the earlier part of the life cycle.

The next set of experiments reports the results when farmers and the self-employed are excluded from the sample. When both groups are excluded the coefficient estimate on REPP declines, by an average (across the three wealth measures) of about 40 percent of its original value, and the p-values against the hypothesis that the coefficient on REPP is zero hover around

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included find that neither measure is individually significant.

0.10 for all three wealth measures. When either farmers or the self-employed remain in the sample, however, the coefficient estimates remain relatively close to their initial values and retain a high degree of statistical significance.

The final set of tests adds occupation then education to the set of control variables. When occupation is added, the results are generally similar to the results when farmers and the self-employed are excluded from the sample. Further data analysis indicates that the effect on the coefficient estimate is, as one might expect, primarily the result of the dummies for farmers and the self-employed. When education is added (and occupation again excluded), there is little effect on the coefficient estimates or their significance.

The sensitivity of our results to the inclusion of farmers and the self-employed bears closer examination. As indicated in appendix table B, both measures of certainty are much higher for these two groups than for any other occupation groups. Tabulations of wealth (mean, median, or other quantiles) by occupation find that these two groups are substantially richer than the rest of the population. What we learn from the regressions is that there are apparently no other covariates included in our control set which explain why these two groups have high wealth. Our interpretation of these findings is that farmers and the self-employed provide exactly the kind of variation in the independent variable which is very valuable in identifying the coefficient on uncertainty, and hence these groups should remain in the sample.

Two well-known previous studies (Friedman (1957) and Skinner (1988)) failed to find higher than average saving for farmers and the self-employed, and speculated that consumers who are risk-averse tend to avoid these two occupations because of the great income uncertainty they exhibit. Both of these studies, however, used measures of flow saving (income minus consumption) rather than wealth. Measurement error for flow saving is likely to be particularly severe, however, for these two groups, partly because of the difficulty of distinguishing business expenditures (on motor vehicles, for instance) from personal consumption.

Of course, it remains possible that there is a selection effect of the kind Friedman and Skinner speculated about. If present, however, such an effect would bias our coefficient estimates downward relative to the true coefficients. The reader should therefore bear in mind that, to the extent that such selection effects exist, our estimates of the extent of precautionary saving may be too small.

V. How Would Wealth Change if There Were Less Uncertainty?

The econometric estimates of the sensitivity of wealth to uncertainty in Table 2 can be used to determine the impact of income uncertainty on the aggregate wealth distribution for the consumers in our sample. We use the empirical model to simulate the distribution of wealth that would prevail if all households faced the same, small, amount of uncertainty, instead of the amount of uncertainty they actually faced in our data.[19] The second-stage regressions presented in Table 2 using the REPP generate a wealth equation for each household:[20]

$$\log(W_i) = a_0 + a_1 \, REPP_i + a_2 \log(P_i) + a_3' Z_i + v_i \tag{5}$$

where $REPP_i$ is the instrumented estimate of income uncertainty. The equation fits exactly because the estimation errors v_i are defined as the difference between the predicted value of log

[19] We did not set uncertainty to zero because the model's coefficient estimates were obtained in a region of the data very far from zero uncertainty, and it is well known that even models which perform well in-sample can do a very poor job forecasting behavior in regions far from the space spanned by the data sample.

[20] The simulation results were similar when we used LVARLY.

wealth and the actual value.[21] We construct a new measure of wealth, W_i^*, such that:

$$\log(W_i^*) = \log(W_i) - a_1 \left[REPP_i - REPP^* \right] \tag{6}$$

which should tell us how wealth would change if uncertainty were to change from $REPP_i$ to REPP*. Implications about the aggregate wealth distribution can then be derived by aggregating up these simulated values for all the individual households.

