JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY
RICE UNIVERSITY

INCOME VOLATILITY AND MOBILITY:
U.S. INCOME TAX DATA, 1999-2007

BY

DAVID SPLINTER

GRADUATE STUDENT,
DEPARTMENT OF ECONOMICS, RICE UNIVERSITY

VICTORIA BRYANT

STATISTICS OF INCOME, INTERNAL REVENUE SERVICE

JOHN W. DIAMOND, PH.D.

EDWARD A. AND HERMENA HANCOCK KELLY FELLOW IN PUBLIC FINANCE
JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY, RICE UNIVERSITY

SEPTEMBER 2010

Income Volatility and Mobility:
U.S. Income Tax Data, 1999-2007

David Splinter*
Victoria Bryant**
John Diamond*

Previous Version: January 2010

Revised Version: September 2010

Abstract

How do earnings volatility and mobility impact different income groups? We describe household earnings volatility by the full distribution of percent earnings changes and contrast measures of relative and absolute mobility using a panel of U.S. income tax returns from 1999 to 2007. While earnings volatility looks similar across most of the income distribution, we find more volatility among the bottom quintile of households, mostly from earnings gains, and more volatility among the top one percent, mostly from earnings losses. Large earnings gains persist more for the bottom quintile and large losses persist more for households higher up the income distribution. In contrast to typical findings of lower relative mobility among the bottom and top quintiles, we find higher absolute earnings mobility among households at the extremes of the distribution.

* Rice University, Houston, TX; splinter@rice.edu and jdiamond@rice.edu
** Statistics of Income, Internal Revenue Service, Washington, DC

I. Introduction

Short-term income shocks can be characterized by *volatility*, measured by the dispersion of percent changes in incomes; and can reflect income *mobility* if the shocks persist in the long run or income *instability* if the shocks represent transitory changes from permanent income. Using a panel of income tax returns from 1999 to 2007, we estimate income volatility and several measures of income mobility.

We find that earnings volatility looks similar across most of the income distribution, although the bottom quintile and top one percent of households have higher earnings volatility. For the bottom quintile earnings gains are more frequent and persistent, while for the top one percent losses are more frequent and persistent. This suggests a reversion to household level mean earnings for these households.

Income mobility can be described by *relative mobility*, as measured by the amount of rank reversal, or by *absolute mobility*, as measured by how much a household's income changes from period to period independent of other households. Relative mobility measures movement within the income distribution. Absolute mobility measures the opportunity to grow one's income and the predictability of one's income. Consistent with other studies on mobility (Díaz-Jiménez, Quadrini, and Ríos-Rull, 1997; Carroll, Joulfaian, and Rider, 2007), we find more quintile persistence within the bottom and top quintiles. We contrast this standard observation of less relative mobility among the bottom and top quintiles with our findings of higher absolute mobility among these groups. In other words, absolute mobility reveals income movements that relative mobility may hide.

II. Literature Review

Many studies report a single average volatility measure, which gives an incomplete picture of the relative importance of extreme income changes in the tails of the distribution or modest changes near the median. The U.S. Congressional Budget Office (2008) focuses on the tails by using Social Security Administration data to estimate the percentage of workers with earnings changes

of 25 percent or more and the percentage of households with income changes of 25 percent or more. They find that these measures of volatility have been stable since 1990, while slightly increasing for the bottom quintile of households. We find similar percentages of households with large changes, despite using tax data and looking at three-year changes in earnings rather than annual income changes. In addition, we estimate the fraction of households with large earnings changes that persist over time and address the issue of how to summarize volatility by characterizing the full distribution of earnings changes.

