Did Household Consumption Become More Volatile?*
[SUBMITTED]

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January 8, 2009

Abstract

I show that after accounting for predictable variation arising from movements in real interest rates, preferences, income shocks, liquidity constraints and measurement errors, volatility of household consumption in the US increased between 1970 and 2004. For households headed by nonwhite and/or poorly educated individuals, this rise was significantly larger. This stands in sharp contrast with the dramatic fall in instability of the aggregate U.S. economy over the same period. Thus, while aggregate shocks affecting households fell over time, idiosyncratic shocks increased. This finding may lead to significant welfare implications.

Keywords: panel data, Euler estimation, consumption risk, aggregate volatility

JEL Classification: D80, D91, E21

*I am grateful to Orazio Attanasio, Christopher Carroll, Karen Dynan, Marjorie Flavin, Maia Güell, Brendan O'Flaherty, Bruce Preston, Bernard Salanié, Gary Solon, Jonathan Thomas, Stephen Zeldes and seminar participants at 2007 NBER Summer Institute on Aggregate Implications of Microeconomic Consumption Behavior, The Board of Governors of the Federal Reserve System, Columbia University, McGill University, University College London, and University of Edinburgh for their constructive criticism and very useful comments and suggestions. I would also like to thank Keshav Dogra for his excellent research assistance.

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1 Introduction

By now it is well documented that volatility of individual earnings increased substantially from the 1970s to early 1980s, was stable in the 1980s to early 1990s, and began to increase again since the mid 1990s.[1] Volatility of family income, both its permanent and transitory components, also increased substantially since 1970s.[2]

Greater income uncertainty, however, may not necessarily translate into welfare losses if people can find ways to smooth consumption. Having a good measure of the volatility of household consumption is thus fundamental to assessing whether, and to what extent, welfare was affected by increased income shocks. I provide a novel way to compute household level volatility of consumption, after accounting for predictable variation arising from movements in real interest rates, preferences, income shocks, as well as liquidity constraints and measurement errors, and show that examining changes of average income uncertainty might not be enough.

I use data from the Panel Study of Income Dynamics (PSID), the only source of panel data in the US that provides information on consumption, income, wealth and demographic characteristics at the level of disaggregation that this study requires. Given that the PSID consumption data is restricted to food,[3] the results are based on food consumption data[4] and therefore provide a conservative estimate of volatility of total household consumption. In order to make such exercise more realistic, I allow household utility function to be non-separable between consumption of food and other nondurables. The unit of observation is the household, the level at which consumption data is collected, and the unit relevant to

[1]See for example, Moffitt and Gottschalk [1994, 1998, 2002], Dynarski and Gruber [1997], Haider [2001], Hacker [2006], Dynan et al. [2007], Keys [2008], Shin and Solon [2008], Jensen and Shore [2008].

[2]See for example Dynan et al. [2007], Keys [2008], Shin and Solon [2008], and Jensen and Shore [2008].

[3]Expenditures on utilities, vehicles, and repairs are available but very sparse. PSID also provides data on housing costs.

[4]Another frequently used source of consumption data on household level, Consumer Expenditure Survey, is unsuitable for this study as it has a very short time dimension of only four quarters. CES data would require implementation of synthetic cohort techniques, which are inappropriate for this study as discussed in some detail in the next section.

most consumption decisions. The estimation recognizes and consciously controls for the fact that household consumption might change with changes in household composition.[5]

The theoretical literature on consumption volatility suggests that consumption is volatile because its growth rate responds to changes in permanent income and to unanticipated changes in transitory shocks (Campbell [1987]). For individuals who are liquidity constrained, consumption growth tracks some predictable changes in income as well (Meghir [2004]).[6] The implications for volatility of consumption are clear: if agents are unable to smooth consumption, volatility will be high.

I use a consumption model with nonseparable preferences for food and other nondurable goods, that also allows for measurement error in consumption and liquidity constraints. I find that after accounting for predictable variations in consumption due to changes in family composition and structure, real interest rates and income uncertainty (as a proxy for precautionary savings), and after controlling for measurement error in consumption, nonseparability of preferences, endogeneity in savings, and liquidity constraints, mean volatility of household food consumption increased between 1970 and 2004 by 6.5 percentage points or by 20 percent. Since a part of this increase is due to measurement error, the growth rate in volatility is likely to understate the actual percentage change.[7] I find that for households

[5]I control for household composition by including change in a number of adults, a number of children in the household, and a change in marital status variables. A different concern is that some household decisions are not necessarily collective. Without priors on how the intricacies of intra-household decision making should affect the consumption volatility measure, I do not attempt to establish or disentangle this possible decision making effect.

[6]Zeldes [1989] finds that for liquidity constrained households, defined by low asset holdings, growth rate in consumption responds to lagged income, while it does not for unconstrained households. Jappelli et al. [1998] show that using more direct measures of liquidity constraints than simple asset splits, the response of consumption growth to lagged income for the liquidity constrained households is even more significant than what Zeldes [1989] had demonstrated.

[7]The issue of measurement error arises if the assumption of stationarity of the growth rate of the measurement error is not satisfied, or if liquidity constraints are not fully controlled for. Thus, in this paper I always provide information on percentage point changes in addition to growth rates or levels in volatility series.

headed by nonwhite and/or poorly educated individuals, rise in volatility was significantly larger than for the average household. For households whose head was nonwhite and had no more than 12 years of education, volatility increased by 17 percentage points (or 53 percent). On the other hand, volatility rose by only 2 percentage points for households with more than 12 years of education irrespective of race of their head. Households whose marital status did not change throughout the sample in comparison to those whose status did change, experienced a much smaller increase in volatility, 3.6 percentage points versus 6 percentage points, respectively.

This work is directly related to the large literature on income and consumption inequality.[8] The main finding of this literature is that income inequality in the United States has increased over the last several decades and that this increase was at least partly attributable to the rise in transitory income shocks. Cutler and Katz [1991a,b] and Johnson et al. [1997] document that the sharp increase in income inequality of the early 1980s has been accompanied by an increase in consumption inequality. But Krueger and Perri [2006] point out that the increase in consumption inequality was less than that of income inequality, which is also consistent with Slesnick [2001]. Storesletten et al. [2004] find that inequality in earnings and consumption increases substantially between ages 23 and 60, though the increase in consumption is less than the increase in earnings, and that the increase in both is approximately linear. Keys [2008] adopts Moffitt and Gottschalk [1994] methodology and also finds that both transitory and permanent components of income and consumption shocks increased since 1970, particularly among low-income households.

Krueger and Perri [2006] conjecture that the increased income uncertainty was not only an important reason for the increased income inequality, but also helped the development of financial institutions which in turn allowed consumers to better insure against income risk. The findings of this paper, that realized consumption risk, computed using a *temporal* mea-

[8] See for example, Baker [1997], Gottschalk [1997] Moffitt and Gottschalk [1994, 2002], Katz and Autor [1999], Blundell and Pistaferri [2003], Gyourko and Tracy [2003], Storesletten et al. [2004], Attanasio et al. [2004], Krueger and Perri [2006], Blundell et al. [2008], Davis and Kahn [2008], Gordon and Dew-Becker [2008], Keys [2008], Primiceri and vanRens [2009], Heathcote [2009].

sure of volatility, *increased* for the average household between 1970 and 2004, put Krueger and Perri's conjecture in question at least to the extent that variability of food consumption is of concern. The most recent studies by Jensen and Shore [2008] and Keys [2008] find that average permanent income volatility as well as average transitory income volatility increased substantially since 1970s. Since there has been an increase in permanent income shocks, it is not all that surprising that consumption volatility has also increased.

While mean household consumption volatility increased, aggregate volatility of real GDP fell by 60 percent, between 1970 and 2004, since its peak in 1984.[9] Volatility of aggregate food consumption fell by 73 percent since its peak in 1976. I reconcile these diverging trends by showing that average covariances of food consumption growth rates across households fell dramatically between 1970 and 2004. In other words, while aggregate shocks affecting households fell over time, idiosyncratic shocks increased.

Even though the aggregate economy became more stable, an increase in household consumption volatility could well be detrimental to social welfare. The estimates of welfare costs from volatility of consumption range from near zero, Lucas [1987], to 7.5 percent of aggregate consumption per year (see for example, Beaudry and Pages [2001], Krebs [2003], Storesletten et al. [2004], Barlevy [2004]).[10] A back of the envelope calculation using the magnitude of the increase in volatility and its concentration among the disadvantaged groups, that this work documents, suggests a substantial increase in social cost during this period, between 1 and 2 percent of aggregate consumption per year.[11]

The rest of the paper is organized as follows. Section 2 describes PSID data used in the estimation and documents average variance of household consumption growth. In section 3, consumption model with nonseparable preferences, liquidity constraints and measurement error is presented and solved. Section 4 describes estimation of liquidity constraints, prefer-

[9]See for example McConnell and Perez-Quiros [2000], Blanchard and Simon [2001], Stock and Watson [2002] who find that the US economy became more stable since 1984. Aggregate volatility in these studies is constructed from National Income and Product Accounts data.

[10]See Barlevy [2005] for a comprehensive survey on the subject.

[11]These numbers are indicative of the order of magnitude only. A full welfare analysis is left for future research.

ence shocks, precautionary savings and provides results of the estimation of Euler equations with and without nonseparabilities of preferences. Section 5 presents the main results of the paper: estimations of consumption risk by different demographic categories. Section 6 proposes a way to reconcile trends in aggregate versus household level volatility series, and section 7 concludes.

2 Description of the Volatility of Household Food Consumption

2.1 Data and Variables

To analyze evolution of volatility of individual welfare I use the Panel Study of Income Dynamics (PSID). The PSID is the only cross-sectional time-series survey that collects data on household consumption. The Consumer Expenditure Survey (CEX) collects a more complete inventory of consumption data, but its structure as a repeated cross-section makes it impossible to construct individual volatility measures that track volatility for the same household over periods of time longer than one year.[12] Due to this major limitation, I use PSID data in this study.

Consumption data in PSID are limited to food and shelter. I discuss potential data extensions and their limitations in the Data Appendix. I compute all the consumption volatility measures on food consumption calculated as a sum of food consumed at home plus away from home plus food stamps received. Food consumption is also the choice variable

[12] Current work on inequality utilizes CEX data by constructing synthetic cohorts. This strategy is inappropriate here as my main concern is to provide a measure of temporal volatility for each household. Synthetic cohort techniques would require aggregation within cohorts, which in itself introduces a lot of data smoothing, and is exactly what I want to avoid. I plan to extend this study, at later date, by combining information from both PSID and CEX surveys. The information obtained from the two surveys will provide a more complete understanding of uncertainty faced by households in the US. It is unclear though whether this extra information will bring more benefit than cost, as it will introduce extra model uncertainty. Thus, interpretation of results on evolution of residuals squared might not be as clear cut as they are now.

in other studies of household consumption behavior,[13] and I feel that its use here enables complementarity and comparability with these studies. My utility specification will allow for the nonseparability of food consumption from other nondurable consumption goods in the utility function. I also disaggregate food consumption into subcategories in order to study the effect of shocks on normal (food at home) versus luxury (food away from home) good and show that this does not alter the results or conclusions. Since food consumption is well known to have low income elasticity, (see for example, Bunkers and Cochrane [1957]), the results presented in this study are a lower bound of what might have actually happened to volatility of total nondurable consumption.

The core sample contains data from 1968 to 2005, and consists of heads of households (both female and male) who are not students and are not retired. I keep households whose head is at least 25 years old but less than 65. I drop all the households that belonged to the Latino or Immigrant samples, and those that were drawn from the Survey of Economic Opportunity (SEO). Households that report negative or zero food consumption levels (that is a sum of food at home plus away from home plus food stamps) are also eliminated. In order to minimize effects of outliers on the results, I follow the literature by dropping households who report more than 300 percent change in family income or food consumption over a one year period as well as those whose income or consumption fall by more than 33 percent (see for example Zeldes [1989]). I also estimate results allowing change in log income to be outside these bounds to allow for major changes in household's income such as for example entrance and exits from unemployment. Definitions of all the variables used are included in the Appendix. Summary statistics can also be found in the Appendix, Table 5.

The most important issue to note regarding the data is that it became biennial after 1997. Thus, I compute all my results on annual data before 1997. I then construct a hypothetical biennial sample to study the evolution of consumption volatility upto 2004. Since income and consumption data is collected for previous year, the biennial sample has data for *even* years from 1976 to 2004. Issues related to matching contemporary observations on demographics

[13]See Hall and Mishkin [1982], Zeldes [1989] for earlier studies, and Hurst and Stafford [2004], Cox et al. [2004] for examples of recent work.

to the income/consumption data in the biennial sample are discussed in the data Appendix.

