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Abstract

Has greater turbulence among firms fueled rising wage instability in the U.S.? Gottschalk and Moffitt [1994] find that rising earnings instability was responsible for one third to one half of the rise in wage inequality during the 1980s. These growing transitory fluctuations remain largely unexplained. To help fill this gap, this paper further documents the recent rise in transitory fluctuations in compensation and investigates its linkage to the concurrent rise in volatility of firm performance documented by Comin and Mulani [2006].

We find strong support for the hypothesis that rising high-frequency turbulence in the sales of large publicly-traded U.S. firms over the past three decades has raised their workers' high-frequency wage volatility. The evidence comes from two data sets: the Panel Study of Income Dynamics (detailed longitudinal information on workers), and COMPUSTAT (detailed firm information, plus average wage and employment levels). Through controls and instrumental variable probes, we rule out straightforward compositional churning as an explanation for the link between firm sales and wage volatility. We also observe that the relationship between sales and wage volatility at the frm level is stronger since 1980, is present only in large companies and is stronger in services than in manufacturing companies.

Keywords: Transitory wage volatility, firm volatility, PSID, turbulence, COMPUSTAT.

JEL: J3, J5.

1. Introduction

Has more creative destruction among firms raised wage volatility in the U.S.? Gottschalk and Moffitt [1994, 2002] called attention to the recent rise in the variation of transitory earnings for U.S. workers when they estimated that this enhanced volatility accounts for one third to one half of the rise in wage inequality during the 1980s.[1] What is the source of this new instability in pay? Despite its importance, little is known about its correlates or origins.[2]

Most of the related research on the remarkable and well-documented widening of wage inequality in the U.S. over the past three decades focuses on permanent components of workers' earnings, particularly the rising returns to education and ability associated with technological change, trade, and de-unionization.[3] However, this emphasis ignores the less-studied contribution of larger transitory fluctuations. This study helps to fill that gap.

We conjecture that the recently documented increase in firms' turbulence has led to more volatile earnings for their employees. Recent work by Comin and Mulani [2005], Comin and Philippon [2005] and Davis et al. [2006] finds that the volatility of the performance of publicly traded firms, whether measured by the profit-to-sales ratio or the growth rate of sales, employment, or sales per worker, has experienced a prominent upward trend since at least 1970. They find that the loss of stability at the firm level is due to heightened creative destruction, stemming from factors including the decline of regulation, improved capital markets, and more research and development. Hence, the increase in creative destruction may drive the rise in wage volatility.

Beyond the coincidence of timing, a link between higher firm volatility and the rising variance of wages is likely on both empirical and theoretical grounds. Empirically, wage differences among employers for observationally equivalent workers form a substantial part of wage variation (Groshen [1991a, b], Currie [1992] and Abowd et al. [2001]), providing a margin on which this effect could operate.

[1] Later studies such as Cameron and Tracy [1998] support this finding. Recent work by Autor, Katz and Kearney [2005] also underlines the importance of non-compositional, within-group wage differences in the 1980s and 1990s rise in wage inequality.

[2] Violante [2001] posits that returns to skill within firms have become more volatile as the pace of technological change has increased.

With regard to theory, there are a wide range of models with relatively rich wage-setting mechanisms that predict a link between compensation of incumbent workers and firm performance—in sharp contrast to the perfectly competitive result that workers' wages are determined by aggregate, not-firm-specific, conditions. Examples of such richer theories include the wages that result from bargaining processes between unions and management, or models with endogenous turnover (e.g. Salop and Salop, 1976).

In these environments, wage premia linked to firm performance will become more variable as firm performance becomes more volatile. In the canonical example of Nash bargaining, workers will appropriate part of the firm's profits in good times delivering an average wage which is positively correlated to the firm's performance. In models with endogenous turnover, firms provide rents to reduce turnover. As a result, a firm will pay higher wages in periods with a greater marginal hiring cost. In the presence of convex firm hiring costs, the wage rate will be positively correlated to the firm's desire to hire workers which is presumably higher when the firm is performing better. A similar prediction holds in models where the firm is a monopsonist in the labor market. In these environments, the wage rate offered to the workers is increasing in the marginal hiring cost which is higher in good times.

Using the COMPUSTAT data set, which covers the universe of publicly-traded companies, we explore whether workers' average pay is more volatile in firms that have experienced higher turbulence in sales. We find that this is the case, even when we control for firm characteristics, including average wage, average profits, size, age, or firm-specific fixed effects.

However, this evidence of a correlation between firm and wage volatility could reflect reorganization rather than pay changes. That is, if a firm that experienced severe revenue swings replaced (or laid off) a large part of its workforce, average pay could be strongly affected even if its continuing workers' wages were unchanged. To test for this possibility, we perform a number of tests including controlling for employment growth, growth in the average wage (to control both for reorganization that affects the number

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[3] The variance of the permanent component of earnings across workers has increased due to a higher return to education, to a higher return to ability, to globalization, and to institutional changes such as de-unionization. See summaries in Levy and Murnane [1992] and, more recently, Autor, Katz and Kearney [2005].

[5] We have also checked the robustness of our results to using the profit to sales ratio as a measure of the firm performance.

and/or the skill/type of workers), and instrumenting firm volatility by lagged firm volatility and by lagged R&D intensity. All these tests suggest that the linkage between firm and wage volatility is unlikely to reflect the direct effects of reorganization. Hence, we conclude that increased firm turbulence has raised the volatility of wages for U.S. workers.

Note that this paper assumes that the direction of causation flows from firm volatility to earnings volatility, rather than the reverse. We maintain this assumption because the demand for labor is derived from firms' product-market demand, rather than the opposite. Labor supply is typically determined by slow-moving factors such as population growth, immigration, and education, so we do not think it plausible that a coincidentally more volatile labor supply is the cause of this phenomenon. To be certain to control for changes in aggregate supply, we add year dummies and show that the relationship between wage and firm volatility remains unaffected.

Furthermore, the effect of its own workers' incomes on a firm's demand is unlikely to be a major source of fluctuations in sales for two reasons. First, the share of sales to its own workers is surely negligible. Second, while more volatile wages could raise the volatility of workers' effort (and therefore output and sales), this effect is also unlikely to be large. Workers' effort in efficiency wage models depends on the wage relative to the market wage. Since firm-specific fixed effects explain a substantial fraction of the variation in wages (Groshen [1991b]), the size of the transitory fluctuations we detect are unlikely to substantially alter wages relative to the market. Finally, efficiency wage premia are more likely to be amplification mechanisms than complete theories of fluctuations since they do not explain why wages fluctuate in the first place.

In the final empirical section, we examine whether the strength of the phenomenon varies over time or by industrial sector or firm size.. This exercise has several purposes. First, we explore the consequences for wage volatility of the downward trend in firm volatility uncovered by Davis et al. (2007) when focusing on non-publicly traded companies. Since privately-held companies are on average much smaller than publicly-traded companies, we intend to obtain some understanding of this issue by splitting the COMPUSTAT sample according to whether firms have more or less than 250 employees. Our findings are striking. the effect of firm volatility on wage volatility is completely driven by large companies. These two variables are virtually unrelated for small companies. Based on this finding, we conjecture that the upward trend in individual earnings volatility is much larger for workers of big publicly-traded companies than for workers of small privately-held companies.

Second, we explore whether the relationship between firm and wage volatility has changed over time. We find that it has become significantly steeper since 1980. We interpret this as reflecting the adoption of bonuses in the compensation of workers and the virtual elimination of piece-wise compensation schemes. This change in compensation practices may be a consequence of the shift in the composition of jobs towards occupations where the worker's individual output is harder to monitor. To align the workers and the firm's incentives the only feasible schemes are those that condition the workers compensation on the firm's aggregate performance.

Finally, we explore whether there is some cross-sectoral variation in the relationship between firm and wage volatility. We find that this relationship is steeper in services than in manufacturing. This finding provides some support to the hypothesis that the increase in the firm's risk transferred to workers since 1980 is in part due to the fact that new jobs are more like 'service jobs'.

The structure of this paper is as follows. Section 2 describes the data sets and measures of volatility. Section 3 documents recent trends in volatility in wages and firm performance in the PSID and COMPUSTAT. Section 4 presents the empirical analysis of the link between firm performance and wage volatility. Section 5 discusses the results further, and Section 6 concludes.

2. Measures and Data

Before conducting the empirical analysis we discuss the measures of volatility and the data we use.

2.1 Measures of volatility

Our analysis focuses on the volatility of three variables:

- log annual earnings of a worker,
- log average wage paid in a firm, and
- log real sales in a firm.[5]

The first two measure wage turbulence, while the third measures firm turbulence. We measure the volatility of each variable as the variance over a rolling window of a specified number of years. This measure removes individual or firm-specific averages. Therefore, its evolution over time controls for major compositional biases. Applied to wages, this time-series variance captures what Gottschalk and Moffitt (GM) call the transitory component of wage inequality—the variance in the deviations of a worker's log earnings over a given time interval.

The specification of the length of rolling windows is important for volatility analysis. We choose a length of ten years in order to maintain comparability with the 9-year windows used by Gottschalk and Moffitt while also preserving the ability to examine the higher frequency volatility. Formally, our basic measure of the transitory variance for the log of variable *x* for cell *i* in (the interval centered around) year *t* is defined as follows:

$$V_{10lxit} = V[\{\ln(x_{i\tau})\}_{t-5}^{t+4}],$$

where V[{.}] denotes the variance of the elements in {.}.

The ten-year transitory variance can be decomposed into two "very transitory" variances and a "persistent" component. The very transitory variance measures the fluctuations in the relevant variable over 5-year intervals. This high-frequency volatility is the main focus of this paper. Formally it is defined as:

$$V_{lxit} = V[\{\ln(x_{i\tau})\}_{t-2}^{t+2}]$$

What we call the "persistent" component of transitory variance captures lower frequency variation and is computed as the variance of two consecutive non-overlapping five-year averages of the relevant variable. Formally, it is defined as:

$$V_{lxit}^{P} = V[Avg[\{\ln(x_{i\tau})\}_{t-5}^{t-1}], Avg[\{\ln(x_{i\tau})\}_{t}^{t+4}]],$$

where $Avg[\{.\}]$ denotes the average of the elements in $\{.\}$.

Then, the transitory variance over a 10-year period (close to GM) can be decomposed into the very transitory variances of the two non-overlapping intervals and the persistent variance as follows:

$$V_{10lxit} \equiv V[\{\ln(x_{i\tau})\}_{t-5}^{t+4}] = 1/2(V_{lxit-3} + V_{lxit+2}) + V_{lxit}^{P}.$$

To aggregate individual variances across individuals in a given year, we compute the average of the individual measures of volatility. For firms, we aggregate them by running weighted regressions on a set of year dummies. As weights we use the share of employment in the firm in total employment.

Starting in 1997, the PSID switched from annual to biennial data collection. As a consequence, in order to extend the study beyond the early-nineties, we adopt a methodology which calculates each of the three volatility measures in the interval centered around year *t* as the variance of every other year of data. The very transitory volatility in year *t* using this "skipping years" methodology, for example, is the variance of the log real wage in years *t-2*, *t*, and *t+2*. Formally, the very transitory volatility using the skipping years method for the log of variable *x* for cell *i* in year *t* can be defined as:

$$V^{S}_{lxit} = V[\{\ln(x_{i\tau})\}_j] \text{ , j = \{}t\text{-}2, t, t\text{+}2\text{).}$$

The calculations using both methodologies are listed in the appendix, and our results are robust to the type of methodology employed.

2.2 Data

The two data sources we use are compared in **Table 1**. The Panel Study of Income Dynamics (PSID) and COMPUSTAT are well-studied, long-lived panels of individual and firm-level data, respectively. Note that for each wage series we convert to real wages using the PCE deflator.

The PSID collects annual data for members in a panel of families. As is typical for wage studies using the PSID, we restrict our sample to heads of households because information on earnings is most consistent and complete for this group.[6] To focus on the effects of firm volatility on wages for incumbent workers, we also present results for a sample restricted to job-stayers, workers who have not changed employers over the period. In the PSID, wages are self-reported earnings from the primary job, divided by hours worked. Fringe benefits are not included. PSID wage data are very noisy; a high incidence of error in self-reported earnings and hours generates considerable spurious transitory variation. However, there is no reason to think that there is any trend in this noise.

