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Causes of Earnings Volatility and Risk Sharing*

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This paper investigates the causes of volatility of household heads' earnings, evaluates the extent to which variability of the heads' earnings is translated into changes in household consumption, and, in the process, identifies effective measures of smoothing idiosyncratic earnings variation. Analysis, based on the Panel Study of Income Dynamics (PSID) data, reveals that, although causes of the earnings volatility are multi-dimensional, job separations are closely related with substantial earnings changes. Evidence also shows that estimated volatility in the heads' earnings is almost entirely smoothed by a combination of various smoothing measures, with the labor supply of other family members being the most effective measure among them. Overall, the current findings suggest that the welfare loss may not be as great as what is suggested by the observed volatility of the heads' earnings.

JEL Classification: E3, J3
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I. Introduction

For the last two decades or so, there has been a small explosion of research about trends in earnings variability in the United States (e.g., Gottschalk and Moffitt (1994, 2002), Dynarski and Gruber (1997), Cameron and Tracy (1998), Haider (2001), Moffitt and Gottschalk (1995, 2006), Hacker (2006), Congressional Budget Office (2007), Dynan et al. (2008), Shin and Solon (2011)).[1] Despite the repeated

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[1] Most existing studies found consistently that earnings volatility increased during the 1970s. Regarding the trend in the 1980s and 1990s, while Gottschalk and Moffitt (1994), Moffitt and Gottschalk (2002, 2006), and Hacker (2006) used the PSID data to find that earnings instability generally increased during the period, Cameron and Tracy (1998) studied longitudinally matched Current Population Survey (CPS) data to report that earnings volatility did not show an upward trend.

report that earnings volatility is greater now than in the 1970s, little attention has been paid to the causes and consequences of such increase in earnings volatility. As exceptions, Stevens (2001) finds that job displacement substantially raises earnings instability for several years after job loss. Leonardi (2008) conducts a similar analysis, focusing on job-to-job voluntary changers. Dynarski and Gruber (1997), Blundell et al. (2008), and Gorbachev (forthcoming) analyze welfare consequences generated by earnings volatility.

The main purposes of this paper are two-fold: to investigate the causes of volatility in the household heads' earnings and to analyze how the heads' earnings volatility is transmitted to consumption volatility of the heads' households. Unlike a few existing studies that analyze causes of earnings changes based on parametric models, the current study tabulates the frequency of substantial earnings changes by their causes. Compared with a few existing studies that examine welfare losses generated by earnings changes, the current analysis considers a more comprehensive set of measures of smoothing consumption volatility, providing a quantitative explanation of effectiveness of each smoothing measure. These two research goals are closely connected and, therefore, need to be simultaneously pursued in one study: for example, given that job separations are the primary cause of heads' earnings volatility, the resulting earnings volatility could be effectively smoothed by joint labor supply of family members.

To be more specific, we use the Panel Study of Income Dynamics (PSID) data for the 1969-1971 through 2002-2004 period to explain how much of (trend movements in) the heads' earnings volatility is explained by wage volatility and how much by hours volatility. Using more detailed job-specific information collected in recent surveys, we also attempt to investigate more thoroughly the causes of substantial earnings changes experienced by household heads.

As emphasized by Cunha et al. (2005), Blundell et al. (2008), and Shin and Solon (2011) among others, the earnings volatility experienced by household heads need not be a source of welfare loss to their households. Families can rely on their own savings and borrowings, the labor supply of other family members, and other measures to smooth their heads' earnings volatility, and thereby their consumption. If earnings shocks are to translate into economic risk, additional information is needed on whether or not the affected individuals were insured against the shocks.

The latter finding was confirmed by the Congressional Budget Study (CBO) that used Social Security (SS) earnings data. Recognizing the inconsistency, Shin and Solon (2011) reinvestigated the issue using the PSID and found that men's earnings volatility trended upwards during the 1970s, but did not show a clear upward trend after that until climbing again after 1998. So, their findings are consistent with Cameron and Tracy's (1998) CPS based results, and also with the CBO's SS based result. Finally, regarding the trend in the 2000s, the CBO found that earnings volatility started to increase from the late 1990s, which is quite consistent with Shin and Solon's (2011) evidence based on the PSID and the National Longitudinal Survey of Youth (NLSY).

Whether substantial earnings changes are the results of individuals' choice is also to be considered in the discussion of welfare losses associated with earnings volatility. Using the approach developed by Asdrubali et al. (1996), this paper conducts a quantitative assessment of the extent to which heads' earnings volatility is transmitted into their household consumption, and, in the process, identifies effective measures of smoothing idiosyncratic earnings variation. We consider a comprehensive set of smoothing measures: We examine how volatility of heads' earnings is smoothed by the labor supply of other family members, investment in the capital market, government tax and transfer programs, and by saving, borrowing, and private transfers.

The major findings are as follows. Aside from hours, wage volatility also plays an important role in driving both the heads' earnings volatility and its trend movements, signifying the importance of job turnovers as a potential contributing factor to earnings volatility. Further analysis based on more detailed job-specific information collected in recent surveys concludes that, although the causes of the earnings volatility are multi-dimensional, substantial earnings changes are associated with job separations, and that both incentive payments and income from self-employment are mainly responsible for large earnings changes experienced by job stayers. Evidence shows that volatility in the heads' earnings is almost entirely smoothed by a combination of aforementioned smoothing measures, and that the labor supply of other family members is the most effective measure among them. It is also found that, among various smoothing measures, only the labor supply of other family members has been playing an increasingly important role in reducing volatility of the heads' earnings. Overall, the current findings suggest that the welfare loss may not be as great as what is suggested by the observed volatility of the heads' earnings. The current findings survive a variety of robustness tests, including endogeneity of earnings changes.

