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Abstract: The Food Stamp Program constitutes a major component of any effort to address the nutritional deficiencies found among vulnerable populations in the United States. Concern has been raised among policy makers and researchers that food stamp participation rates tend to decline with age, especially among the elderly who may be financially vulnerable. In this paper we use data from the Panel Study of Income Dynamics (PSID) from 1980 to 2003 and a correlated random effects estimator to estimate the effects of age and income volatility on the decision to participate in food stamps. Controlling for other factors, we find evidence of a U-shaped pattern in food stamp participation by age, and we find that households with above-average income volatility are more likely to participate than those with lower income volatility at most ranges across the age gradient.

Low intakes of essential nutrients present a threat to the health of elderly persons in the United States. In national nutrition studies, the elderly have been found to have low intakes of energy, fiber, magnesium, antioxidants, and some other micronutrients (Berg & Cassells, 1992). For about 25% of elderly persons, these intakes are low enough to lead to an increased risk of nutrient deficiencies (Millen, 1999). These nutritional deficiencies can have serious consequences including diminished immune response, longer hospital stays, impairment in physical function, premature institutionalization, reduced activity levels, and higher risks of coronary heart disease (Chen, *et al*., 2001; Chima, *et al*., 1997; Hendy, *et al*., 1998; Herndon, 1995; Lesourd, *et al*., 1998; Seiler & Stahelin, 1999; Sharkey, *et al*., 2002). The effect of low nutrient intakes is large enough that an estimated one-third to one-half of all health conditions in elderly persons may be related to these low intakes (Ryan & Bower, 1989).

One way for policymakers to address these nutritional deficiencies among the elderly, and especially among the low-income elderly, is to encourage participation in the largest food assistance program in the U.S., the Food Stamp Program. This is especially true since research with both elderly and non-elderly populations has demonstrated that food stamp recipients have higher nutrient intakes than eligible non-recipients (Akin, *et al*., 1985; Basiotis, *et al*., 1998; Devaney & Moffitt, 1991; Wilde, *et al*., 1999). To receive food stamps, households must meet three financial criteria: the gross income test, the net income test, and the asset test. The elderly, however, do not have to meet the gross income test and they have higher asset limits than non-elderly. Despite these more lax eligibility requirements and a net income calculation which would benefit many elderly persons (especially the deduction for medical care), participation among the elderly remains stubbornly low. In 2001, the participation rate among elderly persons eligible for food stamps was 28.0 percent versus an average participation rate of 61.6 percent for the population as a whole (Cunnyngham, 2003).

These low rates of participation have been ascribed to several factors. Among these factors are diminished need for food stamps (Haider, *et al.*, 2003) and lower rates of food insecurity (Gundersen and Oliveira, 2001). However, even after controlling for these factors, the lower rates of participation remains largely unexplained. In this paper, we consider two heretofore unexplored reasons for these lower participation rates among the elderly – reductions in income volatility among older persons as they exit the labor force and the experiences of the elderly with the Food Stamp Program. In terms of the former reason, if potential recipients view the Food Stamp Program as an assistance program to be used in the face of negative income fluctuations but not when incomes are permanently low, reductions in income volatility may be a factor among the elderly. In terms of the latter reason, we consider the effect of date of birth cohort on current use of the Food Stamp Program. One potential reason for the historically lower participation rates of the elderly might be due to the newness of the Food Stamp Program. In its present format (i.e., at a national level and without the "purchase requirement"), food stamps have only been in existence since 1980. It may therefore be the case that persons who were 65 years old in, say, 1985, may have far less knowledge of food stamps than persons who were 65 years old in 2000. In response, food stamp participation rates may be higher among the elderly in more recent years than in previous years.

In this paper we use data from the 1980 to 2003 waves of the Panel Study of Income Dynamics (PSID) to estimate the effects of age, income volatility, and birth cohort on Food Stamp Program participation, and the extent to which the effect of volatility on participation varies across the age gradient. We use standard measures of income volatility from Gottschalk and Moffitt (1994) along with a correlated random effects estimator to estimate model parameters (Hausman and Taylor 1981). The correlated random effects estimator is advantageous in this context because it permits identification of both time-varying and time-invariant regressors, the latter of which include birth cohort and some of our measures of income volatility. For the sake of robustness we also estimate a correlated random effects estimator without birth cohorts and a standard fixed-effects linear probability model which still permits identification of both the age gradient and the effect of volatility along the gradient.

We find that participation in food stamps is U-shaped across the life course, contrary to the conventional wisdom of simple summary statistics that show participation declining monotonically across the age gradient. Consistent with the idea of greater familiarity with the Food Stamp Program encouraging participation, we find that younger birth cohorts have higher rates of food stamp participation than earlier birth cohorts. We also find that at on average food stamp participation is higher among those with high levels of "permanent" income volatility, but is lower among those with volatile transitory incomes measure at high frequencies. We also identify important heterogeneity in the effect of income volatility across the age gradient, finding that at any given age participation in food stamps is higher among those with above average income volatility.

II. Patterns of Food Stamp Participation and Income Volatility over the Life Course

We begin our analysis with a description of our data and then present basic patterns of food stamp participation and income volatility over the life course.

A. Data

The data we use come from the Panel Study of Income Dynamics (PSID) for interview years 1980–2003 (calendar years 1979–2002). The survey has followed a core set of households since 1968 plus newly formed households as members of the original core have split off into new families. We begin in 1979 because this is when the Food Stamp Program ended the so-called purchase requirement where recipients needed to pay for a set amount of discounted food stamps with the price directly related to a household's income. The PSID is advantageous because it contains detailed information on income and household composition.

The sample we use is an unbalanced panel treating missing observations as random events. By eliminating only a missing person year of data, the time series for each household can be of different length within 1980–2003. To be included in the sample the household head must (1) be in the sample at least three years; (2) be at least 25 years old in 1980; (3) not be a student, permanently disabled, or institutionalized; (4) and not have year-to-year increases in real income exceeding 300 percent or declines exceeding 75 percent. We also require annual family income to be no less than $1,000 in inflation-adjusted terms. We define date-of-birth cohorts in ten-year intervals in the PSID in order to maintain adequate within-cohort sample sizes. There are 72,311 person-years in the base case sample of all persons.

In addition to the base case sample we also attempt to isolate the effect of age and income volatility on food stamp participation among a population most likely to join the program. Income and assets are obvious metrics to isolate an "at risk" population of food stamp recipients, but because food stamp eligibility is determined in part by the levels of income and assets selecting an income and asset eligible sample is will impart an endogeneity bias into our estimated coefficients. As an alternative we select a subsample of family heads with less than a high school diploma as the at risk population. The advantage of using education is that it is exogenous to the food stamp eligibility formula, but at the same time is a common proxy in economics for permanent income; that is, this sample is likely to select individuals with low permanent incomes and thus a high ex ante probability of food stamp participation relative to family heads with higher levels of formal schooling (e.g., Gundersen and Oliveira, 2001; Bhattarai et al., 2005). There are 17,560 person-years in this sample.

One potential drawback to the PSID is the smaller number of elderly persons in comparison to other surveys. In particular, it is smaller than the Survey of Income and Program Participation (SIPP) and the Health and Retirement Survey (HRS). Despite this smaller sample size, the PSID is the only data set with sufficient number of years to (a) adequately measure income volatility and (b) incorporate the effects of birth cohorts over an extended time period.

B. Food Stamp Participation

The Food Stamp Program, with a few exceptions, is available to all persons who meet income and asset tests. To receive food stamps, households must meet three financial criteria: a gross-income test, a net-income test, and an asset test. A household's gross income before taxes in the previous month cannot exceed 130 percent of the poverty line, and net monthly income cannot exceed the poverty line.[1] Finally, income-eligible households with assets less than $2,000 qualify for the program. The value of a vehicle above $4,650 is considered an asset unless it is used for work or for the transportation of disabled persons. Households receiving Temporary Assistance for Needy Families (TANF) and households where all members receive Supplemental Security Income (SSI) are categorically eligible for food stamps and do not have to meet these three tests. There are two distinctions for older persons. First, persons over the age of 60 do not

[1] Net income is calculated by subtracting a standard deduction from a household's gross income. In addition to this standard deduction, households with labor earnings deduct 20 percent of those earnings from their gross income. Deductions are also taken for child care and/or care for disabled dependents, medical expenses, and excessive shelter expenses.

have to meet the gross income test. (But they do have to meet the net income test.) Second, the asset limit for persons over the age of 60 is $3,000 rather than $2,000.

A large fraction of households eligible for food stamps do not participate. A common argument made for the existence of eligible nonparticipation is that there may be stigma associated with receiving food stamps. Stigma encompasses a wide variety of sources, from a person's own distaste for receiving food stamps to the fear of disapproval from others when redeeming food stamps to the possible negative reaction of caseworkers (Daponte, Sanders, and Taylor 1999; Ranney and Kushman, 1987; Moffitt, 1983). Another reason often suggested is that transaction costs can diminish the attractiveness of participation.[2] A household faces these costs on a repeated basis when it must recertify its eligibility. Additionally, weighed against these costs, the benefit level may be too small to induce participation; food stamp benefits can be as low as $10 a month for a family. In light of the low participation rates of the elderly, these factors may be especially relevant for them.