COMPUSTAT is compiled by Standard & Poor from annual corporate reports of publicly traded companies, augmented by other sources as needed. The variables used in this analysis are annual employment, sales, and wage bill. Employment is the sum of all workers in the firm including all part-time and seasonal employees, and all employees of both domestic and foreign consolidated subsidiaries. Our key variable, the wage bill, includes all wage and benefits costs to the company for all employees. We have over 50,000 firm-year observations in COMPUSTAT for the wage bill and between 5 and 6 times more for employment and sales. These should suffice to explore the trends in firm volatility for publicly traded companies and the relationship between firm performance volatility and the volatility of average firm-level wages.

3. Trends in wage and firm volatility

Our first tests of the hypothesis set the stage for the remainder of the study by documenting the recent rise in wage volatility.

3.1 Individual wage volatility trends in the PSID

This section broadens the evidence on the rise in transitory volatility among individuals' earnings by extending the time period and the workers covered and by focusing on workers who do not change jobs. These extensions form the first tests of our hypothesis, which predicts that wage volatility continued to rise after 1989, and that this trend applies to workers who did not change employers and is not restricted to white males. For comparability with previous studies on firm volatility, we compute volatility measures using both the log-levels and the growth rates of real earnings. We find that the upward trend in transitory earnings volatility is quite robust to variants in methodology. The complete results of these calculations are presented in appendix tables **A1**, **A3**, **A5**, and **A7**. Also, **Figures 1**, **2**, and **3** show the plots of the three volatility measures for various groups.

First we repeat the GM exercise in a way as comparable as possible to our analysis of COMPUSTAT. One adjustment concerns the GM control for age of workers. The subsequent effects of age on earnings are highly non-linear, so changes in the age structure of a workforce could alter the volatility of wages even if wage-setting regimes remain unchanged. To control for changes in the age composition of the sample, GM filter the log of earnings with a quartic in age prior to computing their volatility measures. Specifically, GM estimates two quartic regressions, one prior to 1980 and one after 1970. We employ a

[6] The head of a household is defined as the husband in a married couple family, a single parent, or an individual who lives alone.

similar but more flexible methodology in which we estimate a different age profile for each year.

An additional adjustment we make is to incorporate demographic weights. Given the oversampling of poor households and non-random attrition from the program, the PSID sample is not representative of the U.S. workforce. We correct for these biases by using the demographic weights provided by the PSID.

Table 3 reports the average transitory volatility of earnings of white male heads of households in several non-overlapping five-year periods. **Table 3a** reports results using the skipping years methodology, while **Table 3b** reports results using annual data. For brevity, we will discuss **Table 3a**; however, the results are robust to the methodology.

The first five rows of **Table 3a** report the variance of log real annual transitory earnings over the five non-overlapping periods. The sixth row contains the increment in the variance of transitory earnings from the first period (1972-1976) to the last period (1995-1999), and the last row reports the percentage change from the first to the last period.

There are two important observations. First, the volatility of transitory earnings of white males rose substantially over 10-year periods when extended beyond the GM time frame. This rise of 5.4 percentage points represents an increase of 67 percent in the variance of log wages. Second, the rise in transitory earnings volatility for white male heads of household who did not change employers during the period is similar in magnitude to the increase for the sample that includes job switchers and represents a larger percent increase.

Next, we split the 10-year measures shown in **Table 3** into their very transitory and persistent components (as described in the previous section) to determine their separate influences. For brevity we restrict our attention to measures calculated using the skipping years methodology.

The first five rows of **Table 2a** report the average variance of very transitory earnings in the five non-overlapping 5 year periods. The periods are the same as **Table 3a**; the first is 1972-1976 and the fifth is 1995-1999. The average variance of very transitory real earnings increased by 6 percentage points for white male heads of households and by 4.8 percentage points for white male heads of household who did not change jobs, representing an increase of 81 and 96 percent, respectively. **Table 4a** reports the evolution of the variance of persistent earnings between the same periods. The increment for all white male heads of household is 1.4 percentage points (a 30 percent increase), while for job-stayers the variance of the persistent component of earnings increased by 0.7 percentage points (a 17 percent increase).

We lose the convenient additive property among the three volatility measures when we employ the skipping years volatility. However, **Tables 2b**, **3b**, and **4b** report the results using annual data, where the additive property holds. Using these results, we find that both the very transitory and the more persistent component of earnings changes are important for explaining the increase in the variance of transitory real earnings. Forty-five to 60 percent of the increase in the variance of transitory real earnings of white males over 10 year periods is due to the increase in the average variance of very transitory earnings, with the remainder due to increased in variation of the persistent component of real earnings. For the subgroup who did not change jobs, the share of transitory earnings variance attributable to the very transitory earnings variance ranges from 35 to 70 percent.

The GM exercise focuses on white males, in contrast to the COMPUSTAT data, which cover firms and occupations with no demographic limitations. Thus, we extend the analysis of volatility trends to all heads of households in **Tables 2a**, **3a**, and **4a** using the skipping years methodology. Results are similar using annual data, and are reported in **Tables 2b**, **3b**, and **4b**. We discuss the results using the skipping years method.

Table 2a show that, for all groups, the increase in the variance of very transitory real earnings is largely monotonic until the last five year period, where it falls slightly. For workers who did not change jobs, there was a pause in the upward trend of transitory earnings volatility during the 80s and the trend resumed during the late 80s and early 90s. Quantitatively, the variance of very transitory earnings rose by 36 percent for all heads of household and by 46 percent for the subset that did not change jobs.

Table 3a reports the evolution of the variance of the transitory (10-year) component of earnings for our five year increments. For all heads of households, transitory volatility rose by 3.2 percentage points, or about 29 percent. For heads who did not change jobs, transitory volatility rose by 2.7 percentage points, or about 35 percent.

Tables 4a and **4b** report the five year increments for the persistent component of earnings volatility. Using the skipping years methodology, we were able to calculate the persistent component from 1974 through 1991, and for 1993 and 1995. The change between the first five year period (1972-1976) and 1995 was 5.9 percent for all heads of households and -5.4 percent for those heads of households who did not change jobs. However, the percent change from the first period to the mean of the last period for which we have more than one value (1990-1994) shows an increase of about 25 percent for all heads and of 8.3 percent for all heads who stayed in their jobs. The result of a positive increase in the persistent component is also shown using annual data in Table 4b.

We conclude that the rise in the volatility of earnings of individuals persisted into the 1990s, applies to job-stayers and workers other than white males, and is robust to various methods of calculation. Furthermore, the very transitory and more persistent components both play a role in the rise of wage volatility.

3.2 Firm volatility trends in COMPUSTAT

Have transitory variations in firms' average wages trended up along with other measures of firm volatility? The affirmative answer to this question provides support for the hypothesis presented in this paper.

Comin and Mulani [2004] find that the average firm's sales have become increasingly volatile in the 50 years since the end of WWII, even as the aggregate economy has become more stable. More specifically, for each firm in COMPUSTAT, Comin and Mulani [2004] compute the standard deviation of the firm's annual growth rate of real sales over a rolling window. Then the average firm volatility in a year is computed as the average of the individual firms' volatilities in a given year.

The upward trend in firm volatility is robust to controlling for mergers and acquisitions, to weighting the firms' volatility measures by their share in total sales, to computing the median firm volatility instead of the average (Comin and Philippon [2005]), to removing the effect of age and size on the firm volatility measure before aggregating it, to including firm-specific fixed or cohort effects, and to allowing for size and age-specific cohort effects (Comin and Mulani [2004]).[7] The magnitude of the increment in volatility is quite robust to almost all of these variations.

Since we cannot present the evolution of the volatility of performance for the firms in COMPUSTAT for all these variations, we report here two representative aggregation

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[7] Comin and Mulani [2004] argue that the robustness of the upward trend in volatility to these variations implies that the upward trend in firm volatility is not driven by compositional change in the sample of COMPUSTAT firms.

schemes. Aggregation method 1 results from regressing the volatility measure on the log age -- measured by the years since the firm first appears in COMPUSTAT -- the log of real sales and a full set of year dummies weighting each observation by the employment in the firm in the year. The evolution of the volatility measure is given by the coefficients on the year fixed effects. Aggregation method 2 further controls for compositional change by including (in addition to the age and size controls) a firm fixed effect. When computing the effect of firm volatility on wage volatility in section 5, we will use the evolution of firm from aggregation method 2 since the regressions that estimate the relationship between firm and wage volatility will include firm-level fixed effects.

Table 5 reports levels of these measures of volatility at the beginning, middle, and end of the covered period. Panel A reports the measures aggregated according to the first method (i.e. without firm fixed effects) and Panel B reports the results when aggregated according to the second (i.e. with firm fixed effects).

Between 1972 and 1999 the very transitory, persistent and transitory variances of real sales show a steep upward trend. The very transitory volatility of sales computed with method 1 has increased, respectively, by 7.4 and 6.3 percentage points. Persistent volatility measures have also increased. In particular, the persistent volatility of real sales increased by 8.3 percentage points between 1974 and 1997. Similarly, the transitory (i.e. over a ten-year window) volatility of real sales between 1974 and 1997 has increased by 13.5 percentage points. This steep trend in volatility is completely robust to removing firm heterogeneity with firm-level fixed effects. If anything, it has become steeper using our second aggregation scheme. As shown in Panel B of **Table 5**, the very transitory volatility of sales increases 21 percentage points while persistent volatility increases by 28 percentage points, while transitory volatility increases by 43 percentage points, respectively.

COMPUSTAT's information on the total wage bill of firms allows us to construct a series of the average wages paid by firms. **Table 5** tracks the evolution of the very transitory, persistent and transitory variances of the firm-level average wage in the COMPUSTAT sample. The volatility of firms' average wages has increased. The magnitude of this increase is smaller than for real sales. This contrast is at least partly due to respondent bias. Many firms (over 80%) do not report their wage bill in COMPUSTAT, and those who do report tend to have experienced smaller increases in the volatility of their sales than non-reporters. Despite this bias, very transitory wage volatility between 1972 and

1999 has increased by 1.3 or 2.1 percentage points depending on whether we use aggregation methods 1 or 2. Persistent wage volatility has increased by less than one percentage point between 1974 and 1997, and transitory wage volatility has increased by 1.7 or 1.1 percentage points depending on the aggregation method.

Thus, since 1970 both the variance of individual worker real earnings documented in the PSID and the variance of the average real wages at the firm level in COMPUSTAT have increased. Applied to the decomposition of the variance of individual earnings in (1), that means that both the left-hand side term and the first term on the right-hand side have increased.

3.3 Comparison of trends in firm average wage volatility in COMPUSTAT with individual wage volatility in the PSID

What fraction of the increase in the variance of individual earnings can be attributed to the increase in the variance of the average wage paid by firms?

To answer this question, we decompose a worker's (log) real wage (lw_{it}) as follows:

$$lw_{it} = lw_{f(i)t} + (lw_{f(i)t} - lw_{it}),$$

where $lw_{f(i)t}$ denotes the average wage paid in worker i 's firm. The second term is the individual's idiosyncratic wage change within the firm. Individual wage volatility (V_{lwit}) is equal to:

$$V_{lwit} = V_{lwf(i)t} + V_{(lwf(i)t-lwit)} + 2Cov(lw_{f(i)t}, lw_{it} - lw_{f(i)t}), \tag{1}$$

where the first term in the right-hand side, $V_{lwf(i)t}$, is the variance of the average wage volatility at the firm level and $Cov(x,y)$ denotes the covariance between x and y. Averaging across all the individuals, the average individual wage volatility is equal to:

$$\sum_i V_{lwit} / N = \sum_i V_{lwf(i)t} / N + \sum_i V_{(lwf(i)t-lwit)} / N, \tag{2}$$

where the covariance term drops because the two arguments are orthogonal within any given firm.

It follows from (2) that, in order to answer the question posed above, we need to compute the increment in the volatility of the average wage at the firm level, weighted by firm employment share.

One important issue in this calculation is whether the increment in the average weighted firm volatility in COMPUSTAT is an accurate estimate of the increment in the average weighted firm volatility in the U.S. economy. There are two reasons to be cautious. First, as argued above, the firms that report the wage bill in COMPUSTAT do not experience increases in sales volatility as steep as the representative traded firm. We deal with that by estimating first the relationship between firm volatility and average wage volatility and then using this elasticity and the evolution of firm volatility in COMPUSTAT to predict the increment in average wage volatility for the publicly traded companies. A second reason for caution is the different evolution in the volatility of privately-held companies (Davis et al. [2007]). We will address this in more detail below by splitting the COMPUSTAT sample between small (i.e. fewer than 250 employees) and large firms.