Our estimates of volatility for different income groups are consistent with other studies which find that income shocks at the bottom and top of the income distribution may contribute significantly to average volatility. Sabelhaus and Song (2009) find that adding the bottom ten percent of Social Security earnings records for workers age 25 to 55 causes volatility to double. Jensen and Shore (2008) use the Panel Study of Income Dynamics (PSID) to show that the increase in income volatility since the 1970s has not affected most individuals: "the self-employed and those who self-identify as risk-tolerant are much more likely to have such volatile incomes." They also show that volatility increases seem most prominent in the top five percent of the income distribution. While sample size and top-coding in the PSID limits examination of volatility within the top one percent of the income distribution, our data allows us to look at the top tenth and hundredth of one percent.

A number of studies find increasing income volatility in recent decades. Using the PSID, Dynan, Elmendorf, and Sichel (2008) estimate that between 1971 and 2004 household income volatility increased by one-third. Jensen and Shore (2008) also find increasing volatility with the PSID. Hertz (2007) uses the Current Population Survey to show increasing volatility since the mid-1980s and that residents of some states consistently have more volatility. Meanwhile, the U.S. Congressional Budget Office (2008) and Sabelhaus and Song (2009) find that volatility of Social Security earnings fell in the late 1980s and has held steady since then except for a slight increase following the 2001 recession. While our data cannot address the long-run trend of earnings volatility, we do observe a slight decrease in earnings volatility between the first and second halves of our sample as we move from the 2001 recession to an expansion. This is consistent with the typical observation of countercyclical volatility.

A related set of studies decomposes permanent and transitory income changes. Gottschalk and Moffitt (2009) use the PSID to estimate that about half of the increase in male earnings inequality from 1974 to 1990 came from increasing instability, as measured by variance of transitory earnings. While male earnings instability has been relatively stable since the late 1980s, they find that family income instability has continued increasing. In contrast, Kopczuk, Saez, and Song (2010) use Social Security Administration data to find that the variance of transitory individual earnings has remained stable since 1960. Interestingly, this repeats the trend seen above—studies using the PSID find increasing volatility and those using Social Security Administration data find stable levels of volatility. Our income change estimates do not control for permanent earnings and so it is not clear how much of the earnings gains we find are due to permanent life-cycle income changes.

III. Data Description

This study uses the Statistics of Income 1999 Edited Panel, a stratified random sample of income tax returns from 1999 to 2007. There are 83,406 households in the entire panel in 1999, with 12,512 in the top one percent and 4,199 in the top 0.01 percent in 1999. The entire panel represents 127 million households in 1999 and 101 million in 2007.

We limit the sample to households with constant filing status (e.g., single, joint, head of household) to remove income changes due to marriage and divorce. We also exclude observations that fail to file a return in any year, which may affect our results to the extent that consistently filing tax returns is correlated with economic success. This leaves 47,131 households. To limit the effect of job entry and retirement, we remove households for years in which primary filers are younger than 25 or older than 61. This leaves 36,701 households in 1999 and 30,995 households in 2007. This "restricted" sample used throughout the study represents about 50 million tax returns. The median age of the restricted sample increases 4 years (43 to 47) across the sample, a bit more than the U.S. Census reported median increase of 2.4 years (35.5 to 37.9).

We limit our study to earnings (wages, salaries, tips, etc., as reported on tax returns) and index all values to 2007 dollars using the Consumer Price Index Research Series (CPI-U-RS). Table 1 shows income group cutoffs and the ratio of cutoffs to median incomes at the beginning and end of our sample, both years at the height of business expansions.

Table 1: Earnings Group Cutoffs and Cutoff to Median Ratios (2007 dollars)

Quintile or Percentile	1999 Earnings Cutoffs	2007 Earnings Cutoffs	1999 Cutoff to Median Ratio	2005 Cutoff to Median Ratio
20th percentile	20,214	19,407	0.43	0.43
40th percentile	37,618	35,856	0.80	0.79
median	47,018	45,415	1.00	1.00
60th percentile	58,220	56,748	1.24	1.25
80th percentile	88,453	89,164	1.88	1.96
Top 1%	322,363	330,787	6.86	7.28
Top 0.1%	1,140,792	1,086,792	24.26	23.93
Top 0.01%	5,285,942	4,262,148	112.42	93.85

Notes: Restricted sample, i.e., households with constant filing status,
filing all nine years of the panel, and primary earners between the ages of 25 and 61.