Our paper unfolds as follows. Section II introduces data and the estimation strategy, and Section III reports empirical results. Section IV concludes.

II. Data and Measurement Issues

1. Data

To address the current issues, we adopt the PSID, a longitudinal survey administered by the University of Michigan's Survey Research Center every year since 1968 through 1997 and every other year since then. As in most PSID-based studies, we use the data from the nationally representative Survey Research Center

component of the PSID sample.[2] All imputed earnings for missing values are excluded from the sample because measurement errors in earnings variables would distort measured earnings volatility. Since the wage and salary income variable is available only in interval form for the PSID's 1968 and 1969 interviews, our data set begins with the 1970 survey, which collected income information for the 1969 calendar year. Because the PSID was administered annually through 1997 and every other year since, our earnings data are for every year from 1969 through 1996 plus 1998, 2000, 2002, and 2004. Accordingly, our analyses of earnings changes pertain to two-year differences for 1969-1971, 1970-1972, 1971-1973, …, 1994-1996, 1996-1998, 1998-2000, 2000-2002, and 2002-2004. As in Shin and Solon (2011), the sample of earnings observations is restricted to calendar years when the male head of household is between the ages of 25 and 59. For a two-year change to be included in our analysis, the worker must be within that age range in both years. From 1969-1971 through 2002-2004, we examine how volatility of the heads' earnings and its trend movements are explained by their hours volatility and wage volatility.

Since the 2003 survey, the PSID has collected job-specific information up to five jobs respondents had between the two adjacent survey points, which includes, among others, beginning and ending points of each job, reasons for job separations, weekly hours, and whether respondents received other sources of labor income than basic wages and salaries. This information is used for a detailed investigation of causes of the heads' earnings changes.

For the purpose of conducting a quantitative assessment of the completeness and the sources of smoothing volatility of the heads' earnings, we use four different earnings variables along with household consumption: labor income of a family head, the total labor income of the head's family, the total family income including non-labor income, the total family income adjusted by government's taxes and transfers, and the family's total expenditure. Unfortunately, the PSID's total consumption variable and information on taxes and public transfers are available only since the 1999 and 1982 surveys, respectively. We adopt the longest sample period possible in analyzing trend movements of the contribution of each smoothing measure to the reduction of heads' earnings volatility. A more formal and regression-based analysis of sources of smoothing heads' earnings volatility will be based on a balanced sample for 1998-2000, 2000-2002, and 2002-2004, in which all the above five variables are available.

2. Methodology

In measuring earnings or consumption volatility, we follow Dynaski and Gruber

[2] See Shin and Solon (2011) for arguments of not using the Survey of Economic Opportunity component of the PSID sample.

(1997), Cameron and Tracy (1998), Congressional Budget Office (2007), Dynan, Elmendorf, and Sichel (2008), Kopczuk, Saez, and Song (2010), and Shin and Solon (2011) to avoid complicated parametric earnings dynamics models often adopted by Moffitt and Gottschalk (1995, 2002), Haider (2001), Baker and Solon (2003), and Gottschalk and Moffitt (2006),[3] and focus on standard deviation of earnings changes, which serves as a reasonable measure of earnings volatility under a wide range of data-generating processes. As discussed by Shin and Solon (2011), in contrast to the model-based studies that have attempted to isolate the transitory component of earnings inequality, an earnings volatility measure based on dispersion in year-to-year earnings change reflects permanent shocks in addition to transitory ones. This makes sense, as mentioned in Shin and Solon (2011), when the purpose of the research is not to disaggregate cross-sectional inequality into long-run and transitory components, but rather to measure volatility trends. They go on to explain that the recent interest in volatility trends stems in large part from a concern about whether earnings risk has increased. Because permanent shocks, such as those experienced by many displaced workers, are even more consequential and difficult to be insured than transitory ones, it makes good sense to include them in the measurement of earnings volatility. This simple dispersion measure is used to compare volatility across different variables and to display how volatility has changed over time. In computing standard deviation of relative earnings changes as a volatility measure, we use residuals obtained in the preliminary regression of relative earnings changes against age and age squared, which aims at controlling for earnings changes generated by life-cycle effects.

One of our main study purposes is to explain what fractions of idiosyncratic shocks to heads' earnings are smoothed by various measures of within- and between-family risk sharing. The method developed by Asdrubali et al. (1996) is applied in quantifying the contribution of each smoothing measure to the reduction of volatility of heads' earnings.[4] Let us start with the following identity. For notational simplicity, we suppress the time index and the individual index.

$$Y_{HL} = \frac{Y_{HL}}{Y_{FL}} \frac{Y_{FL}}{Y_{FT}} \frac{Y_{FT}}{Y_{FG}} \frac{Y_{FG}}{Y_{FC}} Y_{FC} \tag{1}$$

, where Y_{HL} represents earnings of family heads, Y_{FL} the total labor income at the family level, Y_{FT} the total family income, Y_{FG} the total family income adjusted by government's taxes and transfers, and Y_{FC} represents the total family consumption. Let $y = \ln(Y)$, and let Δ represent change of a variable between two adjacent years. A simple manipulation of the identity yields,

[3] See Shin and Solon (2011) for the discussion of limitations of such parametric models.