2.2 Preliminaries for Volatility of Household Food Consumption

By now it is well documented that volatility of men's earnings increased since 1970. In particular, volatility increased substantially from the 1970s to early 1980s, was stable in the 1980s to early 1990s, and began to increase again since the mid 1990s. Volatility of family income, on the other hand, was less widely studied. The most recent study by Jensen and Shore [2008] find that average permanent income volatility as well as average transitory income volatility increased substantially since 1970s, whereas median volatilities remained unchanged over the same period. This study also finds that households with higher education, or those with incomes above the median, or married households are less likely to have high levels of volatility of income.

Recent work by Dynan et al. [2007] document that family income volatility also increased since the 1970s, and in particular since the 1990s.[14] They also show that the probability of large increases in income (larger than 25%) increased from on average 9% between 1970 and 1990, to 15% by 2002; though this probability fell back to 9% by 2004. At the same time, probability of getting a large negative shock (larger than 25%) was stable around 9% until late 1990s, it increased substantially to almost 14% by 2004. In addition, Dynan et al. [2007] demonstrate that the magnitudes of income changes between the 25th and 90th percentiles have shifted little over time, but that the magnitude of changes at the 10th percentile has become much larger (in absolute value). Thus, they suggest that income volatility has increased over time primarily because of thickening in the tails of the percent-change distribution.

Of course increase in income volatility does not necessarily translate into higher welfare costs as members of household can smooth consumption by adjusting their working hours, borrowing or utilizing their savings. Thus, to analyze whether household's welfare was

[14] I confirm these findings and show that mean volatility of family income increased between 1970 and 2004 with my data. These results are available upon request.

affected by increases in income uncertainty, I examine what happened to the variability of household consumption.

I first construct a descriptive statistic that captures how the volatility of household food consumption evolved over the 1970-2004 period. The most common measure of volatility is variance based on the history of an economic variable. In the next section I present a model that will allow me to control for predictable variations in consumption growth as well as measurement errors and liquidity constraints.

To examine possible changes in volatility over time, I look at the growth rates of food consumption squared.[15] This method of computing volatility allows for historical comparisons though it is purely a descriptive statistic.

Since the measure of consumption volatility is based on food consumption alone, I first check whether by aggregating food consumption across households and then constructing 'aggregate' food consumption volatility measure, I get patterns similar to that of aggregate food consumption volatilities computed on NIPA data. I find that 'aggregate' food volatility in PSID is highly correlated with aggregate volatility of food consumption from NIPA, with correlation coefficients of 0.60.[16]

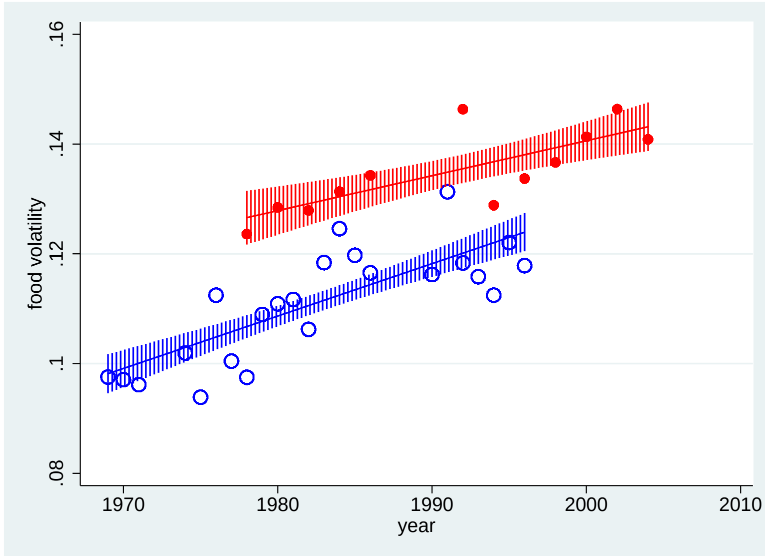
While aggregate volatility of the US economy fell substantially since 1984, average household consumption volatility rose. Figure 1 depicts average volatility of food consumption computed on annual and biannual growth rates, as well as a linear trend with 95% confidence interval. From this picture we see that the series have a strong positive trend. There has been a substantial increase in volatility of food consumption since 1970. This result holds for both annual and biennial data series.

Figure 2 disaggregates volatility by race and educational attainment. We see that the

[15] Blanchard and Simon [2001] use five-year moving variance of aggregate detrended (by typically using HP-filter) real GDP growth. Comin and Mulani [2006] use standard deviation of the growth rate of firm level sales. A similar measure can be constructed here by first detrending the consumption growth rate series by household specific trend. The results from such an exercise are qualitatively similar to the ones presented in this paper and are available upon request.

[16] 'Aggregate' volatility of family income in PSID also closely follows that of real GDP from NIPA, with correlation coefficient of 0.65.

Figure 1: Volatility of Food Consumption: Annual vs. Biennial Data



Hollow circles for volatility computed on annual growth rates, and filled circles for biennial data; with 95% confidence intervals.

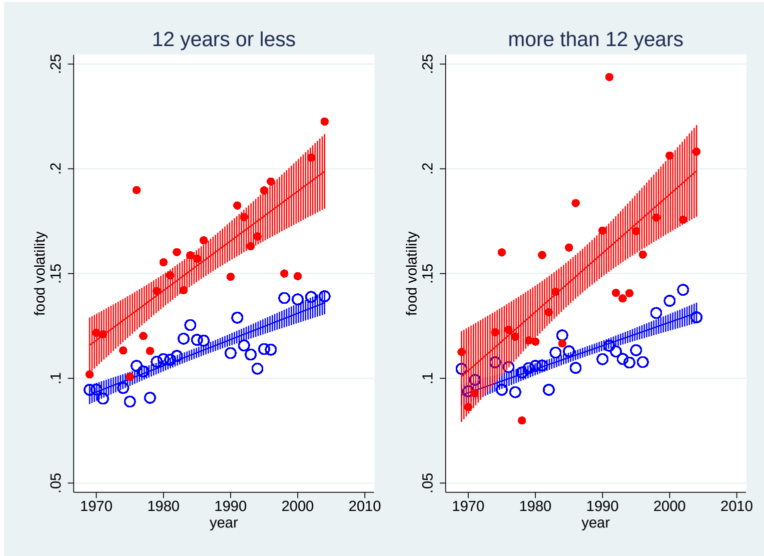
main differences are between white and nonwhite households. While mean volatility increased across all groups, white households experienced a lower level and a lower growth rate in volatility than nonwhite households.[17]

Figure 3 depicts volatility disaggregated by family types. Continuously married or cohabiting households experienced a much lower increase in volatility of consumption than single parent households. It is worth noting that though volatility increase is statistically significant for both groups, consumption volatility of single parents is substantially more variable than that for married households.

Davis and Kahn [2008] using cross-sectional data from Consumer Expenditure Survey which has a very short panel dimension – 4 quarters of data over one year, compute volatility of consumption as absolute value of log change in consumption expenditures for each household and then average over households. They also find that volatility of total non-

[17]In what follows, whenever I refer to a family by a demographic category, I always refer to the head of the household. Thus, if I call a family white, it means that the family is headed by a white individual.

Figure 2: Volatility of Food Consumption by Race and Educational Attainment

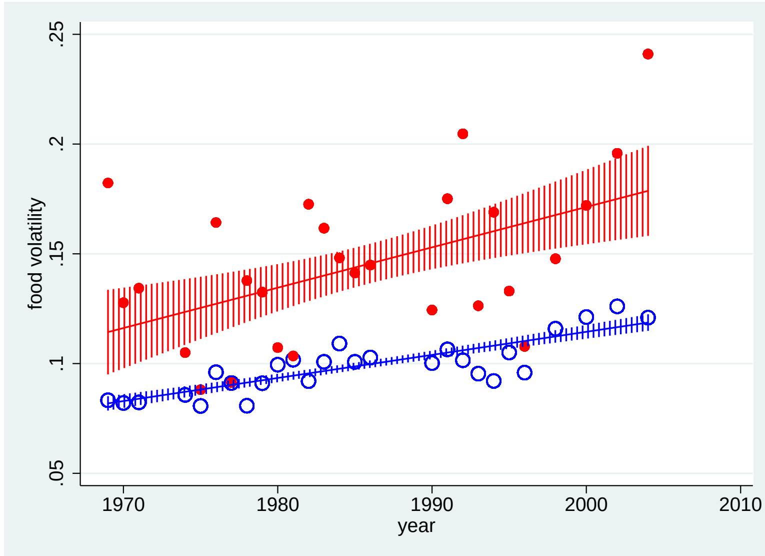


Hollow circles for households headed by white individuals, and filled circles for households with nonwhite heads; with 95% confidence intervals.

durable consumption increased between 1980 and 2004.

The measure of volatility of food consumption presented in this section and that used by Davis and Kahn [2008] is purely descriptive and might suffer from measurement error, we might be observing an increase in volatility that is due to increased skill premium or simply life-cycle considerations, or preference shocks, all of which will have different welfare implications. In the next two sections I present a semi-structural model that is used to decompose variations in the growth rate of consumption into predictable (those due to anticipated shocks to preferences, interest rates, and precautionary saving motive) and unpredictable components. I will show that the descriptive statistic used here give the same qualitative result as volatility of household consumption computed on unpredictable shocks.

Figure 3: Volatility of Food Consumption by Marital Status



Hollow circles for continuously married households, and filled circles for continuously single individuals with children; with 95% confidence intervals.

3 A Consumption Model

From standard consumption theory we know that household's consumption responds to predictable and unpredictable changes in preferences or demographics (including family composition, labor decisions, health status, and others), discount rates, real interest rates, current and future labor income and other wealth, and idiosyncratic shocks. Households are unable to insure against unpredictable shocks, with the consequence that an increase in unanticipated risk would directly increase volatility of consumption especially if households have limited ability to smooth out these shocks. Since families desire to smooth consumption, such an increase in volatility would have a negative impact on welfare, other things being equal. Thus, it is critical to study the evolution of unpredictable, in addition to, predictable uncertainty of household consumption. The consumption model outlined below will allow us to do exactly that.

Consumption growth varies with preferences or demographics, the risk free interest rate, anticipated income shocks, cash-on-hand relative to future wealth, and idiosyncratic risk. To see this, consider a typical Euler equation.

$$E_t\left[\frac{U'(C_{h,t+1};\theta_{h,t+1})(1+r_{h,t+1})}{U'(C_{h,t};\theta_{h,t})(1+\delta_h)}\right](1+\lambda_{h,t+1})=1 \tag{1}$$

where h stands for household and t for time; $C_{h,t}$ is real consumption of family h in period t; $\theta_{h,t}$ are family $h's$ tastes; δ_h is its rate of time preference and is assumed to be household specific but time invariant; E_t is the expectation operator, conditional on information available at time t; $r_{h,t+1}$ is the ex post real return on risk free asset held by family h between periods t and $t+1$; $\lambda_{h,t+1}$ is the extra utility that would result from borrowing an extra dollar, consuming it, and reducing consumption the next period accordingly to repay the debt. If $\lambda_{h,t+1}>0$, the liquidity constraint is binding and the family cannot borrow, and thus will have to consume out of current assets.

In order to allow for precautionary savings and nonseparability of preferences between consumption of food and other nondurables,[18] and to be able to take the model to the data, I assume that the utility function takes the constant relative risk aversion form, such that

$$U(O_{h,t},F_{h,t};\theta_{h,t})=e^{\theta_{h,t}}\left[\frac{O_{h,t}^{\alpha}F_{h,t}^{\beta}}{1-\gamma}\right]^{1-\gamma} \tag{2}$$

where $F_{h,t}$ is food consumption and $O_{h,t}$ is consumption of other nondurable goods, such that $p_t^F F_{h,t}+p_t^O O_{h,t}=C_{h,t}$; α and β are share parameters measuring the importance of consumption of other nondurable goods relative to food and visa versa; and γ controls the degree of relative risk aversion.[19]

The above Euler equations with respect to food consumption will now become:

$$E_t\left[\frac{p_t^F U_F(O_{h,t+1},F_{h,t+1};\theta_{h,t+1})(1+r_{h,t+1})}{p_{t+1}^F U_F(O_{h,t},F_{h,t};\theta_{h,t})(1+\delta_h)}\right](1+\lambda_{h,t+1})=1 \tag{3}$$

[18]As pointed out by example Attanasio and Weber [1995], Meghir and Weber [1996], Banks et al. [1997] it is important to control for nonseparability of food consumption relative to consumption of other goods.