Our choice for REPP* is the minimum predicted value of $REPP_i$ in the sample.[22] This corresponds to the uncertainty that would be faced by the consumer in the sample with the least risky set of characteristics, e.g. a high degree of education, a job in public administration, etc. Figure 3 plots the simulated values of the log(NHNBW) measure of wealth against the true distribution of log(NHNBW).* Specifically, two points are plotted for each household in the sample: (w_i, p_i) and (w_i^*, p_i) where p_i indicates the percentile ranking for household *i* in the true wealth distribution, w_i indicates the log of actual wealth W_i, and w_i^* indicates the simulated value of the log of wealth for that household when $REPP_i$ is set to the chosen value of $REPP^*$ (i.e. $\log(W_i^*)$ in equation (6)). All simulated wealth points lie to the left of the actual wealth distribution, because everyone's uncertainty has been reduced (except the household that already had the minimum predicted value of REPP).

Simulated aggregate wealth is given by the sum of the simulated wealth of the individual households. The top panel of table 4 shows how aggregate wealth in our sample should change if everyone's uncertainty were set to REPP*. The first row shows that reducing every household's uncertainty to the minimum predicted value reduces aggregate very liquid assets by 39 percent,

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[21]These v_i are the residuals from the second stage of the 2SLS regressions; they are not the IV residuals.

[22] Recall that the $REPP_i$ here are the predicted, not the measured, values of REPP. If we were to use the measured values,

aggregate non-housing, non-business wealth by 46 percent, and total net worth by 44 percent. The next three rows of the table present the results for simulations in which $REPP^*$ is set to the 10th, 25th, and 50th percentiles of $REPP_i$'s predicted value.

Statements about how aggregate wealth would change in our sample are a good guide to the effects on aggregate wealth in the US population only if our sample is representative of the population. Carroll and Samwick (1995a) perform detailed comparisons of the demographic and other household characteristics of our PSID sample to the corresponding statistics in the population, and generally find that our sample is very similar to the comparable portion of the population. Curtin, Juster, and Morgan (1989) present a detailed comparison of the PSID and the *Survey of Consumer Finances* (SCF) measures of wealth, and find that the PSID agrees with the SCF over most of the distribution of wealth; only at the top end do the surveys differ significantly. The discrepancy at the top is not surprising; in large part, the SCF was developed because the existing wealth surveys (like the PSID) tend to underestimate wealth at the very top of the distribution.

If the difference between the aggregate estimates of wealth in the PSID and the SCF is entirely due to the PSID's undersampling of the wealthy, it is possible to use the information in the SCF to calculate a lower bound on the precautionary component of US aggregate wealth for consumers like those in our sample by assuming that the *none* of the wealth missed by the PSID is precautionary wealth. The second panel of Table 4 presents such lower-bound estimates for the under-50 population in the US. We find that setting uncertainty to the lowest predicted value in the sample would reduce very liquid assets by 25 percent, NHNBW by 48 percent, and

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we would probably choose a consumer for whom measurement error in uncertainty was large and negative.

total net worth by 36 percent.[23]

VI. Conclusion

The absence of a simple measure of uncertainty that embodies all of the relevant characteristics of a stochastic income distribution has plagued empirical analyses of whether precautionary saving is an economically important phenomenon. The first contribution of this paper is to show that if consumers behave according to a buffer-stock model of saving and face plausible distributions of income shocks, the relationship between the log of target wealth and income uncertainty should be approximately linear when the measure of income uncertainty is based on either Kimball's (1990a) Relative Equivalent Precautionary Premium (REPP) or the log of the variance of the log of income (LVARLY). Our principal econometric finding is that wealth holdings are indeed positively and significantly related to income uncertainty for various measures of wealth and both the REPP and the LVARLY measures of uncertainty.

Simulations of the econometric model suggest that approximately a third of total net worth, almost half of non-housing, non-business wealth, and about a quarter of very liquid assets of households younger than age 50 are held as a precaution against the systematically greater uncertainty that some households face as compared with others. Our finding that less of very liquid assets than of non-housing, non-business wealth is attributable to precautionary saving suggests that the bulk of precautionary saving exists to insure against relatively large shocks--perhaps substantial spells of unemployment--compared to which the cost of liquidating moderately illiquid assets is small.