[4] A similar method is applied by Park and Shin (2010) to the Korean labor market.

$$1 = \beta_{within-family} + \beta_{capital} + \beta_{govt} + \beta_{save/borrow} + \beta_{unsmoothed} \quad (2)$$

, where the five β coefficients are obtained by applying Ordinary Least Squares (OLS) to the following five models, respectively.

$$\Delta y_{HL,i} - \Delta y_{FL,i} = \alpha_{within-family} + \beta_{within-family}\Delta y_{HL,i} + \varepsilon_{within-family,i} \quad (3)$$

$$\Delta y_{FL,i} - \Delta y_{FT,i} = \alpha_{capital} + \beta_{capital}\Delta y_{HL,i} + \varepsilon_{capital,i} \quad (4)$$

$$\Delta y_{FT,i} - \Delta y_{FG,i} = \alpha_{govt} + \beta_{govt}\Delta y_{HL,i} + \varepsilon_{govt,i} \quad (5)$$

$$\Delta y_{FG,i} - \Delta y_{FC,i} = \alpha_{save-borrow} + \beta_{save-borrow}\Delta y_{HL,i} + \varepsilon_{save-borrow,i} \quad (6)$$

$$\Delta y_{FC,i} = \alpha_{unsmoothed} + \beta_{unsmoothed}\Delta y_{HL,i} + \varepsilon_{unsmoothed,i} \quad (7)$$

In this setup, β_j ($j = within-family$, $capital$, $govt$, and $save/borrow$) is interpreted as the incremental percentage amount of volatility of the heads' earnings that is reduced as an additional smoothing measure is newly adopted at level *j*, and β_u as the amount not smoothed after all measures are taken. As explained in Asdrubali et al. (1996), if $\beta_u = 0$, there is full risk sharing, and $1 = \beta_{within-family} + \beta_{capital} + \beta_{govt} + \beta_{save/borrow}$. In addition, a negative value of β_j implies that dis-smoothing occurs at level j. In a steady state, β_j can be estimated by running the panel regressions to equations (3) through (7) that allow time fixed effects.

Among the four smoothing measures considered in the current study, all the other measures than government taxes-transfers intend to smooth shocks through transactions on markets. The first measure is taken in the labor market, the second in the capital market, and the last measure is taken in the credit market. While capital market smoothing is arranged before the arrival of shocks, credit market smoothing takes place ex post. While the first three measures are intended to smooth both permanent and transitory shocks, saving and borrowing smooth only transitory shocks.

It is recognized that the contribution of each smoothing measure to the reduction of heads' earnings volatility cannot be determined by simply comparing two estimated volatilities. To see this, let us express each β coefficient as a function of volatilities of two neighboring variables.

$$\beta_{within-family} = 1 - \frac{Cov(\Delta y_{HL}, \Delta y_{FL})}{Var(\Delta y_{HL})} = 1 - \rho_{\Delta y_{HL}, \Delta y_{FL}} \frac{\sigma_{\Delta y_{FL}}}{\sigma_{\Delta y_{HL}}}$$

$$\beta_j = \rho_{\Delta y_{HL},\Delta y_{j-1}} \frac{\sigma_{\Delta y_{j-1}}}{\sigma_{\Delta y_{HL}}} - \rho_{\Delta y_{HL},\Delta y_j} \frac{\sigma_{\Delta y_j}}{\sigma_{\Delta y_{HL}}} \quad \text{for} \quad j = capital,$$

$govt$, and $save / borrow$.

Therefore, when volatility of Y_{FL} is smaller than that of Y_{HL}, that is, $\sigma_{\Delta y_{FL}} < \sigma_{\Delta y_{HL}}$, $\beta_{within-family}$ is always positive. If $\sigma_{\Delta y_{FL}} > \sigma_{\Delta y_{HL}}$, however, $\beta_{within-family}$ could be either positive or negative. Generally, the sign β_j depends not only on volatility of each smoothing measure ($\sigma_{\Delta y_{j-1}}$ and $\sigma_{\Delta y_j}$) but also on how changes of each measure are correlated with heads' earnings changes. Other things being held constant, a weak correlation of changes of a smoothing measure with heads' earnings changes indicates a greater contribution of that measure to smoothing heads' earnings volatility.

Existing studies often suggest that earnings variables are subject to measurement errors (for example, see Asdrubali et al., 1996; Dynarski and Gruber, 1997; Blundell et al., 2008). Consequently, both dependent and explanatory variables in equation (3) through (7) are subject to measurement errors. It is well recognized that measurement errors in the dependent variable merely lead to greater standard errors, as long as they are randomly mis-measured.[5] Measurement errors in the independent variable, however, attenuate the estimated slope coefficients, and this problem can be more serious when data are specified in first-differences.

To understand how measurement errors in the explanatory variable affect the identification of our regression parameters, let us understand that

$$\beta_{within-family} = 1 - \delta_{FL}, \quad \beta_{capital} = \delta_{FL} - \delta_{FT}, \quad \beta_{govt} = \delta_{FT} - \delta_{FG},$$
$$\beta_{save/borrow} = \delta_{FG} - \delta_{FC} \quad \beta_{unsmoothed} = \delta_{FC}$$

, where δ_j is the slope coefficient of the following regression equation.

$$\Delta y_{j,i} = \mu_j + \delta_j \Delta y_{HL,i} + \omega_{j,i}, \text{ for } \quad j = FL, \quad FT, \quad FG, \text{ and } \quad FC \tag{8}$$

Because, upon the heads' earnings variable being error-ridden, the probability limit of an OLS estimator of δ_j is equal to $\sigma^2_{\Delta y_{HL}} / (\sigma^2_{\Delta y_{HL}} + \sigma^2_{\Delta v}) \cdot \delta_j$ for all j,[6] where $\sigma^2_{\Delta y_{HL}}$ and $\sigma^2_{\Delta v}$ are variances of true changes and error changes, respectively, only $\beta_{within-family}$ is overstated, and all the other β coefficients are understated by OLS, including time-fixed effects estimators.[7]

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[5] Kim and Solon (2005) show that, in some situations, mean-reverting measurement errors in the dependent variable can lead to attenuation bias in the estimated slope coefficient.

[6] Here, we consider classical measurement errors for the purpose of illustration.