[19]The coefficient of relative risk aversion with this utility specification is given by $\frac{-FU_{FF}}{U_F}=1-\beta(1-\gamma)$. Intertemporal elasticity of substitution for food consumption is pinned down by $\frac{1}{\beta(1-\gamma)-1}$. The assumption of the iso-elastic form for the utility function means that, in a world without uncertainty, an increase in lifetime wealth will lead to a proportionate increase in consumption. This form also assumes that utility is time additive.

It is well known that consumption is measured with error. To control for this error, so that it can later be excluded from volatility calculations, consider that true food consumption $\widetilde{F}_{h,t}$ is given by:

$$\widetilde{F}_{h,t} = F_{h,t}\psi_{h,t} \tag{4}$$

where $F_{h,t}$ is measured consumption of household h at time t as reported in PSID, and $\psi_{h,t}$ is measurement error.

Taking natural logs of Euler equations (with respect to $O_{h,t+1}$ and $F_{h,t+1}$), and then a second-order Taylor expansion of expectations errors, we can log linearize these Euler equations as:[20]

$$\Delta lnO_{h,t+1} = \frac{1}{1-\alpha(1-\gamma)}\left[\beta(1-\gamma)\Delta lnF_{h,t+1} + B_{h,t+1} - \Delta lnp^O_{t+1}\right] + u^O_{h,t+1} \tag{5}$$

$$\Delta lnF_{h,t+1} = \frac{1}{1-\beta(1-\gamma)}\left[\alpha(1-\gamma)\Delta lnO_{h,t+1} + B_{h,t+1} - \Delta lnp^F_{t+1}\right] + u^F_{h,t+1} \tag{6}$$

where

$$\begin{aligned}
\Delta ln(F_{h,t+1}) &= ln(F_{h,t+1}) - ln(F_{h,t}) \\
B_{h,t+1} &= \Delta\theta_{h,t+1} + ln(1+r_{h,t+1}) + ln(1+\lambda_{h,t+1}) - ln(1+\delta_h) \\
u^O_{h,t+1} &= \frac{1}{1-\alpha(1-\gamma)}\Big(\frac{V_t\epsilon^O_{h,t+1}}{2} + \xi^O_{h,t+1} + \beta(1-\gamma)(\kappa_h - \zeta_{h,t+1})\Big) \\
&\equiv \frac{1}{1-\alpha(1-\gamma)}\Big(\frac{V_t\epsilon^O_{h,t+1}}{2} + \beta(1-\gamma)\kappa_h\Big) + \varsigma^O_{h,t+1} \\
u^F_{h,t+1} &= \frac{1}{1-\beta(1-\gamma)}\Big(\frac{V_t\epsilon^F_{h,t+1}}{2} + \xi^F_{h,t+1}\Big) - (\kappa_h - \zeta_{h,t+1}) \\
&\equiv \frac{1}{1-\beta(1-\gamma)}\frac{V_t\epsilon^F_{h,t+1}}{2} - \kappa_h + \varsigma^F_{h,t+1}
\end{aligned}$$

where $\xi^i_{h,t+1}, i = \{O, F\}$, subsumes higher order terms, variances of interest rate and preference shocks as well as covariance terms, that are assumed to be of smaller magni-

[20] Attanasio and Low [2004] show that a log-linearized Euler equation for consumption yields consistent estimates of the preference parameters when utility is isoelastic and a sample covers a long time period. The requirement on the length of the panel is imposed in order to tackle estimation problems that arise due to the presence of liquidity constraints.

tude. $E_t(\varsigma^i_{h,t+1}) = 0$ and $V_t(\epsilon^i_{h,t+1})$ is the variance of the expectation error conditional on information available at time t, which in turn is used as a proxy for precautionary saving as it captures the effect of risk on household's consumption.[21] I follow Alan et al. [2005] in assuming that measurement error is stationary and independent of all the regressors, including lagged values of the measurement error and expectations error, consumption levels and interest rates. Thus, I do not require a specific distribution or a unitary mean. These assumptions allow me to write the expectations of the growth rate of the measurement error as $E_t(\Delta ln\psi_{h,t+1}) = E_t(\kappa_h + \zeta_{h,t+1}) = \kappa_h$.

Substituting (5) into (6) and rearranging the terms gives us:

$$\begin{aligned}
\Delta lnF_{h,t+1} &= \frac{1}{1-(1-\gamma)(\alpha+\beta)}\Big[\Delta\theta_{h,t+1} + ln(1+\lambda_{h,t+1}) + ln(1+\delta_h)\Big] \\
&- \frac{1}{1-(1-\gamma)(\alpha+\beta)}\Big[ln(1+r_{h,t+1}) + \Delta lnp^F_{t+1} + \alpha(1-\gamma)(\Delta lnp^O_{t+1} - \Delta lnp^F_{t+1})\Big] \\
&- \frac{1}{1-\beta(1-\gamma)}\kappa_h + z_{h,t+1} \qquad (7)
\end{aligned}$$

where

$$\begin{aligned}
z_{h,t+1} &= \frac{\alpha(1-\gamma)-1}{(1-\beta(1-\gamma))(1-(1-\gamma)(\alpha+\beta))}\Big[\varsigma^F_{h,t+1} - \frac{V_t\epsilon^F_{h,t+1}}{2}\Big] \\
&- \frac{\beta\alpha(1-\gamma)^2}{(1-\beta(1-\gamma))(1-(1-\gamma)(\alpha+\beta))}\Big[\varsigma^O_{h,t+1} + \frac{V_t\epsilon^O_{h,t+1}}{2}\Big] \\
&= \varsigma_{h,t+1} - \frac{V_t\epsilon_{h,t+1}}{2}
\end{aligned}$$

To summarize, the growth rate of household food consumption, $\Delta ln(F_{h,t+1})$, is a function of anticipated changes in demographics or preferences $\Delta\theta_{h,t+1}$ and risk free interest rate $ln(1+r_{h,t+1})$, the shadow price of borrowing an extra dollar $ln(1+\lambda_{h,t})$, personal discount rate $ln(1+\delta_h)$, on changes in food prices, Δlnp^F_{t+1}, on price differential between inflation in food and other nondurables, $\Delta lnp^O_{t+1} - \Delta lnp^F_{t+1}$, on precautionary saving motive, $V_t\epsilon_{h,t+1}$, on measurement error in food consumption, κ_h, and on idiosyncratic shocks to consumption growth, $\varsigma_{h,t+1}$.

[21] See Browning and Lusardi [1996] for a comprehensive review of the literature on the precautionary saving motive.

The decomposition of consumption growth into predictable and unpredictable parts using this Euler equation (7), is the first step in the volatility decomposition strategy. In the next subsection I discuss estimation strategies for each component of the Euler equation, and in section 5, I present the results of the decomposition.

Since PSID became biennial after 1997, I also estimate volatility of consumption on biennial growth rates. The Euler equation holds for two year growth rates with some important changes:

$$\begin{aligned}
\Delta lnF_{h,t+2} &= \frac{1}{1-(1-\gamma)(\alpha+\beta)}\Big[\Delta\theta_{h,t+2} + ln(1+\lambda_{h,t+1}) + 2ln(1+\delta_h)\Big] \\
&- \frac{1}{1-(1-\gamma)(\alpha+\beta)}\Big[ln(1+r_{h,t+2}) + ln(1+r_{h,t+1})\Big] \\
&- \frac{1}{1-(1-\gamma)(\alpha+\beta)}\Big[\Delta lnp^F_{t+2} + \alpha(1-\gamma)(\Delta lnp^O_{t+2} - \Delta lnp^F_{t+2})\Big] \\
&- \frac{1}{1-\beta(1-\gamma)}\kappa_h + z_{h,t+1} \qquad (8)
\end{aligned}$$

where

$$\begin{aligned}
\Delta lnF_{h,t+2} &= lnF_{h,t+2} - lnF_{h,t} \\
z_{h,t+2} &= \frac{\alpha(1-\gamma)-1}{(1-\beta(1-\gamma))(1-(1-\gamma)(\alpha+\beta))}\Big[\varsigma^F_{h,t+2} - \frac{V_t\epsilon^F_{h,t+2}}{2}\Big] \\
&- \frac{\beta\alpha(1-\gamma)^2}{(1-\beta(1-\gamma))(1-(1-\gamma)(\alpha+\beta))}\Big[\varsigma^O_{h,t+2} + \frac{V_t\epsilon^O_{h,t+2}}{2}\Big] \\
&= \varsigma_{h,t+2} - \frac{V_t\epsilon_{h,t+2}}{2}
\end{aligned}$$

4 Estimation

4.1 Liquidity Constraints

When liquidity constraints are not binding, $\lambda_{h,t+1} = \lambda_{h,t+2} = 0$, and equations (7) and (8) are greatly simplified. If liquidity constraints are ignored, then their presence will show up in the error term. Given that the last 30 years saw a boom in credit markets it is reasonable to assume that liquidity constraints have relaxed or at the least remained unchanged.[22] If liquidity constraints have relaxed over time, then the estimation results of the Euler equation will be biased and the squared residuals will be on average underestimated in the later half of the sample. Since the purpose of this paper is to understand the evolution of consumption risk, unbiased estimation of Euler equation coefficients is a secondary goal.

I run all the estimations on the full sample, where the only requirement is that the food consumption is positive and both income and consumption growth rates are within reasonable bounds.[23] I then gradually increase the constraint and separate the sample into liquidity constrained and unconstrained households based on income and consumption levels and growth rates, and net wealth information.

To classify household as unconstrained I use information on the amount of net wealth each household owns during previous year.[24] Since PSID has sparse information on wealth holdings,[25] I supplement it by including households with positive asset income.[26] Thus, unconstrained households are those with nonnegative net worth and/or positive asset income,

[22]Torralba [2006] finds that between 1970 and 1998, the proportion of all US households that had at least one credit card grew from 16% to 68%, and that credit card ownership in the lowest income quintile went from 2% to 25% and the highest from 33% to 95%.

[23]As already mentioned, I drop observations if absolute value of the change in log consumption or log income is above 1.1. I also run all the regressions allowing income shocks to be unconstrained by these limits, thus effectively allowing large negative or positive shocks to income, due for example to entrance or exit into/from unemployment. Qualitative results outlined below are all the same, but much stronger, as is not surprising, they are available upon request.

[24]This strategy is very similar to the one employed by Zeldes [1989] or more recently by Parker and Preston [2005].

[25]Wealth information is available for 1984, 1989, 1994, 1999, and biennially thereafter. Net worth was calculated as the sum of the net values of the following assets owned by the households: real estate other than main home, vehicles, farms or businesses, private annuities, IRAs, money in checking or savings accounts, money market funds, certificates of deposit, government saving bonds, Treasury bills, and any other savings or assets; minus any other debts held by a household.

[26]Positive asset holdings are inferred from information on total asset income which is available for every year of the survey. Total asset income is a sum of income from rent, dividends, interest, trust funds and royalties.

positive food consumption, and reasonable growth rates of food and income.

This split might be too restrictive in a sense that I might be counting as constrained those households that were actually unconstrained, since households with zero net worth could still be able to borrow. But Jappelli et al. [1998] find that only 12 percent of the households classified as liquidity constrained by the asset split method are actually unconstrained.[27] Loosing these unconstrained households will lower the power of my estimated coefficients, but it will not bias the results.

Households can transition between these categories as time passes. Thus, if a household with zero net worth one year has negative net worth next year, it will switch from being classified as unconstrained to constrained group.

4.2 Preference Shocks

I postulate that preferences, $\theta_{h,t}$, are a quadratic function of age and family structure, and can be modeled as follows:

$$\theta_{h,t} = \beta_0 age_{h,t} + \beta_1 age_{h,t}^2 + \beta_2 N_{h,t} + \beta_3 MS_{h,t} + \beta_4 Edu_h + \omega_h + \eta_t + u_{h,t} \tag{9}$$

where $N_{h,t}$ is a measure of size of the household h at time t which is proxied by number of adults and number of children in the household, (see Appendix Table 6 for details); $MS_{h,t}$ is a dummy for household's marital status (I consider 4 different types of family structures: cohabiting, never married and single, divorced/separated, and widow/widower), Edu_h is a dummy for all but one of the four educational attainment categories attained by the head of the household;[28] and $(\omega_h + \eta_t + u_{h,t})$ are unobserved shocks to preferences that include household specific shock ω_h, aggregate shock η_t and idiosyncratic shock $u_{h,t}$.

[27] Jappelli et al. [1998] find that households with less than college education, unemployed, or younger than 38 are more likely to be turned down for a loan. Lyons [2003] finds that borrowing gap has narrowed since 1983 and most dramatically between 1992 and 1998. But that individuals younger than 35, who are black, or poorly educated continued to be constrained, though the constraints have loosened for them as well.