IV. Earnings Volatility and Persistence of Earnings Shocks

We examine "medium-term" earnings volatility by measuring the distribution of household earnings changes. Figure 1 shows the distribution of percent changes in average three-year earnings from 2000 to 2003 and from 2003 to 2006 (centered years, i.e., 2000 is the average earnings from 1999 to 2001). The distribution of the entire sample looks normal. The more disperse distributions of the bottom quintile and the top 0.1 percent (P99.9-P99.99, excludes top 0.01 percent) suggest more volatility for bottom and very top earners. The other four quintiles are not shown, as their distributions are similar to that of the entire sample.

A decrease in volatility from a recessionary period (2000 to 2003) to an expansionary period (2003 to 2006) is shown by the increasing fraction of households at median percent earnings changes and decreasing standard deviations of percent earnings changes. The standard deviation of the entire sample falls from 630 to 540. The standard deviation for the bottom quintile falls from 1400 to 1100, for the middle quintile from 160 to 150, and for the top quintile from 110 to

100. To calculate standard deviations we raise all earnings to at least a $3K threshold, otherwise earnings close to zero can lead to infinitely high percent changes.

Figure 1: "Medium-term" Household Earnings Volatility
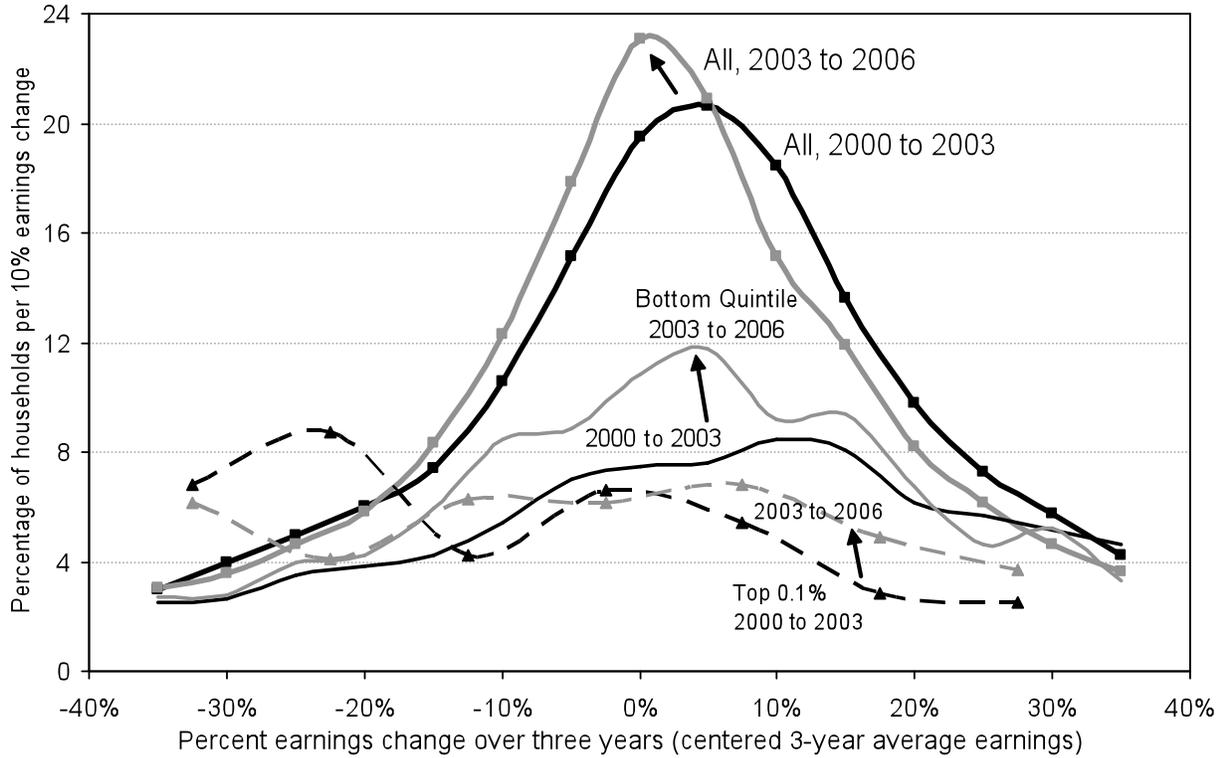
Notes: Three-year average earnings measured in five-percent bins after three years.
Ten-percent bins measured for the top 0.1 percent, i.e., P99.9-P99.99.
Restricted sample used, where income groups are based on each initial three-year period earnings.