[23] The adjustment factors, representing the ratio of PSID to SCF wealth in each category, are 0.64 for VLA, 1.05 for NHNBW, and .81 for NW. The 1.05 figure for NHNBW reflects the fact that the PSID misses a substantial amount of mortgage debt at the upper reaches of the income distribution, and so it *overestimates* NHNBW compared to the SCF.

An important limitation of our approach is that it does not directly address the question of the proportion of the wealth of consumers over age 50 (or of the entire population) that can be attributed to precautionary saving behavior. However, our empirical results (and those of Carroll (1997) and Carroll and Samwick (1995b)) are consistent with a parameterization of the life cycle model under uncertainty which implies that consumers engage in buffer-stock saving behavior until around age 50 and switch over to traditional life cycle retirement saving thereafter. A natural extension would be to estimate the proportion of total wealth attributable to uncertainty, or to differentials in uncertainty across households, by performing simulations like those of Hubbard, Skinner, and Zeldes (1994, 1995) but under parameter values that generate buffer-stock saving behavior consistent with our empirical results for consumers under the age of 50.

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Appendix

1) Sample restrictions imposed

Several restrictions are imposed on the sample drawn from the PSID to ensure that observed fluctuations in income over the sample period 1981 - 1987 are not unduly influenced by (possibly planned) demographic transitions. The number of observations eliminated with each such restriction or by missing values for key variables are given in the following table:

Sample Restriction	Number of Households Eliminated	Number of Households Remaining
Full Sample		8129
No households from the supplemental Survey of Economic Opportunity (poverty subsample)	3783	4346
No households with the head younger than 26 in 1981	596	3750
No households with the head older than 62 in 1987	796	2954
No households with the head older than 50 in 1981	572	2382
Head of household in 1981 is head for all years 1981-1987.	894	1488
Marital status of head of household is the same in all years 1981-1987.	213	1275
Head of household is in the labor force in 1981 (occupation is reported).	81	1194
Nonmissing industry and education reported in 1981.	33	1161
Nonmissing labor income data reported in all years 1981-1987.	3	1158

All tables below and analyses within the text that depend only on income data use this sample of 1158 households. The number of observations in each regression in Table 3 is also affected by the availability of wealth data as defined in section (4) of this Appendix.

2) The set of instrumental variables

Throughout the empirical section, we make use of a set of variables to instrument for income uncertainty and permanent income. They are:

A) Household composition

Appendix Table A

Variable	Description	Comment
Age	Age in years	Sample mean is 35.6 years.
Age^2	Square of age	
Married	Marital status indicator	83.1% of household heads are married.
White	Race indicator	91.8% of household heads are white.
Female	Sex indicator	11.5% of household heads are female.
Kids	# of children under age 18	Sample mean is 1.4 children.

B) Indicator variables for occupation

Appendix Table B

Occupation group	Mean REPP	Mean LVARLY	Percent of sample
Professional and Technical Workers	0.086	-3.828	23.7
Managers (not self-employed)	0.092	-3.623	11.6
Managers (self-employed)	0.161	-2.601	4.3
Clerical and Sales Workers	0.100	-3.486	14.2
Craftsmen	0.093	-3.527	20.5
Operatives and Laborers	0.132	-3.154	17.2
Farmers and Farm Laborers	0.301	-1.919	2.7
Service Workers	0.115	-3.301	6.0

The occupation variables are also interacted with Age and Age^2 to allow for occupation-specific age-income and age-uncertainty profiles.