Despite those concerns, it is still informative to compare the trend in the volatility of the average wage paid in the COMPUSTAT firms with the average individual wage volatility in the PSID. The two samples overlap between 1970 and 2001. Between 1972 and 1999, the very transitory variance of real earnings for workers that did not change jobs in the PSID has increased by 5.7 percentage points, while between 1974 and 1995, their persistent variance has not increased and the transitory variance has increased by 3.9 percentage points.

Between 1972 and 1999, the very transitory variance of the firm-level average real wage in COMPUSTAT aggregated using method 1 increased by 1.4 percentage points, while using method 2 it increased by 2.1 percentage points. The annual increment in the very transitory volatility of the average wage paid in the firm is between half and one tenth of a percentage point.

We can conduct a similar computation to assess the relevance of the evolution of the between-firm effects in the increment by 2 percentage points in the persistent variance of individuals' earnings in the PSID. In particular, the persistent variance of the firm-level average wage using the first aggregation method has increased by 0.06 percentage points between 1974 and 1997, while using the second aggregation method it increased by six tenths of one percentage point.

These aggregate time series trends provide some suggestive evidence that, specially, the increase in very transitory average wage volatility can be an important driver of the increase in transitory wage inequality documented by Gottschalk and Moffitt [1994]. Next, we use panel evidence to evaluate more seriously the hypothesis that earnings volatility this is driven by higher firm instability.

4. Determinants of wage volatility in firms

In this section we explore whether firms that experienced a rise in sales volatility raised the volatility of the wages they paid to their workers. We first investigate whether wages are related to firm's sales using specifications in levels. Second, we turn to specifications in variances, which allows us to add further controls for omitted variables and explore the frequency at which relationship holds, After that, we test our hypothesis separately for measures of very transitory volatility and more,persistent volatility.

4.1 Determinants of firm-level average wage volatility—level regressions

If firm and wage volatility are related because wages respond to firm performance, we can assess the importance of firm volatility in the increase in earnings volatility by deriving an elasticity from the estimate of the relationship in levels between sales and average wages at the firm-level. Though this approach is subject to several caveats that we describe later, we still find instructive to initiate our exploration showing these results. To this end we estimate regression (3)

$$lw_{ft} = \alpha + \beta ls_{ft} + \gamma X_{ft} + \varepsilon_{ft}, \qquad (3)$$

where lw_{ft} denotes the log of the average wage paid in firm f ls_{ft} denotes the log of real sales and X_{ft} is a set of controls that includes the log of the number of employees, year dummies and may include the log of the age of the firm. The observations are weighted by the number of employees.

The first two columns of **Table 6** report the estimates from this regression. They show that an increase in real sales of one percentage point is associated with an increase in the average wage of about 0.73 percent. The second two columns report the results after including firm fixed effects. These capture persistent differences in average wage across firms (Groshen, 1991b). Controlling for them does not reduce the association between wages and sales noticeably. The elasticity remains approximately 0.6 and is still highly significant.

These estimates of β imply that a one percent increase in the variance of real sales is associated with an increase in the variance of the log average wage of approximately 0.36 percentage points.

This approach to estimating the elasticity between firm and wage volatility has some limitations compared to regression in variances. First, the economic mechanisms by which controls should enter in the regression in levels and in variances may be different. For example, a larger number of employees may allow firms to reduce use of overtime to meet demand fluctuations and hence may reduce the variability of the average wage per worker. This effect, however, may not show up on the level regression. Second, in a similar vein, it may be difficult to control for compositional change in level regressions since we cannot use changes in levels to control for compositional change. Third, level regressions do not provide any information about the frequency at which firm and wage volatility are related. For these reasons the rest of the paper uses regressions in variances.

4.1 Determinants of transitory volatility of firm-level average wages—variance regressions

We next turn to exploring whether COMPUSTAT firms pay more volatile average wages when they experience more turbulence. To this end, we estimate the following regression:

$$V_{lwft} = \alpha + \beta V_{lsft} + \gamma X_{ft} + \varepsilon_{ft}, \tag{4}$$

where V_{lsft} is the very transitory variance of sales in firm f between $t-2$ and $t+2$, V_{lwft} is the variance of log (real wages) in firm f during the same 5 year interval, X_{ft} is a vector of other controls, and ε_{ft} is a potentially serially-correlated error term. To obtain an unbiased estimator of the standard errors of the estimates in the presence of auto-correlated errors, we use the Newey-West estimator with autocorrelation for up to 5 lags. Regression 3 is run weighting each observation by their share in total employment. **Table 7** reports the estimates for various specifications.

The first column of **Table 7** reports the coefficient on sales volatility for the weighted and unweighted regressions. Very transitory volatility of the average wage paid in the firm rises strongly and significantly with the very transitory firm volatility of sales.

This positive association persists with the addition of several relevant controls, as shown in column 2. First, we follow Comin and Mulani [2004] in recognizing that size may have an effect on firm volatility. Consistent with their findings, we observe that log sales is negatively related to the variance of the average wage; large firms show less wage volatility. Second, we also allow for log wage to have an effect on the volatility of wages. This effect is negative and statistically significant; high-wage firms have less volatile wages. Third, we control for the log of the firm's age measured by the years since it first appeared in the COMPUSTAT sample. We find that younger firms pay more volatile average wages. However, neither of these latter effects diminishes the coefficient on firm volatility.

The upward trend observed in both sales and wage volatility invites us to add time trends and year fixed effects to show that the positive association between wage and sales volatility is not driven by a spurious correlation. Columns 3 and 4 in **Table 7** show that the strength and statistical significance of this association is unaffected by adding a time trend or time dummies.

One interesting question is whether the observed association between wage and firm volatility is driven by industry-specific shocks. Columns 5 of **Table 7** test this hypothesis by including 3-digit sector-specific year fixed effects as a control. This does not reduce the observed relationship between wage and firm volatility.

4.2 Compositional change controls–variance regressions

One important concern, at this point, is whether the observed relationship between wage and firm volatility is driven by compositional changes that are correlated to firm performance. There are two forms of potential compositional change that we need to deal with: across firms and within firms.

Suppose that more volatile firms pay more volatile wages, but when a firm's performance becomes more volatile the firm does not pay more volatile wages. This difference between firms would yield positive estimates of β. Further, changes in the composition of COMPUSTAT towards more volatile firms could produce the observed upward trends in firm and wage volatility. By contrast, in our hypothesis,,the positive estimate of β results from the within-firm co-movement between wage and employment volatility, changes in the distribution of aggregate employment across firms should not play a major role in the increase in wage volatility. That is, the increase in turbulence experienced by the median firm would drive the increase in transitory wage volatility.

To test whether the positive relation between wage and employment volatility results from the differences among or within firms, we introduce firm-specific fixed effects in our regression:

$$V_{lwft} = \alpha_f + \delta t + \beta V_{lxft} + \gamma X_{ft} + \varepsilon_{ft} \tag{5}$$

Remarkably, introducing firm-specific fixed effects does not affect the significance or size of the association between firm volatility and the volatility of the average wage at the firm level (see columns 6 and 7 of **Table 7**). Thus, we conclude that this association is driven predominantly by within-firm co-movements between wage and employment volatility and that the association between wage and firm volatility is driven by within firm dynamics.

A second compositional explanation for the positive association between firm and wage volatility is that firms which experience more sales turbulence also hire and fire workers, or open and close establishments, or buy and sell subsidiaries more frequently—and that, as a result of high job churning, their wage volatility is higher. This explanation is closely related to Violante [2002] and to Manovski and Kambourov [2004]. However, this argument faces the problem that the increase in transitory wage volatility (and its components) in the PSID is the same for those workers that stayed in the same job as for those who changed jobs during the 5-year period.[8] Therefore, it seems likely that the main force driving the increase in transitory wage volatility operates within the job.

In any case, we would like to assess whether the estimates of β reflect the association between firm turbulence and the volatility of earnings of individual workers or firm turbulence and changes in the composition of the workforce in the firm. To explore the importance of this source of compositional change, we include two additional controls in regression (5). The first addition is the growth rate of employment over the 5-year window used to compute the very transitory volatility. This controls for changes in the composition of employment at the firm level that affect firm size. The second addition is the growth rate of the average wage in the firm over the 5-year window. This controls for

[8] That fact was first noted by Gottschalk and Moffit [1994].

changes in the composition of the workforce in the firm that affect the average wage. Such changes include, for example, changes in the average skill and/or experience of workers.

Columns 8 and 9 in **Table 7** report the results from this exercise. As one might expect, wage volatility is higher in firms that downsize their workforce. This effect, however, is not significant at standard confidence levels. Similarly, the change in the average wage over the 5-year interval does not have a significant effect on wage volatility. Interestingly, controlling for changes in firm size or in the average wage does not affect the magnitude or significance of the association between wage and firm volatility. The relationship between wage turbulence and firm turbulence is, thus, unaffected by the controls for compositional change in the workforce.

4.3 Instrumental variables—variance regressions

Two more alternatives to the hypothesis advanced here for the correlation between firm and earnings volatility are reverse causality (i.e., higher earnings volatility caused greater firm instability) and omitted variable bias (i.e., another factor raised both sorts of turbulence).

As the introduction notes, it is very unlikely that causation runs from wage to firm volatility for four reasons. First, labor demand is derived from product demand. Second, the workers in a firm constitute a negligible share of the total demand they face. Third, pure labor supply fluctuations operate at lower frequencies and, since they are aggregate, are taken care of by the time dummies. Interestingly, time dummies do not affect the estimated relationship between firm and wage volatility. A final more interesting channel by which wage fluctuations may affect firm volatility comes from efficiency wage theory. According to this theory, fluctuations in the worker's wage relative to the market wage may affect the effort exerted by the worker and therefore the firm performance. However, this channel is unlikely to be important because, given the importance of the firm-level fixed effects in wages (Groshen [1991b]), the relative position of the firm wages is unlikely to vary much at the high frequencies studied in this paper.

A second source of concern is omitted variable bias. That is, the positive association found between firm and earnings volatility could be due to a third omitted variable that is correlated with both wage and firm volatility and that drives the increase in the volatility of firm performance and worker's compensation.

We are unaware of any such omitted influence and many of our probes rule out variants of this alternative hypothesis, so we consider it unlikely. First, the positive association between firm and wage volatility is robust to the inclusion of firm fixed effects. Thus, the relationship is not driven by omitted variables that are roughly constant for firms. This rules out large classes of possible omitted variables, including persistent differences in compensation schemes across firms that are correlated with their volatility and persistent cross-sectional variation in the occupational composition of firms.

Similarly, the robustness of our estimates to the inclusion of year fixed effects implies that the positive association between firm and wage volatility is not driven by aggregate or regional shocks that affect simultaneously the volatility of wages and firm performance.

To further discard the possibility that our estimates of β are the result of omitted variable bias or compositional change we proceed to instrumenting firm volatility. To find these instruments we borrow from the firm volatility literature, which has identified some determinants of volatility (Comin and Philippon, 2006, Comin and Mulani, 2007, Comin and Mulani, 2005). In particular we consider two IVs: lagged volatility and lagged expenditures in research and development (R&D) at the firm divided by sales. Lagged firm volatility is correlated with current volatility because there is mean reversion in volatility. Lagged R&D expenditures predict current volatility because R&D may open new growth possibilities for the firm. These possibilities may materialize and over a period there may cause turbulence in the firm performance.

In the first stage, we regress current firm volatility on firm volatility three years ago, R&D intensity at the firm 4 years ago and the controls we have used in (5). The first two columns in **Table 8** report these results. The difference between these two columns is that in column 2 we include as an additional control the average profit rate over the 5-year period over which current volatility is computed. The main observation from the first stage regression is that the instruments are jointly and individually significant.

A priori, there is no reason why our two instruments should be correlated with the error term. We do not believe that they should be correlated with average firm performance over the 5-year volatility window. Nevertheless, we check below for robustness of the instrumented effect to controlling for the firm's average profit rate over this period.

Similarly, there is no obvious reason why lagged firm volatility or lagged R&D intensity should affect current wage volatility apart from the effect they have on current volatility.

