

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

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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 wage volatility looks similar across most of the income distribution, although the bottom quintile and top 1 percent of households have higher wage volatility. For the bottom quintile wage gains are more frequent and persistent, while for the top 1 percent losses are more frequent and persistent. This suggests a reversion to household level mean wages 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 income mobility among these groups. In other words, absolute mobility reveals bottom quintile and top earner income movements that relative mobility may hide.

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 estimate similar statistics for households with tax data and find similar results despite looking at 3-year changes in wages rather than annual income changes. In addition, we estimate the fraction of households with large wage changes that persist over time and address the issue of how to summarize volatility by characterizing the full distribution of income 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, p. 351) find that adding the bottom 10 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, but is concentrated among the self-employed and those who self-identify as risk-tolerant. They also show that volatility increases seem most prominent in the top 5 percent of the income distribution. While sample size and top-coding in the PSID limits examination of volatility within the top 1 percent of the income distribution, our data set also allows us to look at the top tenth and hundredth of 1 percent.

*In this article we use the term *wages* to describe a measure of *earnings*, not wage rates. We have benefited from comments by Bradley Heim and George Zodrow and participants at the National Tax Association annual conference and Rice University seminar.

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 (2008) 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 wage volatility, we do observe a slight decrease in wage 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 wages and so it is not clear how much of the wage gains we find are due to permanent life-cycle income changes.

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 1 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 economics 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 wages (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.

WAGE VOLATILITY AND PERSISTENCE OF WAGE SHOCKS

We examine “medium-term” wage volatility by measuring the distribution of households with different percent wage changes. Figure 1 shows the distribution of percent changes in average 3-year wages from 2000 to 2003 and from 2003 to 2006 (centered years, i.e., 2000 is the average wage 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 show, as their distributions are similar to that of the entire sample.

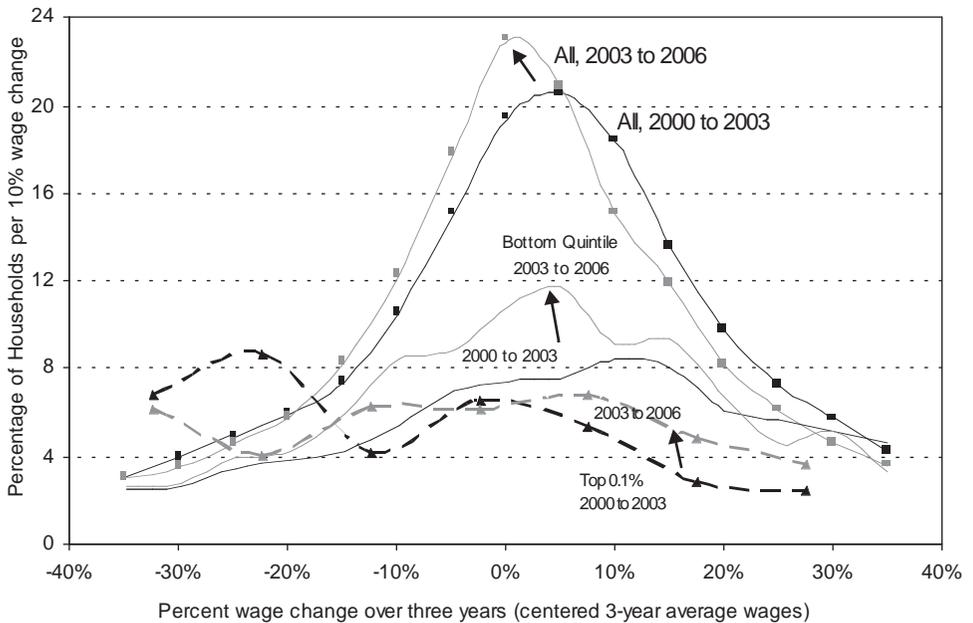
A decrease in volatility from a recessionary period (2000 to 2003) to an expansionary period (2003 to 2006) is shown by the increasing fraction of households at median percent wage changes and decreasing standard deviations of percent wage changes. The standard deviation of the entire sample falls from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

Table 1
Income Group Cutoffs and the Ratio of Cutoffs to Median Incomes in 2007 Dollars

<i>Quintile or Percentile</i>	<i>1999 Income Cutoffs</i>	<i>2007 Income Cutoffs</i>	<i>1999 Cutoff to Median Ratio</i>	<i>2005 Cutoff to Median Ratio</i>
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

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

Figure 1: "Medium-term" Household Wage Volatility



Notes: Three-year average wages measured in 5 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 3-year period wages.