C) Indicator variables for education

Appendix Table C

Education group	Mean REPP	Mean LVARLY	Percent of sample
0-8 Grades	0.151	-2.851	3.71
9-12 Grades	0.130	-3.086	9.50
High School Diploma	0.127	-3.318	18.57
Some College, No Degree	0.098	-3.499	39.38
College Degree	0.097	-3.617	19.86
Some Advanced Education	0.104	-3.704	8.98

The education variables are also interacted with Age and Age^2 to allow for education-specific age-income and age-uncertainty profiles.

D) Indicator variables for industry

Appendix Table D

Industry Group	Mean REPP	Mean LVARLY	Percent of sample
Agriculture, Forestry, Fishing	0.243	-2.241	3.97
Mining	0.067	-3.861	1.12
Construction	0.149	-2.925	6.65
Manufacturing	0.099	-3.479	28.58
Transportation, Communications, and Utilities	0.088	-3.658	10.62
Wholesale and Retail Trade	0.121	-3.252	14.68
Finance, Insurance, and Real Estate	0.100	-3.475	4.75
Business and Repair Services	0.103	-3.544	3.71
Personal Services	0.165	-2.597	1.55
Entertainment and Recreation Services	0.098	-3.387	0.50

Professional and Related Services	0.101	-3.642	15.98
Public Administration	0.063	-4.069	7.77

3) The wealth regressions

The econometric specifications in Tables 3 and 4 have the household composition variables (A) as independent variables, along with permanent income and income uncertainty. The instrument set consists of all the variables given in (A) - (D) above.

4) Wealth measures

We use three measures of wealth constructed from the wealth supplement to the 1984 wave of the PSID. They are:

A) Very Liquid Assets (VLA)

Includes balances in checking accounts, savings accounts, money market funds, certificates of deposit, government savings bonds, Treasury bills, shares of stock in publicly held corporations, mutual funds, and investment trusts. Any such assets in IRA's are also included because they are not reported separately.

B) Non-Housing, Non-Business Wealth (NHNBW)

Includes VLA plus the net value of real estate other than the main home, including a second home, land, rental real estate, and money owed on a land contract; and the net value of vehicles, including cars, trucks, motor homes, trailers, and boats. Outstanding balances on credit cards, student loans, medical or legal bills, and loans from friends are subtracted.

C) Total Net Worth (NW)

Includes NHNBW plus the net equity in the main home and the net value of farms and businesses.

Sample statistics on these measures of wealth, taken from the sample of 1158 households for whom income uncertainty measures can be constructed, are given in the following table, with comparisons to an analogously constructed sample in the *Survey of Consumer Finances*, 1983.

Table 1

Regressions of Simulated Log of Target Wealth Ratios on Uncertainty Measures
Univariate Nonparametric Distributions of Shocks to Income Estimated from PSID

Uncertainty Specification	Constant	REPP	VARY	VARLY	Adjusted R^2
Level	-1.377 (15.49)	2.782 (13.40)			0.8772
Level	-0.564 (8.45)		1.105 (6.137)		0.5946
Level	-1.022 (33.21)			3.019 (27.67)	0.9683
Log	0.746 (8.76)	1.068 (11.65)			0.8434
Log	-0.361 (3.87)		0.448 (6.60)		0.6298
Log	0.947 (32.45)			0.8477 (40.85)	0.9852

Notes:
1) REPP: Relative Equivalent Precautionary Premium
VARY: Variance of Income
VARLY: Variance of Log(Income)

2) Each regression has 26 observations (8 occupation, 6 education, 12 industry groups)

3) Level (log) specifications use the level (log) of the uncertainty measures as regressors.

4) T-statistics are reported in parentheses.