Instrumented firm volatility has a significant effect on wage volatility in both specifications, as shown in columns 3 and 4 of **Table 8**. Interestingly, the magnitude of the effect of firm volatility on wage volatility (approximately 0.25) is virtually the same as in the non- instrumented regressions. Given the less than perfect fit in the first stage regression, one interpretation of this finding is that firm volatility is not endogenous, as the non instrumented regressions assumed.

4.4 Determinants of persistent volatility of firm-level average wages—variance regressions

Of course, the relationship between firm and wage volatility may also operate at lower frequencies. To explore whether this is true we use the measures of persistent volatility defined above. Specifically, we run the following regression:

$$V_{lwft}^{P} = \alpha + \beta V_{lsft}^{P} + \gamma X_{ft} + \varepsilon_{ft}. \tag{6}$$

Table 9 reports the estimates of the parameters in equation (5). For brevity we include from the beginning the baseline set of controls and find in column 1 that there is a positive association between persistent sales volatility and persistent average wage volatility. In column 2, we observe that this association is robust to including year fixed effects and to controlling for the growth rate of sales and employment over the 10-year window over which persistent volatility is computed. As for the above relationship for transitory volatility, this shows that the association between wage and firm volatility does not reflect the omission of changes in the composition of the workforce in the firm. The last column of **Table 9** shows that the association between firm and wage persistent volatility takes place firms rather than across them.

The first two columns of **Table 10** show the robustness of these findings to instrumenting persistent sales volatility with lagged (5-year) persistent volatility. The strong mean reversion in persistent volatility (shown in the first column) allows us to use lagged volatility to obtain variation in current persistent volatility. As with transitory volatility, we do not believe that the variation induced by lagged persistent volatility is driven by other variables that affect directly current persistent wage volatility. This is specially the case given the large set of controls for current state of the firm. (We also experimented with controlling for lagged measures of firm performance and find that the results are robust to such controls. This provides further proof, in our view, of the exogeneity of the variation induced by 5-year lagged persistent sales volatility.)

Beyond the statistical significance of the association between wage and sales persistent volatility, one interesting finding from **Tables 9** and **10** is that the magnitude of this association is approximately one fifth of the size of the association we see between transitory volatilities. This is not surprising. Even though short-run firm conditions strongly affect wages paid in firms, in the medium term, firms can adjust along other margins, so wages tend to be more determined by market (rather than firm) conditions.

5. Accounting for the role of firm turbulence in increased wage turbulence

Next we continue to explore the importance of firm-specific turbulence as an explanation for higher earnings volatility experienced by workers. In particular, we investigate whether the slope of the relationship between firm and wage volatility has changed over time, and whether it varies by firm size and by sector. We conclude by taking stock of our findings and computing the increment in earnings volatility due to firm specific factors.

5.1 Changes in the slope?

Have firms increased the loading of their workers in the firm performance recently? To explore this possibility, we re-estimate our regressions splitting the dataset in two samples, before and after 1980. The first two columns of **Table 11** report the results from estimating these two regressions for the instrumented very transitory volatility measures. The results are striking. The coefficient before 1980 was an insignificant 4 percent, while after 1980 it was a significant 26 percent. So, the effect of very transitory firm volatility on very transitory wage volatility seems to be a phenomenon that virtually started in the 80s. Columns 3 and 4 of **Table 10** show, however, that there has been no significant increase in the effect of persistent firm volatility on persistent wage volatility.

Why have firms adopted compensation schemes that are more loaded on firm performance? Answering this question goes beyond the scope of this paper but we feel compelled to speculate. One possibility is that the new jobs created as a result of the adoption of computers and the expansion of the service economy are harder to monitor. Hence, it was not possible to condition the worker on his individual performance to align the workers' incentives with firm goals,. The second best option is to condition the compensation of the only observable, that is, firm performance.

The latter part of the 20^{th} century saw a decline in the prevalence of piece-rate compensation, while bonuses have become much more common (Milcovich and Stevens 1999; Levine et al. 2002). We shall show below some more quantitative evidence in support of this story when exploring the sectoral variation in the relationship between firm and wage volatility.

In another story, factors such as declining unionism and real value of the minimum wage in the US (Freeman 2008), have led some observers (Gali and This, 2008) to argue that US labor markets have moved closer to a spot market since around 1980, and away from arrangements where firms sheltered workers from aggregate fluctuations. Note that this hypothesis, would not deliver *a priori* the findings of this paper because movement toward a spot labor market would weaken the connection between firm volatility and wage volatility rather than strengthen it, as has occurred in the US publicly traded companies since 1980.

5.2 Differences between large and small firms

Do we observe any variation in the relationship between firm and wage volatility across firm size? To answer this question we re-estimate our baseline regressions splitting the COMPUSTAT sample into large and small firms, using 250 employees as the threshold. Since COMPUSTAT over-represents large companies the subsample of over 250 employees will be much larger than the subsample of less than 250 employees, but we will still be able to compare the point estimates.

Columns 3 and 4 of **Table 11** report the estimates for the instrumented transitory volatility measures. We find a sharp contrast in the effects of transitory firm volatility on wage volatility for big and for small firms. While for big firms there is a significant effect (comparable to the effect reported in the previous analysis), for small firms there is virtually no effect of firm volatility on wage volatility. Given the small subsample of small firms we also report in columns 5 and 6 the results for regressions where firm volatility is not instrumented. These are basically the same as those for the instrumented regressions.

Columns 5 and 6 of **Table 10** show that there is no significant difference in the effect of persistent firm volatility on the persistent volatility of wages between big and small firms.

These findings are significant in the light of the conclusion reached by Davis et al. (2007) that privately-held firms have become less volatile since the mid 1970s. Since privately-held companies are much smaller than publicly-traded ones, it seems reasonable to think of the relationship between firm and wage volatility for privately-held firms as similar to the relationship found in COMPUSTAT for small firms. Hence, the picture that emerges is that large companies became more volatile and found it optimal to pass along some of this greater turbulence to their employees in the form of more volatile earnings. Small firms may have experienced a decline in volatility, but, since they have not found it optimal to link their wages so tightly to firm performance, their employees' wages have not become more stable.

Why have only large companies passed on their turbulence to their workers in the form of more volatile wages? This finding may seem surprising at first. According to agency theories of compensation (e.g., Holmstrom, 1982), the optimal compensation of a worker has a loading of $b>0$ in the worker's signal and a loading of d on the firm's signal, with $0>d>-b$,. For larger firms, the firm-level signal is less noisy and therefore the loading d becomes closer to $–b$, reducing the dependence of the average wage in the company on the firm's performance.

A more promising avenue of future research may reside in thinking of big firms as monpsonists in the labor markets where they operate. In such environments it may be possible to write models where the wages these firms pay vary with the product demand conditions they experience. Small firms, in contrast, are price takers in the labor markets. Therefore, the wages they pay do not vary with firm conditions but are determined by aggregate factors.

5.3 Differences across sectors

Finally, we explore whether the link between sales volatility and wage volatility at the firm level is stronger or weaker in manufacturing than in non-manufacturing sectors. Columns 7 and 8 of **Table 11** report the estimates for both sub-samples after instrumenting very transitory volatility and columns 9 and 10 report the estimates without instrumentation. The main finding is that the slope of the relationship between firm and wage volatility is steeper in non-manufacturing firms than in manufacturing firms. The slope is not significant in the non-manufacturing sub-sample due to the reduction in the sample size due to the use of R&D intensity as instrument. The point estimate, however is very large (0.58). When we do not instrument we find a significantly larger estimate in the non-manufacturing sub-sample.

As advanced above, the larger effect of firm volatility on wage volatility found in non-manufacturing provides some support to the notion that part of the increase in the coefficient observed since 1980 may be driven by the difficulty to condition the workers' compensation on their own performance inherent in many jobs in the service sector. New jobs created due to the digital revolution are more service-like in their difficulty to observe easily the individual performance of a worker and hence the need to condition of firm-level performance measures to align the incentives of the workers and the company.

5.4 Adding up

How much of the increment in earnings volatility can be traced back to firm volatility? To answer this question we offer first a simple calculation based on regressions 5 and 6. Given an estimate for β of 0.25 for the very transitory volatility regressions, and an increment in the very transitory volatility of real sales of 0.21, the increment in the very transitory volatility of average earnings induced by the higher very transitory volatility experienced by firms is of 5.2 percentage points. As shown in the second row of **Table 1**2, an equivalent calculation shows that 1.1 percentage points of the persistent volatility of the average wage at the firm level are driven by the increment in the persistent volatility of firm-level sales. Hence, the increment in transitory firm volatility (i.e., the sum of very transitory and persistent) has lead to an increase in 6.3 percentage points for the transitory volatility of the earnings of publicly-traded companies.

But this is just part of the story. As firms have increased the leverage of the workers compensation on the firm's performance, firm turbulence has also been increased earnings volatility. Using the estimates of the increment of β from **Tables 10** and **11**, rows 3 and 4 of **Table 12** compute the additional effect that this has on the increment in the volatility of the average wage at very transitory and persistent frequencies.

Very transitory volatility of the average wage rate at the firm level increases by 1.2 additional percentage points. While, given the lack of a significant increment in the slope of the relationship between persistent volatility measures, the computation of the increment in persistent wage volatility does not change.

Adding up, we find that the transitory volatility of the average firm level wages of workers in publicly-traded companies has increased by 7.5 percentage points between 1970 and 1999 due to the turbulence experienced by their firms. This figure is approximately 2.5 times higher than the observed increment in transitory volatility during the same period in the PSID (2.7 percentage points). It is, of course, perfectly plausible that our predicted increase is higher than the observed increase in the PSID. This is the case because COMPUSTAT only covers publicly-traded companies and our best guess for the evolution of the average wage in the non-publicly traded companies based on the smaller companies in COMPUSTAT is that it has not increased. Hence, firm turbulence seems an important factor towards understanding the evolution of individual workers' earnings volatility.

6. Conclusion

Our findings suggest that rising turbulence in sales among U.S. firms over the past three decades has raised their workers' wage volatility, increasing wage risks for many workers. The effect is strong and has grown markedly since the 1980s.

Using household panel data in the PSID, GM find that wage volatility has risen substantially for white male workers. We confirm the robustness of this result, focusing on workers who have not changed jobs and extending it to all demographic groups. Using firm data from COMPUSTAT, we find rising volatility of firms' mean wages that mirrors the rise in volatility of firm performance and robust evidence that when firms experience more turbulence they pay more volatile wages.

To ensure that the connection between these two volatilities does not reflect the impact of the impact of compositional changes between or within firms, we turn to additional controls and instrumental variables. The positive impact of firm turbulence on wage volatility is robust to the introduction of these controls both for volatility measures that capture very transitory and more persistent changes.

Our analysis focuses on the impact of this turbulence on wage changes for incumbent workers, not for workers who have changed jobs. However, there are reasons to think that the increase in firm turbulence may also increase risk for workers who switch employers. First, firm turbulence may increase the dispersion of average wages in occupations within a firm or in a given occupation across firms. Second, because of these two forces, firm turbulence may lead to more job turnover. We leave exploration of these hypotheses for future work.

Our findings have important implications for theories of labor markets and optimal wage compensation schemes. Existing models cannot explain all the findings uncovered in this paper. Perfectly competitive labor market models cannot explain the effect of firm volatility on wage volatility. Models of compensation based on agency theory cannot explain the observed larger effect of firm volatility on wage volatility in large than small companies. Finally, models of de-unionization cannot account for the increase in the link between firm and wage volatility observed since 1980.

Finally, from a policy standpoint, these findings highlight a source of increased risk faced by U.S. workers since the 1980s. As they adjust to the decline of defined-benefit pensions, health insurance, social safety net programs, and job security, Americans now find their paychecks tied to increasingly rocky corporate ships. The implications of this heightened risk for financial markets and for social and economic policy, not to mention families and communities, are still unknown.

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PSID Appendix – Construction of Samples

This document details the steps used to construct the dataset we use to analyze the transitory and persistent volatility of wages.

1. The first thing we do is download the data from the PSID family file. All wage data come from the family file except for the years 1994 through 2001, which come from the Income Plus file. Demographic data are downloaded in order to generate our sample. Weights are also downloaded.

