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Turbulent Firms, Turbulent Wages?
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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 [2005] among others. After examining models that explain the relationship between firm and wage volatility, we investigate the linkage in three complementary panel data sets, each with its own virtues and limitations: the Panel Study of Income Dynamics (detailed information on workers, but no information on employers), COMPUSTAT (detailed firm information, but only average wage and employment levels about workers), and the Federal Reserve Bank of Cleveland's Community Salary Survey (wages and employment for specific occupations for identified firms). We find complementary support for the hypothesis in all three data sets. We can rule out straightforward compositional churning as an explanation for the link to firm performance in high-frequency (over spans of 5 years) wage volatility, although not in more persistent fluctuations (between successive 5-year averages). We conclude that the rise in firm turbulence explains about sixty percent of the recent the rise in the high frequency (5-year) volatility of wages.

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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], Cheney et al. [2003] and Comin and Philippon [2005] finds that the volatility of firm-level performance, 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.

With regard to theory, we present two classes of models with different interpretations of the nature of the rise in average wage volatility in firms. First, we consider a model where the linkage

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[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.

arises because firms are sorted by skill and are subject to firm-specific shocks that alter their skill profiles. In this context, an increase in firm turbulence causes more frequent compositional changes within firms, leading to more volatile average wages. In this case, controls for human capital and compositional volatility should eliminate the link between firm and wage turbulence. Alternatively, a wide range of richer wage-setting models predict that compensation of incumbent workers should be linked to firm performance. If so, wage premia linked to firm performance will become more variable as firm performance becomes more volatile. Our empirical exercise finds evidence of the link and then tests the first interpretation of this link against the alternative models (taken as a group).

This line of reasoning may have important implications for our perception of labor market institutions. Models of wage setting that predict an association between wages and firm performance underlie the concept of internal labor markets. Internal labor markets have often been regarded as a welfare-enhancing institution because they can insulate workers from temporary aggregate fluctuations and encourage the development of firm-specific skills. On a national level, GDP volatility has declined dramatically since the early 1980s (McConnell and Perez-Quiroz [2000]). Ironically, as firm volatility has risen, the same shielding that once protected workers from large macro fluctuations may now work to allow firms to share their idiosyncratic risk. That is, firms may now rely on wage or job fluctuations to smooth profitability in a riskier marketplace.

Investigation of this question requires information on both employers and their employees. As such data are rare, we take a mosaic approach—investigating the relationship in three complementary panel data sets, each with virtues and limitations. Two of these data sets are well known: the Panel Study of Income Dynamics (PSID, a household survey with detailed information on workers) and COMPUSTAT (detailed firm information taken from corporate reports). The more unusual source is the Federal Reserve Bank of Cleveland's Community Salary Survey (CSS), which reports wages and employment levels for detailed occupations for identified firms. These latter data allow us to test the relationship between firm and employee compensation volatility most conclusively.

We begin by examining the PSID. Echoing Gottschalk and Moffitt, but focusing on continuing workers, we find that wages for U.S. workers who did not change jobs saw rising

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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].

volatility in their earnings from 1970 to 1993. This rise in transitory variation remains evident when we expand the sample beyond white men. However, the PSID cannot link a worker's wage volatility to the performance of his or her employer.

Next, we explore whether workers' average pay is more volatile in firms that have experienced higher turbulence in sales, employment or profits. Using the COMPUSTAT data set for the period 1950 to 2003, we find that this is the case, even when we control for firm characteristics, including growth, size, age, or firm-specific fixed effects. Furthermore, this effect is strong; about half of the rise in average wage variance is due to rising firm volatility. However, this evidence of a correlation between firm and wage volatility is necessarily circumstantial because a change in average pay in a firm 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. While controlling for firm growth provides partial control for this effect, firms could still up- or down-skill their workforce substantially without changing size.