"Long-term" earnings volatility, shown in Figure 2 by changes in three-year average earnings from 2000 to 2006, also appears highest at the extremes of the earnings distribution. Standard deviations for the 1st to 5th quintiles are 3000, 250, 220, 230, 160; again using an earnings threshold.[1] The higher households climb up the top one percent of the income distribution the farther their earnings tend to fall in the following period. Specifically, median percent earnings changes after six years are -20, -50, and -83 percent for the top one percent (P99-P99.9), top 0.1 percent, and top 0.01 percent of households. As one goes up the income distribution the fraction of households with small earnings changes decreases and the fraction with large earnings

---

[1] The 1st quintile standard deviation drops to 1800 with a threshold of $5K instead of $3K.

changes increases. This suggests increasing "long-term" volatility as households rise to the top of the income distribution.

Figure 2: "Long-term" Household Earnings Volatility between 2000 and 2006
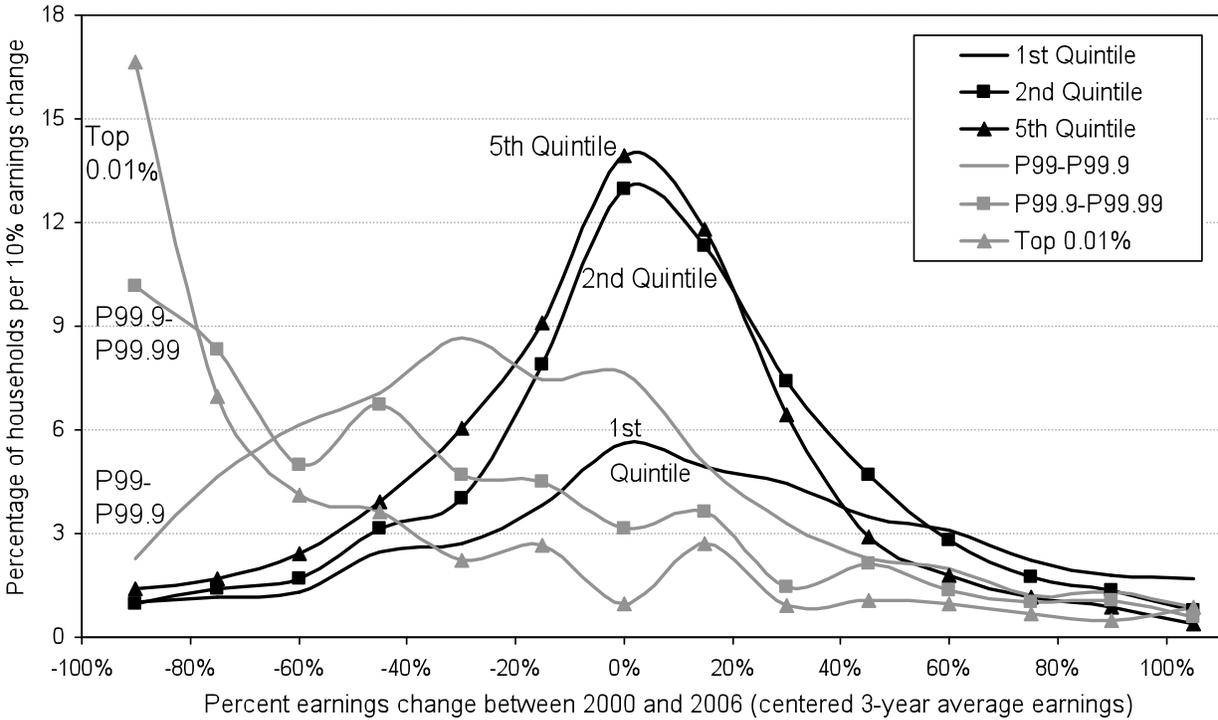
Notes: Fifteen-percent bins estimated for restricted sample, where income groups are based on initial period earnings.

