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Age-specific Rise of Income and Consumption Inequality

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Abstract
Based on Panel Study of Income Dynamics (PSID) and Consumer Expenditure Survey (CEX), the author presents evidence that the rise of income/consumption inequality over the past decades is more significant among younger households. This is consistent with the theory that the secular rise of inequality is due to increasing heterogeneity in earning ability. The author further shows that such age-specificity implies significant changes to the previously documented life-cycle profiles of inequality which are the basis of many important economic inferences.

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Keywords Age-specific inequality, consumption inequality, income inequality, life-cycle profile

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1 Introduction

The rise of economic inequality over the past decades has spawned a vast literature. However the literature has paid little attention to how the rise varies across different age groups.[1] This paper specifically addresses the issue, focusing on the commonly used measures of economic inequality – the variances of logarithms of income and consumption. Based on income data from the Panel Study of Income Dynamics (PSID), I show that the rise of income inequality between mid-1970s and early 2000s is age-specific, much more significant among younger households. Using data from Consumer Expenditure Survey (CEX), the rise of consumption inequality is also found to be age-specific, but to less extent compared to the rise of income inequality.

The age-specificity of rising inequality is consistent with the view that inequality rises because of increasing heterogeneity in earning ability, as in Primiceri and van Rens (2009) and Guvenen and Kuruscu (2009). Along this line, a plausible explanation is proposed.

Taking the age-specificity of the secular rise of inequality into account leads to significantly different lifecycle profiles of income and consumption inequality. These profiles have been a foundation in the study of many important issues in modern economics, such as the completeness of markets, the size and nature of idiosyncratic income shocks, and the extent to which risks are shared.[2] This paper compares these profiles with the traditional ones, suggesting the need to to reassess the inferences based on these profiles.

The remaining of this paper is organized as follows. Section 2 describes the data and basic statistics. Section 3 presents the age-specific rise of income and consumption inequality, then discusses a plausible explanation. Section 4 discusses the implied lifecycle profiles of inequality. Section 5 concludes.

[1] I am aware of only one documented observation that is related to this issue – the secular rise of college-high school wage gap is more significant among younger individuals. See for example Card and Lemieux (2001).

[2] For example, Aguiar and Hurst (2008), Blundell and Preston (1998), Guvenen (2007), Guvenen (2009), Guvenen and Smith (2009), Huggett et al. (2007), Huggett and Parra (2010), Maziero and Ales (2008), Storesletten et al. (2004).

2 The Data

Empirical results in this paper are based on income data from PSID 1968-1997, and consumption data from CEX 1981-2003. In model specification test, income data from CEX is also used.[3] Inequality is measured by the variances of logarithms of income and consumption based on synthetic cohorts, as is standard in the literature.

Arguably PSID provides the best income data in the US. I use family income from PSID 1968-1997, deflated by price indexes for personal consumption expenditures from National Income and Products Accounts (table 2.5.4.). Family income is the sum of taxable income of each family member plus transfers. Thus income includes labor part of farm income and business income, bonuses, overtime, commissions, professional practice, and labor part of income from roomers and boarders or business income. Such a broad definition of income is appropriate for the study, because income inequality is to be compared with inequality of family consumption. Data selection criteria follow the general practice in the literature. Specifically I exclude households that (1) are from SEO subsample; (2) have less than 3 years of positive income; (3) within any three years, have income that's more than 20 times or less than 1/20 of the adjacent value(s); (4) are without consistent information for househead's education; (5) are aged under 20 or over 65. In most of the age-year cells, there are more than 100 observations. Age and education of each household are defined by the househead.

CEX data are from Krueger and Perri (2006), publicly available at http://www.fperri.net/research_data.htm. Items included in the nonhousing consumption measure are: food, alcoholic beverages, tobacco and smoking products, personal care, fuels and utilities, household furnishings and operations, public transportation, motor fuels, apparel, tuition expenditures, recreational reading material, medical care and miscellaneous personal services. These expenditures are deflated by expenditure-specific, quarter-specific consumer price indexes (CPIs). Households with one of the following traits are excluded: (i) those with clear evidence of measure error, see Krueger and Perri (2006) for details, (ii) househead's

[3]Using CEX income data yields qualitatively the same results regarding life-cycle profiles. These profiles are not reported in the paper, but available from the author upon request.

age under 20 or over 65, (iii) reported annual income less than $3000, (iv) rural households, and (v) households that have not completed the full set of four interviews.