Table 2

Instrumental Variables Regressions of Wealth on Income Uncertainty -- All Households 50 and Under

Uncertainty Wealth	Constant	Uncertainty	Income	Age	Age^2*10^{-3}	Married	White	Female	Kids	OID Test
REPP										
VLA (896 obs)	24.697** (3.120)	3.980* (1.837)	2.995** (0.292)	0.089 (0.103)	-0.090 (0.137)	-0.404 (0.244)	0.352 (0.218)	0.085 (0.174)	-0.233** (0.054)	0.264
NHNBW (860 obs)	16.282** (2.838)	5.352** (1.508)	2.057** (0.255)	0.196* (0.085)	-2.400* (1.131)	0.128 (0.207)	0.268 (0.193)	0.090 (0.176)	-0.111* (0.047)	0.293
NW (874 obs)	13.634** (2.607)	5.344** (1.480)	1.790** (0.231)	0.212* (0.089)	-2.371* (1.167)	0.587** (0.219)	0.388 (0.202)	0.071 (0.150)	-0.042 (0.050)	0.097
LVARLY										
VLA (896 obs)	24.095** (3.051)	0.368* (0.161)	3.048** (0.304)	0.127 (0.106)	-1.420 (1.423)	-0.493* (0.238)	0.322 (0.219)	0.081 (0.180)	-0.245** (0.055)	0.188
NHNBW (860 obs)	16.557** (2.946)	0.574** (0.166)	2.248** (0.303)	0.256** (0.091)	-3.242** (1.228)	-0.017 (0.210)	0.280 (0.193)	0.142 (0.185)	-0.130** (0.047)	0.277
NW (874 obs)	13.363** (2.449)	0.510** (0.129)	1.922** (0.247)	0.259** (0.089)	-3.023* (1.181)	0.460* (0.210)	0.418* (0.198)	0.097 (0.152)	-0.060 (0.051)	0.053

1) VLA - Very Liquid Assets; NHNBW - Non-housing, Non-business Wealth; NW - Total Net Worth
REPP - Equivalent Precautionary Premium; LVARLY - Log of Variance of Log Income Shocks
2) The first (second) 3 equations use REPP (LVARLY) as the measure of income uncertainty.
3) ** indicates significance at the 1 percent level, * indicates significance at the 5 percent level
4) All wealth and income values are in logs.
5) All observations with negative reported wealth are excluded.
6) OID test is the p-value from the heteroskedasticity-robust test of the overidentifying restrictions.
7) Heteroskedasticity-robust standard errors are reported in parentheses.
8) The set of instrumental variables is described in the Appendix.

Table 3				
Robustness Tests				
Experiment	Wealth Measure	Coefficient Estimate on REPP	Standard Error	t-statistic
Baseline Estimate	VLA	3.98	1.84	2.17
Add ages > 50	VLA	4.85	2.51	1.93
Exclude Farmers, SE	VLA	3.00	1.96	1.53
Exclude SE	VLA	4.22	2.06	2.05
Exclude Farmers	VLA	3.56	1.76	2.02
Occupation as control	VLA	2.92	1.99	1.46
Education as control	VLA	4.47	2.11	2.12
Baseline Estimate	NHNBW	5.35	1.51	3.55
Add ages > 50	NHNBW	6.56	4.10	1.59
Exclude Farmers, SE	NHNBW	2.95	1.56	1.90
Exclude SE	NHNBW	4.79	1.38	3.47
Exclude Farmers	NHNBW	4.54	1.90	2.39
Occupation as control	NHNBW	4.06	1.82	2.23
Education as control	NHNBW	5.22	1.79	2.92
Baseline Estimate	NW	5.34	1.48	3.61
Add ages > 50	NW	6.84	4.03	1.70
Exclude Farmers, SE	NW	2.24	1.65	1.36
Exclude SE	NW	4.37	1.65	2.65
Exclude Farmers	NW	4.50	1.59	2.84
Occupation as control	NW	2.87	1.82	1.57
Education as control	NW	5.81	1.70	3.44
1) All notes except 2), 3) and 6) from Table 2 apply.				