2. The data are all "wide." In other words, each row in the matrix corresponds to the head of the household, and the columns are that head's 1970 PSID code, his 1970 wage, his 1971 code, his 1971 wage,…, his 2001 code, his 2001 wage. We now go through each dataset (wage file, sex file, age file, etc.) and drop the blank code observations. This ensures that all individuals have a PSID code for each year.

3. At this point we merge the various datasets into one master dataset. In other words, we merge wage data, age data, sex data, the weights, a price index, etc. into a master file. The price index we use is the monthly personal consumption expenditures chain-type price index, aggregated to annual values, with 1982 equal to zero.

4. We now use the wage data to compute the natural log of the real wage.

5. We apply an age filter to the log real wage. To do this, we regress log real wage on a quartic in age and collect the residuals, which we call the age filtered log real wage.

For analysis of all heads:

6. At this point we begin to generate our sample. We drop heads who are greater than sixty or less than nineteen years of age.

7. We drop all heads who are full time students.

8. We replace all observations with a wage equal to zero as a missing value.

9. After this, we drop all heads who report income of less than or equal to the first percentile and greater than or equal to the ninety-ninth percentile. After this step is taken, there are no observations which remain with a topcoded value as their wage.

10. At this point we reshape the data as "long" and are able to compute our volatility measures. The five and ten year volatility measures are only computed for individuals with five and ten years of consecutive non-zero wage data, respectively.

For analysis of white male heads:

6. At this point we begin to generate our sample. We drop all heads who are not male.

7. We drop all heads who are not white.

8. We drop heads who are greater than sixty or less than nineteen years of age.

9. We drop all heads who are full time students.

10. We replace all observations with a wage equal to zero as a missing value.

11. After this, we drop all heads who report income of less than or equal to the first percentile and greater than or equal to the ninety-ninth percentile. After this step is taken, there are no observations which remain with a topcoded value as their wage.

12. At this point we reshape the data as "long" and are able to compute our volatility measures. The five and ten year volatility measures are only computed for individuals with five and ten years of consecutive non-zero wage data, respectively.

Table 1: Description of Data Sources

	Panel Study of Income Dynamics (PSID)	**COMPUSTAT**
Years covered	1970 – 2001	1950 – 2003
Unit of observation	Worker (head of household).	Firm
Average number of observations per year	Job stayers: FILL IN All workers: FILL IN	3,115
Sample definition	Stratified random sample of families in population drawn in 1968, with attrition since then.	Publicly-held companies, entire corporation.
Source of information	Annual interviews with participating families until 1997, interviews every other year afterwards.	Standard and Poor collects and aggregates data from Securities and Exchange Commission annual report forms, other public information, and contact with the company.
Wage concept	Annual earnings of the worker in his or her primary job, with no fringe benefits.	Total annual wage bill (including bonuses and fringe benefits expenditures) divided by total employment.
Documentation website	http://psidonline.isr.umich.edu/	http://www.compustat.com

Table 2a: Very transitory (5-year) earnings volatility in the PSID using the skipping years methodology

	All		Job stayers	
Period	All heads	White males	All heads	White males
1972-1976 mean	0.106	0.074	0.074	0.050
1977-1981 mean	0.124	0.094	0.095	0.069
1982-1989 mean	0.141	0.124	0.092	0.080
1990-1994 mean	0.161	0.143	0.117	0.100
1995-1999 mean	0.145	0.133	0.107	0.098
Increment	0.039	0.060	0.033	0.048
Percent change	0.363	0.811	0.455	0.963

Notes: (1) Earings volatility in year t equals the variance of age filtered log real wage in years t-2, t, and t+2. (2) 1995-1999 mean is the average of 1995, 1997, and 1999 earnings volatility measure. (3) All other means take the average of all years specified.

Table 2b: Very transitory (5-year) earnings volatility in the PSID not using the skipping years methodology

	All		Job stayers	
Period	All heads	White males	All heads	White males
1972-1976 mean	0.084	0.060	0.048	0.036
1977-1981 mean	0.095	0.074	0.065	0.049
1982-1989 mean	0.107	0.094	0.058	0.050
1990-1994 mean	0.128	0.114	0.078	0.065
1995	0.127	0.122	0.074	0.074
Increment	0.043	0.062	0.026	0.038
Percent change	0.509	1.024	0.536	1.037

Notes: (1) Earnings volatility in year t equals the variance of age filtered log real wage in years t-2 through t+2. (2) The 1995 value is not an average. (3) All other means take the average of all years specified.

Table 3a: Transitory (10-year) earnings volatility in the PSID using the skipping years methodology

Period	All		Job stayers	
	All heads	White males	All heads	White males
1972-1976 mean	0.111	0.081	0.080	0.057
1977-1981 mean	0.120	0.094	0.086	0.067
1982-1989 mean	0.137	0.120	0.091	0.080
1990-1994 mean	0.155	0.140	0.111	0.096
1995-1999 mean	0.143	0.134	0.107	0.098
Increment	0.032	0.054	0.027	0.040
Percent change	0.289	0.665	0.345	0.707

Notes: (1) Earnings volatility in year t equals the variance of age filtered log real wage in years t-4, t-2, t, t+2, and t+4. (2) The 1972-1976 mean is the average of 1974-1976 values. The 1990-1994 mean is the average of 1990-1993 values. The 1995-1999 mean is the average of 1995 and 1997 values. (3) All other means take the average of all years specified.

Table 3b: Transitory (10-year) earnings volatility in the PSID not using the skipping years methodology

Period	All		Job stayers	
	All heads	White males	All heads	White males
1972-1976 mean	0.088	0.067	0.056	0.045
1977-1981 mean	0.095	0.076	0.063	0.050
1982-1989 mean	0.107	0.093	0.061	0.053
1990-1994 mean	0.124	0.112	0.074	0.060
Increment	0.036	0.045	0.018	0.015
Percent change	0.406	0.679	0.314	0.329

Notes: (1) Earnings volatility in year t equals the variance of age filtered log real wage in years t-5 through t+4. (2) The 1972-1976 mean is the average of 1975 and 1976 values. The 1990-1994 mean is the average of 1990-1993 values. (3) All other means take the average of all years specified.

Table 4a: Persistent earnings volatility in the PSID using the skipping years methodology

	All		Job stayers	
Period	All heads	White males	All heads	White males
1972-1976 mean	0.063	0.046	0.056	0.041
1977-1981 mean	0.069	0.056	0.050	0.039
1982-1989 mean	0.076	0.068	0.056	0.049
1990-1994 mean	0.078	0.074	0.060	0.053
1995	0.066	0.061	0.052	0.048
Increment	0.004	0.014	-0.003	0.007
Percent change	0.059	0.305	-0.054	0.172

Notes: (1) Earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-4, t-2, and t. The second is the average of the age filtered log real wage in years t+2, t+4, t+6. (2) The 1972-1976 mean is the average of 1974-1976 values. The 1990-1994 mean is the average of 1990, 1991, and 1993 values. The 1995 value is not an average. (3) All other means take the average of all years specified.

Table 4b: Persistent earnings volatility in the PSID not using the skipping years methodology

	All		Job stayers	
Period	All heads	White males	All heads	White males
1972-1976 mean	0.045	0.031	0.033	0.026
1977-1981 mean	0.048	0.038	0.038	0.031
1982-1989 mean	0.052	0.046	0.034	0.030
1990-1994 mean	0.060	0.054	0.037	0.030
Increment	0.016	0.023	0.003	0.004
Percent change	0.354	0.721	0.100	0.152

Notes: (1) Earnings volatility in year t equals the variance of two numbers: the average of the age filtered log real wage in years t-5 through t-1 and the average of the age filtered log real wage in years t through t+4. The 1972-1976 mean is the average of 1975 and 1976 values. The 1990-1994 mean is the average of 1990-1993 values. (3) All other means take the average of all years specified.

Table 5: Evolution of very transitory and persistent volatility of the firm-level variables in COMPUSTAT

Table A: Individual firm volatility measures aggregated after filtering effect of age and size (i.e. Method 1).

	Very transitory volatility (5 years)		**Persistent volatility**		**Very transitory volatility (10 years)**	
	Sales	*Wages*	*Sales*	*Wages*	*Sales*	*Wages*
Period						
1972	0.0449	0.0167				
1974	0.0467	0.0179	0.0573	0.0028	0.0930	0.0140
1997	0.0965	0.0424	0.1406	0.0034	0.2280	0.0307
1999	0.1107	0.0304				
2001	0.0762	0.0596				

Table B: Individual firm volatility measures aggregated after filtering effect of age, size and firm fixed effects (i.e. Method 2).

	Very transitory volatility (5 years)		**Persistent volatility**		**Very transitory volatility (10 years)**	
	Sales	*Wages*	*Sales*	*Wages*	*Sales*	*Wages*
Period						
1972	0.0449	0.0167				
1974	0.0712	0.0136	0.0800	0.0049	0.1195	0.0162
1997	0.2482	0.0373	0.3436	0.0112	0.5320	0.0271
1999	0.2561	0.0380				
2001	0.2363	0.0269				

Notes: Very transitory volatility (5 years) is measured by the average variance across firms over five years. Persistent volatility is measured by the average variance across firms between five-year means for the period. Very transitory volatility (10 years) is measured by the average variance across firms over ten years. All estimates are weighted by firms' shares of employment in the sample. Size measured by log number of employees

Periods are centered in the year reported.

Table 6: Relationship between (log) average wage and (log) real sales at the firm level in COMPUSTAT

Dependent Variable: log average real wage$_f$

Independent variables	1	2
log sales$_f$	0.732	0.596
	(0.066)	(0.024)
log employment$_f$	-0.71	-0.74
	(0.069)	(0.034)
No. of obs:	48,729	42,858
F-stat:	46.36	26.68
Prob > F:	0.0000	0.0000
Firm-level fixed effects	No	Yes

Notes:
Robust standard errors in parentheses. All regressions include year fixed effects and are weighted by employment share.

Table 7: Relationship between very transitory variance of average wage and employment at the firm level in COMPUSTAT

Dependent Variable: v (log average real wage$_f$)

Independent variables	1	2	3	4	5	6	7	8	9
v (log sales$_f$)	0.272	0.265	0.256	0.255	0.181	0.193	0.194	0.224	0.223
	(0.051)	(0.053)	(0.055)	(.056)	(.043)	(0.059)	(0.059)	(0.056)	(0.056)
log age$_f$		-0.009	-0.011	-0.009	-0.04	0.001	0.006	0.001	0.008
		(0.002)	(0.002)	(.003)	(.035)	(0.01)	(0.02)	(0.013)	(0.017)
log real wage$_f$		0	-0.004	-0.050	-0.040	-0.003	-0.004	-0.014	-0.017
		(0.005)	(0.005)	(0.006)	(0.006)	(0.019)	(0.019)	(0.02)	(0.021)
log employment$_f$		-0.0015	-0.0019	-0.0018	-0.0017	-0.005	-0.005	-0.014	-0.015
		(0.0006)	(0.000)	(0.001)	(0.000)	(0.012)	(0.012)	(0.015)	(0.017)
Growth rate of firm employment between t-2 and t+2								-0.397	-0.419
								(0.258)	(0.273)
Growth rate of firm average real wage between t-2 and t+2								0.248	0.24
								(0.425)	(0.44)
No. of obs:	29,957	29,957	29,957	29,957	29,957	26,741	26,741	26,741	26,741
F-stat:	27.87	17.78	16.75	3.66	4.71	3.23	2.85	3.02	1.67
Prob > F:	0.0000	0.0000	0.0000	0.0000	0.0003	0.0117	0.0000	0.0059	0.0012
Time trend	No	No	Yes	-	-	Yes	-	Yes	No
Year fixed effects	No	No	No	Yes	-	No	Yes	No	Yes
3-digit sector-specific year fixed effects	No	No	No	No	Yes	No	No	No	No
Firm level Fixed effects	No	No	No	No	No	Yes	Yes	Yes	Yes

Notes:
Robust standard errors (in parentheses). All regressions are weighted by employment share.
Very transitory volatility is measured by the variance of 5 consecuative log sales or log average wage both at the firm level

Table 8: Very transitory average wage and sales volatility at the firm level in COMPUSTAT - Instrumented regressions