Table 5 reports the basic statistics about the samples. Income and consumption are both in 1983 dollar. It can be seen that the two samples are quite comparable. This is not surprising given that both are nationally representative.

3 Age-specific Rise of Inequality

Income Inequality Age-specific rise of income inequality is obvious in the simple plots of the data, which is illustrated in Figure 1. The top panel plots the variances of log income from 1968 to 1997 at 5-year intervals for two age groups, 30-40 and 45-60. Clearly the rise of income inequality is more significant for the younger group. The bottom panel plots the variance of log income from three cross sections: 1970, 1980 and 1990. For each cross section it plots income inequality by age that ranges from 26-65. The age-specificity is quite visible in the scatter plot, and even clearer in the linear fitted line. For older households income inequality exhibits little change within the two 10-year time intervals; while for younger ones, the inequality has been more than quadrupled. Overall the rate of increases in inequality declines with age.

Figure 1 is directly comparable with Figure I and Figure II in Card and Lemieux (2001) that demonstrate similar age-specificity of the rise in college-highschool wage gap. In particular, using 1960 Census and March Current Population Survey from 1970 to 1997, they show that the college-highschool wage gap has doubled for younger U.S. men, while remained almost constant for older men. They also documented similar trends using U.K. data and Canadian data for the same period of time.

To test the statistical significance of the age-specificity, I run the following regression.

$$y_{h,t} = \alpha + D_{age}(h)\Psi + D_{yr}(t)B + [D_{yr}(t) \times h]\,\Gamma + \epsilon_{h,t} \tag{1}$$

where let $y_{h,t}$ is the inequality of households aged h in year t, $D_{age}(h)$ is the set of age dummies with $H-1$ entries that take value zeros except the one corresponding

to age h, and $D_{yr}(t)$ is the set of year dummies with $T-1$ entries that take value zero except the one corresponding to year t. $\Psi = \{\psi_h\}_{h=2}^{H}$, $B = \{\beta_t\}_{t=2}^{T}$ and $\Gamma = \{\gamma_t\}_{t=2}^{T}$ are regression coefficients.[4]

Based on the observed age-specificity in Figure 1, one would expect the estimated vector $\hat{\Gamma}$ to be negative. This is confirmed by results reported in Table 5. Using the full PSID sample, all the coefficients are negative and most of them are statistically significant (See column (2) and column (3)). Age-specificity is strongest in 1980s, a time period in which income inequality has risen sharply. Such a timing is also observed when the sample is split according to education attainment, as shown in column (4) through column (7) in the table. The average of $\hat{\gamma}$ in full sample is -0.0095. In the less-educated subsample (years of schooling $\leq$ 12), the average is -0.0121; while in the more-educated subsample (years of schooling $>$ 12), the average is -0.0063. Thus the rise of income inequality is more age-specific among less-educated households.

Consumption Inequality Turning to consumption inequality, I run equation (1) on consumption data from CEX, with $y_{h,t}$ denoting the logarithm of variance of consumption. Table 5 reports the results. During 1982-2003, coefficients on the interaction terms between age and year dummies are positive for 8 year. Other years have negative coefficients, but some are not statistically significant. Age-specificity is stronger in late 1980s and early 1990s. The average of $\hat{\gamma}$ equals -0.0006, thus the rise of consumption inequality diminishes with age slightly. Splitting the sample by education attainment reveals that the secular rise of consumption inequality is more age-specific among more educated households. By contrast, the secular rise of income inequality is more age-specific among less educated households.

A Plausible Explanation Why has the rise of inequality been diminishing with age? A plausible explanation lies in the model of human capital accumulation. Skill-biased technical changes raise the return to human capital, which motivates those with greater learning ability to accumulate more human capital and earn

[4]Equation (1) restricts the year effect to change with age linearly. I also run the regression with quadratic term $D_{yr}(t) \times h$, the coefficients are mostly insignificant.

higher income. Standard human capital accumulation theory predicts that such a motivation must be stronger among younger households, who have longer horizon and can reap the return of human capital for longer time. The proposed explanation is along the line of Primiceri and van Rens (2009) and Guvenen and Kuruscu (2009). They argue that the secular rise of economics inequality has been mainly driven by increased heterogeneity in earning ability.

4 Implied Life-cycle profiles

Lifecycle profiles of income and consumption inequality have been a foundation in the study of incomplete markets and the related issues, such as risk-sharing and self-insurance. The standard practice is to extract lifecycle profiles from the data using dummy regression.[5] Along with age dummies, typically either year dummies or cohort dummies are included as controls. The regression model with year dummies is labeled "year effect model" and the one with cohort dummies is labeled "cohort effect model". By contrast, Equation (1) represents age-specific year effect model. Lifecycle profiles from these models are shown in Figure 2.