Persistence of Earnings Shocks

We now consider the fraction of households facing large earnings shocks and the persistence of those shocks. We find that the fraction of households with persistent gains outweighs that of households with persistent losses. Between 2000 and 2003, 19 percent of households enjoy large (at least 30 percent) three-year average earnings gains, but only 12 percent suffer large losses. While 65 percent of households with large earnings increases sustain their gains until 2006, only 37 percent of those suffering large earnings decreases sustain those losses. This means more than twice as many households have persistent large positive shocks than persistent negative shocks (12 vs. 5 percent).

For low earnings households, earnings gains are more common and more persistent. Four times as many bottom quintile than third quintile households have large gains (see Table 2). While 49

percent of bottom quintile households enjoy large gains, only 16 percent suffer large losses. Large gains to bottom quintile earnings also persist much more than losses (71 vs. 22 percent).

Table 2: Percentage of Households with Earnings Shocks and Persistent Shocks

	Percent with Initial Shock					Percent with Persistent Shock Conditional on Initial Shock				
	1st Quintile	3rd Quintile	5th Quintile	P99-P99.9	Top 0.01%	1st Quintile	3rd Quintile	5th Quintile	P99-P99.9	Top 0.01%
>30% positive shock	49	12	7	15	10	71	63	58	49	40
>30% negative shock	16	11	9	33	65	22	43	47	52	52
>20% positive shock	54	21	15	20	14	70	61	56	50	33
>20% negative shock	19	16	20	43	68	25	42	50	53	53
>10% positive shock	62	36	30	27	16	69	60	59	50	33
>10% negative shock	24	24	29	54	75	28	45	51	54	56

Notes: Percentage of households in restricted sample with earnings shocks to centered three-year average earnings. Initial shock is 2000 to 2003 earnings and persistence is 2003 to 2006.

As one moves up the income distribution the fraction of households with earnings gains falls and the fraction with earnings losses increases. The percentage of households with large *gains* is 19 percent, but for the top quintile is only 7 percent. The percentage of all households with large *losses* is 12 percent, but for the top one, 0.1, and 0.01 percent is an incredible 33, 55, and 65 percent. This observed reversion to the mean among top earnings households may be less surprising considering the three-year average top one percent cutoff of $330K and top 0.01 percent cutoff of $4 million. Not only do large gains become less frequent and losses more frequent moving up the distribution, the gains persist less and losses persist more. For example, fewer top quintile than bottom quintile households sustain large gains (58 vs. 71 percent) and twice as many sustain large losses (47 vs. 22 percent).

V. Absolute Mobility

We estimate volatility in the previous section as the dispersion of percent change in earnings across two periods. This is based on an *absolute mobility* measurement because it uses independent earnings changes for each household, as opposed to *relative mobility* measures that

depend on the incomes of others in the sample. In this section, we estimate various measures of absolute mobility proposed by Gary Fields and Efe Ok and presented in Fields (2005).