To nail down the link between wage and firm volatility, we turn to the Federal Reserve Bank of Cleveland's Community Salary Survey (CSS), which tracks wages for detailed occupations in a sample of firms in Cleveland, Cincinnati, and Pittsburgh. In this survey, we find clear confirmation that average and occupation-specific wages in firms are more volatile when firm employment is more volatile. This relationship applies to detailed definitions of occupation and is robust to the addition of controls for changes in occupational employment levels at that firm. Thus, the linkage 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. Absent any change in employment contracts or the variability of labor supply, rises in wage volatility will reflect increased demand volatility. We test whether employment contracts now transmit a larger share of demand shocks to wages and find only mild statistical evidence that they have changed. 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 by occupation, industrial sector, firm size, or over time. The purpose of this exercise is to establish that the effect is pervasive and to further describe its impact on the labor market and economy in general. We find that the positive effect of firm volatility on average wage volatility holds for manufacturing and non-manufacturing firms; for small and large firms; for white-, blue-, and pink-collar occupations; and before and after 1980.

The structure of this paper is as follows. In Section 2 we present various simple models that illustrate why firm volatility may affect wage volatility. Section 3 describes the data sets and measures of volatility. Section 4 documents recent trends in volatility in wages and firm performance in the PSID and COMPUSTAT. Section 5 presents the empirical analysis of the link between firm performance and wage volatility. Section 6 discusses the results further, and Section 7 concludes.

2. Models

This section reviews three models of wage determination. The first model, a perfectly competitive market where firms are sorted by occupation, predicts a relationship between the volatility of average wages and firm performance when firm-specific shocks alter firms' skill sets. The other two models do not rely on compositional changes for their predicted positive relationship. This difference in predictions permits us to informally test the first model against the other two. Our analysis, however, does not intend to determine which of the latter two models provides a better description of the data. Indeed, other models also deliver this result. Our intention, rather, is to underline the generality of the prediction that a rise in firm volatility is likely to raise wage volatility.

Indeed, since the U.S. labor market is an amalgam of many different submarkets, the link between firm and wage volatility could well result from different mechanisms in different sectors.

2.1 Perfectly competitive labor markets

We begin by considering a perfectly competitive labor market. Every period *t*, a continuum of firms indexed by *f* experience a productivity shock, A_{ft}, and decide how many workers to hire at the competitive wage rate, w_t, in order to maximize their profits. Without loss of generality, we suppose that the shock $A_{ft}=A_t*a_{ft}$, where A_t is an aggregate shock and a_{ft} is an orthogonal firm specific shock such that $\int_0^1 a_{ft}^{1/(1-\alpha)} df = 1$.

Each firm has access to the following production function:

$$y_{ft} = A_{ft} l_{ft}^{\alpha}, \alpha \in (0,1) \ ,$$

where y_{ft} is the firm's output and l_{ft} is the number of workers it employs. In this context, firm *f* demands $l_{ft} = (\alpha A_{ft} / w_t)^{1/(1-\alpha)}$ units of labor.

To close the model, suppose that there is a fixed aggregate supply of l_t workers. Then the equilibrium wage rate is $w_t = \alpha(\int_0^1 A_{ft}^{1/(1-\alpha)} df)^{1-\alpha} l_t^{-(1-\alpha)} = \alpha(A_t / l_t)^{(1-\alpha)}$. Substituting back into the firm's labor demand, it follows that $l_{ft} = a_{ft}^{1/(1-\alpha)} l_t$.

Two conclusions follow from these expressions. First, under perfect labor markets, wages depend only on aggregate conditions. Second, each firm's employment depends on its specific shocks.[4] As a result, the variance of the average wage paid by the firm is independent of the variance of firm's employment.

This benchmark, however, may be seen as a straw man since there is no heterogeneity in the average wage paid in firms. To extend this model to include wage differences among firms, we focus on two firms with two types of labor. One firm produces a high-price good and employs highly skilled labor, while the other produces a low-price good using unskilled labor. Both firms are price-takers. In the labor market they pay wage rates w_s and w_u for skilled and unskilled workers,

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[4] Of course, shocks to aggregate labor supply induce a negative co-movement between wages and employment at the firm level that could translate into a positive correlation between their variances. This is highly unlikely, however, because the variance of aggregate labor supply is orders of magnitude smaller than the variance of employment or wages at the firm level.

respectively. In the goods markets they receive a price p_s or p_u for a unit of high- or low-price output, respectively. For simplicity, suppose that there are no aggregate shocks and that firms have access to the following production function:

$$y_f = l_x^{\alpha} ,$$

for $x=\{s,u\}$.