[28] In the sample, education is time invariant since I include households during their midlife, 25 to 65, and exclude students. I consider four educational attainment categories: no high school diploma, high school diploma, some college education but no Bachelor's degree, and at least a Bachelor's degree.

Taking time difference of (9),[29] preference shocks can be modeled as:

$$\begin{aligned}\Delta\theta_{h,t+1} &= \beta_0 + \beta_1 + 2\beta_1 age_{h,t} + \beta_2\Delta N_{h,t+1} + \beta_3\Delta MS_{h,t+1} + \Delta\eta_{t+1} + \Delta u_{h,t+1} \\ &= c + 2\beta_1 age_{h,t} + \beta_2\Delta N_{h,t+1} + \beta_3\Delta MS_{h,t+1} + \Delta\eta_{t+1} + \Delta u_{h,t+1}\end{aligned} \quad (10)$$

Thus, preference shocks are a function age, changes in family size and its structure, aggregate shocks, and idiosyncratic shocks.

4.3 Precautionary Savings

The precautionary saving motive depends on the household's expectations about the uncertainty associated with future exogenous variables, such as for example, uncertainty about income and/or health. Families with higher uncertainty of future family income will have higher savings and therefore lower consumption today. Some families might have higher uncertainty of medical expenses and thus lower consumption. But, as pointed out by Browning and Lusardi [1996], precautionary savings also depend on the current level of cash-on-hand, $X_{h,t}$, relative to expected future income. Families with identical income volatilities but lower current wealth will have higher precautionary savings.

A large body of research has focused on the effect of income uncertainty on precautionary savings.[30] Following this work, I postulate that the precautionary saving motive can be proxied by the variance of the unexpected shocks to family income, $(\sigma^{\widetilde{Y}}_{h,t})^2$, adjusted by $\left[\frac{Y_{h,t-1}}{F_{h,t-1}}\right]^2$ as a way to account for cash-on-hand relative to expected income.

I model family income process as:[31]

$$\Delta ln(Y_{h,t+1}) = X_{h,t}\vartheta_g + \nu_{h,t+1} \quad (11)$$

where $X_{h,t}$ captures the predictors of income growth, and $\nu_{h,t+1}$ the idiosyncratic shocks to income. In individual labor income models, these regressors are usually proxied by age, age

[29] Notice that $\beta_1(age^2_{h,t+1} - age^2_{h,t}) = \beta_1(1 + 2age_{h,t})$.

[30] See Carroll and Samwick [1997, 1998], Carroll [2000], Carroll et al. [2003], Banks et al. [2001], Hurst et al. [2006] just to name a few.

[31] This is a standard model of the income process, see for example MaCurdy [1982] or Hall and Mishkin [1982] for the early treatment, or Banks et al. [2001] for a more recent study.

squared, dummy variables for education, occupation and industry categories, and interactions between age, age squared and education, sex and race indicators. Since in the present case I am interested in the family income process, I redefine these parameters as those pertaining to the head of household, and include additional parameters, such as head's marital status, number of hours worked by head and his partner, and the number of children in the household. I allow the coefficient ϑ_g to be group specific and define groups by race (white or nonwhite), sex and educational attainment categories (less than 13 or at least 13 completed years of education).

The disturbance term, $\nu_{h,t}$ is composed of aggregate shocks and household specific shocks to permanent and transitory family income. I assume that households are unable to distinguish between these shocks.[32]

The squared residual from equation (11), adjusted for cash-on-hand relative to current income, $\left[\frac{Y_{h,t-1}}{C_{h,t-1}}\right]^2(\sigma_{h,t}^{\widetilde{Y}})^2$ is a proxy for precautionary saving motive.[33]

4.4 Euler Estimation Revisited

The estimation strategy allows for household fixed effects to account for measurement error and discount factors.[34] To control for the possibility that labor decisions are not separable from the marginal utility of consumption, I include the change in the total number of hours

[32]By 'not distinguishable' I mean that a household observes a shock to income, but is unable to distinguish between the three different shocks, and even if it is able, the households is unable to disentangle the size of each shock.

[33]In the previous version, I used stochastic variance of income shocks adjusted for cash-on-hand as proxy for precautionary savings motive, but found that this variable did not have a good explanatory power in the regressions unlike the variable used in this paper. As a recent paper by Kaplan and Violante [2008] point out that putting too much structure on income process, especially if it is a wrong structure, might be misleading, I allow more flexibility in this version of the paper.

[34]Households that expect consumption risk will be higher in the future might behave as a liquidity constrained household (or perceive a higher discount factor) even though they are not actually constrained. Thus, I include household fixed effects under an assumption that household's discount factor is time invariant. Notice also that I exclude $\Delta\eta_{t+1}$ from the regression since its presence would lead to misidentification of parameters, as I would be unable to disentangle its effects from those of $ln(1+r_{h,t+1})$.

worked by the head of the household and by their partner.[35]

To address endogeneity that arises due to the second and higher-order terms in the residual, it is typical to estimate the model using as instruments information known at time t.[36] The instrument set includes lagged terms of all the parameters in the Euler equation, and lagged family income and food consumption growth squared. I correct for heteroskedasticity and intragroup correlation (by allowing for time clusters).

The results of Euler equation estimations are illustrated in the Appendix, Table 8 provides results based on annual growth rates and Table 9 on biennial data. The sample is broken down by education, households whose head has high school degree or less, and those with more than a high school degree; households without changes in their marital status and continuously married households.[37] It is interesting to note that the proxy for precautionary savings is significant, at different levels, for all but one specification. On the other hand, the coefficients on food price inflation are insignificant in all cases and are significant for two specifications for inflation in other goods. When I do not restrict $\Delta lny_t \leq \mid 1.1 \mid$, coefficients on real interest rates and on price changes are significant at 10 percent level. The overall significance of all the regressions is high, with the exception of that for low educated households. The tests for the validity of instruments and their appropriateness are all reasonable.

When preferences for food and other goods are assumed to be separable such that $U(F_{h,t};\theta_{h,t}) = e^{\theta_{h,t}} \frac{F_{h,t}^{1-\gamma}}{1-\gamma}$, the estimates of the coefficients of the Euler equation are consistent with the literature. Table 10 shows the results of this specification. I estimate the intertemporal elasticity of substitution, $(\frac{1}{\gamma})$, to be 0.54 with robust standard error of 0.27.[38] The

[35]The inclusion of the information on the labor supply decision is important for the identification purposes, see Attanasio [1999].

[36]See Attanasio and Low [2004] for a detailed discussion of issues involved in estimating log linearized Euler equations.

[37]I also split the sample into households headed by white individuals and/or males. These results are similar to the ones in the Table 8 and are omitted to safe space. Statistics are available upon request.

[38]This number is very close to 0.61 with standard error of 0.09 estimated by Parker and Preston [2005]. Attanasio [1999] documented that research up to that point found this coefficient to be 'just below' 1.

coefficient changes slightly when I allow it to differ by groups. When tighter liquidity constraints are imposed on the sample, estimate of the intertemporal elasticity of substitution is not different from 1.0 at a 5 percent level of significance.

5 Evolution of Consumption Risk

To summarize the time trend in the data for each group g in a simple way, I run a pooled regression that allows for a time trend:

$$\widehat{\varsigma^2_{h,t+1}} = \beta_{g,0} + \beta_{g,1}t + \omega_{h,t+1} \tag{12}$$

where $\widehat{\varsigma^2_{h,t+1}}$ is the squared residual from estimating equations (7) or (8) depending on the frequency of the data used; and $\beta_{g,0}$ reflects the average variance of the measurement error, which I assumed to be stationary for each household. If the constant is well estimated, we can then analyze volatility changes in addition to its levels.

5.1 What happened to household consumption volatility?

Tables 1 and 2 show that for the sample as a whole, as well as for all the disaggregations that are reported, the coefficient of consumption risk on the time trend is highly statistically significant. Coefficients in these tables are robust to heteroskedasticity and within group correlations. Consumption risk for the entire sample increased by 6.5 percentage points between 1970 and 2004, or by 21 percent, when estimated on annual growth rates; it increased by 5 percentage points or by 19 percent when estimated on biennial data.

Examining first annual growth rates sample, several interesting results are apparent. Table 1 clearly shows that there are significant differences between groups. For households headed by individuals with a High School Diploma or less, volatility increased by 10 ppts. or by 30 percent since 1970, where as this increase was substantially smaller for households with more education, 3 ppts. (or 11 percent). In contrast, households whose marital status did not change throughout the sample saw a smaller increase in volatility when compared to the sample as a whole. For these households, volatility increased by 3.6 ppts. or by 13

Table 1: Time evolution of consumption risk - annual growth rates, 1970-1996.

	Total	$edu \leq 12$	$edu > 12$	$\Delta mstatus = 0$	married
year $\times 10^{-3}$	1.28	2.14	0.64	0.64	1.42
robust	(0.33)*	(0.92)**	(0.26) *	(0.14)*	(0.53)*
cluster(hh)	(0.36)*	(0.95)**	(0.31) **	(0.18)*	(0.54)*
cluster(year)	(0.60)**	(2.29)‡	(0.49)	(0.41)‡	(0.67)**
Constant	-2.43	-4.11	-1.17	-1.18	-2.72
robust	(0.66)*	(1.84)**	(0.51)**	(0.28)*	(1.06)*
cluster(hh)	(0.71)*	(1.88)**	(0.62)†	(0.35)*	(1.08)**
cluster(year)	(1.19)**	(2.55)‡	(0.98)	(0.82)	(1.32)**
Num. Obs.	22,499	12,309	10,124	22,221	16,641
F-stat	4.52	2.76	1.67	20.00	4.56
Prob>F	0.05	0.11	0.21	0.00	0.05

Either simple robust standard errors or robust standard errors with household or year clusters in parentheses
* significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

percent. On the other hand, if household's marital status did change throughout the sample, and they were married at some point of time, their consumption risk increased by 6 ppts. or by 20 percent. The same increase was felt by single parents. Singles on the other hand, saw a smaller increase of 4ppts. or 11 percent. Thus marriage per se does not necessarily lead to greater economic stability whereas continuous marriage does, or in other words, changes in marital status constitute a great drain on household welfare.

Disaggregating the data a bit further shows that nonwhite households were particularly badly hit (see Tables 11 and 12 in the Appendix for detail). They experienced a 16 ppt increase (54 percent) between 1970 and 2004. Nonwhite households with less than 13 years of education were also deeper affected than white households with the same level of education, they saw 17 ppts. (or 53 percent) vs. 9 ppts. (or 25 percent), respectively. On the other hand, households with more than 12 years of education saw a 2ppts. (2 percent) increase in volatility of consumption irrespective of their race.

There do not appear to be significant differences in evolution of consumption risk by

Table 2: Time evolution of consumption risk - biennial growth rates, 1978-2004.

	Total	$edu \leq 12$	$edu > 12$	$\Delta mstatus = 0$	married
year $\times 10^{-3}$	0.79	3.79	1.13	1.16	0.62
robust	(0.21)*	(2.25)†	(0.27)*	(0.31)*	(0.20)*
cluster(hh)	(0.23)*	(1.95)**	(0.33)*	(0.30)*	(0.25)*
cluster(year)	(0.40)†	(2.27)‡	(0.36)*	(0.50)**	(0.37)‡
Constant	-1.49	-7.41	-2.16	-2.21	-1.16
robust	(0.41)*	(4.46)†	(0.53)*	(0.62)*	(0.40)*
cluster(hh)	(0.46)*	(3.86)†	(0.65)*	(0.60)*	(0.50)**
cluster(year)	(0.80)†	(4.50)‡	(0.99)*	(1.11)‡	(0.74)‡
Num. Obs.	9,891	5,243	4,751	9,646	7,267
F-stat	3.88	2.79	9.59	13.71	2.82
Prob>F	0.08	0.13	0.01	0.00	0.12

Either simple robust standard errors or robust standard errors with household or year clusters in parentheses
* significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

gender of the head of the household or by the marital status. I find that even though the increase in volatility for single parents is significant, it is not statistically different from that experienced by married households. In fact, volatility has a negative trend for single parents with at least 13 years of education, it falls by 3 ppts. or by 10 percent over the period, whereas it rises by 5 ppts. (or 18 percent) for married households. Part of the finding regarding single parent households could be due to measurement error due to changes in liquidity constraints for these households. On the other hand, this result could be due to the fact that volatility experienced by single parents is mitigated by public insurance schemes. Another possible explanation might be that since average income of single parents is lower and income volatile is higher than that of married households Shore [2009], they have very little room to change their food expenses, and food for them is a necessary rather than a normal good.[39]

Table 2 gives results for evolution of volatility of food consumption computed on biennial

[39]Disentangling the reasons behind this observation is left for future research.