[7] Allowing non-classical measurement errors in the independent variable may lead to different

Two different approaches are adopted to mitigate the measurement error problems. First, following Asdrubali et al. (1996), variables are differenced over longer horizons. Long-difference tends to make true variation greater relative to error variation, due to greater change in the permanent income component. It also tends to make serial correlation of errors, if any, weaker. The second approach is to use instrumental variables that are correlated with true earnings changes and uncorrelated with measurement errors. Similar to Dynarski and Gruber (1997), we create a dummy variable which equals one for job changers between the two income years. This dummy variable represents unemployment shocks to a household head, as job changes are often associated with unemployment, voluntary or involuntary. The dummy variable is believed to meet the following three conditions for valid instrument: it is exogenous to the head's consumption decisions, it indicates a significant change in the earnings prospects of the head, and any measurement error associated with the dummy variable for job changing status is plausibly independent of errors in the heads' earnings.

As noted by Dynarski and Gruber (1997, p. 248), this measure of unemployment shocks also deals with two additional econometric problems, namely, endogeneity through planned coincident changes in consumption and labor supply, and nonlinearity in consumption smoothing. Recognizing that endogeneity may cause a serious inconsistency problem in the estimated coefficient, we take an additional approach, suggested by Dynarski and Gruber, of restricting the sample to prime-age (30-55) male heads: Because full-time work is a norm for these heads, restricting the sample to this group makes changes in labor supply largely exogenous.

III. Empirical Results

1. Causes of Trend Movements in Heads' Earnings Volatility

Figure 1 displays estimated earnings, hours, and wage volatility of household heads from 1969-1971 through 2002-2004. In computing standard deviation of relative earnings or hours changes as a volatility measure, we use residuals obtained in the preliminary regression of relative earnings or hours changes against age and age squared, which aims at controlling for earnings or hours changes generated by life-cycle effects. The time axis in the figure labels observations by the recent year in the two year difference; e.g., the observation for 1969-1971 is labeled as 1971. The line connecting the rectangular data points displays the volatility of heads' earnings, the line connecting the triangular data points represents the volatility of the heads' annual hours, and the line connecting the circular data points denotes volatility of

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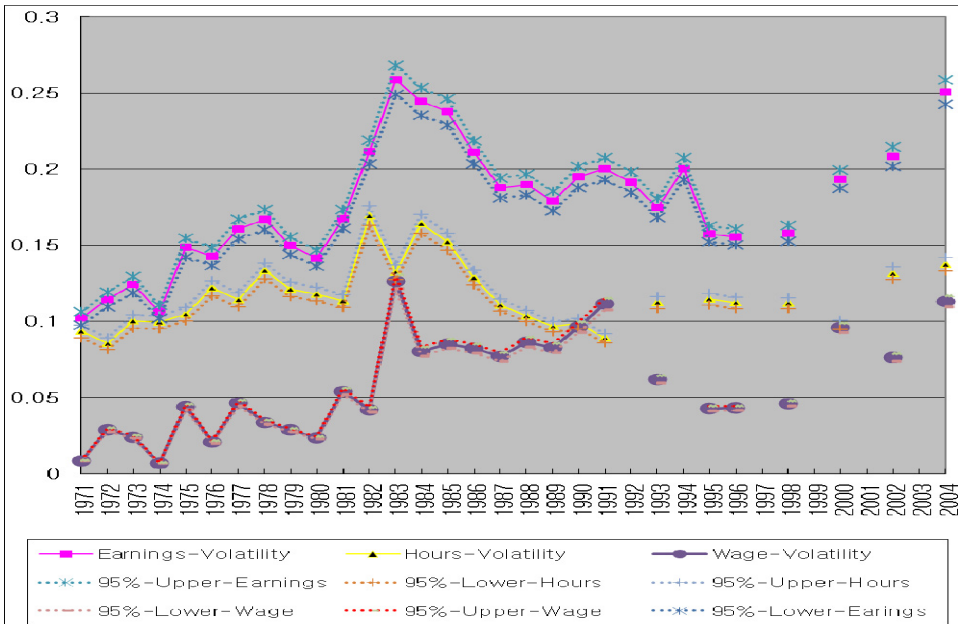
predictions.

the wage rate. Each pair of dotted lines represents lower and upper bounds of a 95% confidence interval for the corresponding volatility.

[Figure 1] Earnings Volatility, Hours Volatility, and Wage Volatility



Data: Panel Study of Income Dynamics, 1969-1971 to 2002-2004. The earnings variable stands for heads' wages and salaries. The volatility of a variable (y) is computed as a standard deviation of residuals obtained from the preliminary regression of $\ln y_{it} - \ln y_{i,t-2}$ on age and age squared. The time axis labels observations by the recent year in the year-to-year difference; e.g., the observation for 1969-1971 is labeled as 1971. The 95% confidence band of each series is based on the asymptotic distribution of the sample mean squared residual under the classical regression assumptions (Schmidt, 1976).

A few results emerge immediately.[8] First, a greater portion of earnings volatility is explained by hours volatility rather than wage volatility. Readers can easily verify this by observing that, for almost all the years, estimated hours volatility is greater than estimated wage volatility.[9] Second, the contribution of estimated wage volatility to estimated earnings volatility became greater since the early 1980s: the

[8] As reported in Shin and Solon (2011), men's earnings volatility increased during the 1970s, but did not show a clear trend afterwards until a new upward trend appeared in the last few years. As for cyclical movements, earnings volatility is strongly countercyclical, as already noted by Haider (2001), Cameron and Tracy (1998), Baker and Solon (2003), Gottschalk and Moffitt (2006), and Shin and Solon (2011).