In this context, the number of employees hired by the high- or low-price firm are respectively $l_s = (\alpha p_s / w_s)^{1/(1-\alpha)}$ and $l_u = (\alpha p_u / w_u)^{1/(1-\alpha)}$. The average wages paid are w_s for the high-price firm and w_l for the low-price firm. Note, therefore, that this sorting of skills among firms generates firm-level variation in average wages.

To explore the implications for second moments, suppose that the two firms flip the good they are producing with a Poisson probability λ per instant of time. Then, the time-series variance in the log of the average firm-level wage is $V(\overline{w}) = \lambda(\ln(w_h / w_l))^2$, while the variance in the number of employees at the firm level is $V(l) = \lambda(\ln(l_s / l_u))^2$.

It follows from these expressions that firms with higher turnover, or more creative destruction, (i.e., with higher λ) will experience higher volatility in both employment and average wages. Note, however, that the connection between firm-level performance and average wage volatility arises only because of changes in the composition of the labor force in the firm, not because individual workers' wages became more volatile. If the labor mix used to produce both types of goods were the same, there would be no variation in the average wage paid in the firm over time. In other words, under perfectly competitive labor markets there is no connection between firm-level employment variance and firm-level average wage volatility after controlling for changes in the composition of employment within firms.

2.2 Relative performance evaluation

The second framework we explore is a version of the Holmstrom [1982] agency model with multiple agents that face correlated productivity shocks. More specifically, suppose that every firm, *f*, employs a continuum of workers indexed by *i*. Worker *i*'s output is $y_i=e_i+a_i+a_f$, where e_i is her effort, a_i is an i.i.d., normally-distributed, zero-mean worker-specific productivity shock, and a_f is a firm productivity shock that follows a random walk with normally-distributed innovations. The worker's utility is given by $U = -e^{-r(w-c(e_i))}$, where *r* is the worker's coefficient of absolute risk aversion, and

$c(e_i)$, with $c'>0$ and $c''>0$, is the worker's monetary equivalent to the cost of exerting effort e_i. The principal determines the compensation scheme offered to the worker and how many workers to hire every period. He makes these decisions before the realization of shocks. The principal accrues profits at a rate given by the following expression: $\sum_{j=1}^{l_t}(y_j - w_j) - l_t^{\varsigma}/\varsigma$, with $\varsigma > 1$.

In this context, the optimal linear[5] compensation scheme for worker i depends both on his output and on the average of the other workers output in the following way: $w_{it} = w_0 + by_i - dy_{fi}$, where $1>b>d>0$, and $y_{fi} = \sum_{j\neq i} y_j/(l_t - 1)$. In general, the optimal loading on the average output of the rest of the workers is determined by trading off the reduction in noise from making the compensation orthogonal to a_{ft} with the additional noise introduced through the (non-zero) sample average of the other workers' idiosyncratic shocks. Because of this second effect, the weight on the other workers' average output is smaller than the weight on the worker's own output (i.e. $b>d$).[6]

Substituting in the expressions for y_i and y_{fi}, it follows that $w_{it} = w_0 + b(e_i + a_{it} + a_{ft}) - d(\sum_{j\neq i} e_j + a_{jt} + a_{ft})/(l_t - 1)$. In addition, the level of effort exerted by the workers, e^*, is implicitly defined as

$$b = c'(e^*).$$

As a result, in the symmetric equilibrium, the realized average wage is $\overline{w}_t = w_0 + (b-d)(e^* + \sum_{j=1}^{l_t} a_{jt}/l_t + a_{ft})$.

At the beginning of the period, the principal expects to pay an average wage $E_{t-1}\overline{w}_t = w_0 + (b-d)(e^* + a_{ft-1})$ and will hire $l_{ft} = ((1-b+d)(e^* + a_{ft-1}) - w_0)^{1/(\varsigma-1)}$ workers.

A number of interesting conclusions emerge from this model. First, contrary to the perfect competition baseline, a worker's wage depends on the firm-specific shock, a_f, with a one-period lag. Second, the number of workers employed by the firm also depends on a_{ft-1}. Third, it follows that the time-series variance of both employment and average wage of any firm increases with the time-series variance of a_f. Therefore, the firm-level volatility of employment and of wages are positively correlated even after controlling for the composition of employment in the firm.[7]

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[5] Holmstrom and Milgrom [1987] provide conditions under which this linear schedule is globally optimal.