For both income inequality and consumption inequality, the profile from age-specific year effect model lies between those from traditional models. Parallel to the stronger age-specificity of income inequality, the profiles of income inequality from three models exhibit larger differences. Heathcote et al. (2005) also find that lifecycle profile from cohort effect model is steeper than that from year effect model. They suggest the use of year effect model because more evidence exists for year effect than for cohort effect. However, when year effect is age-specific, age-specific year effect model should generate more precise lifecycle profiles.

As further evidence in support of the profiles from age-specific year effect model, I conduct goodness-of-fit test for the three models and report the results in Table 5.[6] A comparison of p-values in the table shows that, for both income inequality and consumption inequality, age-specific year effect model fits the data

[5] See Deaton and Paxson (1994) and Heathcote et al. (2005).

[6] Let $Y = \{y_{h,t}\}$ represent the vector of unobservable true inequality. Let $X = \{y_{h,t}\}$ represent the corresponding vector of inequality obtained from the data, then $X - Y$ is normally distributed with mean zero and variance-covariance matrix Σ, where Σ is the sampling variance of X. For the goodness-of-fit test, denote the predicted inequality

best. For consumption inequality, p-value from year effect model is very close to that from age-specific year effect model, indicating mild age-specificity in the rise of consumption inequality during the sampling period.

To highlight the importance of the steepness of lifecycle profiles, consider the gap between the life-cycle profiles of income and consumption inequality. Suppose the sharp rise of within cohort income inequality is due to idiosyncratic income shocks, then a large gap between income and consumption inequality implies that large portion of the idiosyncratic income risks is shared among households, rather than translated into consumption inequality(Storesletten et al. (2004)). Alternatively, suppose the rise of within cohort income inequality is due to heterogeneity in earning ability that is revealed gradually over time, then the large gap implies that much of the later-revealed ability is known to households early on(Guvenen (2007)). Using age-specific year effect model, the gap increases by 0.5 log point over life-cycle; while the number is 0.78 with cohort effect model and 0.2 with year effect model. Therefore if the true data generating process is consistent with age-specific effect model, inferences based on cohort effect model would either overstate the degree of risk-sharing, or overstate the extent to which households know their earning ability. On the other hand, inferences based on year effect model would understate risk-sharing or priori knowledge possessed by households.

5 Conclusion

I have shown that the rise of income and consumption inequality since mid-1970s is age-specific, more significant among younger households. A human capital accumulation model with heterogeneous learning ability can potentially explain the age-specific rise of income and consumption inequality. Taking the age-specificity into account, the commonly-used dummy regression scheme produces lifecycle pro-

from a particular model $\hat{X} = f(z|\hat{\Theta})$, where z stands for the vector of regressors. In addition, let S be a consistent estimate of Σ. Under the null that model $f(z|\Theta)$ is correctly specified, $(X-f(z|\hat{\Theta}))^T S^{-1}(X-f(z|\hat{\Theta}))$ asymptotically follows a Chi-square distribution, In practice, I follow the procedure of two-step Feasible Generalized Least Square. In the first step, variance-covariance matrix of residuals, S, is obtained from the error terms of OLS. Next, I minimize $(X-f(z|\hat{\Theta}))^T S^{-1}(X-f(z|\hat{\Theta}))$ to obtain the chi-square statistic.

files of inequality that are significantly different from the ones documented in the literature, suggesting the need to reassess some existing economic inferences.

References

Aguiar, Mark and Erik Hurst, "Deconstructing Lifecycle Expenditure," NBER Working Papers 13893, National Bureau of Economic Research, Inc Mar 2008.

Blundell, Richard and Ian Preston, "Consumption Inequality And Income Uncertainty," *The Quarterly Journal of Economics*, May 1998, *113* (2), 603–640.

Card, David and Thomas Lemieux, "Can Falling Supply Explain the Rising Return to College for Younger Men? A Cohort-Based Analysis," *The Quarterly Journal of Economics*, 2001, *116* (2), 705–746.

Deaton, Angus and Christina Paxson, "Intertemporal Choice and Inequality," *Journal of Political Economy*, 1994, *103* (3), 437–467.

Guvenen, Fatih, "Learning Your Earning: Are Labor Income Shocks Really Very Persistent?," *American Economic Review*, 2007, *97* (3), 687–712.