Table 3: Time evolution of consumption risk, separable utility function, annual growth rates, 1970-1996.

	Total	$edu \leq 12$	$edu > 12$	$\Delta mstatus = 0$	married
year $\times 10^{-3}$	1.47	2.30	0.47	0.75	1.79
robust	0.36*	0.90*	0.23**	0.17 *	0.67*
cluster(hh)	0.39*	0.92**	0.29†	0.20*	0.68*
cluster(year)	0.60**	1.21†	0.44	0.40†	0.78**
Constant	-2.80	-4.43	-0.83	-1.38	-3.45
robust	0.72*	1.78**	0.46†	0.34*	1.33*
cluster(hh)	0.77*	1.83**	0.58‡	0.40*	1.34*
cluster(year)	1.18 **	2.39†	0.86	0.80†	1.54**
Num. Obs.	23,577	12,920	10,815	23,287	17,397
F-stat	16.25	6.59	2.59	19.27	7.13
Prob>F	0.00	0.01	0.11	0.00	0.01

Either simple robust standard errors or robust standard errors with household or year clusters in parentheses
* significant at 1%, ** at 5%, † at 10%, and ‡ at 15%

data. The conclusions are qualitatively the same as those outlined for annual data. The only exception is that the trend on biennial data gives a much steeper increase for poorly educated sample, 19 ppts (or 81 percent).

Similar results hold if separable utility function is assumed instead. Table 3 illustrates that all the results are highly statistically significant, and that for a sample as a whole, volatility increased by 7 ppts. or by 23 percent. It increased by 9.4 ppts. (or 31 percent) for those households with less than 13 years of education, and by 2.5 ppts. (or 8 percent) for those with at least 13 years of education. Again, the increase was less pronounced for those households for whom there was no change in marital status during the entire period.

Table 4 shows that if tighter liquidity constraints are imposed, the increase in volatility does not disappear, but rather strengthens. The finding that volatility increased by much less for liquidity constrained households could be due to, as already mentioned above, underestimation of the increase due to changes in liquidity constraints, and on the other hand, the fact that liquidity constrained households treat food as a necessary rather than a normal

Table 4: Time evolution of consumption risk, annual growth rates, 1970-1996.

	Nonseparable Utility		Separable Utility	
	Unconstrained	Constrained	Unconstrained	Constrained
year $\times 10^{-3}$	2.42**	0.60**	2.36**	0.38†
	(1.20)	(0.25)	(1.03)	(0.22)
Constant	-4.66†	-1.11**	-4.54**	-0.66‡
	(2.48)	(0.49)	(2.04)	(0.44)
Num. Obs.	14,456	8,043	15,083	8,494
F-stat	4.09	5.91	5.24	2.94
Prob>F	0.04	0.02	0.02	0.09

Robust standard errors in parentheses; * significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

good. Disentangling the reasons behind this observation is left for future research.

5.2 Are results due to wealth effects?

How much of the increase in household volatility of food consumption is due to wealth effect? - as households grow richer, they substitute basic food items for those of higher quality (and thus more expensive goods) or into food away from home. It is difficult to say whether an increase in volatility of food away from home and a stagnant food at home would necessarily mean that the observed increase in total food consumption volatility does not have welfare implications. To answer such a question one needs to make positive rather than normative statements or at least have a model in mind. I leave this question to future research and in this paper only document the facts.

I look separately at evolution of volatility for food at home and food away from home. I use the same techniques as in the above, including separate variables for changes in prices for food at home and food away from home, as well as changes in prices of other goods. I find that volatility of food at home had increased significantly between 1970 and 2004, it rose by 13 ppts. or by 43 percent. Controlling for the household specific trend in the growth rate of food consumption as a way to get to wealth effects, I find that volatility of food consumed at home went up by 10 ppts. or by 34 percent over the period. From this simple exercise, it is clear that changes in volatility of consumption away from home are not driverd of the results.

This finding is not too surprising. Before the 1970s, food away from home was a luxury good. It constituted a very small percent of annual food expense. But, since then, while food prices fell (see Figure 6 in the Appendix), the number of fast food restaurants per capita doubled and the number of full-service restaurants per capita increased by 35%[40] These facts coupled with the increases in hours worked and increases in labor force participation, converted food away from home from luxury to normal good. In my view, it is more appropriate to look at household food expenditure as a sum of food away from home and food at home, rather than at each component separately.

6 Reconciling Aggregate and Household Level Data

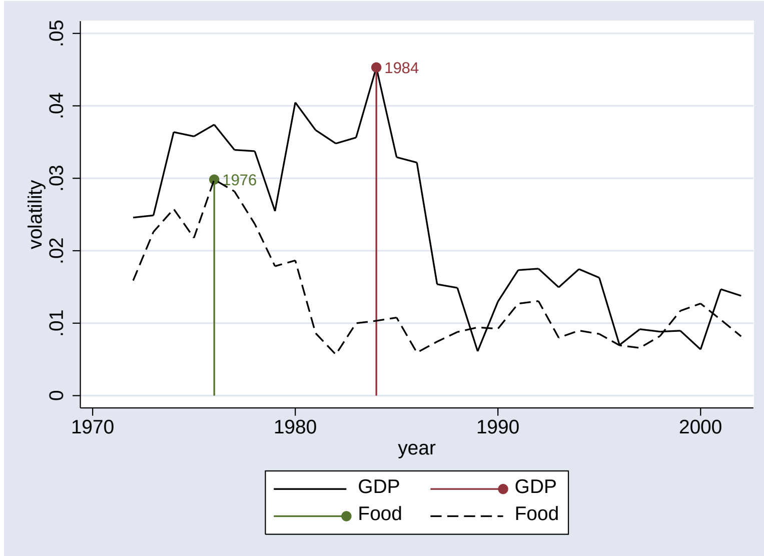
The results above indicate that mean volatility of household consumption increased between 1970 and 2004. In contrast, aggregate volatility of the US economy fell dramatically since 1984. Figure 4 documents that aggregate volatilities of detrended real GDP and food consumption both fell sharply over 1970-2004 period.[41] Volatility of real GDP fell by 60 percent from its peak in 1984, and that of aggregate real food consumption by 73 percent since its peak in 1976.

Assuming for simplicity that aggregate consumption growth, ΔlnC_t, can be expressed as a weighted average of household consumption growth rates, aggregate volatility can be decomposed into the average volatility of individual consumption plus the average covariances

[40] See for example Cutler et al. [2003], or Chou et al. [2004] for detailed review of food prices and evolution of restaurants.

[41] McConnell and Perez-Quiros [2000], Stock and Watson [2002], Blanchard and Simon [2001] study aggregate volatility of real GDP growth and find that a structural break occurred in 1984 for this series. I find that the maximum volatility was achieved in 1976 for real food consumption growth series, and since then it remained stable.

Figure 4: Aggregate Volatility of Real GDP and Real Food Consumption



Source: National Income and Product Accounts from Bureau of Economic Analysis.
Note: Volatility is computed as a 5-year moving standard deviation of detrended real GDP and real food consumption data.

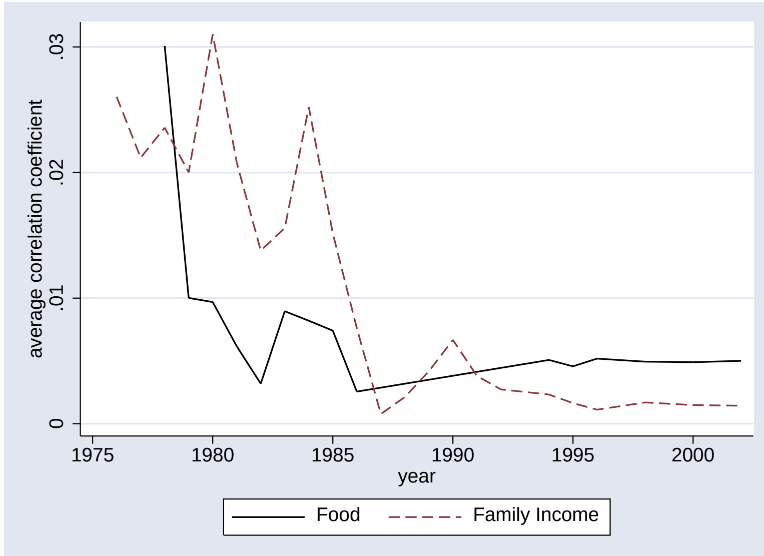
of these shocks between different individuals.

$$\begin{aligned}
\sigma_t^2 = Var_t(\Delta lnC_{t+1}) &= Var_t\left[\frac{1}{H}\sum_{h=1}^{H} w_h \Delta lnC_{h,t+1}\right] \quad (13)\\
&= \frac{1}{H^2}\sum_{h=1}^{H} w_h^2 Var_{h,t}(\Delta lnC_{h,t+1}) + \frac{2}{H^2}\sum_{i\neq j} w_i w_j Cov_t(\Delta lnC_{i,t+1}, \Delta lnC_{j,t+1})\\
&= \frac{1}{H^2}\sum_{h=1}^{H} w_h^2 \sigma_{h,t}^2 + \frac{2}{H^2}\sum_{i\neq j} \rho_t w_i w_j \sigma_{i,t}\sigma_{j,t}
\end{aligned}$$

where $Var_t(\Delta lnC_{t+1})$ is the 5-year variance of the average consumption in the economy as of time t. I assume that redistributive weights, w_h, do not change over time and are equal across households, or that $w_i = w_j = w$. From this simple decomposition, it is easy to see how the current situation, in which aggregate consumption volatility fell but mean household volatility increased, might occur.

Aggregate volatility could go down while the average of individual volatilities goes up, if the average covariances fall enough to compensate for the increase in the average of individual volatilities, or if the correlation coefficients fall significantly. Figure 5 demonstrates how

Figure 5: Average Correlation Coefficients: Family Income vs. Food Consumption



dramatic the fall of the correlation coefficients for both income and food consumption has been over the 1970-2004 period.[42] The decline was much steeper for the consumption series, though the average correlation coefficient on food consumption did not fall to the level of income.[43] This situation describes an economy in which aggregate shocks became less important as a source of variation of the individual consumption and income series.

One of the reasons behind the fall in correlation coefficients can be seen from data disaggregated by racial groups. I find that the path of average correlations for white families closely resembles that of the aggregate economy. On the other hand, for nonwhite households, though average correlation coefficients of income growth rates fell as for the white households, average correlations for food consumption increased slightly between 1980 and 2004. Correlation coefficients between white and nonwhite households also fell over this

[42]For this graph I compute average correlation coefficients on the changes in family income and on changes in food consumption around the trend, and not on the idiosyncratic shocks or unpredictable income and consumption components.

[43]These results are reinforced by the presence of measurement error in consumption. In the early years, it is reasonable to believe that quality of consumption data was worse than in the recent decade, due to for example, the use of computers versus phone surveys.

period for both food consumption and income data.[44]

To summarize, the US economy can be characterized by a fall in aggregate shocks but an increase in individual consumption and income risk over the 1970-2004 period.

7 Conclusions

The current study extends the literature that strives to understand the evolution of social welfare over the last thirty years by looking at the evolution of household consumption volatility. I show that volatility of household food consumption, computed as a squared residual from Euler equation increased significantly between 1970 and 2004, particularly for households headed by nonwhite or poorly educated persons. In fact, volatility for an average household increased by 20 percent and that for nonwhite households with no more than 12 years of education by 53 percent, where as for households with more than a high school degree it went up by only 2 percent. Given that volatility is computed using data on food expenditure, these are conservative estimates of volatility of total nondurable consumption.

Not all variations in consumption are detrimental to households' welfare, but some negative unpredictable shocks unambiguously are, even to households that are not liquidity constrained. Indeed, an increase in the volatility of unexpected shocks for these latter households indicates that even unconstrained households were unable to smooth consumption risk by drawing on their savings. The increase in volatility of food consumption, and its concentration among disadvantaged groups, suggests a substantial fall in welfare during this period. A full evaluation of the attendant welfare costs and their policy implications is beyond the scope of this paper.

The increase in household consumption risk stands in sharp contrast to the dramatic fall in aggregate volatility of the US economy over the same period. I showed that a spectacular

[44] It is possible that these differences come from the disparity in the skill composition among households. Thus, in 1970, 81 percent of the nonwhite households were headed by the individual with no more than 12 years of education, and 62 percent of the white households were poorly educated. By 2004, 50 percent of the nonwhite and 37 percent of the white households were poorly educated.

fall in average covariances of consumption growth rates across households during this period accounted for the diverging paths of aggregate and household level volatilities.