[9] As in Haider (2001), estimated covariance is close to zero in all years. This is also easily verified by examining that, in all years, the sum of estimated hours and wage volatilities are approximately equal to estimated earnings volatility.

estimated gap between hours and wage volatilities is much smaller since the early 1980s, compared with the 1970s. Third, more importantly, the trend movements of earnings volatility are better explained those of wage volatility than hours volatility. This seems at odd with Haider's (2001) finding that the rise in earnings volatility in the United States during the 1970s is mostly explained by the rise in hours volatility. Unlike the current study, however, the volatility measure in Haider (2001) as well as Moffitt and Gottschalk (1994, 2002, 2006) considers only transitory components of earnings.

That wage volatility plays an important role in driving large earnings volatility signifies the importance of job turnovers as a potential contributing factor to earnings volatility. This is so because job changes are typically associated with changes in the wage rate. It should be also reminded that the volatility measure adopted in the current paper reflects permanent shocks in addition to transitory shocks. As previously mentioned, the inclusion of permanent shocks (such as those experienced by displaced workers[10]) in the volatility measure is important when the research purpose is to measure volatility trends or to evaluate welfare implications of earnings changes.

2. Detailed Investigation of the Causes of Heads' Earnings Volatility in Recent Years

In this subsection, we focus on recent years for more detailed investigation of the causes of earnings volatility. Since the 2001 survey, the PSID has reported detailed job specific information for up to five jobs held by respondents between two adjacent survey years, which includes starting and ending points of each job, reasons for job changes, employment types, and weekly hours, among others. For 2000-2002 and 2002-2004, we identify those who experience substantial changes in labor income and investigate the causes of those changes. The total labor income variable includes all sources of labor income such as wages and salaries, overtime pay, bonus, tip, commission, income from extra jobs, other job related income, and labor part of business income. We use relative earnings to define substantial earnings changes: earnings winners (losers) are defined by those whose earnings increase (decrease) by at least 15 percentiles between two adjacent income years.

Table 1 examines how substantial earnings changes are associated with job turnovers. Included in the group of voluntary changers are those who quit jobs for higher pay, pregnancy, change, or retirement. Involuntary changers are defined by those who lose their jobs due to layoff, company shutdown, death of employers, completion of contracts, or end of seasonal or temporary jobs. The other/mixed/missing category includes those who quit their jobs to join the armed

[10] See Jacobson et al. (1993) and Stevens (1997, 2001) among others.

forces, those who experience both voluntary and involuntary separations between two adjacent years, or those whose reasons for job separations are not available for all job separations. Figures in Table 1 show that, for 2000-2002 and 2002-2004, 538 and 569 respondents are defined as earnings losers and winners, respectively. Among 538 losers, 64% are classified as job changers. A comparable figure for winners is 45%, implying that being a loser is associated with a greater chance of job separation, voluntary or involuntary. Put differently, job stayers are more likely to be earnings winners than losers. Overall, job turnovers are important in explaining substantial earnings changes. This finding is in line with what is observed in Figure 1: the wage rate is substantially volatile especially since the early 1980s. It is also interesting note that the proportion of voluntary changers is almost twice as great as that of involuntary changers, which is true even for earnings losers. It deserves further investigation that so many people leave jobs voluntarily to be substantial earnings losers.[11]

[Table 1] Substantial Earnings Changes and Job Changes

		Losers	Winners
Job changers	Voluntary	126(23.4%)	120(21.1%)
	Involuntary	61(11.3%)	46(8.1%)
	Other /mixed/missing	158(29.4%)	90(15.8%)
Job stayers		193(35.9%)	313(55.0%)
Total		538(100%)	569(100%)

Data: Panel Study of Income Dynamics, 2000-2002 and 2002-2004. Winners (losers) are defined by those whose earnings increase (decrease) by at least 15 percentiles between year t and $t-2$. Included in the group of voluntary changers are those who quit jobs for higher pay, pregnancy, change, or for retirement. Involuntary changers are defined by those who lose their jobs due to layoff, company shutdown, death of employers, or completion of contracts, or seasonal or temporary jobs. The other/mixed/missing category includes those who quit their jobs to join armed forces, those who experience both voluntary and involuntary separations between two adjacent years, or those whose reasons for job separations are not available for all job separations.

A more puzzling finding is that job stayers experience substantial earnings changes. As previously stated, 36% of losers and 55% of winners are job stayers. In addition, as demonstrated in Table 2, stayers experience as much earnings changes as changers, winners or losers. For example, among losers for 2000-2002, average earnings percentile went down by 38.8, 37.5, and 36.2 for stayers, voluntary changers, and involuntary changers, respectively. Among winners for the same

[11] Although detailed investigation is delayed due to data limitations, our initial survey reveals that hours change is much greater for job changers than stayers; among job changers, hours reduction for losers is much greater than hours increase for winners; and that retirement is responsible at least in part for substantial earnings reduction of voluntary movers.

period, a similar increase in the earnings percentile is observed between stayers and changers, voluntary or involuntary. This observation seems at odds with the finding of Guiso et al. (2005) that job stayers are mostly insured from transitory wage shocks supplied by their firms. These findings are preserved even for 2002-2004.

[Table 2] Comparison of Earnings Changes between Job Changers and Stayers

Year	Winners/Losers	Changer/Stayer	No. of Obs	Mean Earnings Change
2000-2002	losers	voluntary	66	-37.5(20.5)
		involuntary	27	-36.3(17.4)
		stay	98	-38.9(18.0)
		others	86	-44.2(23.6)
	winners	voluntary	61	30.9(16.3)
		involuntary	28	32.9(19.3)
		stay	164	31.6(18.4)
		others	35	32.3(18.5)
2002-2004	losers	voluntary	58	-31.3(15.8)
		involuntary	34	-34.0(15.4)
		stay	95	-34.1(17.6)
		others	72	-39.1(22.5)
	winners	voluntary	59	35.6(18.1)
		involuntary	18	38.0(19.5)
		stay	149	35.3(19.9)
		others	55	32.9(16.0)

Data: Panel Study of Income Dynamics. Winners (losers) are defined by those whose earnings increase (decrease) by at least 15 percentiles between year t and $t-2$. Included in the group of voluntary changers are those who quit jobs for higher pay, pregnancy, change, or for retirement. Involuntary changers are defined by those who lose their jobs due to layoff, company shutdown, death of employers, or completion of contracts, or seasonal or temporary jobs. The other/mixed/missing category includes those who quit their jobs to join armed forces, those who experience both voluntary and involuntary separations between two adjacent years, or those whose reasons for job separations are not available for all job separations.