_ , "An Empirical Investigation of Labor Income Processes," *Review of Economic Dynamics*, 2009, *12* (1), 58–79.

_ **and Anthony A Smith**, "Inferring Labor Income Risk From Economic Choices:An Indirect Inference Approach," working paper 500 2009.

_ **and Burhanettin Kuruscu**, "A quantitative analysis of the evolution of the U.S. wage distribution, 1970-2000," Staff Report 427, Federal Reserve Bank of Minneapolis 2009.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante, "Two Views of Inequality Over the Life Cycle," *Journal of the European Economic Association*, 2005, *3* (2-3), 765–775.

Huggett, Mark and Juan Carlos Parra, "How Well Does the U.S. Social Insurance System Provide Social Insurance?," *Journal of Political Economy*, 02 2010, *118* (1), 76–112.

_ , **Gustavo Ventura, and Amir Yaron**, "Sources of Lifetime Inequality," NBER Working Papers 13224, National Bureau of Economic Research, Inc July 2007.

Krueger, Dirk and Fabrizio Perri, "Does Income Inequality Lead to Consumption Inequality? Evidence and Theory,," *Review of Economic Studies*, 2006, *73* (1), 163–193.

Maziero, Pricila and Laurence Ales, "Accounting for private information," Working Papers 663, Federal Reserve Bank of Minneapolis 2008.

Primiceri, Giorgio E. and Thijs van Rens, "Heterogeneous Life-Cycle Profiles, Income Risk and Consumption Inequality," *Journal of Monetary Economics*, 2009, *56* (1), 20–39.

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

Table 1

Basic statistics

	PSID	*CEX*
Total obs.	376512	18232
Mean income	26725	23750
Median income	21642	19686
Mean age	43	44
Median age	38	43
Househead's years of schooling$\geq$12	38%	48%
Mean consumption per adult equivalent		2610
Median consumption per adult equivalent		2313

Table 2

Age-specific rise of income inequality

	full sample		*yr. of school* $\leq$ *12*		*yr. of school* $>$ *12*	
year	$\hat{\gamma}_1$	*t-stat*	$\hat{\gamma}_1$	*t-stat*	$\hat{\gamma}_1$	*t-stat*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1969	-0.0003	-0.0965	-0.0010	-0.2790	0.0028	0.5863
1970	-0.0008	-0.2778	-0.0018	-0.4917	0.0057	1.1771
1971	-0.0013	-0.4344	-0.0028	-0.7422	0.0050	1.0296
1972	-0.0026	-0.8666	-0.0041	-1.0887	0.0023	0.4788
1973	-0.0042	-1.3904	-0.0062	-1.6731^{*}	0.0027	0.5603
1974	-0.0028	-0.9290	-0.0042	-1.1247	-0.0021	-0.4399
1975	-0.0058	-1.8967^{*}	-0.0068	-1.8286^{*}	-0.0054	-1.1076
1976	-0.0059	-1.9477^{*}	-0.0062	-1.6693^{*}	-0.0104	$-2.1537^{\dagger}$
1977	-0.0073	$-2.3903^{\dagger}$	-0.0077	$-2.0739^{\dagger}$	-0.0119	$-2.4520^{\dagger}$
1978	-0.0050	-1.6431	-0.0048	-1.2746	-0.0110	-2.2665
1979	-0.0064	$-2.0920^{\dagger}$	-0.0070	-1.8700^{*}	-0.0097	$-2.0092^{\dagger}$
1980	-0.0084	$-2.7576^{\ddagger}$	-0.0092	$-2.4608^{\dagger}$	-0.0115	$-2.3850^{\dagger}$
1981	-0.0084	$-2.7442^{\ddagger}$	-0.0111	$-2.9759^{\ddagger}$	-0.0065	-1.3534
1982	-0.0135	$-4.4310^{\ddagger}$	-0.0143	$-3.8349^{\ddagger}$	-0.0157	$-3.2466^{\ddagger}$
1983	-0.0148	$-4.8296^{\ddagger}$	-0.0172	$-4.6029^{\ddagger}$	-0.0138	$-2.8455^{\ddagger}$
1984	-0.0147	$-4.8134^{\ddagger}$	-0.0158	$-4.2232^{\ddagger}$	-0.0176	$-3.6319^{\ddagger}$
1985	-0.0158	$-5.1567^{\ddagger}$	-0.0167	$-4.4815^{\ddagger}$	-0.0161	$-3.3227^{\ddagger}$
1986	-0.0143	$-4.6651^{\ddagger}$	-0.0184	$-4.9280^{\ddagger}$	-0.0093	-1.9316^{*}
1987	-0.0143	$-4.6878^{\ddagger}$	-0.0205	$-5.5086^{\ddagger}$	-0.0032	-0.6524
1988	-0.0123	$-4.0105^{\ddagger}$	-0.0196	$-5.2449^{\ddagger}$	-0.0006	-0.1248
1989	-0.0108	$-3.5310^{\ddagger}$	-0.0167	$-4.4643^{\ddagger}$	-0.0039	-0.7969
1990	-0.0139	$-4.5441^{\ddagger}$	-0.0175	$-4.6983^{\ddagger}$	-0.0082	-1.6985^{*}
1991	-0.0141	$-4.6129^{\ddagger}$	-0.0167	$-4.4751^{\ddagger}$	-0.0117	$-2.4305^{\dagger}$
1992	-0.0112	$-3.6703^{\ddagger}$	-0.0148	$-3.9571^{\ddagger}$	-0.0090	-1.8630^{*}
1993	-0.0094	$-3.0855^{\ddagger}$	-0.0126	$-3.3694^{\ddagger}$	-0.0047	-0.9668
1994	-0.0113	$-3.6828^{\ddagger}$	-0.0162	$-4.3557^{\ddagger}$	-0.0051	-1.0608
1995	-0.0117	$-3.8203^{\ddagger}$	-0.0173	$-4.6294^{\ddagger}$	-0.0027	-0.5624
1996	-0.0162	$-5.2967^{\ddagger}$	-0.0202	$-5.4124^{\ddagger}$	-0.0047	-0.9624
1997	-0.0169	$-5.5449^{\ddagger}$	-0.0233	$-6.2495^{\ddagger}$	-0.0064	-1.3169
average	-0.0095		-0.0121		-0.0063	