There have been several significant changes in patterns of volatility in the US economy over the past several decades. Income volatility, and both its transitory and permanent components, and consumption volatility have increased, while aggregate fluctuations, risk of job loss and incidence of unemployment have fallen.[45] Possible explanations for this puzzle might include greater wage flexibility,[46] fall in progressivity of the US tax code,[47] changes in the generosity of the welfare programs especially after the reforms of 1996, and increases in costs of health care.

The current study highlights how, in the context of consumption, aggregate declines in volatility might mask greater risks borne at the household level. Resolving the reasons underlying the decline in co-movements of consumption growth rates is a key component of the future research agenda on economic volatility and welfare.

[45]Recent work by Davis [2009] shows that risk of job loss in the US has fallen over the last thirty years.

[46]Davis and Kahn [2008] put forward this explanation in their recent survey of evolution of volatility in macro and micro data.

[47]According to Piketty and Saez [2007] the U.S. tax system became less progressive over the last 40 years. There have also been important changes to capital taxation. For example, Dai et al. [2008] analyze the effect that the Taxpayer Relief Act of 1997 had on increase in stock return volatility. This increase, they point out, is due to the reduced risk sharing between the investors and the government, which increased consumption risk.

References

Sule Alan, Orazio Attanasio, and Martin Browning. "Estimating Euler equations with noisy data: two exact GMM estimators". Technical report, Center for Applied Microeconometrics, Institute of Economics, University of Copenhagen, 2005.

Orazio Attanasio. *Handbook of Macroeconomics*, volume 1, chapter "Consumption", pages 741–812. Elsevier Science B.V., 1999.

Orazio Attanasio and Hamish Low. "Estimating Euler equations". *Review of Economic Dynamics*, 7:406–435, 2004.

Orazio Attanasio and Guglielmo Weber. "Is consumption growth consistent with intertemporal optimization? Evidence from the Consumer Expenditure Survey. *Journal of Political Economy*, 103(6), Dec. 1995.

Orazio Attanasio, Erich Battistin, and Hidehiko Ichimura. "What really happened to consumption inequality in the US?". *NBER Working Paper Series*, w10338, 2004.

Michael Baker. "Growth-rate heterogeneity and the covariance structure of life-cycle earnings". *Journal of Labor Economics*, 15(2):338–375, Apr. 1997.

James Banks, Richard Blundell, and Arthur Lewbel. "Quadratic Engel curves and consumer demand.". *The Review of Economics and Statistics*, LXXIX(4):527–539, Nov. 1997.

James Banks, Richard Blundell, and Agar Brugiavini. "Risk pooling, precautionary saving and consumption growth". *Review of Economic Studies*, 68:757–779, 2001.

Gadi Barlevy. "The cost of the business cycles under endogenous growth". *American Economic Review*, 94(4):964–990, Sept. 2004.

Gadi Barlevy. "The cost of business cycle and the benefits of stabilization". *Federal Reserve Bank of Chicago, Economic Perspectives*, 10:32–49, 2005.

Paul Beaudry and Carmen Pages. "The cost of business cycles and the stabilization value of unemployment insurance". *European Economic Review*, 45(8):15451572, Aug. 2001.

Oliver Blanchard and John Simon. "The long and large decline in US output volatility". *Brookings Papers on Economic Activity*, (1): 135–64, 2001.

Richard Blundell and Luigi Pistaferri. "Income volatility and household consumption - The impact of food assistance programs". *Journal of Human Resources*, 38(S):1032–1050, 2003.

Richard Blundell, Luigi Pistaferri, and Ian Preston. "Consumption Inequality and Partial Insurance". *American Economic Review*, 98(5), 2008.

Martin Browning and Annamaria Lusardi. "Household saving: micro theories and micro facts". *Journal of Economic Literature*, 34:1797–1855, Dec. 1996.

E. W. Bunkers and Willard W. Cochrane. "On the income elasticity of food services". *The Review of Economics and Statistics*, 39(2):211–217, May 1957.

John Campbell. "Does saving anticipate declining labor income? An alternative test of the permanent income hypothesis". *Econometrica*, 55(6):1355–65, 1987.

Christopher Carroll. "Requiem for the Representative Consumer? Aggregate implications of microeconomic consumption behavior". *American Economic Association*, 90(2):110–115, May 2000.

Christopher Carroll and Andrew Samwick. "The Nature of Precautionary Wealth". *Journal of Monetary Economics*, 40:41–71, 1997.

Christopher Carroll and Andrew Samwick. "How Important is Precautionary Saving?". *Review of Economics and Statistics*, 80:410–419, 1998.

Christopher Carroll, Karen Dynan, and Spencer Krane. "Unemployment Risk and Precautionary Wealth: Evidence from Households' Balance Sheets". *Review of Economics and Statistics*, 8: 586–604, 2003.

Shin-Yi Chou, Michael Grossman, and Henry Saffer. "An economic analysis of adult obesity: results from the Behavioral Risk Factor Surveillance System.". *Journal of Health Economics*, 23:565–587, 2004.

Diego Comin and Sunil Mulani. "Diverging trends in macro and micro volatility: Facts". *Review of Economics and Statistics*, 88(2):374–383, May 2006.

Donald Cox, Serena Ng, and Andrew Waldkirch. "Intergenerational linkages in consumption behavior". *Journal of Human Resources*, 39(2):355–381, 2004.

David Cutler and Lawrence Katz. "Macroeconomic performance and the disadvantaged". *Brookings Papers on Economic Activity*, page 174, 1991a.

David Cutler and Lawrence Katz. "Rising Inequality? Changes in the distribution of income and consumption in the 1980s. *American Economic Review*, 82:546551, 1991b.

David M. Cutler, Edward L. Glaeser, and Jesse M. Shapiro. "Why have Americans become more obese?". *Journal of Economic Perspectives*, 17(3):93–118, Summer 2003.

Zhonglan Dai, Douglas Shackelford, and Harold Zhang. "Capital gains taxes and stock return volatility: evidence from the Taxpayer Relief Act of 1997". University of Texas at Dallas mimeo, 2008.

Steven Davis. "The Decline of Job Loss and Why It Matters". *American Economic Review*, 98(2), 2009.

Steven Davis and James Kahn. "Interpreting the Great Moderation: changes in volatility of economic activity at the Macro and Micro Levels". *The Journal of Economic Perspectives*, 22(4), 2008.

Karen Dynan, Douglas Elmendorf, and Daniel Sichel. “The Evolution of Household Income Volatility”. *Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series*, (61), 2007.

Susan Dynarski and Johathan Gruber. “Can families smooth variable earnings?”. *Brookings Papers on Economic Activity*, 1, 1997.

Robert Gordon and Ian Dew-Becker. “Controversies about the rise of American inequality: a survey”. *NBER Working Paper Series*, w13982, May 2008.

Peter Gottschalk. “Inequality, income growth, and mobility: the basic facts.”. *The Journal of Economic Perspectives*, 11(2), 1997.

Joseph Gyourko and Joseph Tracy. “Using home maintenance and repairs to smooth variable earnings”. *Federal Reserve Bank of NY, Staff Reports*, 168, 2003.

Jacob Hacker. *The Great Risk Shift: The Assault on American Jobs, Families Health Care, and Retirement – And How You Can Fight Back*. Oxford University Press, Oct. 2006.

Steven Haider. “earnings instability adn earnings inequality of males in the United States: 1967-1991”. *Journal of Labour Economics*, pages 799–836, Oct. 2001.

Robert Hall and Frederic Mishkin. “The sensitivity of consumption to transitory income: estimates from panel data on households”. *Econometrica*, 50(2): 461–482, Mar. 1982.

Jonathan Heathcote. “discussion of “Heterogeneous life-cycle profiles, income risk and consumption inequality” by g. primiceri and t. vanrens”. *Journal of Monetary Economics*, 2009.

Erik Hurst and Frank Stafford. “Home is where the equity is: Liquidity constraints, refinancing and consumption”. *Journal of Money, Credit and Banking*, 36(6):985–1014, Dec. 2004.

Erik Hurst, Arthur Kennickell, Annamaria Lusardi, and Francisco Torralba. “Precautionary savings and importance of business owners”. *CFS Working Paper Series*, (2006/16), 2006.

Tullio Jappelli, Jörn-Steffen Pischke, and Nicholas S. Souleles. “Testing for liquidity constraints in Euler equations with complementary data sources”. *The Review of Economics and Statistics*, 80 (2):251–262, May 1998.

Shane T. Jensen and Stephen H. Shore. “Changes in the Distribution of Income Volatility”. 2008.

David Johnson, Stephanie Shipp, and Thesia Garner. *Proceedings of the Government and Social Statistics Section*, chapter “Developing Poverty Thresholds Using Expenditure Data”, pages 28–37. American Statistical Association, Alexandria, VA, Aug. 1997.

Greg Kaplan and Giovanni Violante. “how much insurance in bewley models?”. *Working Paper, New York University*, 2008.

L. Katz and D. Autor. *Handbook of Labor Economics*, volume 3A, chapter “Changes in the Wage Structure and Earnings Inequality”. Amsterdam: North-Holland, 1999.

Benjamin Keys. *Income Volatility and Food Assistance in the United States*, chapter "Trends in Income and Consumption Volatility, 1970-2000". Upjohn Institute for Employment Research, 2008.

Tom Krebs. "Growth and welfare effects of business cycles in economies with idiosyncratic human capital risk". *Review of Economic Dynamics*, 6(4):846868, Oct. 2003.

Dirk Krueger and Fabrizio Perri. "Does income inequality lead to consumption inequality? Evidence and theory". *Review of Economic Studies*, 73(1):163–193, Jan. 2006.

Robert Lucas. *Models of Business Cycle*. Oxford: Basil Blackwell, 1987.

Angela C. Lyons. "How credit access has changed over time for US households". *The Journal of Consumer Affairs*, 37(2):231–255, Winter 2003.

Thomas E. MaCurdy. "The use of time-series processes to model the error structure of earnings in a longitudinal data-analysis". *Journal of Econometrics*, 18(1):83–114, 1982.

Margaret M McConnell and Gabriel Perez-Quiros. "Output fluctuations in the United States: What has changed since the early 1980's?". *The American Economic Review*, 90(5):1464–1476, Dec. 2000.

Costas Meghir. "A retrospective on Friedman's theory of Permanent Income". *Economic Journal*, 114:F293–F306, June 2004.

Costas Meghir and Guglielmo Weber. "Intertermporal Nonseparability or Borrowing Restrictions? A Disaggregate Analysis using a U.S. Consumption Panel". *Econometrica*, 64(5), Sept. 1996.

Robert Moffitt and Peter Gottschalk. "Trends in the transitory variance of earnings in the US". *The Economic Journal*, 112: C68–C73, Mar. 2002.

Robert Moffitt and Peter Gottschalk. "The growth of earnings instability in the US labor market". *Brookings Papers on Economic Activity*, 2:217–72, 1994.

Robert Moffitt and Peter Gottschalk. "Trends in the variances of permanent and transitory earnings in the US and their relation to earnings mobility". *Boston College Working Paper*, 444, Nov. 1998.

Jonathan Parker and Bruce Preston. "Precautionary saving and consumption fluctuations". *American Economic Review*, 95(4):1119–1143, Sept. 2005.

Thomas Piketty and Emmanuel Saez. "How Progressive is the U. S. Federal Tax System? A historical and international perspective". *The Journal of Economic Perspecitves*, 21(1), 2007.

Giorgio Primiceri and Thijs vanRens. "Heterogeneous life-cycle profiles, income risk and consumption inequality". *Journal of Monetary Economics*, 56(1), Jan. 2009.

Donggyun Shin and Gary Solon. "Trends in Men's Earnings Volatility: What Does the Panel Study of Income Dynamics Show?". *NBER Working Paper Series*, (W14075), Jun. 2008.

Stephen H. Shore. “For better, for worse: Intra-household risk-sharing over the business cycle”. *Review of Economics and Statistics*, 2009.

Jonathan Skinner. “A superior measure of consumption from the Panel Study of Income Dynamics”. *Economics Letters*, 23:213–216, 1987.

D. Slesnick. *Consumption and Social Welfare: Living Standards and Their Distribution in the United States.* Cambridge: Cambridge University Press, 2001.

James Stock and Mark Watson. “Has the business cycle changed and why?”. *NBER Working Paper Series*, w9127, Aug. 2002.

Kjetil Storesletten, Christopher I. Telmer, and Amir Yaron. “Consumption and risk sharing over the life cycle”. *Journal of Monetary Economics*, 51(3):609–633, Apr. 2004.