Table 4

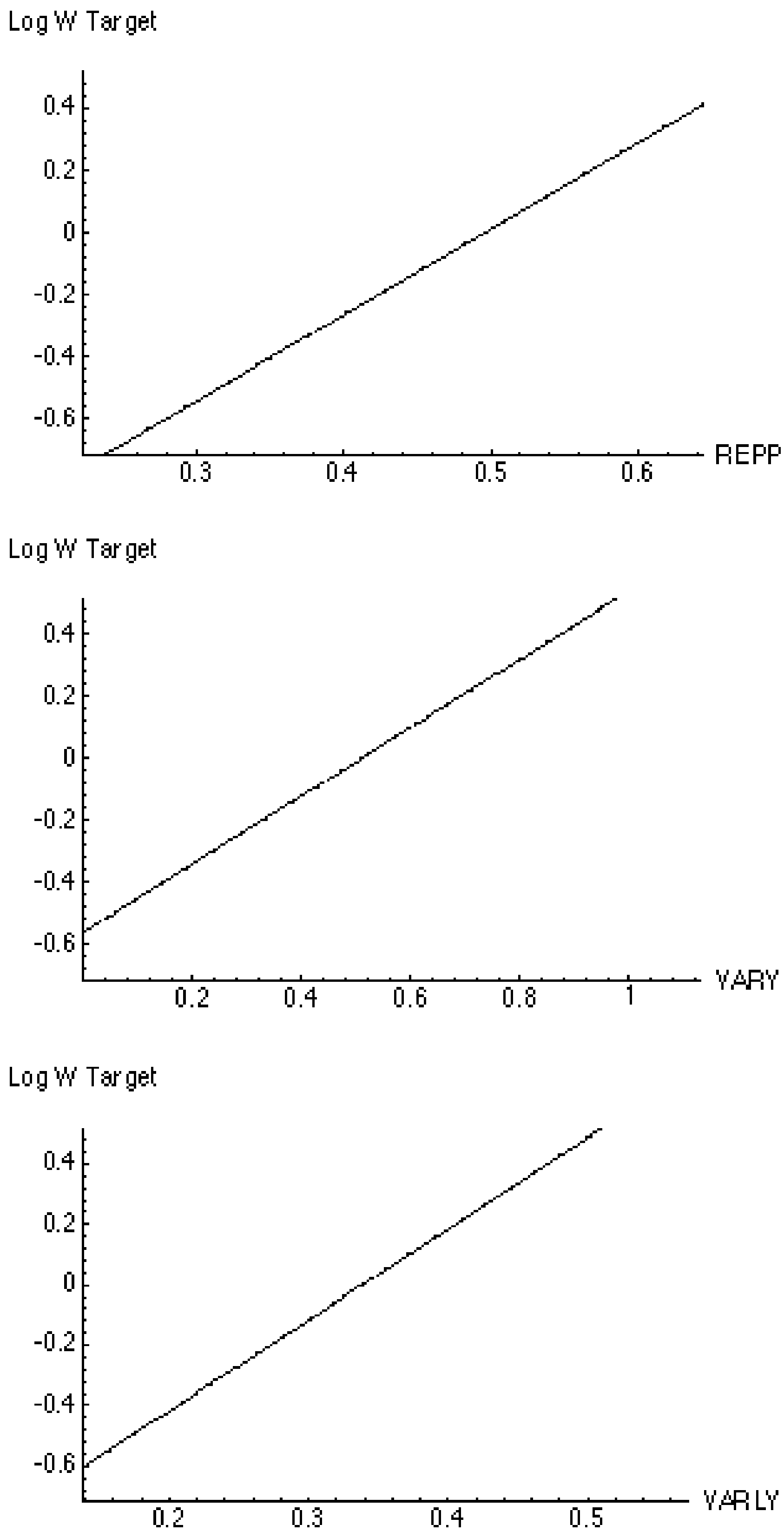
Simulated Reduction in Household Wealth for Fixed Relative Equivalent Precautionary Premiums