Non-Directional Earnings Movements

Non-directional income movements give a sense of the amount of income changes between two periods of time while treating a dollar gain or loss equally. We measure mean absolute earnings changes as follows, where *x* is final earnings and *y* is initial earnings and log earnings changes merely take the log of both *x* and *y*.

$$\text{mean absolute earnings change}(x, y) = \frac{1}{n} \sum_{i=1}^{n} |x_i - y_i|$$

The mean absolute earnings change from 1999 to 2007 is \$15K for the bottom quintile, \$20K for the middle quintile, and then rises to \$83K, \$360K, and \$11 million for the top quintile, one percent, and 0.01 percent (see Table 3). Dividing these amounts by average group earnings gives percent mean absolute earnings changes: 170 percent for the bottom quintile, only 40 for the middle quintile, and 50, 70, and 90 percent for the top quintile, one percent, and 0.01 percent. Higher percent non-directional mobility for bottom quintile and top earners seems consistent with our findings of higher volatility among the extremes of the income distribution.

Standard deviations of the distribution of mean earnings changes can also indicate volatility. The standard deviations for the bottom quintile are slightly larger than those of the third quintile, and top quintile standard deviations are much larger. This is congruent with our previous volatility findings, but indicates more volatility among the entire top quintile rather than just the top one percent of the distribution.

Table 3: Absolute Mobility Measured by Non-Directional and Directional Earnings Changes

		Average (percent of mean earnings)					Average (2007 Dollars)					Standard Dev.		
		1st	3rd	5th	P99-P99.9	Top 0.01%	1st	3rd	5th	P99-P99.9	Top 0.01%	1st	3rd	5th
Non-Directional Mobility	1999 to 2007 (8 yrs)	171%	42%	51%	69%	91%	14,600	19,700	83,200	360,000	1.1E+07	15.4	12.4	148
	1999 to 2000 (1 yr)	64%	15%	26%	40%	77%	5,500	7,000	41,800	205,000	9.6E+06	7.8	4.3	168
	2000 to 2001 (1 yr)	57%	15%	24%	37%	69%	5,100	7,000	40,900	204,000	8.9E+06	5.0	4.9	157
	2001 to 2002 (1 yr)	61%	15%	21%	31%	66%	5,300	7,200	34,500	156,300	6.3E+06	8.3	4.5	86
Directional Mobility	1999 to 2007 (8 yrs)	135%	11%	-2%	-8%	-70%	11,500	5,100	-3,600	-39,600	-8.7E+06	15.8	15.0	149
	1999 to 2000 (1 yr)	40%	2%	1%	4%	-36%	3,400	1,200	1,400	18,600	-4.5E+06	8.0	5.3	168
	2000 to 2001 (1 yr)	32%	1%	-5%	-9%	-56%	2,900	300	-8,600	-49,400	-7.2E+06	5.3	5.8	157
	2001 to 2002 (1 yr)	33%	1%	-5%	-10%	-48%	2,900	400	-8,300	-51,100	-4.6E+06	8.4	5.4	87
Log Non-Directional Mobility	1999 to 2007 (8 yrs)	34%	18%	7%	28%	112%	2.2	2.0	0.8	3.7	18.0	1320	927	628
	1999 to 2000 (1 yr)	17%	2%	2%	4%	15%	1.1	0.2	0.2	0.5	2.5	904	358	194
	2000 to 2001 (1 yr)	15%	2%	2%	3%	14%	1.0	0.2	0.2	0.5	2.2	817	341	240
	2001 to 2002 (1 yr)	17%	2%	2%	3%	16%	1.1	0.2	0.2	0.4	2.5	877	382	234
Log Directional Mobility	1999 to 2007 (8 yrs)	11%	-4%	-5%	-10%	-39%	0.69	-0.45	-0.54	-1.3	-6.3	1554	976	656
	1999 to 2000 (1 yr)	4%	-1%	-1%	-2%	-14%	0.3	-0.06	-0.06	-0.20	-2.21	991	369	202
	2000 to 2001 (1 yr)	2%	-1%	-1%	-2%	-13%	0.15	-0.08	-0.10	-0.26	-2.15	890	351	247
	2001 to 2002 (1 yr)	2%	-1%	-1%	-2%	-15%	0.15	-0.09	-0.11	-0.29	-2.36	961	392	240