Why are earnings of job stayers so volatile? Earnings are expressed as a product of hours and the wage rate; thus, one might expect that large earnings changes of job stayers might be explained by the large hours changes. This is so because little change in the wage rate is expected for job stayers. This conjecture, however, is inconsistent with existing evidence. First, as shown in Table 2, both changers and stayers experience a similar degree of earnings changes. To explain the large earnings changes of stayers by their hours changes, therefore, hours changes need to be greater for stayers than changers, which is in direct contradiction to what is observed in our data (see footnote 11).

[Table 3] Causes of Earnings Changes for Job Stayers

Year	Winners /Losers	Average Percentile Change (No. of Observations)			
		total	minus extra job holders	minus self-employed	Minus 'incentives'
2000-2002	Losers	-40.0(90)	-40.9(83)	-43.5(53)	-28.8(19)
	Winners	31.7(149)	30.4(134)	25.3(82)	23.9(51)
2002-2004	Losers	-34.1(89)	-32.8(78)	-31.7(54)	-31.0(31)
	Winners	35.3(136)	36.1(127)	33.5(86)	22.9(34)

Data: Panel Study of Income Dynamics. Winners (losers) are defined by those whose earnings increase (decrease) by at least 15 percentiles between year t and $t-2$. Included in the category of incentive payments are all other sources of labor income than basic wages or salaries, such as overtime payments, bonuses, commissions, and other sources of labor income.

Table 3 explores the other sources of earnings changes experienced by job stayers. Figures in Table 3 represent average percentile changes and those in parentheses are corresponding sample sizes. For example, for 2000-2002, the average earnings percentile decreases by 40 points for the entire 90 losers. Excluding from the sample of losers those who have more than one job reduces the sample size slightly to 83, but does not alter the estimated percentile change. Excluding self-employed persons dramatically reduces the sample size to 53. And, excluding those who receive incentive payments reduces not only the sample size but also the absolute value of the average percentile change. Although estimated percentile changes and corresponding sample sizes are somewhat different between 2000-2002 and 2002-2004, it is quite robust across samples that self-employment and incentive payments contribute to large earnings changes of job stayers.[12] That incentive payments are at least in part responsible for the large earnings volatility is consistent with Celik et al. (2009). Together with the finding that self-employment also explains some portion of the earnings volatility experienced by job stayers, the current findings suggest that the welfare loss may not be as great as what is suggested by observed earnings volatility. This is so because earnings changes from self-employment or changes in incentive payments are more or less anticipated and can be regarded as the results of individuals' choice.

It is still unclear why certain job stayers experience large earnings changes when they receive only basic wages and salaries with stable work hours. We believe that two factors among others are responsible for this puzzle. First, measurement errors associated with reported earnings tend to make arbitrary earnings changes. Second, as noted by Devereux (2001) among others, due to the structure of the PSID

[12] In the current study, included in category of 'incentive payments' are all other sources of labor income than basic wages and salaries, such as overtime payments, bonuses, commissions, and other sources of labor income.

questionnaires, the wage and salary variable already include at least some of the other sources of volatile income components such as overtime, bonuses, or commissions.

3. Welfare Implications of Heads' Earnings Volatility

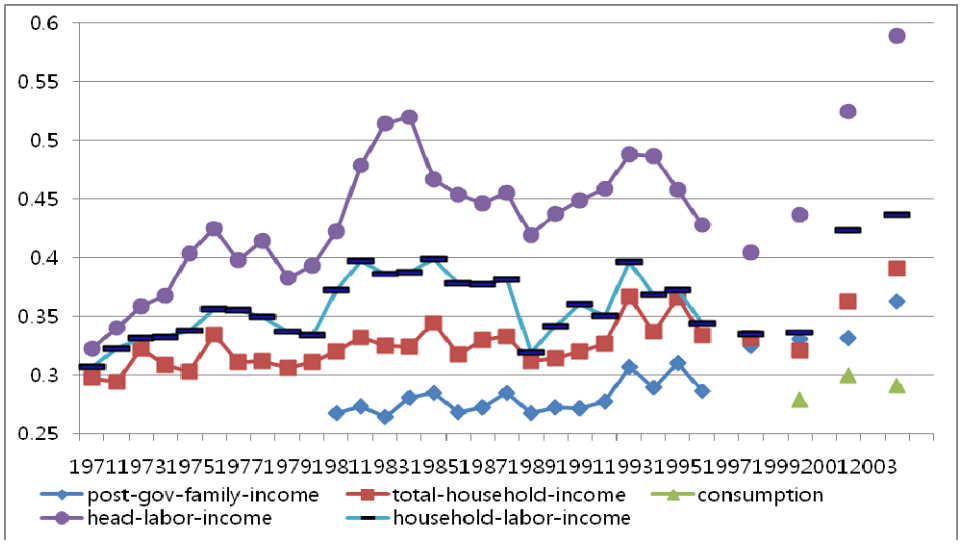
Now we turn to our issue of within- and between-family risk sharing. We first estimate equation (3) through (8) by OLS separately for each year, allowing beta coefficients change over time. They are reported in Figure 1. The line connecting the circular data points displays volatility of heads' earnings,[13] the line connecting the dashed data points volatility of the total labor income pooled across all family members, the rectangular data points volatility of the total family income, the diamond data points volatility of the total family income adjusted by taxes and public transfers, and the line connecting the triangular data points denotes volatility of the household consumption. Estimates in Figure 2 suggest the following. Overall, estimated volatilities become smaller as more smoothing measures are introduced. Focusing on the 1998-2000 through 2002-2004 period, estimated volatilities are systematically reduced as labor earnings are pooled within families, non-labor income is added, taxes and public transfers are adjusted, and saving, borrowing, and private transfers are allowed. Family consumption, however, still remains volatile. The average volatility of the consumption variable is 0.290, which is statistically significant even at the one percent level, which is inconsistent with the full consumption insurance hypothesis (Mace, 1991; Cochrane, 1991; Hayashi et al., 1996).