Income inequality is based on PSID 1968-1997. $\hat{\gamma}_1$ is the vector of estimated coefficients of $D_{yr} \times h$. In D_{yr}, dummy for year 1968 is dropped. Significance levels of 1%, 5%, and 10% are noted by ‡, †, and *.

Table 3

Age-specific rise of consumption inequality

	full sample		*yr. of school* ≤ 12		*yr. of school* > 12	
year	$\hat{\gamma}_1$	*t-stat*	$\hat{\gamma}_1$	*t-stat*	$\hat{\gamma}_1$	*t-stat*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1982	-0.0008	-0.9762	0.0003	0.2519	0.0054	$3.0605^{\ddagger}$
1983	0.0015	1.7159^{*}	0.0012	1.1689	0.0001	0.0393
1984	-0.0009	-1.0169	-0.0020	-1.9427^{*}	-0.0012	-0.6689
1985	0.0018	$2.1764^{\dagger}$	0.0007	0.7220	0.0003	0.1480
1986	-0.0028	$-3.3265^{\ddagger}$	-0.0032	$-3.1371^{\ddagger}$	-0.0038	$-2.1635^{\dagger}$
1987	-0.0012	-1.4280	-0.0009	-0.8592	-0.0036	$-2.0723^{\dagger}$
1988	-0.0035	$-4.1823^{\ddagger}$	-0.0020	$-1.9859^{\dagger}$	-0.0051	$-2.8840^{\ddagger}$
1989	-0.0039	$-4.5925^{\ddagger}$	-0.0053	$-5.2064^{\ddagger}$	-0.0029	-1.6559^{*}
1990	-0.0009	-1.1088	-0.0005	-0.5193	-0.0018	-1.0468
1991	-0.0019	$-2.2070^{\dagger}$	-0.0012	-1.1250	-0.0026	-1.5029
1992	-0.0002	-0.2326	-0.0010	-0.9669	0.0025	1.4043
1993	-0.0006	-0.7310	-0.0007	-0.6940	0.0002	0.0935
1995	0.0005	0.5658	-0.0023	$-2.2154^{\dagger}$	0.0005	0.2768
1996	-0.0012	-1.3926	0.0001	0.1010	-0.0040	$-2.2674^{\dagger}$
1997	0.0013	1.4872	0.0018	1.7379	-0.0008	-0.4597
1998	0.0019	$2.2884^{\dagger}$	0.0009	0.8312	0.0011	0.6384
1999	0.0002	0.2278	0.0010	0.9694	-0.0019	-1.0763
2000	-0.0012	-1.3648	-0.0002	-0.1557	-0.0050	$-2.8632^{\ddagger}$
2001	0.0008	1.0032	0.0002	0.2046	-0.0011	-0.6307
2002	0.0007	0.8020	-0.0010	-0.9963	-0.0006	-0.3389
2003	-0.0013	-1.5573	-0.0020	-1.9465^{*}	-0.0032	-1.8071^{*}
average	-0.0006		-0.0008		-0.0013	