In Figures 1 (full sample) and 2 (low-education sample) we display food stamp participation rates by year for five separate age categories—under 30, between 31 and 40, between 41 and 50, between 51 and 60, and 61 and older. In each figure the food stamp participation rate is calculated as the number of food stamp participants divided by the number of sample participants. The rates are not weighted and thus the levels are likely upper-bound estimates given the oversampling of the poor in the SEO subsample of the PSID. For the full sample and the at-risk group of low-educated heads the participation rate of households headed by someone under the age of 30 exceeds that of all the other age categories (except the last two years in the low education sample) and, in some years, the under-30 versus over-30 gap can be

[2] Examples of such costs include travel time to a food stamp office and time spent in the office, the burden of transporting children to the office or paying for child care services, and the direct costs of paying for transportation.

quite large. Given the larger number of small children among households headed by someone under the age of 30 and the positive relationship between the presence of children and food stamp participation (e.g., Hagstrom, 1996; Bollinger and David, 1997; Bartfeld, 2003), this is not entirely unexpected. Part of this age gap also likely arises from categorical eligibility for food stamps among families receiving AFDC/TANF, the latter of which tends to be dominated by young families. Interestingly, the figures reveal that the participation rates for heads between the age of 41 and 50 are lower than the other age groups for most of the sample period. This age group tends to be the period of the life cycle of peak labor-market earnings and declining family size as children move out of the home. Overall, the cross-sectional age-related differences in Food Stamp Program participation depicted in Figures 1 and 2 using our sample from the PSID suggests that food stamp use declines with age, but it is not monotonic.

In addition, the trends in the figures shed some light on the demographic composition of the caseload underlying the much-studied rise in Food Stamp Program participation in the early 1990s followed by the subsequent decline in the late 1990s (Wallace and Blank 1999; Ziliak, Gundersen, and Figlio 2003). The increase in the late 1980s and early 1990s appears to have been initially driven by a surge in participation among families whose head was under age 30, subsequently followed by an increase in the 31-40 age group. However, participation among the under 30 group started to decline around 1993 even though the peak in aggregate participation was not reached until 1995. Figures 1 and 2 suggest that the continued upward push came from those families whose head was between the ages of 31 and 40 and 41 and 50. Participation then fell for all groups through 2001.

In Figures 3 and 4 we consider the influence of birth cohort on food stamp participation for the whole sample and the at-risk low education sample. We separate the sample into six birth cohorts depending on whether the family head was born prior to 1919, between 1919 and 1928, between 1929 and 1938, between 1939 and 1948, between 1949 and 1958, and after 1958. The figures reveal a striking cohort effect for those heads born after 1958—a head born in the most recent cohort is on average at least 50 percent more likely to participate in food stamps than earlier cohorts, and this cohort gap is more than double when compared to the 1939 to 1948 cohort. Among the low-education sample the cohort effect between those born after 1958 and those born between 1949 and 1958 is narrower than in the full sample, but the differences are still rather stark. The post-1995 decline in food stamp participation is most pronounced among the post-1958 cohort, as well as the pre-1919 cohort. The former is likely due to the strong macroeconomy and welfare-reform related reductions in AFDC/TANF participation (given the categorical eligibility of AFDC/TANF recipients in food stamps). However, the deline among the pre 1919 cohort is quite surprising given that this demographic group is likely retired and thus was largely immune from the labor-market effects of the expanding macroeconomy as well as welfare-reform related changes in the Food Stamp Program. At the same time, the late 1990s was also a time of near unprecedented growth in asset values and thus the liquid asset test of $3,000 may have been binding for an increasing proportion of older Americans. Together, Figures 3 and 4 reveal possibly important cohort effects affecting both the level and trend in Food Stamp Program participation.

B. Income Volatility

We next examine basic trends in income volatility over the past two decades. For our analysis we adopt standard measures of income volatility as utilized in Gottschalk and Moffitt (1994), Dynarski and Gruber (1997), Gundersen and Ziliak (2003), among others, by decomposing income into permanent and transitory components. Let y_{it} be the natural log of income for person *i*, *i* = 1,…,*N*, in time period *t*, *t* = 1,…,*T*, such that

(1) $$y_{it} = \mu_i + \varepsilon_{it},$$

where μ_i is the permanent component and ε_{it} is the transitory component. The corresponding person-specific and time-invariant measure of transitory income volatility is given by

(2) $$\sigma^2_{\varepsilon_i} = \frac{1}{(T_i - 1)} \sum_{t=1}^{T_i} (y_{it} - \bar{y}_i)^2$$

where $\bar{y}_i = \frac{1}{T_i} \sum_{t=1}^{T_i} y_{it}$ is the person-specific time mean, and T_i reflects the fact that the panel is unbalanced such that individuals are present in the sample for different lengths of time. The measure of permanent volatility is given by

(3) $$\sigma^2_{\mu} = \frac{1}{N-1} \sum_{i=1}^{N} (\bar{y}_i - \bar{y})^2 - \frac{\sigma^2_{\varepsilon}}{\bar{T}},$$

where $\bar{y}$ is the overall sample mean, and σ^2_{ε} and $\bar{T}$ are the averages across *i* of the transitory income variances in equation (2) and the number of time periods T_i, respectfully. The transitory variance in equation (2) reflects "within-group" time series variation in income, whereas the permanent variance in equation (3) reflects "between-group" variation. Following Gottschalk and Moffitt (1994) we purge income of life cycle age effects by replacing *y* in equations (2) and (3) with the residuals from a regression of income on a quartic in age.

We consider two variants of equations (2) and (3), one based on all sample periods pooled together and one where we take higher-frequency measures of instability from 1980–1984, 1985–1989, 1990–1994, and 1995-2002. One way to view the low-frequency versus high-frequency estimates of transitory variances in equation (2) is that the low-frequency estimates (which could be based on upwards of 20 years of data) are akin to person-specific permanent variances and the high-frequency estimates are more reflective of traditional transitory variances. Gottschalk and Moffitt (1994) split their sample into 9-year intervals to capture changes in earnings instability between the 1970s and 1980s. Although we are less interested in exploring broad, decadal trends in income volatility in the detail of Gottschalk and Moffitt (1994), we do highlight some important trends and interactions with food stamp participation.

In Table 1 we depict transitory and permanent income volatility for our two time dimensions (low and high frequency) and for each of our two samples (all families and low-educated). By columns, we consider these measures for all households within any given sample, followed by the same age breakdowns as Figures 1 and 2, and for the high frequency estimates the results are further broken down by year. Note that the volatility measures broken down by age use the residuals from a pooled regression across all ages, i.e. the regression coefficients are not allowed to vary by age; thus, the estimates in Table 1 reflect changes in sample composition and not changes in age-earnings profiles per se.

There are a number of observations of note in Table 1. First, permanent income volatility is substantially higher than transitory volatility regardless of sample. Among all families the permanent volatility rose through the mid 1990s until declining by the end of the century. The pattern among low educated families was just the opposite—declining then rising permanent volatility. Second, without exception transitory income volatility among the low-education sample exceeds that for the population as a whole and across the age gradient. This is expected given the greater labor-market churning among low-educated adults in the United States. Third, the estimated low-frequency volatility is typically double the level of volatility measured at high frequency 5-year intervals. This is consistent with our conjecture that estimates from equation

(2) based on all sample years is more akin to a person-specific permanent volatility measure. (Note that the levels of volatility, even at 5-year intervals, exceed those in Gottschalk and Moffitt. This occurs because they use earnings as opposed to income, and they restrict their sample to white male heads of household while we admit nonwhites and female headed families). Finally, for both the high and low frequency measures, transitory volatility is declining across the age gradient. This decline is most pronounced among low-education families.

We conclude our descriptive section by examining a simple bivariate relationship between income volatility and Food Stamp Program participation. Specifically, in Table 2 we split the sample by quartiles of transitory income volatility and then for each quartile we depict the level of food stamp participation. The results in Table 2 indicate that food stamp participation is increasing in income volatility. Indeed, among those in the top quartile of income volatility the likelihood of participating in food stamps is three to five times higher than those in the first quartile depending on whether we focus on the low-education sample or the full sample. This suggests that in addition to age and cohort, income volatility may be an important determinant of food stamp use.

III. The Age Gradient in Food Stamp Program Participation

A. Estimation Methods

The standard static model of welfare participation in economics is to postulate that participation occurs if and only if the net utility gain is positive; that is, the utility of participating less the cost of participating and less the utility of nonparticipation is positive. Defining $V(y_{it}^1; FSP_{it} = 1)$ as the indirect utility obtained from income y_{it}^1 while on food stamps ($FSP_{it} = 1$)

and $V(y_{it}^{0};FSP_{it}=0)$ as the corresponding indirect utility when not participating in food stamps, then the individual participates if $V(y_{it}^{1};FSP_{it}=1) - V(y_{it}^{0};FSP_{it}=0) > 0$. Note that for simplicity we assume the indirect utility function as defined incorporates any direct utility costs of program participation such as the stigma and transactions costs described above. If direct preferences are additive over time, then under two-stage budgeting whereby the individual equates the discounted marginal utility of wealth across periods and then maximizes current period preferences over consumption, leisure, and welfare participation, the static model of welfare participation is "life-cycle consistent" (Blundell and MaCurdy 1999). This implies that all lifetime preference parameters are identified except for the time discount rate and the intertemporal substitution elasticity. As the latter parameters are typically not focal parameters of interest in welfare applications, the static model is fairly general.