Francisco Torralba. “Household debt and consumption volatility”. University of Chicago mimeo, 2006.

Stephen Zeldes. “Consumption and liquidity constraints: An empirical investigation”. *Journal of Political Economy*, 97(2):305–346, 1989.

James Ziliak. “Does the choice of consumption measure matter? An application to the permanent-income hypothesis”. *Journal of Monetary Economics*, 41:201–216, 1998.

A Appendix: Data

A.1 Panel Study of Income Dynamics

PSID, which began in 1968, is a longitudinal study of a representative sample of U.S. individuals (men, women, and children) and the family units in which they reside, and is conducted by the University of Michigan. The PSID's sample size has grown from 4,800 families in 1968 to more than 7,000 families (and over 60,000 individuals) in 2001. Some families are followed for as much as 36 consecutive years.

The PSID original sample in 1968 consisted of two independent samples: a cross-sectional national sample and a national sample of low-income families. The cross-sectional sample was drawn by the Survey Research Center (SRC), and was an equal probability sample of households from the 48 contiguous states. The second sample came from the Survey of Economic Opportunity (SEO), conducted by the Bureau of the Census for the Office of Economic Opportunity. The PSID selected about 2,000 low-income families with heads under the age of sixty from SEO respondents. In 1990, PSID added 2,000 Latino households, including families originally from Mexico, Puerto Rico, and Cuba. But in 1995 this sample was dropped due to insufficient funding.

The PSID is the only cross-sectional time-series survey that collects data on household consumption. But consumption data are limited to food and shelter. Some studies remedy this by estimating total consumption. Skinner [1987] and Blundell et al. [2008] combine PSID's food expenditure data with data from Consumer Expenditure Survey using synthetic cohorts to construct total consumption measures. Skinner [1987] estimates total consumption using CEX for each cohort by postulating that it depends on food at home, food away from home, rent if a renter, utilities, market value of the home if a homeowner, and the number of vehicles owned. He then uses the predictions from this model to estimate total consumption in PSID. Blundell et al. [2008] improve on this methodology by postulating an economically founded theoretical model of total consumption and allowing for total consumption to vary within cohort by using family, demographic and regional characteristics. Ziliak [1998] proposes to use information from PSID's Wealth Supplement (collected only in 1984, 1989, 1994, and biennially since 1999) and PSID's income data to construct total consumption. He estimates savings using the wealth and income data and then uses these estimated savings to generate total consumption as the difference between family income and estimated savings.

But these estimation strategies have obvious limitations, the introduction of model uncertainty and extra measurement error. Since our study's main focus is on variances rather than means of household level consumption, using imputed consumption measures would distort our results in obscure ways.

Another possibility would be to use Consumer Expenditure Survey (CEX), which collects a more complete inventory of consumption data including expenditure on durables and nondurables. But its structure as a repeated cross-section makes it impossible to construct individual volatility measures that track volatility for the same individual over periods of time longer than one year. Current work on inequality utilizes CEX data by constructing synthetic cohorts. This strategy is inappropriate here as our main concern is to provide a measure of temporal volatility for each household. Synthetic cohort techniques would require aggregation within cohort, which in itself introduces a lot of data smoothing, and is exactly what we want to avoid. Due to this major limitation, we use PSID data in this study. We plan to extend our study, at later date, by combining information from both PSID and CEX surveys. The information obtained from the two surveys

Table 5: Selected Summary Statistics for Panel Study of Income Dynamics Sample

	1980		1990		2001	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Age of Head	38.9	11.05	39.28	9.66	42.01	9.64
Male Head	0.84	0.36	0.83	0.38	0.81	0.39
White Head	0.89	0.31	0.91	0.28	0.88	0.32
No High School Diploma	0.14	0.35	0.08	0.28	0.09	0.28
High School Diploma	0.34	0.47	0.35	0.48	0.33	0.47
Some College	0.23	0.42	0.24	0.43	0.27	0.44
At Least Bachelor's Degree	0.28	0.45	0.32	0.47	0.31	0.46
Married	0.76	0.42	0.73	0.44	0.68	0.47
Single	0.14	0.34	0.16	0.36	0.18	0.39
Single parent	0.06	0.23	0.06	0.24	0.06	0.24
Number of Kids	1.14	1.18	1.08	1.18	0.93	1.11
Number of Adults	1.98	0.69	1.93	0.65	1.94	0.71
North East	0.20	0.40	0.20	0.40	0.17	0.38
Mid West	0.31	0.46	0.29	0.46	0.31	0.46
South	0.31	0.46	0.33	0.47	0.33	0.47
West	0.18	0.38	0.18	0.38	0.19	0.39
Family Income	33,225	17,805	36,602	21,012	45,048	30,115
Taxable Family Income	29,962	17,396	33,697	20,867	40,681	29,418
Expenditure on Food	4,006	1,810	3,769	1,766	3,764	1,880
Expenditure on Rent	1,179	2,327	1,751	3,456	1,604	3,459
Mortgage Payments	4,229	4,239	6,529	7,482	7,478	7,999
Number of Observations	2195		2540		3054	

Summary Statistics for income and expenditures are converted to real dollars using All-Urban CPI index with base year 1982-84=100. These statistics are for random sample only, i.e. excluding both SEO and Latino samples.

will provide a more complete understanding of uncertainty faced by households in the US.

Thus, we compute all our consumption volatility measures using food consumption computed as a sum of food consumed at home plus away from home plus food stamps received. We follow the literature by including food stamps in the definition of food consumed. Food consumption is also the choice variable in other studies of household consumption behavior (see Hall and Mishkin [1982], Zeldes [1989] for earlier studies, and Hurst and Stafford [2004], Cox et al. [2004] for examples

Table 6: U.S. Census Bureau Official Equivalence Scale Computed from Poverty Thresholds by Size of Family and Number of Related Children Under 18 Years

	Related children under 18 years								
Size of family unit	None	One	Two	Three	Four	Five	Six	Seven	Eight+
One person	1.00								
Two persons	1.29	1.32							
Three persons	1.50	1.55	1.55						
Four persons	1.98	2.02	1.95	1.96					
Five persons	2.39	2.43	2.35	2.29	2.26				
Six persons	2.75	2.76	2.70	2.65	2.57	2.52			
Seven persons	3.16	3.18	3.12	3.07	2.98	2.88	2.76		
Eight persons	3.54	3.57	3.51	3.45	3.37	3.27	3.16	3.14	
Nine persons or more	4.26	4.28	4.22	4.17	4.09	3.99	3.89	3.87	3.72

of more recent work) and we feel that its use here is also justified on the grounds of complementarity and comparability with these studies.

Another drawback of PSID data is that food consumption was not collected in 1973, in 1988 and in 1989, in addition, the survey became biannual after 1997. We do not impute for the missing years in order to keep measurement error and misidentification to a minimum. We remedy the fact that the survey became biennial by constructing a hypothetical biennial survey, by keeping all the even years of the pre-1997 survey in addition to the data collected post-1997, for the description of the trends in the volatility measure. But the missing data do not constitute a problems for our volatility decomposition exercise since the Euler equation holds true between any two time periods.

Our core sample contains data from 1974 to 2004, and consists of heads of households (both male and female) who are not students and are not retired. We keep households whose head is at least 25 years old but less than 65. We drop all the households that belonged to the Latino sample, and those that were drawn from the Survey of Economic Opportunity (SEO). Households that report negative or zero food consumption levels (that is a sum of food at home plus away from home plus food stamps) are also eliminated. In order to minimize effects of outliers on the results, we follow the literature by dropping households who report more than 300 percent change in family income or food consumption over a one year period as well as those whose income or consumption fall by more than 33 percent (see for example Zeldes [1989]). Summary statistics for the sample are provided in Table 5.

A.2 Definitions of Variables and Liquidity Constraints

At the time of the interview, the respondent is asked questions about income, transfers, wealth and expenditures on food and shelter. The families are asked to report income and transfers received during the previous year. We use total family income to compute income uncertainty. We adjust income data by one period to correspond to the appropriate demographic characteristics for each household. The timing of consumption data is more ambiguous. We follow Zeldes [1989] and assume that the respondent provided information on food expenditures for the year of the survey rather than for the previous year. We use an annual average of monthly data on 1-year constant

Table 7: Summary Statistics for Liquidity Constrained versus Unconstrained Households

	1980		1991		2001	
	yes	no	yes	no	yes	no
Do you save?	0.87	0.13	0.89	0.11	0.86	0.14
Age, head	39.09	37.76	39.83	35.72	42.54	40.52
Years of Education, head	13.46	12.05	13.97	11.41	13.86	12.66
Cohabiting	0.78	0.65	0.79	0.69	0.72	0.56
Single Parent	0.05	0.14	0.03	0.15	0.05	0.11
Number of Adults	1.98	1.96	2.00	1.85	1.97	1.85
Number of Kids	1.10	1.37	1.08	2.34	0.93	1.01
Rent	0.23	0.45	0.22	0.45	0.21	0.40
Weeks Unemployed	0.83	2.08	0.69	2.06	0.68	1.42
Family Income	34,566	23,511	39,059	24,256	42,342	25,531
Number of Observations	2200		1932		2833	
	yes	no	yes	no	yes	no
Are your savings at least 2 mths of annual income?	0.49	0.51	0.29	0.71	0.17	0.83
Age, head	41.76	36.25	44.96	37.42	45.37	40.10
Years of Education, head	13.65	12.95	14.90	13.32	14.41	13.42
Cohabiting	0.79	0.74	0.81	0.77	0.71	0.68
Single Parent	0.04	0.08	0.01	0.06	0.04	0.07
Number of Adults	2.01	1.95	2.08	1.96	2.00	1.92
Number of Kids	0.94	1.32	0.68	1.40	0.73	0.99
Rent	0.19	0.32	0.07	0.31	0.14	0.30
Weeks Unemployed	0.70	1.26	0.46	0.89	0.66	0.92
Family Income	37,927	28,655	54,727	31,273	45,654	34,221
Number of Observations	2119		1875		2639	

Summary Statistics for income and expenditures are converted to real dollars using All-Urban CPI index with base year 1982-84=100. These statistics are for random sample only, i.e. excluding both SEO and Latino samples.

maturity Treasury bills.

All the income, expenditure, wealth, and interest rate data are expressed in real terms. Nominal data are converted into real using item specific regional not seasonally adjusted all urban Consumers Consumer Price Index (CPI-U) with base period of 1982-1984=100. Thus, food expenditures are deflated using the Food and Beverages CPI; housing expenditures, using the Housing CPI; and all income, wealth and interest rate series, using All-Items CPI.

Table 6 provides official equivalence adjustments computed from poverty thresholds used by the U.S. Census Bureau. The change in this adjustment factor is used to proxy for change in the family composition, $\Delta N_{h,t+1}$.

We separate our sample into liquidity constrained and unconstrained households combining Zeldes [1989] and Jappelli et al. [1998] findings. We use information on demographics and the amount of savings each household made during the year. We do two different splits. One counts households as unconstrained if they had any amount of positive savings (save=1). The second is more restrictive and includes households if they saved and if those savings equaled at least 2 months worth of family income (2mnths=1). The resolution of problems associated with endogeneity of asset holdings is left for future research.

In 1969-1972, 1975, 1979-1980, households were asked whether they had any savings. If household responded positively to this question, they were counted as unconstrained for the first split, (save=1). Families were also asked if those savings amounted to at least 2 months of family income. If the answer was positive, these households were counted as unconstrained in our second split, (2mnths=1). We utilized data from Wealth Supplements to split the sample for years after 1980. Wealth information was collected in 1984, 1989, 1994, 1999 and biennially after that. We used information from this supplement regarding household's savings in the same manner. For the years when savings information was unavailable we used standard imputation techniques to construct the splits. Specifically, we ran a probit model to project backwards the probability of having positive savings or savings equal to 2 months of income, in order to construct the savings dummies for the missing years. These probit regressions have a good predictive power, and results available upon request. The resolution of problems associated with endogeneity of asset holdings is left for future research.

As pointed out by Jappelli et al. [1998], households with zero or negative net worth are not necessarily constrained households, as poor household could still have access to credit cards or other lines of credit. Jappelli et al. [1998] propose to use a direct measure of liquidity constraints that relies on information of whether household was denied loans or was discouraged from borrowing or if it did not have a credit card or other lines of credit. Unfortunately, no such information is available from PSID. Thus, we complement our asset split by excluding household according to some demographic characteristics. Jappelli et al. [1998] find that households with less than college education, unemployed, or younger than 38 are more likely to be turned down for a loan. Lyons [2003] finds that although borrowing constraints relaxed since 1983 and most dramatically between 1992 and 1998, individuals younger than 35, who are black, or poorly educated continued to be constrained, though less than before.