Notes: Non-directional (mean absolute) and directional (mean) earnings changes for restricted sample are shown.
Percent averages calculated by dividing dollar averages by the mean earnings for each income group.
Standard deviations of earnings changes (a volatility measure) for non-log values are divided by one million.
Income groups are determined by the period's initial year earnings.

Directional Earnings Movements

We also measure directional earnings movements, taking into account net positive and negative income movements. We define these like the non-directional measurements, but without taking absolute values of earnings changes.

$$\text{mean earnings change}(x, y) = \frac{1}{n} \sum_{i=1}^{n} (x_i - y_i)$$

The mean earnings change from 1999 to 2007 decreases as one moves up the income distribution—with bottom quintile gains of $12K, middle quintile gains of $5K, and losses of $4K, $40K, and $9 million for the top quintile, one percent, and 0.01 percent. Dividing by average group income, bottom quintile gains were 135 percent, middle quintile gains were 11 percent, and top 0.01 percent losses were -70 percent.

How much were annual earnings losses in the 2001 recession for various income groups? The average annual earnings change drops from positive $2K in 1999 to negative $1K in the 2001 recession before recovering to a steady level of positive $1K. Bottom quintile annual earnings changes are consistently $2K above the average, but $4K above during the recession. This implies bottom quintile earnings not only grew faster than average household earnings throughout the sample, but they also suffered less than average households during the 2001 recession. Again, this may be a function of reversion to the mean if households who previously suffered negative shocks that put them in the bottom quintile are more likely to later have positive shocks. From 2000 to 2001, the top quintile, one percent, and 0.01 percent dollar losses were $9K, $49K, and $7 million; while percent losses were -5, -9, and -56 percent. From the perspective of dollar and percent earnings changes, the 2001 downturn seems to have affected high earnings households most severely.

VI. Absolute versus Relative Mobility

Relative mobility measures how frequently households change relative positions in the income distribution across periods. In other words, relative mobility reflects changes in the income distribution, while absolute mobility stays constant with respect to changes in the distribution. Relative mobility can be helpful in measuring how much long-term relative positions equalize over the life cycle.

Some common relative mobility measurements have inherent drawbacks. For example, it is often emphasized that a higher fraction of those in the bottom and top quintiles stay in their relative income group over time. Diagonal elements in quintile transition matrices, such as Table 4, show this pattern, which some interpret as less mobility for these two groups.[2] However, our finding of higher absolute mobility for the bottom and top quintiles suggests the opposite.[3]

---

[2] Studies including retirees, such as Díaz-Jiménez et al. (1997), should expect lower bottom quintile mobility than our sample because the bottom quintile includes many retirees who stay retired.

[3] Table 3 shows that the average absolute value of percent earnings changes (non-directional mobility) over the entire sample was only 42 percent for the middle quintile, but 171 and 51 percent for the bottom and top quintiles.

Table 4: Relative Frequency Table of Earnings for the Restricted Sample

Quantiles in 1999	Earnings Quantiles in 2007								
	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	P90-P99	P99-P99.9	P99.9-P99.99	Top 0.01%
1st Quintile	**57.08**	28.13	9.26	3.91	1.62	0.69	0.04	0	0
2nd Quintile	18.14	**43.65**	28.64	7.26	2.31	0.61	0.09	0	0
3rd Quintile	10.07	13.39	**39.80**	29.91	6.82	1.67	0.10	0	0
4th Quintile	7.35	5.14	15.02	**46.25**	26.24	6.33	0.16	0	0
5th Quintile	6.02	2.79	5.09	15.47	**70.63**	--	--	--	--
P90-P99	5.73	2.45	3.70	9.45	--	**56.85**	5.21	0.33	0
P99-P99.9	8.67	1.53	2.07	2.71	--	35.83	**38.62**	5.18	0.49
P99.9-P99.99	16.12	1.63	2.24	3.95	--	20.77	27.21	**19.98**	5.41
Top 0.01%	34.92	2.26	1.89	1.98	--	10.99	11.56	16.52	**15.96**