To estimate the roles of age and income volatility in the food stamp decision we adopt a reduced-form, index function version of food stamp participation. Let

(4) $FSP_{it} = 1$ if $FSP_{it}^{*} = Z_{it}\pi + X_{i}\gamma + u_{it} > 0$

$FSP_{it} = 0$ otherwise

where FSP_{it}^{*} is the latent propensity to participate in food stamps, Z_{it} is a $(1\times K)$ vector of time varying variables determining participation, X_i is a $(1\times L)$ vector of time invariant variables, π,γ are vectors of unknown parameters to estimate, and u_{it} is a compound error term equal to $u_{it} = \alpha_i + \eta_{it}$. The elements of Z_{it} include the age gradient as represented by the same series of indicators as in Figures 1 and 2, interactions between transitory income volatility and the age gradient, marital status, homeownership status, and family size. Elements of X_i include the race of the head, whether the head is a high school graduate, date-of-birth cohorts as defined in

Figures 3 and 4, and transitory income volatility as defined in equation (2) (permanent volatility will be absorbed in the constant term). When we use income volatility defined over five year time horizons, this measure will be included in Z_{it}.

Because the model is in reduced form we assume that $E[\eta_{is} \mid Z_{it}, X_i] = 0 \forall s,t$, which is the typical strict exogeneity assumption between covariates and the time-varying idiosyncratic error term. However, α_i, which represents latent time-invariant preferences for Food Stamp Program participation is in general not uncorrelated with the regressors, $E[\alpha_i \mid Z_{it}, X_i] \neq 0$. This correlated random effect can arise for a number of reasons, including preferences for welfare participation that vary across education levels or birth cohorts.

Estimation of nonlinear discrete choice models in the presence of correlated unobserved heterogeneity is complicated because simple transformations such as first differencing do not eliminate the nuisance parameters α_i, the exception being the conditional logit estimator of Chamberlain (1980). Most estimators such as the panel probit estimator require a large number of time periods for consistent estimation of both $\hat{\pi}$ and $\hat{\alpha}_i$. A transparent alternative is a panel version of the linear probability model. A concern with this estimator is that predictions may lie outside the unit interval. However, because the focus here is on the effects of age and income volatility on food stamp participation and not on the predicted probability of participation *per se*, we adopt the linear probability model.

Admitting unrestricted correlation between unobserved heterogeneity and the covariates would lead one to apply OLS to the transformed model

(5) $$\widetilde{FSP}_{it} = \widetilde{Z}_{it}\pi + \widetilde{\eta}_{it},$$

where $\widetilde{FSP}_{it} = FSP_{it} - \overline{FSP}_i; \widetilde{Z}_{it} = Z_{it} - \overline{Z}_i; \widetilde{\eta_{it}} = \eta_{it} - \overline{\eta}_i$ are the deviations from time means, with the person-specific time means defined as $\overline{FSP}_i = \frac{1}{T_i}\sum_{t=1}^{T_i} FSP_{it}, \overline{Z}_i = \frac{1}{T_i}\sum_{t=1}^{T_i} Z_{it}$. Estimation of equation (5) yields the so-called within or fixed-effects estimator. Although providing consistent estimates of π, the cost of this approach is that it is no longer possible to identify the coefficients on the time-invariant variables X_i. This implies that it is still possible to identify the interaction between time-invariant low-frequency income volatility and the age gradient, but not the level effects of low-frequency volatility, education, or cohort on food stamp participation (level effects of high frequency volatility from the five-year estimates are identified given sufficient time series variation).

An alternative approach is to use the correlated random effects estimator of Hausman and Taylor (1981). The idea here is to exploit the fact that some of the regressors are correlated with the unobserved heterogeneity and some are not.[3] Any time-varying variables that are uncorrelated with the latent heterogeneity α_i can be used as instrumental variables for time-invariant variables that are correlated. Provided that the number of uncorrelated time-varying variables is at least as large as the number of correlated time-invariant variables the coefficients on the latter are identified.

More specifically, let $Z_{it} = [Z_{it}^1, Z_{it}^2]$ where Z_{it}^1 is a $(1 \times K_1)$ vector of time-varying variables uncorrelated with $\alpha_i, E[\alpha_i \mid Z_{it}^1] = 0$, and Z_{it}^2 is a $(1 \times K_2)$ vector of time-varying variables correlated with $\alpha_i, E[\alpha_i \mid Z_{it}^2] \neq 0$. Likewise let $X_i = [X_i^1, X_i^2]$ be the corresponding $(1 \times L_1)$ and $(1 \times L_2)$ vectors of time-invariant regressors with $E[\alpha_i \mid X_i^1] = 0$ and $E[\alpha_i \mid X_i^2] \neq 0$.

[3] For example, Hausman and Taylor (1981) assume that age in an earnings regression is not correlated with the latent heterogeneity but education is correlated.

Ignoring for the moment the fact that our panel is unbalanced we rewrite the estimating equation of interest in matrix form as

(6) $FSP = Z\pi + X\gamma + \alpha + \eta$,

where *FSP* is $(NT \times 1)$, *Z* is $(NT \times (K_1 + K_2))$, and *X* is $(NT \times (L_1 + L_2))$. Define $\text{cov}(\alpha + \eta) = \sigma_\eta^2 \Omega$, $\Omega^{-1} = Q_a + \theta^2 P_a$, $\Omega^{-1/2} = Q_a + \theta P_a$, $Q_a = I_{NT} - P_a$, $P_a = I_N \otimes T^{-1} e_T e_T'$, and $\theta = \left[\frac{\sigma_\eta^2}{\sigma_\eta^2 + T\sigma_\alpha^2} \right]^{1/2}$, where Q_a is the within (deviation from time mean) transformation, P_a is the time-mean operator, I_N and I_{NT} are $(N \times N)$ and $(NT \times NT)$ identity matrices, and e_T is a $(T \times 1)$ vector of ones. Let $D = [Z, X]$ be the matrix of regressors and $\Gamma = [\pi, \gamma]$ be the vector of parameters, then in order to make the error covariance matrix in (6) homoskedastic it is necessary to premultiply both sides of the equation by $\Omega^{1/2}$ as

(7) $\Omega^{-1/2} FSP = \Omega^{-1/2} D\Gamma + \Omega^{-1/2}(\alpha + \eta)$.

Hausman and Taylor (1981) then suggest the following instrumental variables estimator for equation (7)

(8) $\hat{\Gamma} = [D'\Omega^{-1/2} P_w \Omega^{-1/2} D]^{-1} D'\Omega^{-1/2} P_w \Omega^{-1/2} FSP$

where $P_w = W(W'W)^{-1}W'$ is the projection matrix of instruments *W*. For instruments they suggest $W = [Q_a Z_1, Q_a Z_2, P_a X_1, P_a Z_1]$; that is, the deviation from time means $Q_a Z_1, Q_a Z_2$ are instruments for Z_1 and Z_2, while the time mean of Z_1, $P_a Z_1$, serves as an instrumental variable for the correlated time-invariant regressor X_2 (the time mean of X_1 is an instrument for itself). So long as the order condition $K_1 > L_2$ is met then all model parameters are identified. As our base case we categorize the regressors as follows: $Z_{it}^1 = [Age_{it}^j, \hat{\sigma}_{\varepsilon_i}^2 * Age_{it}^j, year_t]$;

$Z_{it}^2 = [married_{it}, owner_{it}, family_{it}]$; $X_i^1 = [\hat{\sigma}_{\varepsilon_i}^2, race_i]$; and $X_i^2 = [education_i, cohort_i]$, where Age_{it}^j represents the various indicators for the age gradient ($j = \leq 30, > 30 \ \& \leq 40, > 40 \ \& \leq 50, > 50 \ \& \leq 60, > 60$). We assume that preferences for marriage, home ownership, family size, and education are correlated with latent preferences to participate in food stamps, and that different birth cohorts through varied socialization mechanisms have different (and possibly correlated) preference for food stamp use. We have no strong priors to assume that race is correlated with latent preferences to participate conditional on the other covariates and therefore assume it is uncorrelated. Likewise, we assume that income volatility is uncorrelated with unobserved heterogeneity. Note that this does not imply that the *level* of income is uncorrelated with α_i, but the variance is assumed to be uncorrelated. This is a standard assumption that is justified provided that volatility is driven by demand-side market forces or other factors unrelated to time invariant latent heterogeneity.

To operationalize the estimator we first need to replace θ with a consistent estimate. It is recommended that initial consistent estimates be obtained by the within fixed-effects estimator (FE) and the variance terms be constructed as

$$\hat{\sigma}_\eta^2 = \frac{1}{NT - N - K} \sum_i \sum_t (\widetilde{FSP}_{it} - \tilde{D}_{it} \hat{\Gamma}_{FE})^2$$

and

$$\hat{\sigma}_\alpha^2 = \frac{1}{N} \sum_i (\overline{FSP}_i - \bar{D}_i \hat{\Gamma}_{FE})^2 - T^{-1} \hat{\sigma}_\eta^2$$

where as before $\widetilde{FSP}_{it} = FSP_{it} - \overline{FSP}_i, \tilde{D}_{it} = D_{it} - \bar{D}_i$ are the deviations from time mean. Under the correlated random effects structure this estimator is asymptotically more efficient than the within estimator. However, in the event that the assumed lack of correlation between Z_{it}^1 and α_i is violated then the Hausman and Taylor estimator is inconsistent. For robustness, then, we compare our results to that estimated from the within estimator. We also compare our results with a Hausman and Taylor estimator which does not include birth cohorts. It is well known that separate identification of age, year, and cohort effects is complicated without strong functional form assumptions (Heckman and Robb 1985), though in our case the presence of an unbalanced panel aids in identification because new cohorts enter the panel later in the sample period. That said, we are interested in understanding how sensitive the estimated age gradient is to the inclusion of cohort effects.