Dependent variable:	Variance of sales$_{ft}$ (First Stage Regression)		Variance of log real average wage$_{ft}$ (Second Stage Regression)	
Independent variables	1	2	3	4
Instrumented variance of sales$_{ft}$			0.237	0.239
			(0.114)	(0.115)
(Lagged) variance of sales$_{ft-3}$	-0.282	-0.287		
	(0.078)	(0.08)		
(Lagged) R&D expenses over sales$_{ft-4}$	-0.013	-0.013		
	(0.002)	(0.002)		
log real wage$_f$	-0.004	-0.003	-0.009	-0.009
	(0.004)	(0.004)	(0.007)	(0.007)
log age$_f$	0.015	0.016	0.0175	0.0175
	(0.015)	(0.016)	(0.024)	(0.024)
log employment$_f$	-0.005	-0.005	-0.0094	-0.0094
	(0.006)	(0.006)	(0.018)	(0.018)
growth rate of real sales$_f$ between t-2 and t+2	0.093	0.093	-0.18	-0.18
	(0.035)	(0.035)	(0.169)	(0.169)
growth rate of average real wage$_f$ between t-2 and t+2	0.054	0.054	-0.031	-0.031
	(0.018)	(0.018)	(0.439)	(0.439)
Average profit rate between t-2 and t+2		-0.002		0.0007
		(0.003)		(0.0039)
No. of obs:	4,045	4,035	4,045	4,035
F-stat:	9.56	8.51	1.87	1.68
Prob > F:	0.0000	0.0000	0.0812	0.1079

Note:
Standard errors (in parenthesis) are robust. All regressions include firm fixed effects and a time trend.
Observations are weighted by employment share.
Very transitory volatility is measured by the variance of 5 consecuative log sales or log average wage both at the firm level

Table 9: Relationship between persistent volatility of average wage and employment at the firm level in COMPUSTAT

Dependent variable: variance of persistent component of (log average real wage$_f$)

Independent variables	1	2	3
v of persistent component (log real sales$_f$)	0.037	0.047	0.045
	(0.006)	(0.009)	(0.009)
log real wage$_f$	-0.001	-0.003	0.007
	(0.0008)	(0.0009)	(0.003)
log age$_f$	-0.0017	-0.002	-0.007
	(0.0005)	(0.0006)	(0.006)
log employment$_f$	0.000	-0.002	0.002
	(0.0001)	(0.0007)	(0.0016)
growth rate of real sales$_f$ between t-5 and t+4		-0.054	-0.008
		(0.012)	(0.013)
growth rate of average real wage$_f$ between t-5 and t+4		0.222	0.062
		(0.0467)	(0.047)
No. of obs:	17,544	17,540	16,023
F-stat:	16.49	11	5.18
Prob > F:	0.0000	0.0000	0.0000
Year Dummies	No	Yes	No
Firm fixed effects & time trend	No	No	Yes

Note:
Standard errors (in parenthesis) are Newey-West with ten lags.
Weighted regressions are weighted by employment share.
Persistent volatility is measured by the average variance between five-year means.

Table 10: Relationship between persistent volatility of average wage and real sales at the firm level in COMPUSTAT
- Instrumented regressions and change in slope

Dependent variable:	Persistent variance of sales$_{ft}$ (First Stage Regression)	Persistent variance of log real average wage$_{ft}$				
Independent variables	1	2	3	4	5	6
Persistent variance of sales$_{ft}$		0.034	0.047	0.039	0.034	0.024
		(0.0128)	(0.013)	(0.007)	(0.0128)	(0.02)
(Lagged) Persistent variance of sales$_{ft-5}$	-0.252					
	(0.041)					
log real wage$_f$	0.010	0.013	0.007	0.005	0.013	0.013
	'(0.008)	(0.002)	(0.003)	(0.0017)	(0.002)	(0.007)
log age$_f$	-0.048	-0.008	-0.009	-0.005	-0.008	-0.175
	(0.019)	(0.0007)	(0.008)	(0.003)	(0.0007)	(0.089)
log employment$_f$	0.013	0.002	0.001	0.003	0.002	-0.001
	(0.0065)	(0.0015)	(0.002)	(0.001)	(0.0015)	(0.005)
growth rate of real sales$_f$ between t-5 and t+4	0.247	0.006	0.049	0.113	0.006	-0.006
	(0.023)	(0.01)	(0.061)	(0.017)	(0.01)	(0.025)
growth rate of average real wage$_f$ between t-5 and t+4	-0.012	0.019	-0.006	-0.0138	0.019	-0.0004
	(0.016)	(0.04)	(0.0188)	(0.007)	(0.04)	(0.05)
No. of obs:	13,102	12,673	8,344	7,679	12,320	352
F-stat:	27	9.73	4.24	13.75	9.71	1.32
Prob > F:	0.0000	0.0000	0.0003	0.0000	0.0000	0.2458
Sample	All	All	Post-1980	Pre-1980	Big	Small

Note:
Standard errors (in parenthesis) are Newey-West with ten lags. All regressions include firm fi
Observations are weighted by employment share.
Persistent volatility is measured by the average variance between five-year means.

Table 11: Different slopes in relationship between transitory volatility of average wage and sales at the firm level in COMPUSTAT

Dependent variable: transitory variance of (log average real wage$_f$)

Independent variables	1	2	3	4	5	6	7	8	9	10
transitory variance (log real sales$_f$)	0.265	0.041	0.252	-0.049	0.224	0.032	0.143	0.58	0.078	0.244
	(0.126)	(0.039)	(0.125)	(0.0735)	(0.056)	(0.0174)	(0.0678)	(0.482)	(0.057)	(0.058)
log real wage$_f$	-0.012	-0.004	-0.009	0.036	-0.015	0.014	-0.011	-0.002	-0.0399	0.005
	(0.008)	(0.004)	(0.007)	(0.041)	(0.02)	(0.0098)	(0.007)	(0.02)	(0.0269)	(0.0167)
log age$_f$	0.025	0.011	0.0167	-0.312	0.0017	-0.006	0.019	0.0039	-0.0157	0.025
	(0.031)	(0.008)	(0.023)	(0.266)	(0.0135)	(0.0179)	(0.026)	(0.036)	(0.011)	(0.026)
log employment$_f$	-0.015	-0.001	-0.009	-0.1	-0.0148	-0.009	-0.011	0.073	-0.029	0
	(0.027)	(0.002)	(0.0188)	(0.07)	(0.0158)	(0.0116)	(0.007)	(0.076)	(0.0216)	(0.014)
growth rate of real employments$_f$ between t-2 and t+2	-0.235	-0.001	-0.18	-0.106	-0.397	-0.216	-0.145	-0.0404	-0.044	-0.712
	(0.198)	(0.004)	(0.17)	(0.176)	(0.258)	(0.105)	(0.187)	(0.302)	(0.14)	(0.477)
growth rate of average real wage$_f$ between t-2 and t+2	-0.047	0.063	-0.031	0.144	0.249	0.105	0.025	-0.361	0.158	0.306
	(0.505	(0.064)	(0.43)	(0.282)	(0.426)	(0.164)	(0.494)	(0.607)	(0.36)	(0.732)
No. of obs:	2,373	1,668	3,905	140	24,488	2,253	3,552	493	8,504	18,237
F-stat:	1.79	1.53	1.87	0.55	3.05	2.18	1.68	0.48	2.74	4.32
Prob > F:	0.0978	0.1512	0.0825	0.7701	0.0055	0.0426	0.1217	0.8217	0.0116	0.0002
Sample	Post-1980	Pre-1980	Big	Small	Big	Small	Manufacturing	Non-Manufacturing	Manufacturing	Non-Manufacturing
Instrumented	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No

Note:
Standard errors (in parenthesis) are robust. All regressions include firm fixed effects and a time trend and are weighted byemployment share. Instruments are 3-year lagged very transitory volatilit of log real sales and 4-year lagged R&D intensity. Transitory volatility is measured by the variance over 5 consecuative annual observations.

Table 12: Increment in wage volatility at different frequencies due to increment in firm sals volatility

	Very transitory volatility (1)	Persistent volatility (2)	Transitory volatility (1)+(2)
Constant coefficient (A)	0.25	0.045	
Increase in sales volatility (B)	0.21	0.26	
Increase in volatility with constant coefficient (C) = (A)*(B)	0.052	0.011	0.063
Additional increase in wage volatility due to change in slope (D)	0.012	0	0.012
Total increase in average wage volatility (C)+(D)	0.064	0.011	0.075

Table A1. Very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, all heads in PSID, skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Persist	Stayers	5 yr	Stayers	10 yr	Stayers	Persist	Stayers
72							0.082	0.054				
73	0.126	0.091					0.104	0.071				
74	0.128	0.081					0.109	0.077	0.100	0.069	0.061	0.054
75	0.134	0.099	0.110	0.075	0.027	0.021	0.119	0.079	0.116	0.075	0.063	0.055
76	0.151	0.102	0.114	0.080	0.032	0.023	0.115	0.087	0.117	0.095	0.063	0.057
77	0.135	0.095	0.113	0.088	0.040	0.029	0.120	0.076	0.113	0.081	0.069	0.051
78	0.145	0.119	0.120	0.086	0.033	0.019	0.130	0.115	0.110	0.095	0.068	0.059
79	0.140	0.104	0.124	0.092	0.031	0.019	0.117	0.080	0.123	0.086	0.062	0.044
80	0.138	0.113	0.127	0.080	0.041	0.031	0.118	0.101	0.136	0.099	0.077	0.057
81	0.154	0.124	0.126	0.086	0.036	0.024	0.137	0.103	0.117	0.067	0.067	0.039
82	0.161	0.122	0.142	0.112	0.039	0.032	0.150	0.113	0.146	0.114	0.080	0.063
83	0.156	0.104	0.132	0.090	0.041	0.026	0.115	0.077	0.120	0.080	0.068	0.054
84	0.178	0.126	0.142	0.094	0.037	0.023	0.171	0.115	0.147	0.100	0.068	0.052
85	0.186	0.119	0.132	0.075	0.036	0.021	0.135	0.086	0.118	0.081	0.067	0.045
86	0.169	0.109	0.135	0.089	0.040	0.026	0.152	0.093	0.145	0.098	0.076	0.058
87	0.158	0.089	0.145	0.093	0.043	0.033	0.129	0.081	0.122	0.074	0.071	0.044
88	0.151	0.100	0.138	0.078	0.047	0.029	0.137	0.094	0.149	0.095	0.093	0.065
89	0.175	0.120	0.154	0.100	0.047	0.039	0.139	0.078	0.146	0.088	0.082	0.069
90	0.154	0.105	0.154	0.099	0.041	0.031	0.140	0.098	0.157	0.114	0.079	0.058
91	0.179	0.133	0.177	0.146	0.048	0.033	0.168	0.117	0.167	0.126	0.081	0.065
92	0.206	0.147	0.158	0.104			0.168	0.114	0.151	0.105		
93	0.218	0.175	0.168	0.130			0.169	0.139	0.145	0.098	0.074	0.057
94	0.211	0.153					0.159	0.115				
95	0.207	0.154					0.155	0.105	0.145	0.108	0.066	0.052
96												
97							0.141	0.104	0.141	0.106		
98												
99							0.138	0.111				

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2, t, and t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4, t-2, t, t+2, and t+4. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-4, t-2, and t. The second is the average of the age filtered log real wage in years t+2, t+4, and t+6.