There are also problems with comparing relative group persistence in the top and bottom quintiles with middle quintiles because of censoring—households in the bottom quintile can only move up and those in the top can only move down. Auten and Gee (2009) call it a "consistency problem". A related issue is that top quintile household earnings can fall 60 percent, say from $300K to $120K, but remain in the top quintile. Meanwhile, any household in the middle quintiles with a 60 percent change in income will go up or down at least one quintile, and sometimes two. *Relative* mobility measures can thus cloak large *absolute* income mobility that does not push households across income cutoffs.

Our relative mobility measurements for annual earnings are similar to those of Auten and Gee (2009), who also used income tax data. About half (42 percent) of their bottom quintile move to another quintile over a ten-year panel, as compared to 43 percent for our nine-year sample. We also see in our sample that over half of the top one percent of earnings earners fall out of the top one percent after nine years, while three-quarters fall out of the top 0.1 percent and five-sixths out of the top 0.01 percent (55, 74, and 84 percent).

VII. Conclusion

The bottom quintile of households has higher earnings volatility than average households, mostly from gains, and the top one percent has higher earnings volatility, mostly from losses. Large earnings gains to bottom quintile households persist more than large losses and the converse holds for the top one percent. Although we document these trends, we do not examine the

reasons why households at the bottom seem to rebound upward and why tenure at the top seems so temporary. The effects of household composition, secondary earners, occupation, and life cycle earnings profiles may provide some answers.

References

Auten, Gerald, and Geoffrey Gee. Income Mobility in the United States: New Evidence from Income Tax Data. *National Tax Journal* 62 (June 2009): 301-28.

Carroll, Robert, David Joulfaian, and Mark Rider. Income Mobility: The Recent American Experience. Andrew Young School of Policy Studies Research Paper Series, Working Paper 07-18 (March 2007).

Díaz-Jiménez, Javier, Vincenzo Quadrini, and José-Víctor Ríos-Rull. Dimensions of Inequality: Facts on the U.S. Distributions of Earnings, Income, and Wealth. *Federal Reserve Bank of Minneapolis Quarterly Review* 21 (Spring 1997): 3-21.

Dynan, Karen E., Douglas W. Elmendorf, and Daniel E. Sichel. The Evolution of Household Income Volatility. Brookings Institution (February 2008).

Fields, Gary S. The Many Facets of Economic Mobility. Working Paper (July 2005).

Gottschalk, Peter, and Robert Moffitt. The Rising Instability of U.S. Earnings. *Journal of Economic Perspectives* 23 (Fall 2009): 3-24.

Hertz, Tom. Changes in the Volatility of Household Income in the United States: A Regional Analysis. Brookings Institution Metropolitan Policy Program (July 2007).

Jensen, Shane T., and Stephen H. Shore. Changes in the Distribution of Income Volatility. Working Paper (June 2008).

Kopczuk, Wojciech, Emmanuel Saez, and Jae Song. Earnings Inequality and Mobility in the United States: Evidence from Social Security Data since 1937. *The Quarterly Journal of Economics* 125 (February 2010): 91-128.

Sabelhaus, John, and Jae Song. Earnings Volatility Across Groups and Time. *National Tax Journal* 62 (June 2009): 347-64.

U.S. Congressional Budget Office. Recent Trends in the Variability of Individual Earnings and Family Income. Washington, D.C. (June 2008).