B. Results

Our base case results from the Hausman-Taylor estimator with endogenous cohort effects are presented in Table 3. There are two specifications—low- versus high-frequency transitory volatility—for each of our two samples. Recall that in the low frequency model transitory volatility is time invariant and thus is an element of X_i^1; whereas in the high frequency model transitory volatility varies over time for each individual and thus is an element of Z_i^1. The respective transitory income volatility measures are de-meaned prior to interacting with the age gradient, implying that the direct effect of volatility yields the mean effect and the interactions reflect deviations from the mean. In both cases permanent volatility is absorbed into either the constant term or year dummies and thus is not identified.

The results in Table 3 for the full sample indicate that there is a U-shaped pattern to food stamp participation across the age gradient. Relative to household's whose head is under age 30 the probability of food stamp use declines with age until the head reaches the age of 51 and then use begins to increase relative to the young. Among at-risk families whose head has less than a high school diploma there is a similar decline in use until head's reach their 50s, and indeed the decline is more pronounced among this sample than in the population as a whole. For example, in the full sample the probability of food stamp use is 1.8 percentage points among 41-50 year olds compared to heads under age 30 (a 17 percent decline from the baseline probability of 10.5 percent). The comparable estimate is 6.6 percentage points among low-educated heads, or 28 percent of the baseline probability of food stamp use of 23.6 percent. However, unlike the full sample where participation actually increases at older ages, participation among those over 50 in the low-educated group is roughly similar to the under-30 age group. The results of Table 3 suggest that contrary to common perception, Food Stamp Program participation is not monotonically declining across the age gradient.

The direct effect of transitory income volatility on food stamp participation at the mean level of volatility depends on whether the measure captures low-frequency or high-frequency income movements. Families with high levels of volatility over long time horizons, i.e. permanently high volatility, are more likely to participate in the food stamp program. In the full sample this effect is quite large economically and is statistically significant, though the size and significance is diminished in the low education sample. That food stamp use is higher among those with high volatility over low frequencies is in accord with Blundell and Pistaferri (2003) who find that food stamps is a very effective program in smoothing consumption in the face of permanent income shocks. In contrast, households with high transitory volatility over high frequencies are either no more or less likely to participate in food stamps (full sample) or are on average significantly less likely to participate (low education sample). Reduced participation in the face of average-level high-frequency income shocks is perhaps not surprising given the significant transactions costs associated with applying for benefits and with relatively short recertification requirements during much of the 1990s (Kabbani and Wilde 2003).

The interactions between the age gradient and income volatility in Table 3 indicate that at any given age above-average income volatility increases food stamp participation, regardless of whether we measure volatility in low or high frequencies (the exception is the above age 60 interaction in the full sample). The partial effect among the low-education sample is quite large and suggests that the benefits of participation exceeds the costs even in the face of highly volatile incomes, perhaps because this volatility is always occurring at levels below the gross income limit to quality for food stamps. In Figures 5–8 we depict the total effect of age and interactions of age with income volatility (along with the respective 95 percent confidence interval) for a representative individual at each age range with income volatility one standard deviation below or one standard deviation above the mean level of volatility. Figures 5–6 refer to the full sample at low- and high-frequency volatility, and Figures 7–8 refer to the low-education sample. In the full sample younger individuals with income volatility a standard deviation below the mean are less likely to participate in food stamps, but by the age of 50 participation increases among those with less volatile income relative to the young. The latter effect is driven both by the positive coefficients on age among 51-60 year olds and for those over 60, and in the case of those over 60, the negative coefficient on the interaction between age and volatility. On the other hand, among the at-risk sample of low-educated heads with below-average income volatility there is a pronounced U-shape to participation across the life course, but the level is always negative and thus below the under age 30 group. In contrast the age gradient is flattened out in both samples among those with volatility one standard deviation above the mean. One caution in interpreting the latter is that the distributions of both low and high frequency income volatility are skewed and widely disbursed such that one standard deviation above the mean is in the far right tail of the distribution.

In terms of other variables in the regression model they generally align as expected; namely, food stamp participation is lower among those with a high school diploma or more, among white families, among homeowners, among married couples, and among those with small families. We also find that those born in earlier cohorts are less likely to participate in food stamps relative to the post 1958 birth cohort, the exception being that those heads born prior to 1919 are no more or less likely to participate relative to young cohorts. This suggests that controlling for other factors the elderly may not be less likely to join the program, contrary to conventional wisdom (which is based on raw correlations and not partial correlations).

As mentioned previously, separate identification of age, period, and cohort effects is generally achieved by imposing functional form restrictions on the respective parameters. One such restriction is to zero out the cohort effects and examine how the age coefficients change with the omission of controls for birth cohort. In Table 4 we present the results from the Hausman-Taylor estimator without cohort effects. Removing cohort effects from the model raises in absolute value the direct effect of age on food stamp participation among those under age 50, and unlike Table 3, participation flattens out at older ages in the full sample and remains below the under-30 participation rate among the low-education sample. The other covariates are little changed from Table 3. An alternative restriction that can be imposed to eliminate birth cohorts is to assume that all covariates are correlated with the unobserved propensity to participate in food stamps, though at the cost of no longer identifying other time-invariant variables such as our measure of low-frequency income volatility. In Table 5 we impose this assumption and present results from fixed-effects linear probability models. The coefficients on the time-varying variables are little changed from the base-case estimates, lending support for the assumptions underlying the Hausman-Taylor results in Table 3.

IV. Conclusion

We used data from the Panel Study of Income Dynamics over the past two decades to estimate the effect of age, income volatility, and interactions of age and volatility on the probability of participating in the Food Stamp Program. We employed the correlated random effects estimator of Hausman and Taylor (1981) that permits identification of parameters on both time varying and time invariant regressors.

We found that participation in food stamps is U-shaped across the life course, contrary to the conventional wisdom of simple summary statistics that show participation declining monotonically across the age gradient. We also found that at on average food stamp participation is higher among those with high levels of “permanent” income volatility, but is lower among those with volatile transitory incomes measure at high frequencies. We also identified important heterogeneity in the effect of income volatility across the age gradient, finding that at any given age participation in food stamps is higher among those with above average income volatility.

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Table 1: Transitory and Permanent Income Volatility by Age Groups

	All	Under 30	Between 31 and 40	Between 41 and 50	Between 51 and 60	Over 61
	Low Frequency Income Volatility (All Years)					
	All Families					
Transitory	0.148	0.162	0.148	0.137	0.154	0.145
Permanent	0.602					
	Low Education Sample					
Transitory	0.187	0.221	0.215	0.188	0.183	0.150
Permanent	0.513					
	High Frequency Income Volatility (Five Year Time Horizons)					
	All Families					
	1985					
Transitory	0.078	0.097	0.070	0.072	0.080	0.076
Permanent	0.568					
	1990					
Transitory	0.068	0.090	0.067	0.054	0.079	0.064
Permanent	0.669					
	1995					
Transitory	0.085	0.134	0.082	0.069	0.092	0.095
Permanent	0.705					
	2000					
Transitory	0.079	0.095	0.081	0.075	0.076	0.078
Permanent	0.634					
	Low Education Sample					
	1985					
Transitory	0.094	0.121	0.083	0.097	0.099	0.084
Permanent	0.636					
	1990					
Transitory	0.085	0.133	0.100	0.074	0.103	0.065
Permanent	0.624					
	1995					
Transitory	0.109	0.138	0.136	0.103	0.108	0.100
Permanent	0.589					
	2000					
Transitory	0.097	0.124	0.107	0.105	0.119	0.073
Permanent	0.617					

Table 2: Food Stamp Participation by Quartiles of Transitory Income Volatility

	First Quartile	Second Quartile	Third Quartile	Fourth Quartile
	Low Frequency Income Volatility			
All Income Sample	0.040	0.061	0.115	0.209
Low Education Sample	0.150	0.186	0.254	0.363
	High Frequency Income Volatility			
All Income Sample	0.060	0.065	0.097	0.177
Low Education Sample	0.195	0.180	0.236	0.315

Table 3: The Effect of Age and Income Volatility on Food Stamp Participation: Hausman-Taylor with Endogenous Cohort Effects