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 wages to at least a \$3K wage threshold, otherwise wages close to zero can lead to infinitely high percent changes.

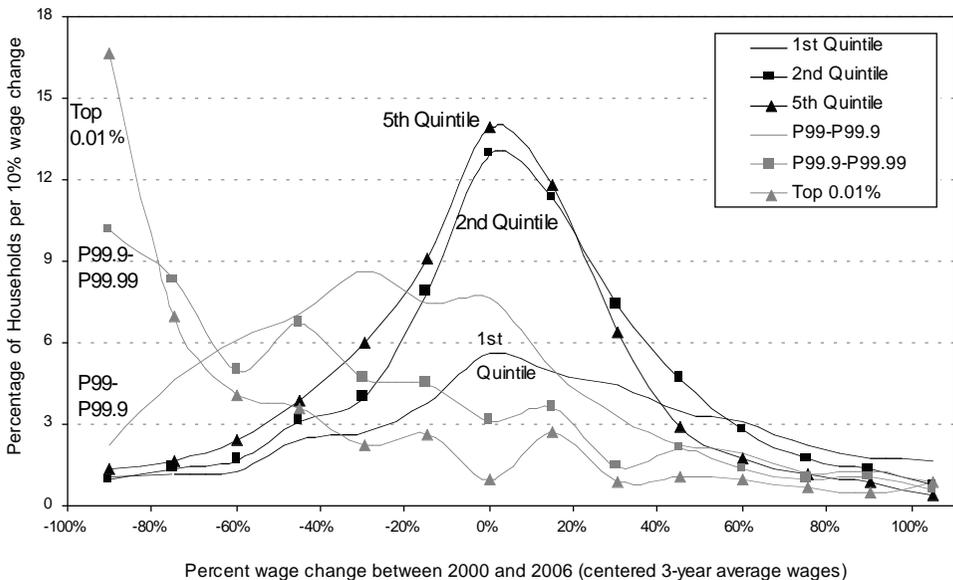
“Long-term” wage volatility, shown in Figure 2 by changes in 3-year average wages from 2000 to 2006, also appears highest at the extremes of the wage distribution. Standard deviations for the 1st to 5th quintiles are 3000, 250, 220, 230, 160; again using a minimum wage threshold.¹ The higher households climb up the top 1 percent of the income distribution the farther their wages tend to fall in the following period. Specifically, median percent wage changes after six years are -20, -50, and -83 percent for the top 1 percent, top 0.1 percent (P99.9-P99.99), and top 0.01 percent of households. As one goes up the income distribution, the fraction of households with small wage changes decreases and the fraction with large wage changes increase. This suggests increasing “long-term” volatility as households rise to the top of the income distribution.

PERSISTENCE OF WAGE SHOCKS

We now consider the fraction of households facing large wage 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) 3-year average wage gains, but only 12 percent suffer large losses. While 65 percent of households with large wage increases sustain their gains until 2006, only 37 percent of those suffering large wage 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-wage households, wage 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 wages also persist much more than losses (71 vs. 22 percent).

Figure 2: “Long-term” Household Wage Volatility Between 2000 and 2006



Fifteen percent bins estimated for the restricted sample, where income groups are based on initial period wages.

Table 2
Percentage of Households with Wage 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

Note: Percentage of households in restricted sample with wage shocks to centered 3-year average wages. Initial shock is 2000 to 2003 wages and persistence is 2003 to 2006.

As one moves up the income distribution the fraction of households with wage gains falls and the fraction with wage 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 1, 0.1, and 0.01 percent is an incredible 33, 55, and 65 percent. This observed reversion to the mean among top wage households may be less surprising considering the 3-year average top 1 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 than bottom quintile households sustain large gains (58 vs. 71 percent) and twice as many sustain large losses (47 vs. 22 percent).