Consumption inequality is based on CEX 1980-2003. $\hat{\gamma}_1$ is the vector of estimated coefficients of $D_{yr} \times h$. Dummy for year 1980 is dropped. Significance levels of 1%, 5%, and 10% are noted by ‡, †, and *.

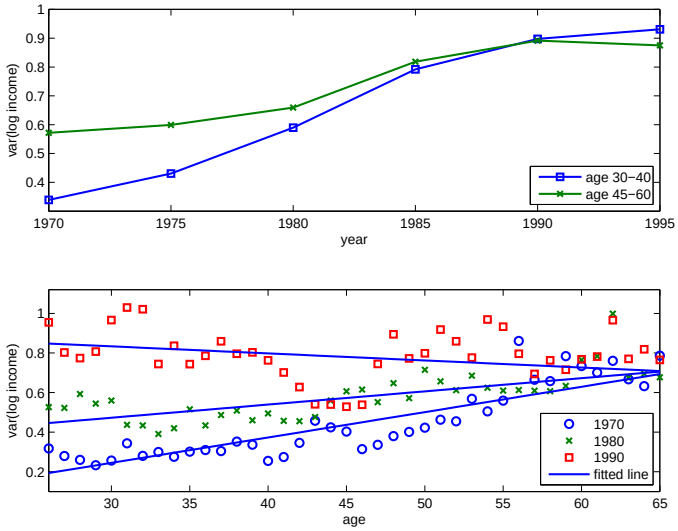
Table 4

Results of model specification test

income inequality from PSID	χ^2	*df*	*p-value*
cohort effect model	1269.1	1260	0.423
year effect model	1299.6	1304	0.530
age-specific year effect model	1255.8	1276	0.652
consumption inequality from CEX			
cohort effect model	841.4	819	0.286
year effect model	851.3	861	0.587
age-specific year effect model	829.2	840	0.598
income inequality from CEX			
cohort effect model	812.5	819	0.557
year effect model	848.4	861	0.614
age-specific year effect model	821.7	840	0.668

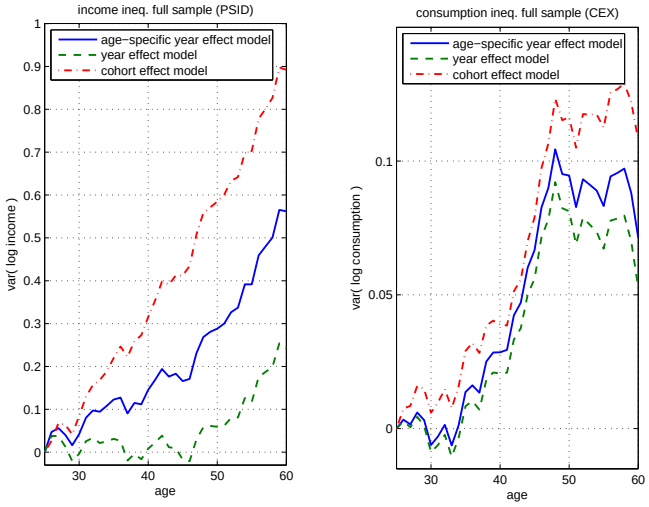
Chi-square statistic is computed as $(X - f(z|\hat{\Theta}))^T S^{-1}(X - f(z|\hat{\Theta}))$, where $f(z|\hat{\Theta})$ is the model under test, with z standing for the vector of regressors. The weighting matrix S^{-1} is calculated from the OLS residuals.

Figure 1: *Age-specific rise of income inequality from PSID 1968-1997.*



The top panel takes two age groups from the data. For each group, it plots the variances of log income of observations in year intervals of 1968-1972 , 1972-1977,..., and 1992-1997. The ticks of horizontal axis are the middle of the 5-year interval. The bottom panel plots data from three cross sections by age to show that from 1970 to 1980, and from 1980 to 1990, the rise of income inequality is much stronger among younger households.

Figure 2: *Profiles from different models*



The figure plots life-cycle profiles of income and consumption inequality from different models, using PSID income data and CEX consumption data.