	All Families		Low Education	
	Low Frequency Income Volatility	High Frequency Income Volatility	Low Frequency Income Volatility	High Frequency Income Volatility
Age between 31 and 40	-0.018	-0.019	-0.042	-0.054
	(0.003)	(0.003)	(0.011)	(0.011)
Age between 41 and 50	-0.018	-0.021	-0.066	-0.079
	(0.005)	(0.005)	(0.016)	(0.017)
Age between 51 and 60	0.021	0.012	-0.002	-0.021
	(0.008)	(0.007)	(0.021)	(0.022)
Age greater than 60	0.035	0.019	0.014	-0.013
	(0.010)	(0.010)	(0.026)	(0.027)
Income volatility	0.232	-0.015	0.066	-0.188
	(0.028)	(0.017)	(0.066)	(0.048)
Age between 31 and 40 * Income volatility	0.030	0.090	0.084	0.329
	(0.014)	(0.020)	(0.037)	(0.061)
Age between 41 and 50 * Income volatility	0.002	0.094	0.180	0.312
	(0.019)	(0.023)	(0.052)	(0.066)
Age between 51 and 60 * Income volatility	0.054	0.151	0.419	0.448
	(0.027)	(0.025)	(0.069)	(0.066)
Age greater than 60 * Income volatility	-0.205	-0.006	0.137	0.167
	(0.033)	(0.024)	(0.079)	(0.060)
Homeowner	-0.026	-0.025	-0.034	-0.030
	(0.003)	(0.003)	(0.009)	(0.009)
Married	-0.024	-0.018	-0.020	-0.026
	(0.004)	(0.004)	(0.012)	(0.012)
High school graduate	-0.084	-0.482		
	(0.079)	(0.129)		
White	-0.144	-0.057	-0.173	-0.190
	(0.020)	(0.036)	(0.028)	(0.027)
Family Size	0.024	0.022	0.033	0.033
	(0.001)	(0.001)	(0.002)	(0.003)
Born between 1949 and 1958	-0.067	-0.019	-0.141	-0.043
	(0.018)	(0.040)	(0.073)	(0.075)
Born between 1939 and 1948	-0.100	-0.089	-0.161	-0.211
	(0.023)	(0.046)	(0.080)	(0.076)
Born between 1929 and 1938	-0.074	-0.141	-0.204	-0.040
	(0.067)	(0.130)	(0.118)	(0.119)
Born between 1919 and 1928	-0.192	-0.230	-0.293	-0.354
	(0.078)	(0.148)	(0.135)	(0.129)
Born before 1918	-0.030	-0.197	-0.134	0.005
	(0.104)	(0.181)	(0.125)	(0.121)

NOTE: Standard errors are in parentheses. There are 72,150 person-years in the full sample and 17,463 in the low-education sample. Each model controls for a vector of year dummies.

Table 4: The Effect of Age and Income Volatility on Food Stamp Participation: Hausman-Taylor without Birth Cohort Effects

	All Families		Low Education	
	Low Frequency Income Volatility	High Frequency Income Volatility	Low Frequency Income Volatility	High Frequency Income Volatility
Age between 31 and 40	-0.027	-0.028	-0.065	-0.071
	(0.003)	(0.003)	(0.010)	(0.010)
Age between 41 and 50	-0.034	-0.041	-0.113	-0.118
	(0.005)	(0.005)	(0.014)	(0.014)
Age between 51 and 60	-0.003	-0.018	-0.072	-0.078
	(0.007)	(0.007)	(0.017)	(0.017)
Age greater than 60	0.005	-0.022	-0.075	-0.084
	(0.009)	(0.009)	(0.020)	(0.020)
Income volatility	0.255	0.004	0.077	-0.185
	(0.025)	(0.017)	(0.057)	(0.047)
Age between 31 and 40 * Income volatility	0.032	0.088	0.090	0.338
	(0.014)	(0.020)	(0.037)	(0.061)
Age between 41 and 50 * Income volatility	0.001	0.085	0.177	0.316
	(0.019)	(0.023)	(0.051)	(0.066)
Age between 51 and 60 * Income volatility	0.049	0.138	0.404	0.448
	(0.027)	(0.025)	(0.067)	(0.066)
Age greater than 60 * Income volatility	-0.216	-0.026	0.112	0.158
	(0.033)	(0.024)	(0.075)	(0.060)
Homeowner	-0.028	-0.028	-0.037	-0.034
	(0.003)	(0.003)	(0.009)	(0.009)
Married	-0.026	-0.023	-0.024	-0.029
	(0.004)	(0.004)	(0.012)	(0.012)
High school graduate	0.007	-0.140		
	(0.031)	(0.029)		
White	-0.167	-0.143	-0.165	-0.176
	(0.010)	(0.010)	(0.022)	(0.022)
Family Size	0.024	0.023	0.034	0.033
	(0.001)	(0.001)	(0.002)	(0.003)

NOTE: Standard errors are in parentheses. There are 72,150 person-years in the full sample and 17,463 in the low-education sample. Each model controls for a vector of year dummies.

Table 5: The Effect of Age and Income Volatility on Food Stamp Participation: Fixed Effects Estimator

	All Families		Low Education	
	Low Frequency Income Volatility	High Frequency Income Volatility	Low Frequency Income Volatility	High Frequency Income Volatility
Age between 31 and 40	-0.018	-0.019	-0.043	-0.055
	(0.004)	(0.004)	(0.013)	(0.013)
Age between 41 and 50	-0.018	-0.022	-0.067	-0.081
	(0.006)	(0.006)	(0.018)	(0.019)
Age between 51 and 60	0.021	0.012	-0.003	-0.022
	(0.007)	(0.007)	(0.023)	(0.024)
Age greater than 60	0.036	0.019	0.013	-0.015
	(0.010)	(0.010)	(0.028)	(0.029)
Income volatility		0.004		-0.185
		(0.017)		(0.047)
Age between 31 and 40 * Income volatility	0.028	0.088	0.077	0.338
	(0.025)	(0.020)	(0.057)	(0.061)
Age between 41 and 50 * Income volatility	0.001	0.085	0.090	0.316
	(0.033)	(0.023)	(0.037)	(0.066)
Age between 51 and 60 * Income volatility	0.049	0.138	0.177	0.448
	(0.049)	(0.025)	(0.051)	(0.066)
Age greater than 60 * Income volatility	-0.215	-0.026	0.404	0.158
	(0.061)	(0.024)	(0.067)	(0.060)
Homeowner	-0.026	-0.024	0.112	-0.028
	(0.003)	(0.003)	(0.075)	(0.010)
Married	-0.020	-0.018	-0.017	-0.021
	(0.004)	(0.004)	(0.013)	(0.014)
Family Size	0.023	0.022	0.033	0.034
	(0.001)	(0.001)	(0.003)	(0.003)

NOTE: Standard errors are in parentheses. There are 72,150 person-years in the full sample and 17,463 in the low-education sample. Each model controls for a vector of year dummies.