Table A2. Number of observations of very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, all heads in PSID, skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Persist	Stayers	5 yr	Stayers	10 yr	Stayers	Persist	Stayers
72	0	0	0	0	0	0	1979	1346	0	0	0	0
73	1825	1285	0	0	0	0	2062	1385	0	0	0	0
74	1851	1333	0	0	0	0	2133	1460	1531	904	1357	751
75	1933	1278	1390	831	1227	679	2228	1398	1574	879	1390	716
76	2028	1388	1424	867	1255	707	2319	1519	1646	946	1457	769
77	2107	1363	1491	834	1296	675	2381	1472	1713	897	1491	732
78	2157	1473	1554	895	1325	682	2443	1629	1782	974	1541	750
79	2209	1363	1583	854	1363	664	2475	1464	1806	920	1564	724
80	2263	1464	1611	875	1389	692	2554	1585	1836	966	1598	762
81	2295	1414	1633	834	1407	637	2600	1549	1865	905	1604	693
82	2330	1427	1658	863	1430	703	2646	1557	1895	928	1649	758
83	2354	1390	1670	810	1459	668	2646	1505	1911	887	1672	734
84	2343	1380	1715	884	1499	736	2627	1469	1967	958	1726	798
85	2325	1373	1752	845	1535	684	2642	1483	1958	919	1722	753
86	2369	1420	1761	927	1535	758	2684	1517	1975	977	1735	807
87	2421	1436	1761	924	1507	762	2771	1558	2006	1005	1725	824
88	2523	1573	1795	948	1492	756	2785	1651	2057	1019	1732	819
89	2518	1603	1806	955	1516	757	2829	1714	2077	1025	1790	833
90	2558	1794	1803	1011	1569	838	2866	1934	2025	1075	1790	900
91	2509	1799	1779	1021	1179	626	2813	1946	2066	1117	1373	695
92	2453	1723	1830	1150	0	0	2791	1894	2108	1262	0	0
93	2472	1779	1396	880	0	0	2818	1963	1597	970	1448	836
94	2514	1811	0	0	0	0	2850	1977	0	0	0	0
95	1878	1358	0	0	0	0	2296	1587	1663	1025	1489	868
96	0	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	2618	1808	1816	1111	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	2739	1896	0	0	0	0

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2, t, and t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4, t-2, t, t+2, and t+4. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-4, t-2, and t. The second is the average of the age filtered log real wage in years t+2, t+4, and t+6.

Table A3. Very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, white male heads in PSID, skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Persist	Stayers	5 yr	Stayers	10 yr	Stayers	Persist	Stayers
72							0.067	0.044				
73	0.092	0.065					0.066	0.043				
74	0.096	0.060					0.075	0.050	0.075	0.048	0.044	0.038
75	0.108	0.080	0.091	0.059	0.023	0.016	0.083	0.058	0.080	0.052	0.049	0.045
76	0.102	0.068	0.085	0.063	0.025	0.018	0.076	0.053	0.087	0.071	0.047	0.041
77	0.103	0.072	0.087	0.063	0.032	0.021	0.083	0.053	0.083	0.063	0.052	0.037
78	0.106	0.087	0.093	0.069	0.029	0.017	0.094	0.077	0.086	0.071	0.054	0.044
79	0.105	0.081	0.101	0.075	0.026	0.016	0.085	0.060	0.095	0.065	0.053	0.036
80	0.108	0.089	0.103	0.074	0.034	0.023	0.095	0.078	0.107	0.075	0.064	0.044
81	0.134	0.103	0.113	0.075	0.032	0.023	0.114	0.079	0.099	0.058	0.057	0.035
82	0.147	0.123	0.119	0.093	0.035	0.030	0.124	0.093	0.118	0.090	0.067	0.050
83	0.140	0.093	0.121	0.088	0.036	0.024	0.102	0.067	0.110	0.079	0.061	0.051
84	0.157	0.101	0.128	0.090	0.034	0.022	0.139	0.084	0.126	0.080	0.060	0.044
85	0.155	0.105	0.111	0.068	0.032	0.020	0.127	0.086	0.104	0.075	0.063	0.044
86	0.159	0.102	0.120	0.080	0.035	0.020	0.131	0.075	0.126	0.086	0.069	0.055
87	0.128	0.075	0.121	0.082	0.037	0.027	0.119	0.076	0.110	0.072	0.065	0.039
88	0.134	0.090	0.116	0.068	0.040	0.023	0.124	0.086	0.131	0.086	0.084	0.058
89	0.156	0.111	0.129	0.080	0.043	0.030	0.123	0.074	0.134	0.070	0.076	0.053
90	0.126	0.092	0.133	0.078	0.038	0.023	0.128	0.090	0.133	0.091	0.076	0.049
91	0.162	0.123	0.159	0.123	0.046	0.030	0.152	0.103	0.147	0.106	0.075	0.058
92	0.184	0.119	0.149	0.096			0.140	0.083	0.140	0.091		
93	0.202	0.156	0.161	0.124			0.154	0.126	0.140	0.096	0.071	0.054
94	0.197	0.136					0.140	0.096				
95	0.203	0.153					0.153	0.106	0.138	0.099	0.061	0.048
96												
97							0.127	0.087	0.130	0.096		
98												
99							0.120	0.099				

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2, t, and t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4, t-2, t, t+2, and t+4. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-4, t-2, and t. The second is the average of the age filtered log real wage in years t+2, t+4, and t+6.

Table A4. Number of observations of very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, white male heads in PSID, skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Persis	Stayers	5 yr	Stayers	10 yr	Stayers	Per	Stayers
72	0	0	0	0	0	0	1427	985	0	0	0	0
73	1335	945	0	0	0	0	1485	1008	0	0	0	0
74	1364	980	0	0	0	0	1565	1062	1166	685	1060	581
75	1450	957	1073	651	967	532	1644	1029	1203	683	1086	557
76	1530	1033	1106	667	992	551	1729	1114	1274	721	1145	591
77	1593	1023	1164	643	1034	530	1781	1095	1334	686	1183	569
78	1647	1084	1224	692	1066	537	1850	1193	1388	742	1229	585
79	1698	1033	1258	669	1105	529	1869	1089	1422	715	1254	571
80	1738	1111	1287	683	1134	546	1927	1187	1459	750	1296	601
81	1772	1085	1319	657	1160	515	1966	1168	1478	697	1303	552
82	1805	1100	1335	681	1181	572	2018	1181	1504	730	1338	611
83	1826	1082	1348	649	1200	540	2013	1151	1518	703	1356	588
84	1828	1074	1388	715	1232	603	2023	1139	1569	765	1404	649
85	1828	1075	1418	681	1262	558	2041	1143	1569	733	1401	603
86	1866	1118	1433	760	1278	641	2075	1176	1598	800	1435	678
87	1902	1123	1440	750	1270	634	2152	1208	1615	799	1435	670
88	1989	1242	1477	784	1275	644	2176	1298	1668	834	1456	690
89	1994	1275	1492	780	1290	636	2200	1342	1700	825	1510	690
90	2032	1438	1520	849	1337	701	2255	1533	1697	897	1516	752
91	2020	1443	1509	863	1024	546	2238	1550	1716	929	1174	598
92	2020	1409	1534	957	0	0	2267	1532	1749	1041	0	0
93	2042	1471	1192	755	0	0	2287	1603	1357	828	1236	712
94	2062	1473	0	0	0	0	2308	1594	0	0	0	0
95	1557	1143	0	0	0	0	1838	1300	1394	866	1247	729
96	0	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	2068	1447	1471	914	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	2127	1496	0	0	0	0

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2, t, and t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4, t-2, t, t+2, and t+4. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-4, t-2, and t. The second is the average of the age filtered log real wage in years t+2, t+4, and t+6.

Table A5. Very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, all heads in PSID, not skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Persist	Stayers	5 yr	Stayers	10 yr	Stayers	Persist	Stayers
72							0.073	0.036				
73	0.131	0.075					0.079	0.049				
74	0.132	0.074					0.088	0.051				
75	0.139	0.085					0.092	0.052	0.084	0.049	0.043	0.027
76	0.146	0.080	0.108	0.062	0.009	0.007	0.088	0.054	0.092	0.063	0.046	0.039
77	0.150	0.093	0.106	0.067	0.011	0.007	0.096	0.062	0.090	0.065	0.050	0.045
78	0.159	0.102	0.108	0.071	0.012	0.009	0.102	0.072	0.090	0.061	0.048	0.036
79	0.148	0.097	0.119	0.080	0.013	0.011	0.088	0.055	0.098	0.074	0.049	0.040
80	0.135	0.094	0.123	0.066	0.010	0.005	0.086	0.062	0.099	0.056	0.047	0.036
81	0.148	0.109	0.125	0.065	0.009	0.006	0.101	0.074	0.099	0.058	0.048	0.034
82	0.161	0.101	0.135	0.078	0.013	0.011	0.108	0.065	0.109	0.072	0.054	0.038
83	0.170	0.093	0.133	0.072	0.013	0.009	0.102	0.056	0.104	0.060	0.056	0.037
84	0.189	0.103	0.134	0.068	0.015	0.008	0.122	0.073	0.107	0.060	0.057	0.040
85	0.195	0.088	0.130	0.062	0.017	0.007	0.112	0.056	0.102	0.058	0.050	0.038
86	0.182	0.082	0.132	0.068	0.011	0.008	0.108	0.051	0.103	0.065	0.049	0.034
87	0.160	0.080	0.135	0.067	0.014	0.006	0.098	0.048	0.103	0.055	0.047	0.025
88	0.160	0.081	0.136	0.068	0.014	0.009	0.101	0.057	0.108	0.058	0.050	0.028
89	0.167	0.095	0.147	0.070	0.016	0.008	0.102	0.054	0.117	0.057	0.056	0.033
90	0.165	0.089	0.151	0.088	0.015	0.009	0.107	0.060	0.117	0.069	0.057	0.035
91	0.186	0.113	0.159	0.100	0.013	0.009	0.127	0.071	0.128	0.089	0.065	0.042
92	0.217	0.131	0.164	0.101	0.015	0.008	0.132	0.080	0.128	0.071	0.063	0.037
93	0.238	0.157	0.169	0.095	0.017	0.010	0.139	0.094	0.123	0.065	0.056	0.032
94	0.242	0.147					0.135	0.086				
95	0.238	0.145					0.127	0.074				

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2 through t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4 through t+5. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-5 through t-1. The second is the average of the age filtered log real wage in years t through t+4.

Table A6. Number of observations of very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, all heads in PSID, not skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Per	Stayers	5 yr	Stayers	10 yr	Stayers	Per	Stayers
72	0	0	0	0	0	0	1935	1145	0	0	0	0
73	1825	1127	0	0	0	0	2020	1191	0	0	0	0
74	1851	1136	0	0	0	0	2083	1204	0	0	0	0
75	1933	1102	0	0	0	0	2161	1173	1390	589	1390	589
76	2028	1115	1308	586	1308	586	2259	1191	1424	602	1424	602
77	2107	1134	1334	562	1334	562	2320	1192	1491	590	1491	590
78	2157	1175	1403	560	1403	560	2384	1258	1554	590	1554	590
79	2209	1151	1432	558	1432	558	2423	1199	1583	591	1583	591
80	2263	1180	1466	554	1466	554	2498	1241	1611	572	1611	572
81	2295	1182	1492	556	1492	556	2538	1254	1633	595	1633	595
82	2330	1176	1521	554	1521	554	2561	1246	1658	573	1658	573
83	2354	1158	1532	559	1532	559	2556	1211	1670	579	1670	579
84	2343	1175	1563	573	1563	573	2530	1224	1715	599	1715	599
85	2325	1183	1599	594	1599	594	2561	1251	1752	621	1752	621
86	2369	1209	1645	613	1645	613	2611	1268	1761	636	1761	636
87	2421	1272	1643	654	1643	654	2700	1347	1761	677	1761	677
88	2523	1363	1642	683	1642	683	2713	1402	1795	719	1795	719
89	2518	1439	1643	692	1643	692	2753	1517	1806	726	1806	726
90	2558	1611	1638	702	1638	702	2783	1699	1803	730	1803	730
91	2509	1631	1668	748	1668	748	2728	1717	1779	766	1779	766
92	2453	1573	1676	801	1676	801	2668	1664	1830	842	1830	842
93	2472	1613	1285	665	1285	665	2682	1701	1396	699	1396	699
94	2514	1638	0	0	0	0	2723	1722	0	0	0	0
95	1878	1211	0	0	0	0	2177	1341	0	0	0	0

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2 through t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4 through t+5. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-5 through t-1. The second is the average of the age filtered log real wage in years t through t+4.