[7] A similar result holds when there is a continuum of workers in the firm but the principal is also risk averse.

2.3 Bilateral monopoly

Next, consider a bilateral monopoly, where wages are determined at the firm level. This situation may arise for various reasons. For example, unions may have the legal right to approve the wage offered by the firm or, alternatively, workers may acquire some specific human capital that makes their marginal product in the firm higher than in the market. In any case, the union and the firm (Nash) bargain over the wage received by each worker after observing the firm-specific productivity shock, a_{ft}. Then the firm decides how many workers to hire at the agreed rate. The workers' outside option is $\underline{w}$; we also assume that if there is no agreement in the bargain, then the firm cannot produce. The firm's production function is $y_{ft} = a_{ft} l_{ft} - l_{ft}^{\varsigma} / \varsigma$, with $\varsigma > 1$.

In this context, the wage rate paid at firm *f* is $w_{ft} = (a_{ft} + \underline{w})/2$, and firm *f* hires $l_{ft} = (a_{ft} - w_{ft})^{1/(\varsigma-1)} = ((a_{ft} - \underline{w})/2)^{1/(\varsigma-1)}$ workers at time *t*.

In these expressions we see that both wage and employment depend on the firm-specific shock. Therefore, the variance of firm employment and the variance of the firm's average wage will be positively correlated. Note that, unlike the firm model, this correlation should be robust to controlling for compositional change within the firm.

2.4 Other models

The relative performance evaluation and bilateral monopoly models presented above are a subset of the many models that predict that greater firm instability raises wage volatility for incumbent workers. For example, two additional models also deliver this prediction. First, consider a situation where firms face liquidity constraints that are less binding when sales are high (as in Gertler and Gilchrist [1994]). As a result, both the wage paid to the average worker and the number of employees may co-vary with sales, since the relaxation of the borrowing constraints allows the firm to increase wages and hire more workers. Second, consider a search model similar to Mortensen and Pissarides [1994] with firm-level shocks. In this context, the insulation induced by the search frictions may force both workers and firms to accommodate the fluctuations in the value of their match.[8]

[8] Note that in a standard search framework, that may be the case even in the absence of agency considerations or hold ups.

All these models demonstrate the generality of the result that firm volatility leads to wage volatility outside of perfectly competitive labor markets. In addition, the models provide some useful theoretical benchmarks for interpreting the results that follow.

3. Measures and Data

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

3.1 Measures of volatility

Our analysis focuses on the volatility of the following variables:

- log annual earnings of a worker,
- log average wage paid in a firm or in an occupation within a firm,
- log number of employees in a firm, and
- log sales and profit-to-sales ratio in a firm.

We use the first two to measure wage turbulence, while the others are used to measure 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, firm-specific or occupation-firm-cell averages. Therefore, its evolution over time controls for major compositional biases. Applied to wages, this time-series variance captures what Gottschalk and Moffitt 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 or firms in a given year, we compute either the simple average or the weighted average of the individual measures of volatility. As weights we use the share of employment or sales in the firm or in the occupation-firm cell in total employment or sales in the year.

3.2 Data

The three data sources we use are compared in Table 1. The Panel Study of Income Dynamics (PSID) and COMPUSTAT data sets are well-studied, long-lived panels of individual and firm-level data. For this reason, we devote more time to describing the Community Salary Survey (CSS). Note that for each wage series we convert to real wages using the GDP 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.[9] 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

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

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, profits, 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.

The annual Community Salary Survey (CSS) was conducted by the Federal Reserve Bank of Cleveland personnel department in order to formulate its yearly salary budget proposals.[10] We use the years 1979 through 1999. The CSS contains wage and employment information from employers in Cleveland, Cincinnati, and Pittsburgh.

The companies represented are large, stable employers that wanted to be good corporate citizens or have access to wage information from other local employers.[11] The Federal Reserve Bank's personnel department offered participation to firms they considered representative of large employers in each city. The industries included vary widely; the main criterion is that the local employer had a large number of occupations that match those covered by the survey. Once they joined, most employers continued to participate for several decades. During the years included here, the CSS covers an average of 107 employers per year.