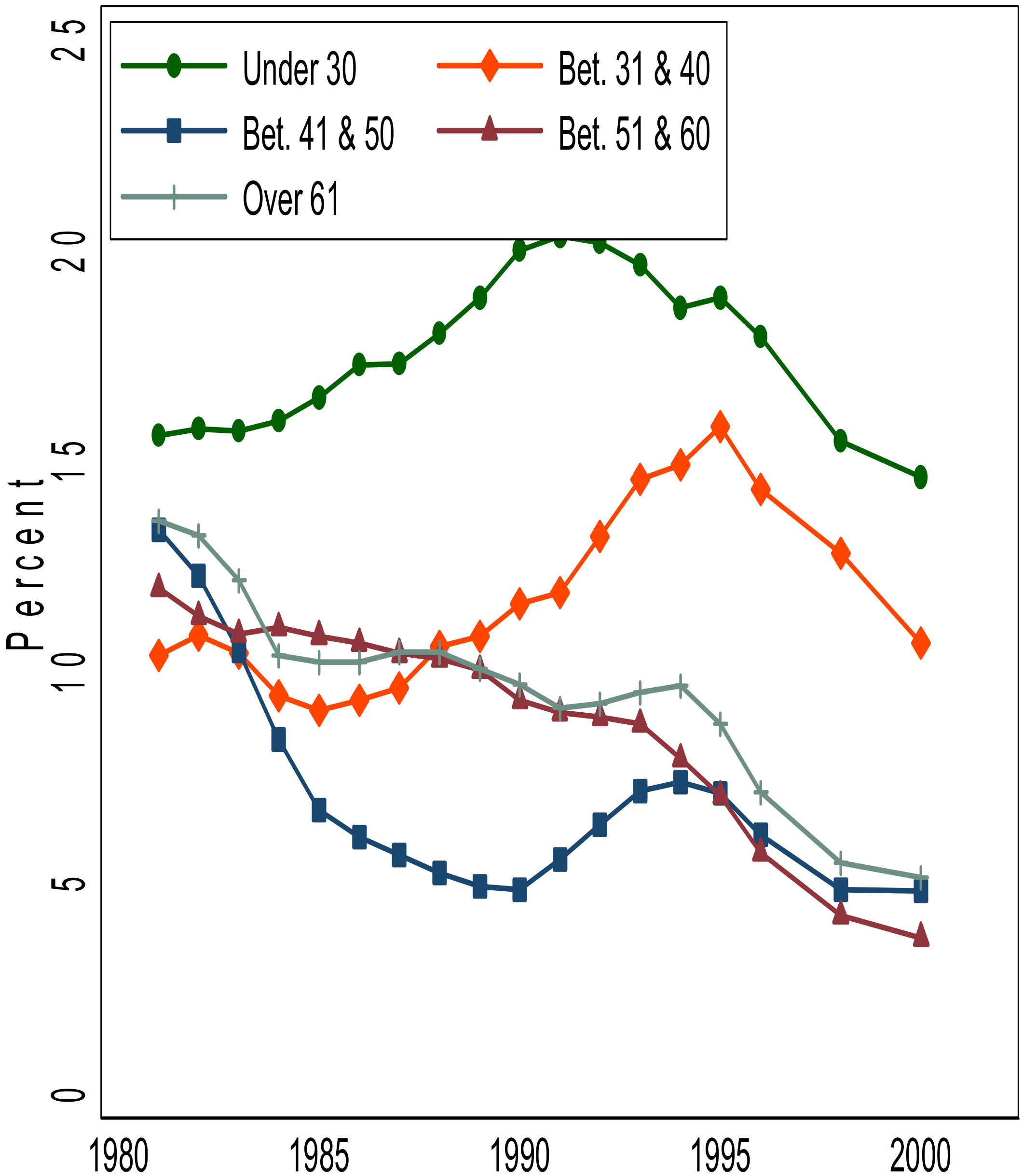

Figure 1. Food Stamp Participation Rates by Age, Full Sample

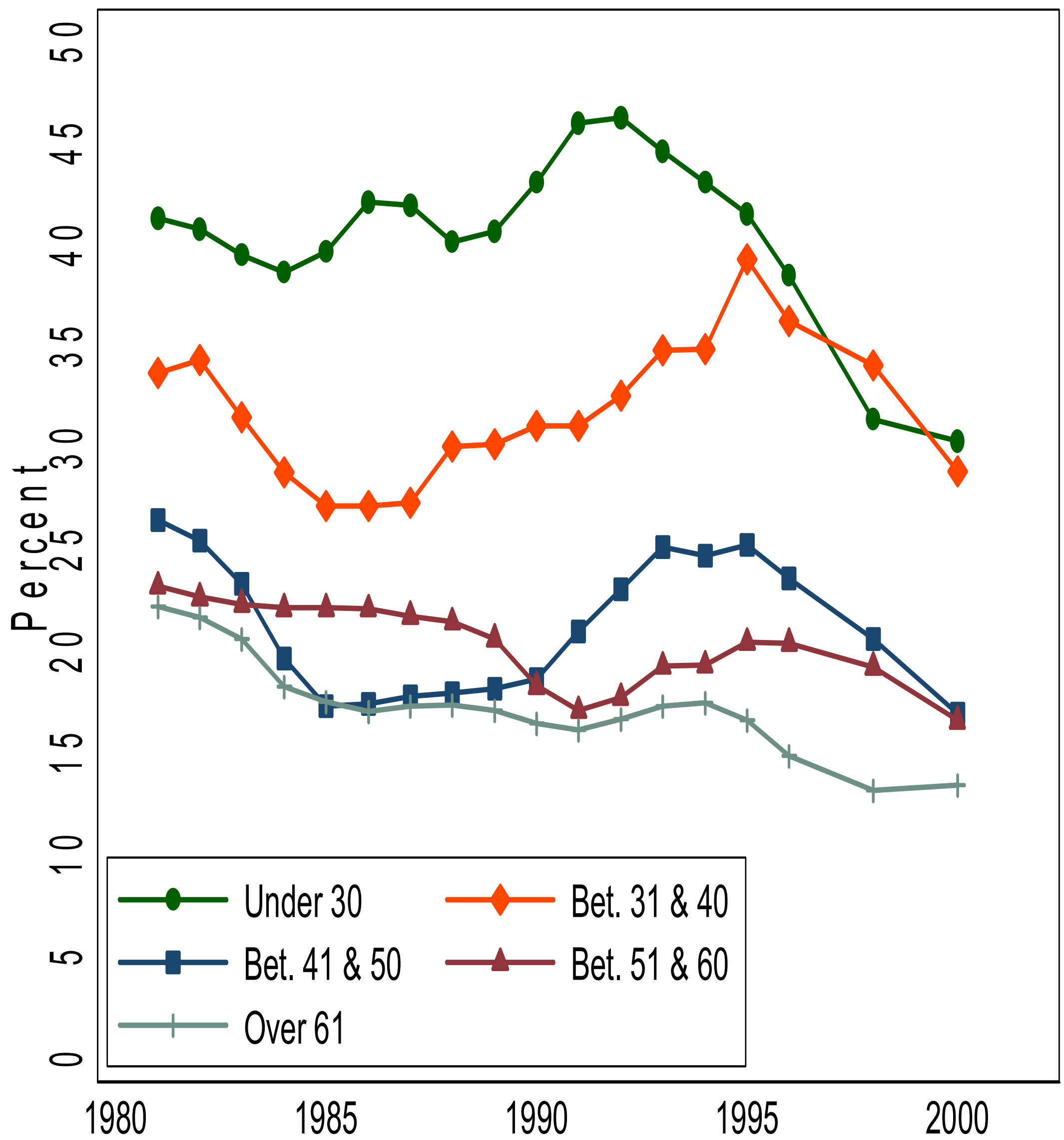

Figure 2. Food Stamp Participation Rates by Age, Low Education Sample

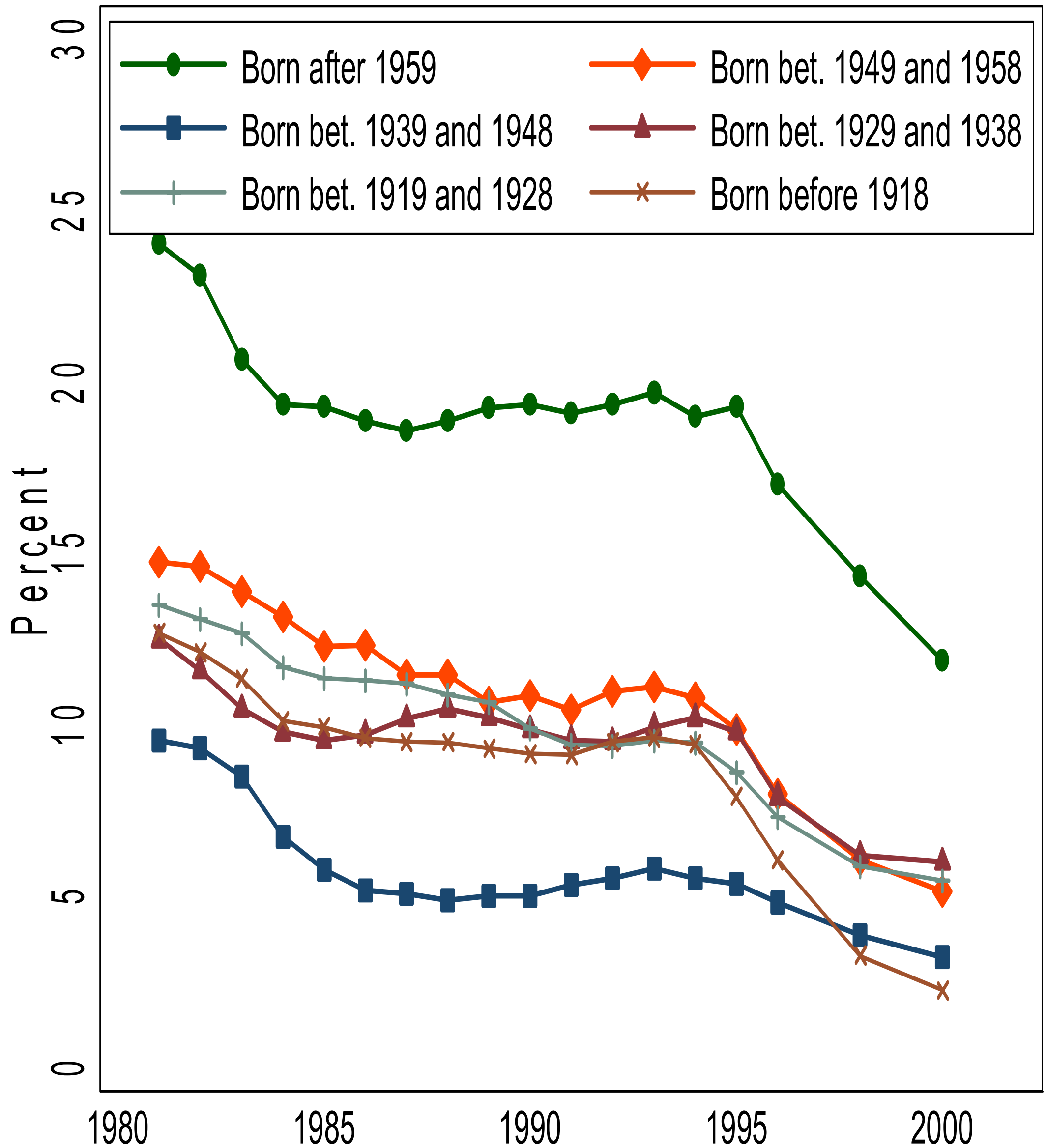

Figure 3. Food Stamp Participation Rates by Birth Cohort, Full Sample