REPP Fixed at Percentile:	Very Liquid Assets	Non-housing, Non-business Wealth	Total Net Worth
Panel A: For Our Unadjusted PSID Sample of Households Under 50			
0	0.39	0.46	0.44
10	0.16	0.24	0.23
25	0.12	0.19	0.16
50	0.04	0.06	0.05
Panel B: For the US Population of Households Under 50			
0	0.25	0.48	0.36
10	0.10	0.25	0.19
25	0.08	0.20	0.13
50	0.3	0.06	0.04

Each cell contains the percent reduction in wealth holdings were each household to face a REPP equal to the value of the REPP at the specified percentile of the predicted REPP distribution instead of its actual REPP.

The calculation for the US population is a lower bound because it is based on the assumption that, of the wealth that the PSID misses, none is precautionary wealth.

Figure 1



Log W Target
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0.2
0
-0.2
-0.4
-0.6
0.3
0.4
0.5
0.6
REPP
Log W Target
0.4
0.2
0
-0.2
-0.4
-0.6
0.2
0.4
0.6
0.8
1
YARY
Log W Target
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YARLY

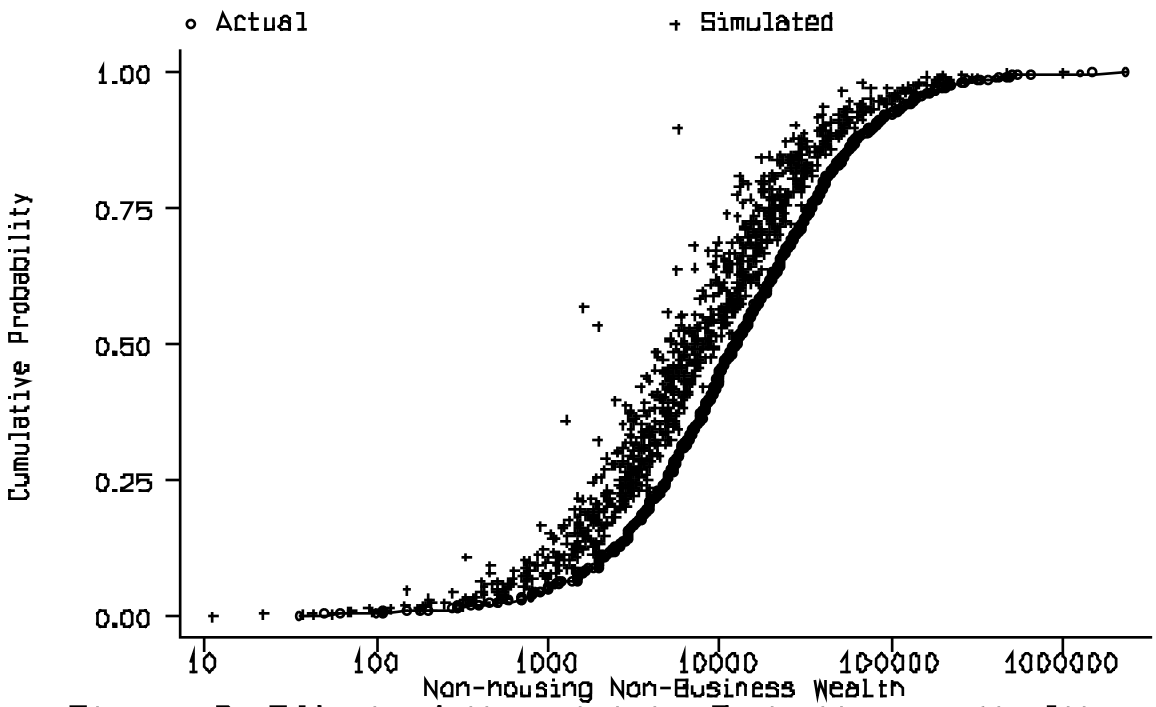

Figure 2: Effect of Uncertainty Reduction on Wealth

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