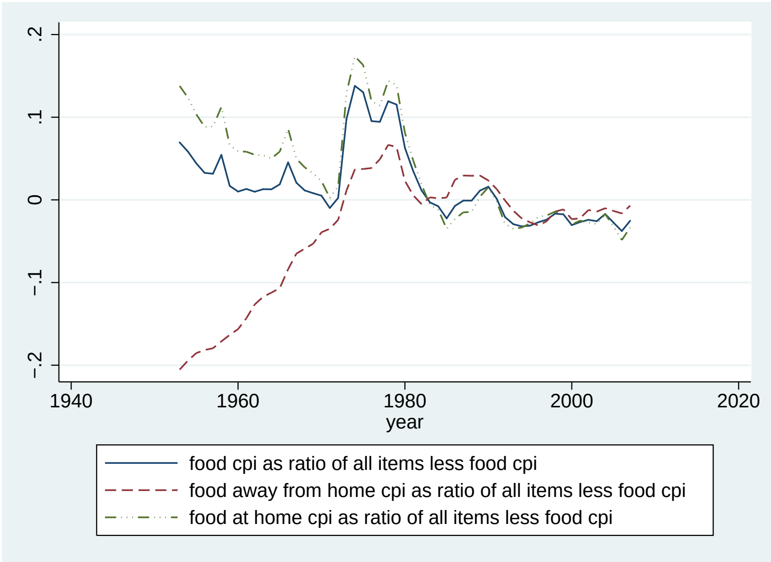
To summarize, we split the sample into two sub-samples: constrained and unconstrained households. *Constrained* households are identified by having zero savings for the first split, and savings of less than 2 months worth of income for the second; and for both splits by having a head of household whose educational attainment is less than a high school diploma, who is under 35 years of age, or who is unemployed.

We allow households to belong to both groups during their sample life depending on the state of their wealth. Thus, if a household with positive savings one year has zero savings the next year, it will be a part of unconstrained and then constrained group. In practice, according to the first split (save=1) only 5 percent of households moved from unconstrained to constrained group, while about

35 percent moved from being constrained to unconstrained in our sample. If we consider the second split, (2mnths=1), these numbers are more pronounced, 24 percent of households transitioned from having savings of at least 2 months of family income to having less than 2 months worth of savings; and only 11 percent transitioned from being constrained to becoming unconstrained. On average, about 13 percent of households are counted as constrained in 1980 and 14 percent in 2001 according to our first measure; and 50 versus 80 percent, respectively, according to the second measure. Summary statistics for constrained and unconstrained households can be found in Table 7.

A.3 Supplementary Figures

Figure 6: The Ratio of Food Prices to the Price of All Other Goods, (1982-1984==100)



Source: Bureau of Labor Statistics.

A.4 Supplementary Tables

Table 8: Euler Equation Estimation - annual growth rates, 1970-1996.

	Total	$edu \leq 12$	$edu > 12$	$\Delta mstatus = 0$	married
Age	-0.00‡	-0.00	-0.00	-0.00	-0.00 *
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\Delta adults$	-0.13*	-0.16*	-0.11**	-0.14*	-0.08**
	(0.04)	(0.06)	(0.05)	(0.04)	(0.04)
$\Delta kids$	-0.07	-0.11	-0.03	-0.09†	0.00
	(0.05)	(0.09)	(0.06)	(0.05)	(0.05)
$\Delta mstatus$	-0.01	-0.04	0.02		
	(0.08)	(0.13)	(0.11)		
Δhrs_h	0.02†	0.02	0.03	0.02†	0.02
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Δhrs_w	0.00	0.01	0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$ln(1 + r_{t+1})$	1.91‡	1.72	0.98	1.00	1.51
	(1.34)	(1.57)	(2.66)	(1.77)	(1.95)
$\left[\frac{Y_{t-1}}{C_{t-1}}\right]^2 (\sigma_t^{\widetilde{Y}})^2$	0.01**	0.01**	0.00	0.01**	0.01†
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Δlnp^F	1.89	1.62	0.33	0.98	1.16
	(2.24)	(2.78)	(4.19)	(1.95)	(2.12)
Δlnp^O	-2.14	-1.87‡	-1.08	-1.26	-1.56
	(1.69)	(2.027)	(3.13)	(1.48)	(1.59)
Num. observations	21,753	11,919	9,780	21,464	16,123
Num. groups (fe)	3,321	1,829	1,479	3,312	2,423
Overall significance test					
Prob > F	0.00	0.12	0.01	0.00	0.00
Underidentification test	17.55	10.15	7.82	14.99	9.55
Chi-sq(2) P-val	0.00	0.00	0.02	0.00	0.01
Weak identification test	1.76	1.02	0.78	1.66	1.06
Hansen J statistic	2.15	3.45	0.05	3.21	0.77
Chi-sq(1) P-val	0.14	0.06	0.82	0.07	0.38

Heteroskedasticity and autocorrelation robust standard errors using the Bartlett kernel with bandwidth of $T^{1/3} = 3$ in parentheses; * significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

Table 9: Euler Equation Estimation - nonseparable utility function, biennial growth rates, 1978-2004.

	Total	$edu \leq 12$	$edu > 12$	$\Delta mstatus = 0$	married
Age	-0.00‡	-0.01**	-0.00	-0.00	-0.00†
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\Delta adults$					
$\Delta kids$	0.07	-0.06	-0.09	-0.11	-0.06
	(0.07)	(0.08)	(0.12)	(0.08)	(0.08)
$\Delta mstatus$	-0.00				
	(0.08)				
Δhrs_h	0.01	0.01	-0.02	0.00	0.01
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)
Δhrs_w	-0.00	-0.00	0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$ln(1+r_{t+2})$	0.78	-1.28	1.99	0.98	1.77
	(1.12)	(1.95)	(1.76)	(1.15)	(1.27)
$ln(1+r_{t+1})$	-0.50	0.80	-1.25	-0.77	-1.23
	(0.78)	(1.20)	(1.02)	(0.76)	(0.91)
$\left[\frac{Y_{t-2}}{C_{t-2}}\right]^2 (\sigma_t^{\widetilde{Y}})^2$	0.00	0.01‡	0.00	0.00	0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Δlnp^F	-0.16	0.06	-0.29	-0.23	-0.28
	(0.98)	(1.40)	(1.46)	(0.98)	(1.10)
Δlnp^O	-0.53	-0.83	-0.37	-0.43	-0.40
	(0.82)	(1.15)	(1.22)	(0.82)	(0.97)
Num. observations	9,102	4,834	4,334	8,837	6,688
Num. groups	2,276	1,188	1,091	2,248	1,684
Overall significance test					
Prof>F	0.00	0.00	0.09	0.00	0.00
Underidentification test	5.68	3.88	9.62	4.26	4.60
Chi-sq(2) P-val	0.06	0.14	0.01	0.12	0.10
Weak identification test	0.57	0.43	0.98	0.47	0.51
Hansen J statistic	2.62	1.85	0.32	1.85	0.78
Chi-sq(1) P-val	0.10	0.17	0.57	0.17	0.38

Heteroskedasticity and autocorrelation robust standard errors using the Bartlett kernel with bandwidth of $T^{1/3} = 3$ in parentheses; * significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

Table 10: Euler Equation Estimation - separable utility function, annual growth rates, 1970-1996.

	Total	$edu \leq 12$	$edu > 12$	$\Delta mstatus = 0$	married
Age	-0.00**	-0.00†	-0.00†	-0.00†	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\Delta adults$	-0.13*	-0.14*	-0.11**	-0.14*	-0.09**
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
$\Delta kids$	-0.07	-0.10‡	-0.09†	-0.05	0.01
	(0.05)	(0.07)	(0.06)	(0.05)	(0.05)
$\Delta mstatus$	0.02				
	(0.08)				
Δhrs_h	0.02†	0.01	0.04†	0.02‡	0.02
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Δhrs_w	0.01		0.01	-0.00	-0.00
	(0.01)		(0.01)	(0.00)	(0.00)
$ln(1 + r_{t+1})$	0.54**	0.44	0.31	0.28	0.57†
	(0.27)	(0.34)	(0.42)	(0.28)	(0.34)
$\left[\frac{Y_{t-2}}{C_{t-2}}\right]^2 (\sigma_t^{\widetilde{Y}})^2$	0.01 **	0.01**	0.00	0.01	0.01**
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Num. observations	22,820	12,832	10,474	22,525	16,880
Num. groups (fe)	3,431	1,928	1,550	3,429	2,507
Overall significance test					
Prof>F	0.00	0.09	0.05	0.00	0.01
Underidentification test	18.62	11.65	8.92	15.87	10.2
Chi-sq(2) P-val =	0.00	0.00	0.01	0.00	0.01
Weak identification test	2.33	1.95	1.27	2.27	1.46
Hansen J statistic	1.44	4.61	0.06	2.50	0.46
Chi-sq(1) P-val =	0.23	0.03	0.81	0.11	0.50

Heteroskedasticity and autocorrelation robust standard errors using the Bartlett kernel with bandwidth of $T^{1/3} = 3$ in parentheses; * significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

Table 11: Time evolution of consumption risk, annual growth rates, 1970-1996.

	All		
year $\times 10^{-3}$	1.06*	1.24*	1.02*
	(0.35)	(0.33)	(0.33)
Nonwhite year $\times 10^{-3}$	2.41**		
	(1.23)		
Female year $\times 10^{-3}$		0.02*	
		(0.00)	
Single Parent year $\times 10^{-3}$			0.00
			(0.00)
Single year $\times 10^{-3}$			0.04*
			(0.01)
Nonwhite	-4.75**		
	(2.43)		
Constant	-2.00*	-2.36*	-1.93*
	(0.69)	(0.66)	(0.66)
Num. Obs.	22,499	22,499	22,499
F-dist	7.82	17.31	19.30
	$\Delta mstatus = 0$		
year $\times 10^{-3}$	0.66*	0.61*	0.45*
	(0.14)	(0.14)	(0.14)
Nonwhite year $\times 10^{-3}$	0.02*		
	(0.00)		
Female year $\times 10^{-3}$		0.02*	
		(0.00)	
Single Parent year $\times 10^{-3}$			0.01*
			(0.00)
Single year $\times 10^{-3}$			0.02*
			(0.00)
Constant	-1.22*	-1.13*	-0.82*
	(0.28)	(0.28)	(0.28)
Num. Obs.	22,221	22,221	22,221
F-dist	37.39	49.44	57.63
Prob>F	0.00	0.00	0.00

Note: Consumption risk is computed from the entire sample or for sample with no change in marital status. All regressions in this table assume that coefficients estimated from the Euler equation are the same for all groups. Robust standard errors in parentheses; * significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.

Table 12: Time evolution of consumption risk, annual growth rates, 1970-1996.

		$EDU \leq 12$	
year $\times 10^{-3}$	1.90**	2.14**	1.94**
	(1.06)	(0.92)	(0.91)
Nonwhite year $\times 10^{-3}$	2.07‡		
	(1.45)		
Female year $\times 10^{-3}$		0.03**	
		(0.01)	
Single Parent year $\times 10^{-3}$			-0.01
			(0.01)
Single year $\times 10^{-3}$			0.04*
			(0.01)
Nonwhite	-4.09‡		
	(2.87)		
Constant	-3.63**	-4.11**	-3.73**
	(2.10)	(1.84)	(1.79)
Num. Obs.	12,309	12,309	12,309
F-dist	6.68	2.73	5.46
Prob>F	0.00	0.04	0.00
		$EDU > 12$	
year $\times 10^{-3}$	0.89**	0.59**	0.86*
	(0.26)	(0.26)	(0.25)
Nonwhite year $\times 10^{-3}$	0.02*		
	(0.01)		
Female year $\times 10^{-3}$		0.02*	
		(0.00)	
Single Parent year $\times 10^{-3}$			-1.45†
			(0.86)
Single year $\times 10^{-3}$			-1.67†
			(0.91)
Single parent			2.89†
			(1.71)
Single			3.39†
			(1.80)
Constant	-1.07**	-1.07**	-1.62*
	(0.51)	(0.51)	(0.50)
Num. Obs.	10,124	10,124	10,124
F-dist	8.04	14.90	19.11
Prob>F	0.00	0.00	0.00

Note: Consumption risk is computed from the sample of households headed by individual with $edu \leq 12$ or $edu > 12$. All regressions in this table assume that coefficients estimated from the Euler equation are the same for all groups. Robust standard errors in parentheses; * significant at 1%, ** at 5%, † at 10%, and ‡ at 15%.