Table A7. Very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, white male heads in PSID, not skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Persist	Stayers	5 yr	Stayers	10 yr	Stayers	Persist	Stayers
72							0.058	0.030				
73	0.100	0.057					0.054	0.032				
74	0.100	0.055					0.062	0.036				
75	0.111	0.069					0.067	0.043	0.064	0.039	0.029	0.022
76	0.104	0.063	0.087	0.050	0.008	0.006	0.062	0.040	0.070	0.051	0.033	0.030
77	0.106	0.066	0.080	0.043	0.008	0.005	0.069	0.042	0.068	0.048	0.039	0.035
78	0.123	0.083	0.088	0.054	0.009	0.007	0.076	0.056	0.072	0.049	0.036	0.028
79	0.107	0.068	0.097	0.064	0.010	0.006	0.065	0.039	0.077	0.055	0.038	0.032
80	0.111	0.069	0.100	0.061	0.008	0.005	0.073	0.050	0.080	0.050	0.038	0.031
81	0.129	0.090	0.109	0.055	0.008	0.005	0.086	0.058	0.083	0.047	0.040	0.026
82	0.144	0.094	0.113	0.064	0.010	0.007	0.092	0.055	0.093	0.056	0.046	0.033
83	0.153	0.081	0.117	0.061	0.012	0.009	0.092	0.048	0.091	0.052	0.046	0.032
84	0.165	0.088	0.119	0.067	0.013	0.007	0.103	0.056	0.096	0.055	0.050	0.036
85	0.167	0.078	0.112	0.055	0.013	0.006	0.099	0.048	0.087	0.050	0.044	0.035
86	0.164	0.082	0.112	0.066	0.010	0.008	0.099	0.048	0.089	0.057	0.043	0.028
87	0.138	0.068	0.115	0.062	0.011	0.005	0.085	0.040	0.090	0.052	0.044	0.024
88	0.145	0.074	0.115	0.061	0.012	0.008	0.090	0.054	0.092	0.049	0.044	0.025
89	0.153	0.090	0.126	0.064	0.014	0.007	0.092	0.052	0.103	0.049	0.051	0.030
90	0.145	0.080	0.131	0.066	0.012	0.006	0.094	0.052	0.102	0.052	0.052	0.031
91	0.166	0.099	0.148	0.081	0.012	0.007	0.111	0.060	0.115	0.070	0.056	0.031
92	0.196	0.105	0.153	0.080	0.014	0.007	0.116	0.057	0.115	0.058	0.057	0.030
93	0.223	0.135	0.154	0.081	0.017	0.010	0.125	0.079	0.118	0.059	0.051	0.029
94	0.224	0.125					0.124	0.076				
95	0.230	0.140					0.122	0.074				

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2 through t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4 through t+5. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-5 through t-1. The second is the average of the age filtered log real wage in years t through t+4.

Table A8. Number of observations of very transitory (5-year), transitory (10-year), and persistent volatility measures, log levels and growth rates, white male heads in PSID, not skipping years method.

	Growth Rates						Log Levels					
Year	5 yr	Stayers	10 yr	Stayers	Per	Stayers	5 yr	Stayers	10 yr	Stayers	Per	Stayers
72	0	0	0	0	0	0	1397	847	0	0	0	0
73	1335	834	0	0	0	0	1462	877	0	0	0	0
74	1364	840	0	0	0	0	1537	886	0	0	0	0
75	1450	821	0	0	0	0	1607	866	1073	459	1073	459
76	1530	833	1025	462	1025	462	1691	880	1106	473	1106	473
77	1593	839	1043	431	1043	431	1742	875	1164	449	1164	449
78	1647	868	1107	433	1107	433	1808	925	1224	453	1224	453
79	1698	866	1140	430	1140	430	1836	887	1258	457	1258	457
80	1738	881	1178	429	1178	429	1898	922	1287	444	1287	444
81	1772	894	1206	425	1206	425	1936	942	1319	454	1319	454
82	1805	908	1240	435	1240	435	1962	953	1335	442	1335	442
83	1826	903	1249	440	1249	440	1962	935	1348	454	1348	454
84	1828	911	1277	456	1277	456	1961	945	1388	473	1388	473
85	1828	927	1305	476	1305	476	1985	965	1418	496	1418	496
86	1866	950	1341	499	1341	499	2032	986	1433	516	1433	516
87	1902	990	1348	535	1348	535	2101	1041	1440	552	1440	552
88	1989	1077	1364	565	1364	565	2124	1102	1477	585	1477	585
89	1994	1154	1373	570	1373	570	2151	1205	1492	592	1492	592
90	2032	1295	1385	585	1385	585	2191	1351	1520	606	1520	606
91	2020	1303	1418	629	1418	629	2182	1367	1509	644	1509	644
92	2020	1290	1424	673	1424	673	2181	1357	1534	702	1534	702
93	2042	1329	1102	567	1102	567	2191	1392	1192	590	1192	590
94	2062	1346	0	0	0	0	2216	1407	0	0	0	0
95	1557	1015	0	0	0	0	1750	1102	0	0	0	0

Notes: (1) Very transitory earings volatility in year t equals the variance of age filtered log real wage in years t-2 through t+2. (2) Transitory earnings volatility in year t equals the variance of age filtered log real wage in years t-4 through t+5. (3) Persistent earnings volatility in year t equals the variance of two numbers. The first is the average of the age filtered log real wage in years t-5 through t-1. The second is the average of the age filtered log real wage in years t through t+4.

Figure 1. Very transitory volatility of log real earnings in the PSID (skipping years method)

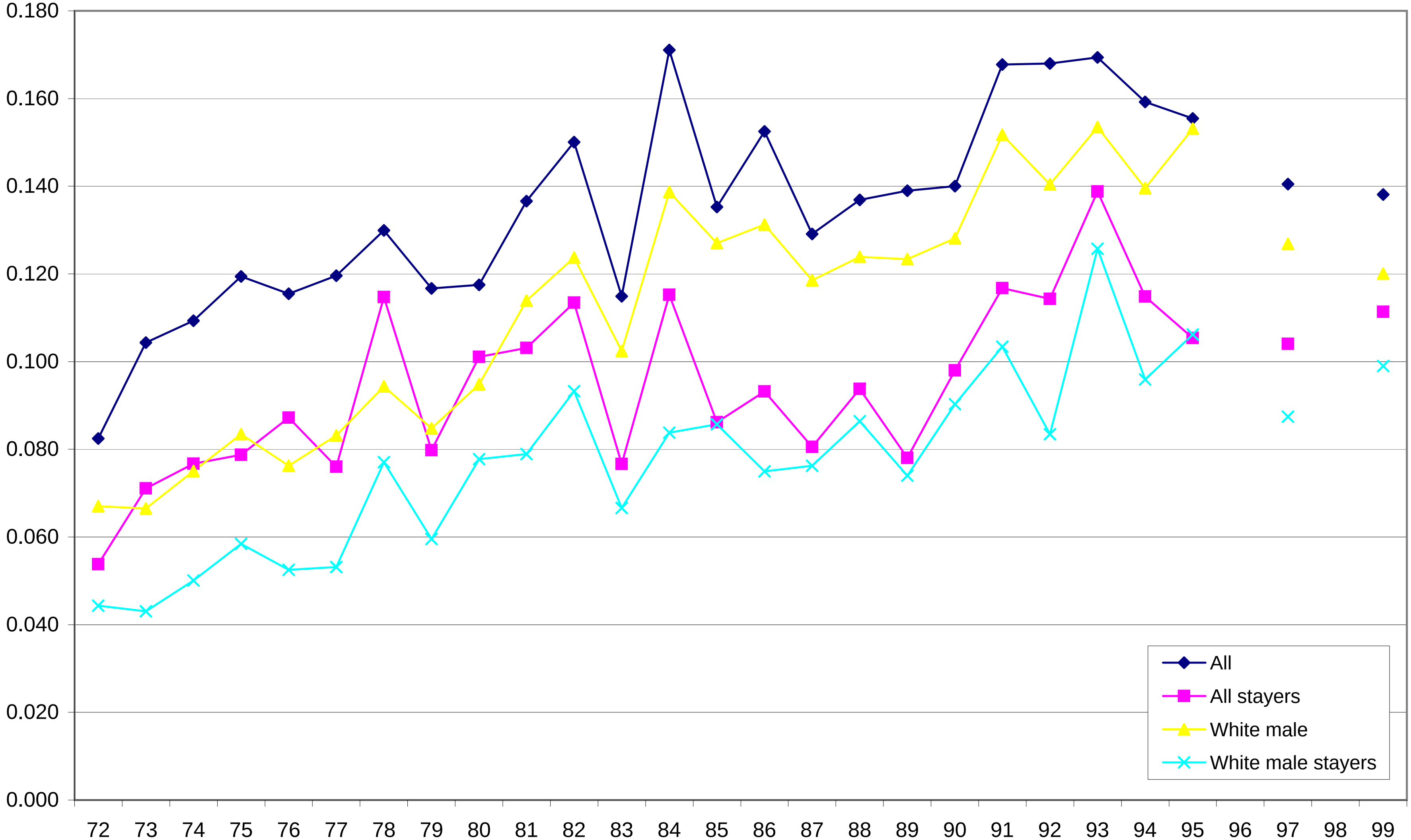

Figure 2. Transitory volatility of log real earnings in the PSID (skipping years method)

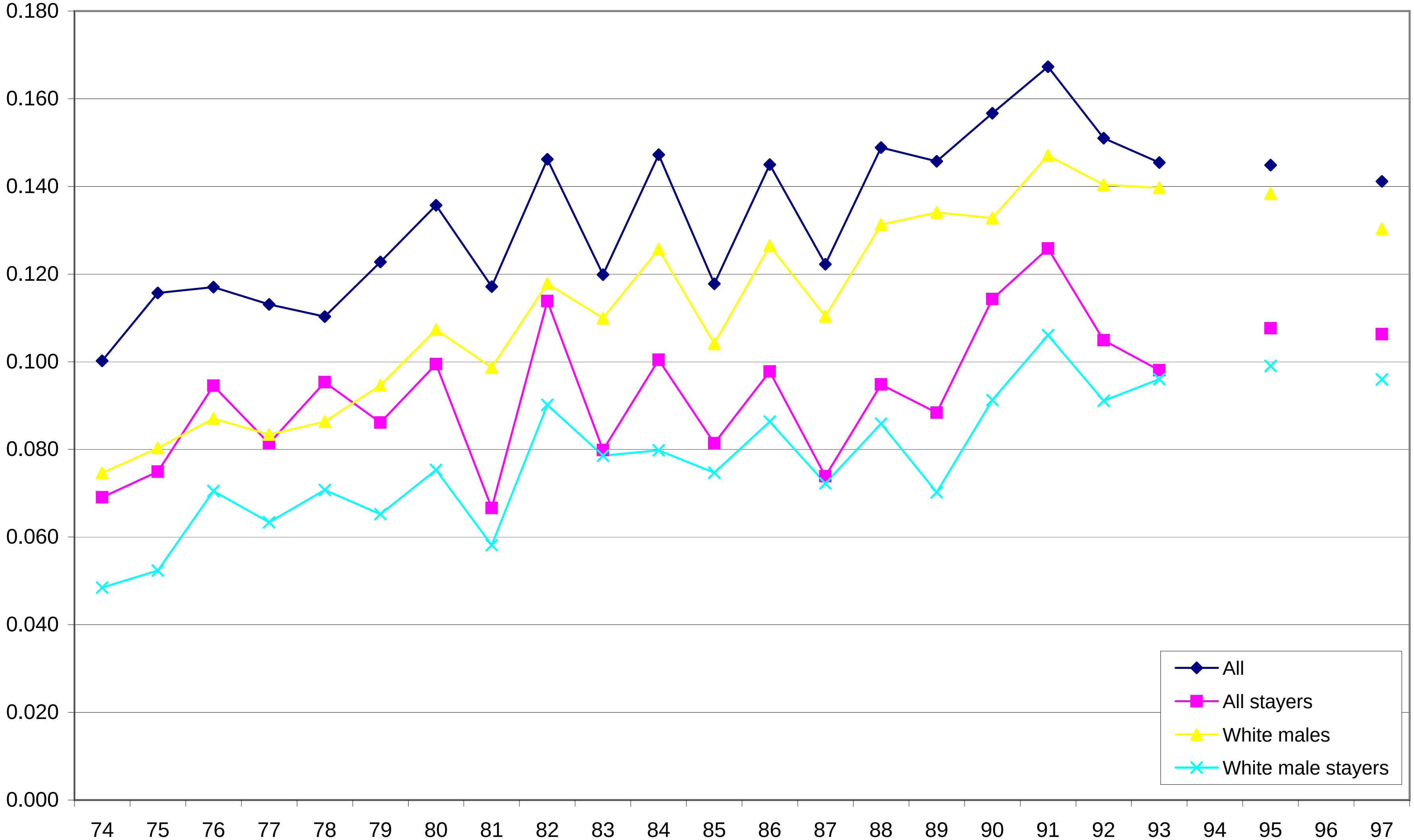

Figure 3. Persistent volatility of log real earnings in the PSID (skipping years method)