As discussed in Section II, the contribution of each smoothing measure to the reduction of the heads' earnings volatility cannot be determined by simply comparing two neighboring estimated volatilities. To evaluate whether and how families are able to smooth idiosyncratic shocks to the heads' earnings, we apply OLS to equation (3) through (7) and report estimated slope coefficients in Figure 3. Several important findings are obtained from the estimates in Figure 3. First, as evident in the series of 'unsmoothed' volatility, volatility in the heads' earnings is almost entirely smoothed by a combination of smoothing measures: pooling of earnings incomes within families, investment in the capital market, the role of

[13] Estimated volatilities of the heads' earnings are slightly different between Figure 1 and Figure 2. First, unlike in Figure 1, the heads' earnings are very broadly defined in Figure 2 to include not only the heads' wages and salaries but also all other sources of labor income such as overtime payments, bonuses, commissions, labor part of business income. On the contrary, only wages and salaries are considered in Figure 1. Second, in Figure 2, we exclude from the sample those household heads who experience changes in the family size between the two adjacent income years. Holding the family size constant helps us to avoid many complicated issues that arise from choice of marriage and divorce, among others, as well as consumption changes generated by changes in the family composition.

government, and private saving, borrowing and transfers. Over the 1998-2000 through 2002-2004 period, the unsmoothed portions of heads' earnings volatility are averaged at 4.4 percent. This finding is qualitatively consistent with the result of Dynarski and Gruber (1997) based on the PSID data.

[Figure 2] Volatility of Various Income and Consumption Variables

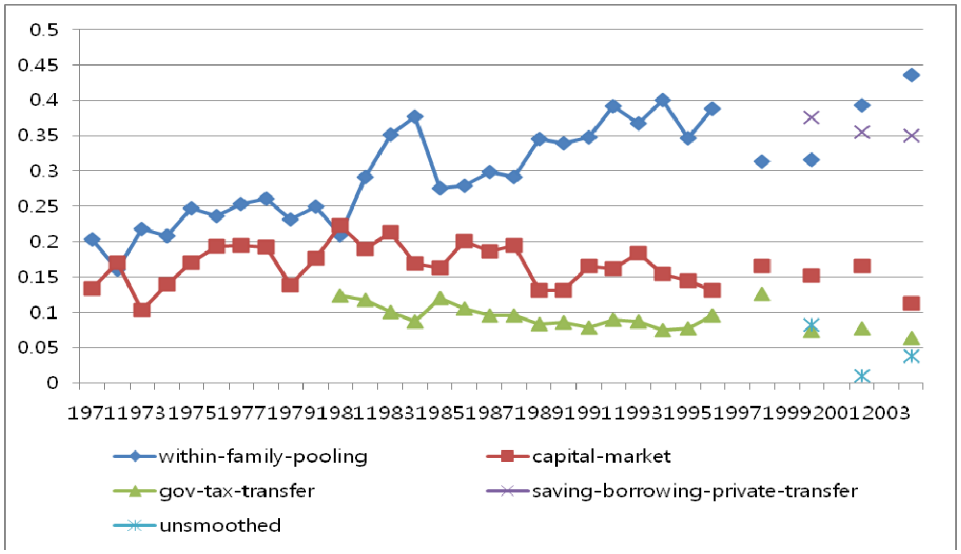


Included in the heads' labor income are not only basic wages and salaries but also all other sources of labor income such as overtime payments, bonuses, commissions, tips, labor part of business income among others. See the text for definitions of other variables. We exclude from the sample those household heads who experience changes in the family size between the two adjacent income years.

Second, focusing on the recent period, two effective measures of smoothing heads' earnings volatility are the labor supply of other family members and saving, borrowing and private transfers. The average contributions of these two measures are 38 percent and 36 percent, respectively. The next most effective measure is investment in the capital market: about 14 percent of the heads' earnings volatility is smoothed by this measure. On the contrary, only 7 percent is reduced by taxes and public transfers. This finding is in stark contrast with Dynarski and Gruber (1997): the latter study finds that roughly half of the earnings volatility experienced by family heads is smoothed by government taxes and transfers.

Third, among the three smoothing measures whose data are available over a relatively long period, only the labor supply of other family members (i.e., within-family income pooling) has been playing an increasingly important role in reducing volatility of the heads' earnings. On the contrary, both the capital market and government have been down-playing their roles at least since the early 1980s.