Employers judge which of their establishments to include in the survey. Some employers include all branches in the metropolitan area, while others report wages for a single facility. The reference unit selected by the employers is consistent over time. We use the terms firm and employer interchangeably to mean the employing firm, establishment, division, or collection of local establishments for which the participant reports wages. This ambiguity is not problematic because it allows participating firms to include all the units for which wage and personnel policies are administered uniformly.

We use detailed occupational codes to control for human capital. In predicting wages, the R^2s yielded by occupation alone in the CSS are typically two to three times that yielded by the

[10] Groshen [1996] and Levine et al., [2002] describe the CSS data in more detail.
[11] In return for their participation, surveyed companies received result books for their own use.

demographic, education, and broad (1-digit) occupation controls typically found in household data such as the Current Population Survey or PSID. Moreover, in the CSS, the returns to working in occupations that typically require more education have risen in tandem with the economy-wide rise in the returns to education (Levine et al. [2002]).

The surveyed occupations are office, maintenance, technical, supervisory, and professional personnel. External markets are well developed for these occupations because they are needed in all industries. Production jobs, which would be specific to a single industry, are not covered. Many jobs are further divided into a number of grade levels, reflecting responsibilities and required experience. Job descriptions for each are quite detailed and at least two paragraphs long.

For the analysis below, the unit of observation is the occupation within the employer, which we refer to as a "cell". For each of these occupation-employer cells, we have the log of the mean wage and the number of workers. The wages reported are the annual salary of each worker in the cell. Cash bonuses are included as salary, but fringe benefits and any overtime pay are not. For some of the analysis we also aggregate up to the employer level for all workers in the surveyed occupations.

The CSS covers between 43 and 100 occupations each year; each employer reports wages for an average of 28 of these. Employers have an average of seven incumbents in each job title. Employers in the CSS that also list employment in the COMPUSTAT database have a median employment of 10,250. Roughly a quarter are unionized.

To measure the volatility of wages and employment at the firm level we aggregate over all observed cells. While this approach omits volatility experienced by non-observed occupations, it should capture the effect of major firm-wide fluctuations.

The CSS offers a unique window into the structure of wages. Rather than a representative sample of working individuals, as in the PSID, a salary survey is a census of individuals working in selected occupations at selected employers. Thus, unlike a household survey, the CSS permits us to investigate wage variations within and between occupations and employers. However, since the CSS does not have identifiers for employees, we cannot follow a particular employee's pay over time. Thus, we observe the path of average wages and employment in firms for narrowly defined skill levels, rather than individual workers' careers.

4. 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.

4.1 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 our other data sets, we also examine the effects of alternative controls for age and of the application of demographic weights. We find that the upward trend in transitory earnings volatility is quite robust, particularly to variants in controls for age and sample definitions.

First we repeat the GM exercise in a way as comparable as possible to our analysis of COMPUSTAT and the CSS. One adjustment concerns the GM control for age. The 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. We explore three filtering schemes to control for worker attributes. First, we do not remove the age effects at all. Second, similar to GM, we estimate two quartic regressions, one prior to 1980 and the other for earnings after 1979. Third, we estimate a different age profile for each year.

An additional effect we consider is the incorporation of 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 2 reports the average volatility of earnings of white male heads of households in two non-overlapping ten-year periods, 1970-1979 and 1984-1993, for the various age-adjustment and weighting schemes.[12] Specifically, the first two rows report the variance of log real annual transitory earnings over the two periods. The third row contains the increment in the variance of transitory earnings, and the fourth and fifth rows report the percent increase computed as the change in the log of volatility and as the increment divided by the volatility of the first period. For brevity, we

[12] The use of demographic weights affects the volatility of earnings for white males because, in addition to varying by race and gender, they also vary by age.

discuss only the first measure of the percent increment in volatility, although we report both in the table.

There are three 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 4.5 to 8 percentage points represents an increase of 33 to 50 percent in the variance of log wages. Second, the increase is robust to the various age-filtering schemes and to the use of demographic weights. In particular, omitting the age adjustment does not lead to an upward bias on estimates of the rise in earnings volatility. Finally, 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 2 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 aggregated with demographic weights.