ABSOLUTE MOBILITY

We estimate volatility in the previous section as the dispersion of percent change in wages across two periods. This is based on an *absolute mobility* measurement because it uses independent wage 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 (2006).

Nondirectional Wage Movements

Nondirectional 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 wage changes as follows, where *x* is final wages and *y* is initial wages and log wage changes merely take the log of both *x* and *y*.

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

The mean absolute wage 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, 1 percent, and 0.01 percent (see Table 3). Dividing these amounts by average group wages gives percent mean absolute wage changes: 170 percent for the bottom quintile, only 40 for the middle quintile, and 50, 70, and 90 percent for the top quintile, 1 percent, and 0.01 percent. The higher percent nondirectional mobil-

ity for the 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 wage 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 1 percent of the distribution.

Directional Wage Movements

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

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

The mean wage 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, 1 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 wage losses in the 2001 recession for various income groups? The average annual wage 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 wage changes are consistently \$2K above the average, but \$4K above during the recession. This implies bottom quintile wages not only grew faster than average household wages 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, 1 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 wage changes, the 2001 downturn seems to have affected high-wage households most severely.

Table 3
Absolute Mobility Measured by Nondirectional and Directional Wage Changes

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

Note: Nondirectional (mean absolute) and directional (mean) wage changes for restricted sample are shown.

Percent averages calculated by dividing dollar averages by the mean wage for each income group.

Standard deviations of wage changes (a volatility measure) for non-log values are divided by one million.

Income groups are determined by the period's initial year wages.

Table 4
Relative Frequency Table of Wages for the Restricted Sample

Wages Quantiles in 2007

Quantiles in 1999	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

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 much 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

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 wages can fall 60 percent, say from \$300K to \$120K, but still 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 wages 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 10-year panel, as compared to 43 percent for our 9-year sample. We also see in our sample that over one-half of the top 1 percent fall out of the top 1 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, 84 percent).

CONCLUSION

The bottom quintile of households has higher wage volatility than average households, mostly from gains, and the top 1 percent has higher wage

volatility, mostly from losses. Large wage gains to bottom quintile households persist more than large losses and the converse holds for the top 1 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 effect of household composition, secondary earners, occupation, and life-cycle earnings profiles may provide some answers.

Notes

- ¹ The 1st quintile standard deviation drops to 1800 with a threshold of \$5K instead of \$3K.
- ² Studies including retirees, such as Diaz-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 wage changes (nondirectional mobility) over the entire sample was only 42 percent for the middle quintile, but 171 and 51 percent for the bottom and top quintiles.

References

- Auten, Gerald and Geoffrey Gee. Income Mobility in the United States: New Evidence from Income Tax Data. *National Tax Journal* 62 (June 2009): 301-328.
- Carroll, Robert, David Jouffiaian, and Mark Rider. Income Mobility: The Recent American Experience. Atlanta, GA: Georgia State University, 2007. Andrew Young School of Policy Studies Research Paper Series Working Paper 07-18.
- 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. Washington, D.C.: Brookings Institution, 2008. Working Paper.
- Fields, Gary S. The Many Facets of Economic Mobility. In Mark McGillivray, ed. *Inequality, Poverty, and Well-Being*. Basingstoke, United Kingdom: Palgrave Macmillan, 2006, pp. 1-7.
- 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. Washington, D.C.: Brookings Institution, 2008. Metropolitan Policy Program Working Paper.

- Jensen, Shane T. and Stephen H. Shore. Changes in the Distribution of Income Volatility. Philadelphia, PA: University of Pennsylvania, 2008. Working Paper.
- Kopczuk, Wojciech, Emmanuel Saez, and Jae Song. Earnings Inequality and Mobility in the United States: Evidence from Social Security Data since 1937. *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): 347-364.
- U.S. Congressional Budget Office. Recent Trends in the Variability of Individual Earnings and Family Income. Washington, D.C., 2008.