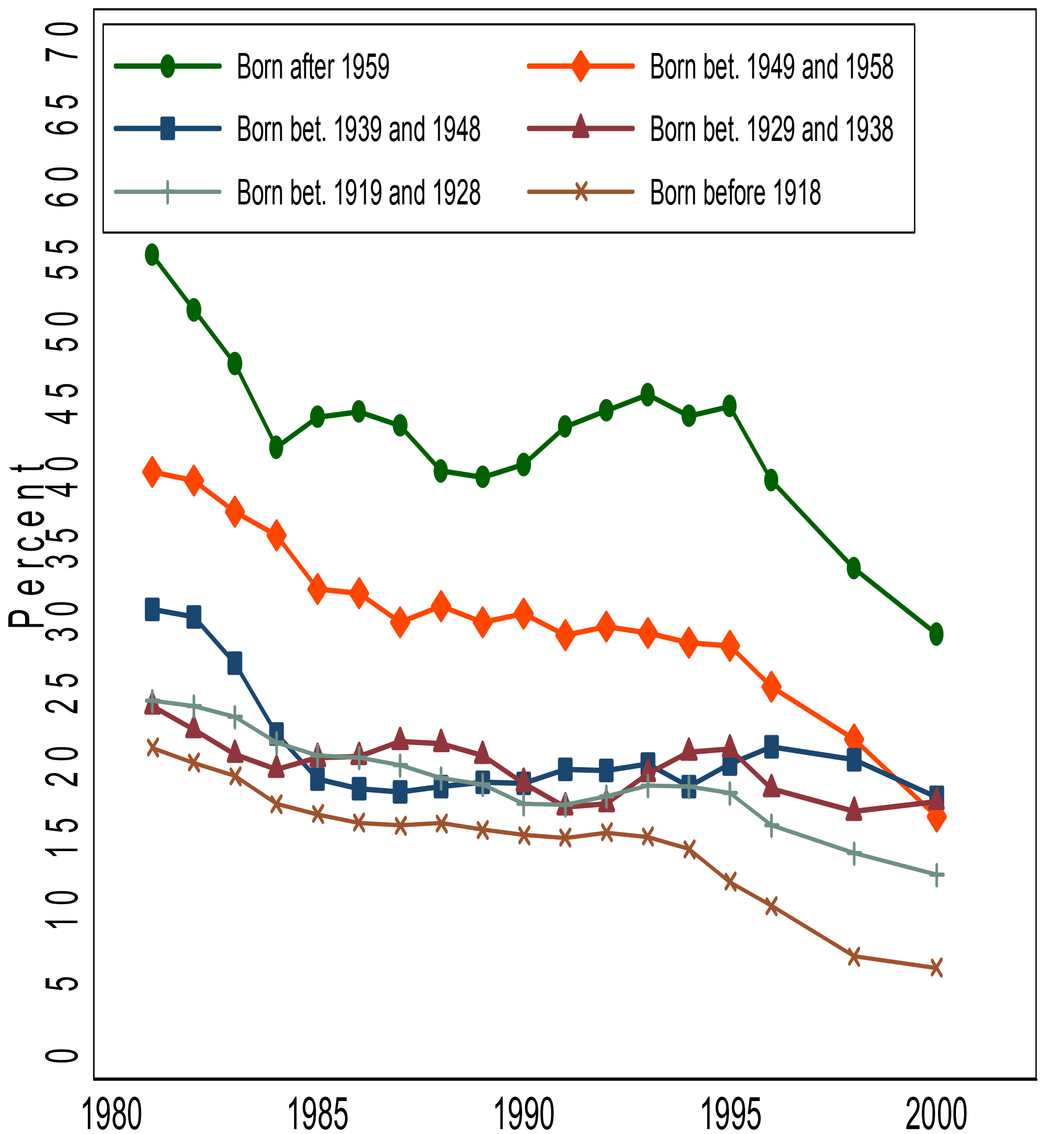

Figure 4. Food Stamp Participation Rates by Birth Cohort, Low Education Sample

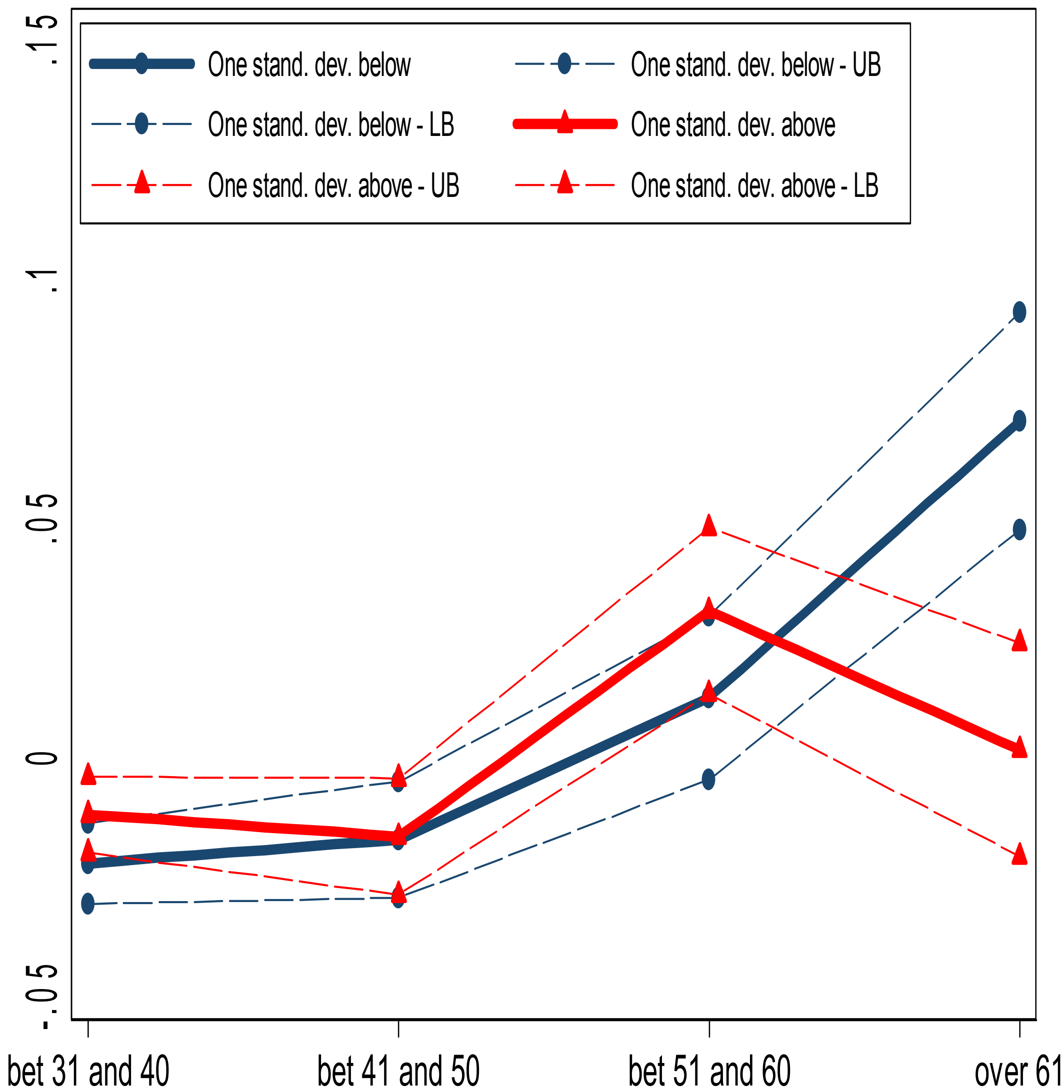

Figure 5. Effects of Income Volatility on FSP Participation by Age, Full Sample

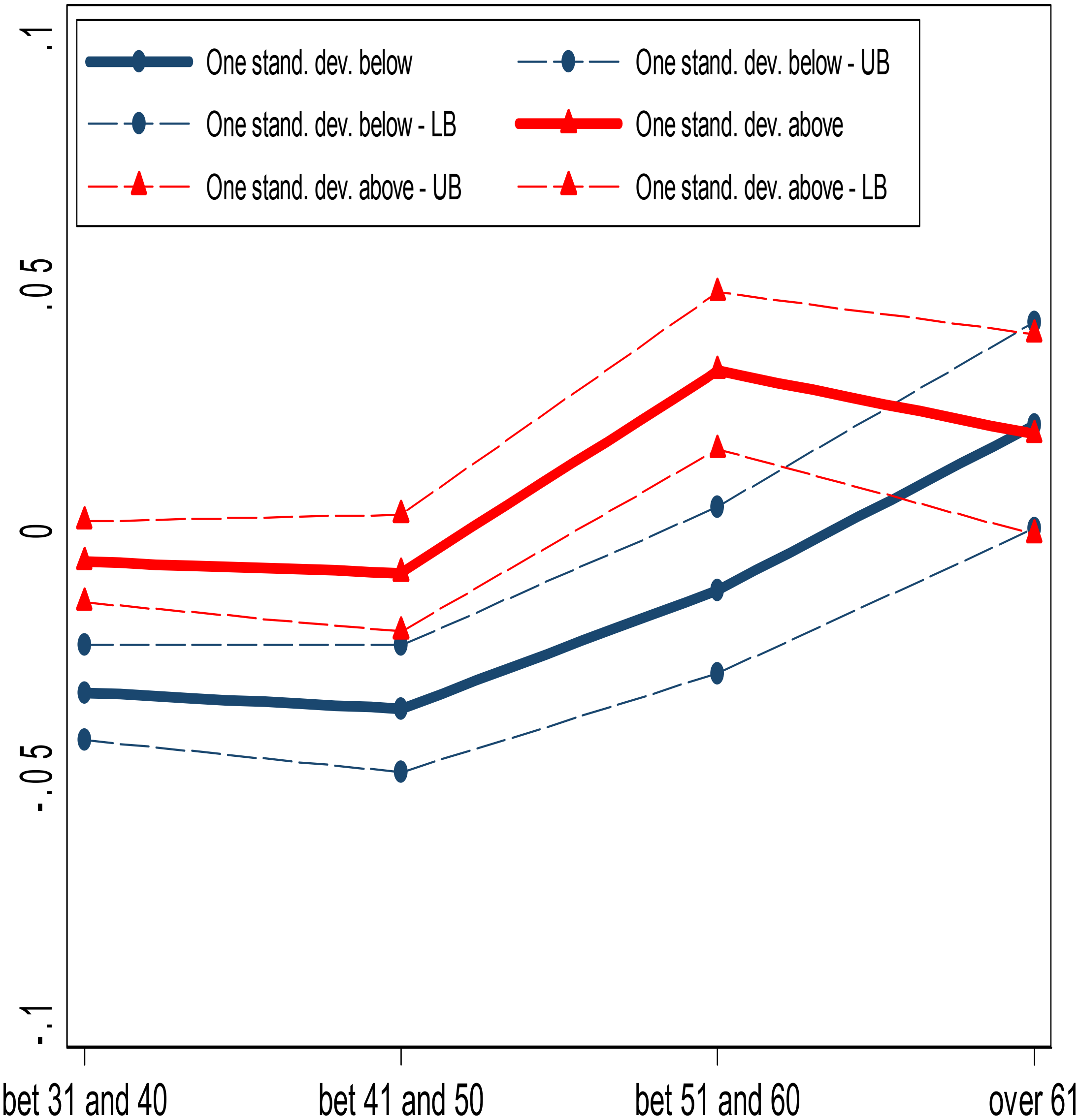