[Figure 3] Contribution of Each Smoothing Measure to Reduction of Heads' Earnings Volatility

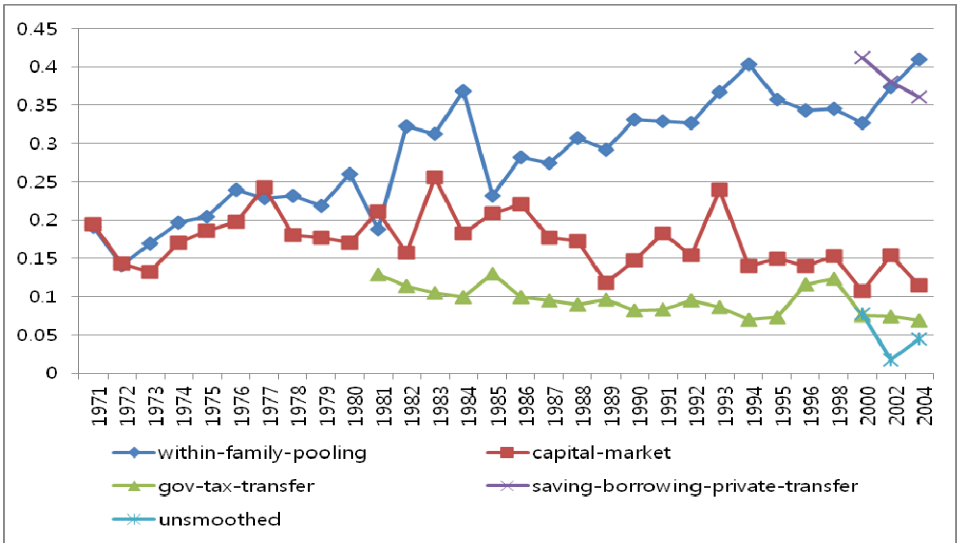


See the text for the definition of each smoothing measure.

To consider endogeneity through planned coincident changes in consumption and labor supply, we take an additional approach suggested by Dynarski and Gruber: because full-time work is a norm for prime-age (30-55) male heads, by restricting the sample to these heads, we can make changes in labor supply largely exogenous. All the above observations, however, are still preserved even with this new exercise, as is evident in Figure 4.

Table 4 conducts various sensitivity analyses regarding the relative contribution of each smoothing measure. To supply a more formal and quantitative discussion, we focus on the recent period where a balanced sample is available across all variables. Data are pooled across all years, and a time fixed effects model is estimated with the restriction of steady-state beta coefficient. Estimates in the first two columns are obtained by applying OLS to equations (3) through (7): the first column uses residualized changes, whereas the second column uses actual changes. Comparison of estimates in the two columns shows that, despite the nature of a long sample period, results are not sensitive to using residualized changes rather than using actual changes, implying that changing age distribution is not an issue in the current study. Results show that, over the 1998-2000 through 2002-2004 period, about 39 and 36 percents of estimated volatility of the heads' earnings are smoothed by within-family pooling and saving/borrowing, respectively. In contrasts, the capital market and the government play about 14 and 7 percents, respectively, in reducing the heads' earnings volatility. And, only 4 percent of the heads' earnings volatility remains unsmoothed.

[Figure 4] Contribution of Each Smoothing Measure to Reduction of Heads' Earnings Volatility: Sample of Prime Age (30-55) Male Heads



See the text for the definition of each smoothing measure.

The third and the fourth columns of Table 4 deal with the measurement error issue previous addressed. When data are differenced over four years instead of two (column 3), the results remain very similar to our previous ones in the first two columns. Results appear somewhat different when the dummy variable for job changing status is used as an instrumental variable for heads' earnings changes (column 4). Above all, the contribution of saving/borrowing as a smoothing measure is reduced to some degree, and due to the large standard error estimates associated with instrumental variable estimation, the estimated contribution is statistically insignificant. Instead, the capital market appears to play a greater role in reducing heads' earnings variation, and the unsmoothed proportion increases up to about 15 percent. Despite these changes, the estimated contribution of within-family earnings pooling remains very similar as 37 percent. Finally, the last column treats endogeneity of labor supply and consumption by focusing on the sample of prime age male heads. Our previous results are generally preserved even with this practice.

That labor supply of other family members plays the greatest role in reducing volatility of the heads' earnings is particularly interesting when we consider that job separation is one of major driving forces of substantial earnings changes of household heads.

[Table 4] Correcting for Measurement Errors and Endogeneity of Earnings Changes

Measures of smoothing	Original		Measurement errors		Endogeneity
	Residual changes	Actual changes	4 year change	Instrumental variables	prime-age (30-55)
Within-family pooling	0.394 (0.008)	0.391 (0.008)	0.399 (0.013)	0.369 (0.063)	0.381 (0.009)
Capital market	0.141 (0.008)	0.142 (0.008)	0.146 (0.011)	0.253 (0.058)	0.130 (0.009)
Government	0.071 (0.007)	0.072 (0.006)	0.075 (0.009)	0.079 (0.038)	0.072 (0.007)
Saving/borrowing	0.358 (0.015)	0.354 (0.015)	0.322 (0.022)	0.155 (0.112)	0.378 (0.016)
Unsmoothed	0.036 (0.011)	0.042 (0.011)	0.059 (0.017)	0.146 (0.086)	0.039 (0.013)
Sum	1	1	1	1	1

Data: Panel Study of Income Dynamics, 1998-2000, 2000-02, and 2002-04. Figures in the table represent estimated β_j in equation (3) through (7), and are interpreted as the incremental percentage amount of volatility of heads' earnings reduced as an additional smoothing measure is newly adopted at level j. $\beta_{unsmoothed}$ represents the amount not smoothed after all measures are taken. Numbers in parentheses are estimated standard errors. The instrumental variable is a dummy variable which equals one if a head experiences a job change between the two adjacent income years.

IV. Conclusion

Analysis based on the Panel Study of Income Dynamics (PSID) data reveals that, although causes of the heads' earnings volatility are multi-dimensional, job separations are closely related with substantial earnings changes, and that labor supply of other family members is the most effective measure of smoothing volatility of the heads' earnings. Evidence also shows that volatility in the heads' earnings is almost entirely smoothed by a combination of smoothing measures: pooling of labor incomes within families, private saving, borrowing and transfers, investment in the capital market, and taxes and public transfers. Therefore, families are able to smooth their consumption in the face of their heads' earnings variability. The current findings survive a variety of robustness tests, including endogeneity of earnings' changes.

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