Figure 6. Effects of Five-Year Income Volatility on FSP Participation by Age, Full Sample

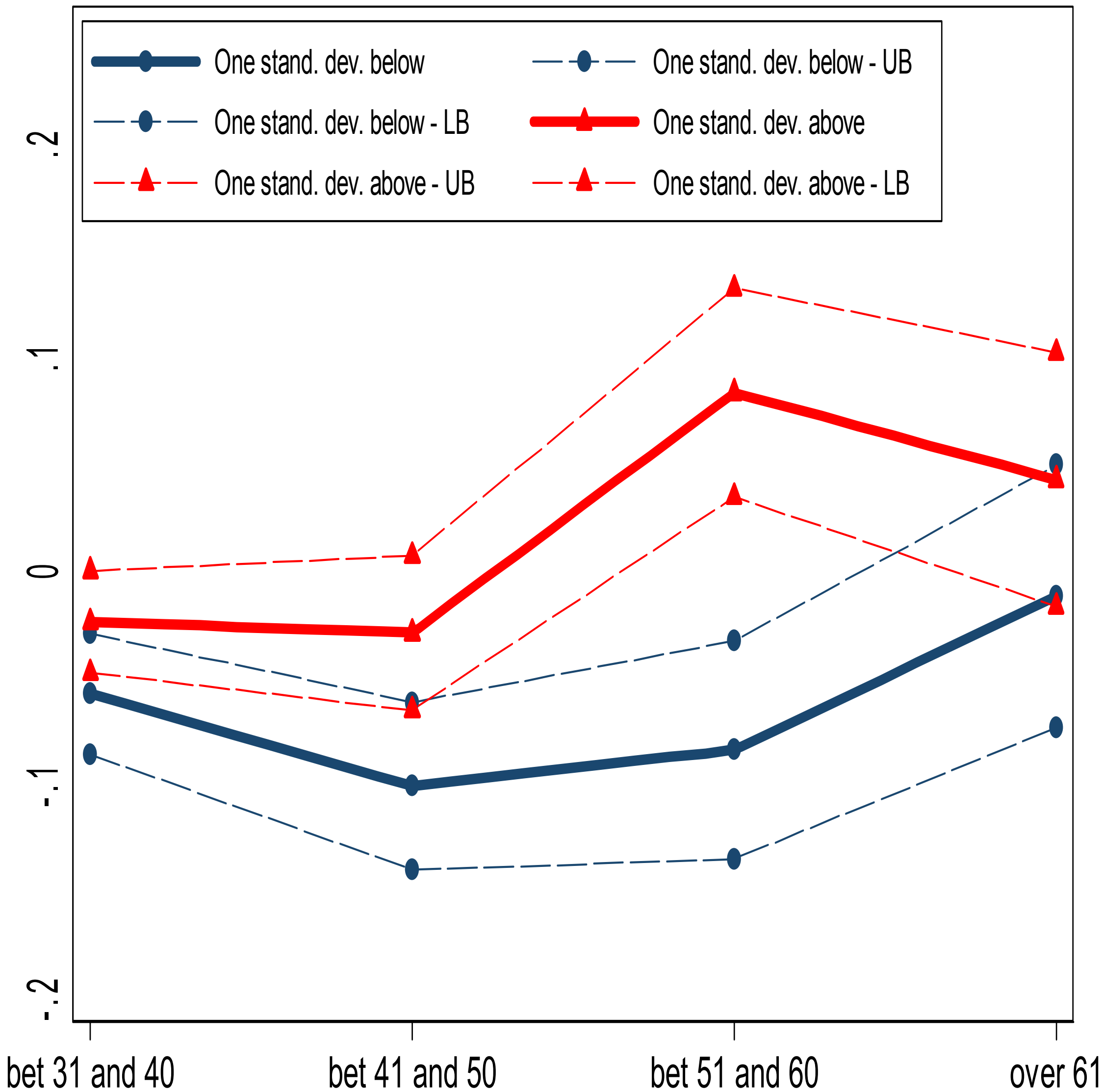

Figure 7. Effects of Income Volatility on FSP Participation by Age, Low Education Sample

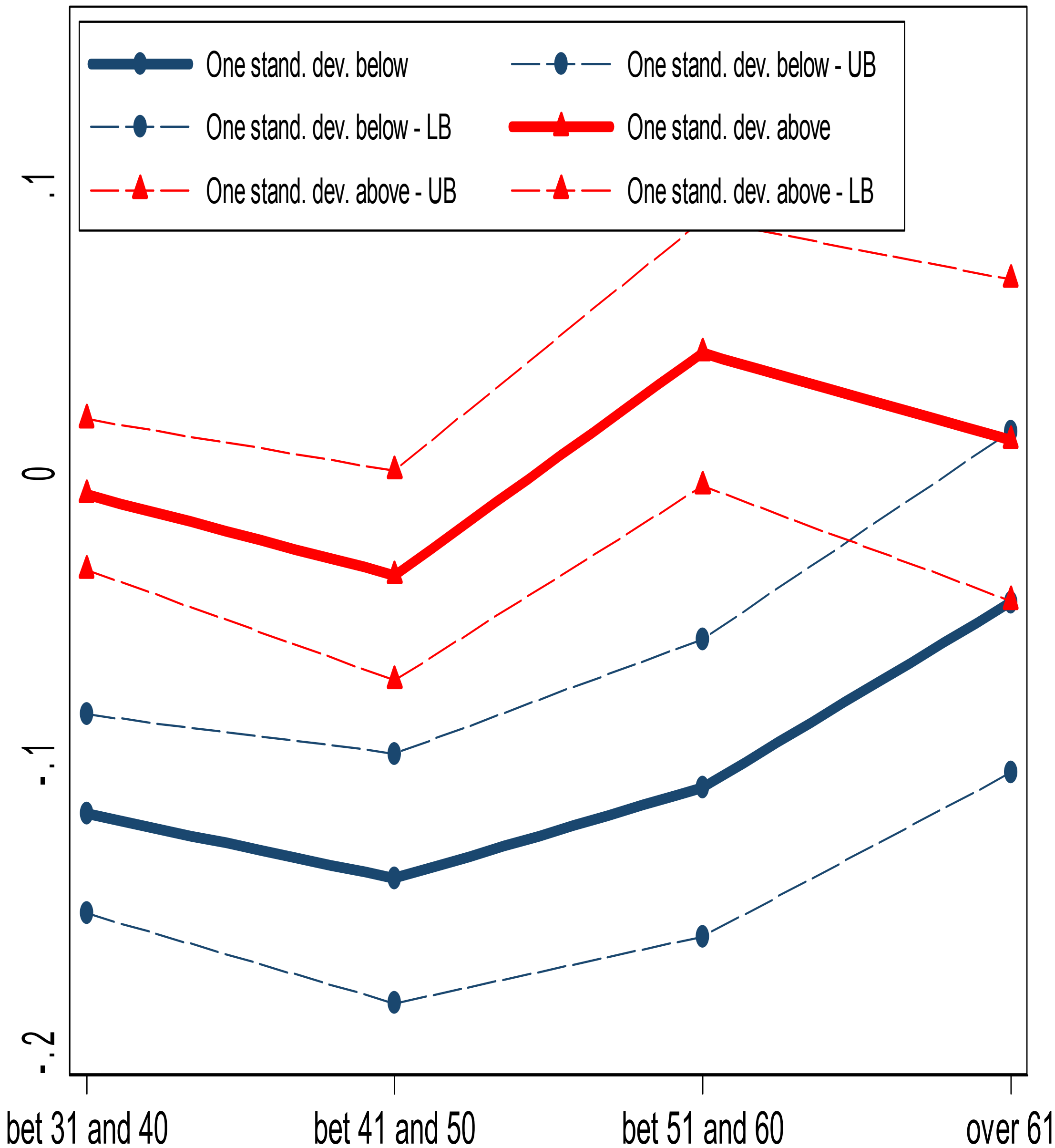

Figure 8. Effects of Five-Year Income Volatility on FSP Participation by Age, Low Education Sample