The first two rows of **Table 3a** report the average variance of very transitory earnings in the two non-overlapping 5 year periods in the intervals 1970-1979 and 1984-1993. The average variance of very transitory real earnings increased by 3.3 to 4.9 percentage points for white male heads of households and by about 2.5 percentage points for white male heads of household who did not change jobs. **Table 3b** reports the evolution of the variance of persistent earnings between the periods 1970-1979 and 1984-1993. The increment for all white male heads of household is 2.2 to 3.8 percentage points, while for job-stayers the variance of the persistent component of earnings increased by 1 to 4.6 percentage points.

Adding these up, 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 and CSS data, which cover firms and occupations with no demographic limitations. Thus, we extend the analysis of volatility trends to all the race and sex groups in **Tables 4a** and **4b** using the PSID demographic weights and the annual age adjustment. Results are similar for other variants.

Table 4a shows the evolution of the variance of very transitory real earnings for individual five-year periods between 1970 and 1993. See **Figure 1** for a plot of the evolution of very transitory earnings volatility for overlapping intervals in the period 1970-1993 for the various demographic groups. The first two columns of **Table 4a** show that the increase in the variance of very transitory real earnings is largely monotonic. 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 7.1 percentage points for all white males and by 5.4 percentage points for the subset that did not change jobs.

The third and fourth columns of **Table 4a** repeat the latter exercise for all heads of household. Despite differing initial levels of volatility, the evolution of very transitory earnings volatility for all heads of household is quantitatively and qualitatively similar to the path for white male heads. Finally, in the last two columns of **Table 4a** we focus on heads of household that live in Kentucky, Ohio, or Pennsylvania--the geographic coverage of the CSS data set. Again, the evolution of the variance of the very transitory earnings in these states is similar to that in the whole sample.

Table 4b reports the evolution of the variance of the persistent component of earnings for three overlapping period in the same groupings as shown in Table 4a with similar results. The increase in persistent earnings variance is also monotonic, as seen in **Figure 2**, which plots the variance of the persistent component of the log of real earnings for white male heads of household for the overlapping 10 year intervals in the period 1970-1993.

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 forms of control for age and to restriction to the three states covered in the CSS. Furthermore, the very transitory and more persistent components both play a role in the rise of wage volatility.[13]

4.2 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] and Cheney et al. [2003] find that the sales and employment of the average firm have become increasingly volatile in the 50 years since the end of WWII, even as the

[13] Recent preliminary work by Gottschalk and Moffit supports this view by showing that transitory wage volatility in the PSID continued to increase through 2002, the lastest year available.

aggregate economy has become more stable. More specifically, for each firm in COMPUSTAT, Comin and Mulani [2004] compute the variance of the firm's annual growth rate of real sales or employment 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 weighting the firms' volatility measures by their share in total sales or in total employment, to computing the median firm volatility instead of the average (Comin and Philippon [2005], Cheney et al. [2003]), 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]).[14] The magnitude of the increment in volatility is quite robust to almost all of these variations. The exception is the weighted firm volatility without controls, which we discuss below.

We start by showing the trends in the volatility (very transitory and persistent) of three measures of firm performance: log employment, log real sales, and the profit-to-sales ratio, all at the firm level. We aggregate firm-level volatility measures by computing either the simple mean or the mean weighted by each firm's annual employment share. **Figure 3** shows the evolution of these measures of firm-level volatility in the COMPUSTAT sample covering the period 1950-2003. In addition, **Table 5** reports levels of these measures of volatility at the beginning, middle, and end of the covered period.

Several facts emerge from **Figure 3** and **Table 5**. Between 1950 and the mid-1970s the very transitory and the persistent variances of employment, real sales, and profits increased only modestly, if at all. Thus, fluctuations in firm volatility during that time dominated any trend. Since the mid-1970s, however, both the very transitory and the persistent variances of firm employment and sales show a steep upward trend. The unweighted very transitory volatility of employment and sales has increased by between 9 and 12 percentage points, while the weighted measures have increased by between 2 and 2.5 percentage points. Persistent volatility measures have also clearly increased. The unweighted persistent variance of employment and real sales increased by about 11 percentage points, while the weighted persistent variance increased by between 2.5 and 5 percentage points.

COMPUSTAT's information on the total wage bill of firms allows us to construct a series of the average wages paid by firms. **Figure 3** and **Table 5** track the evolution of the very transitory and persistent variances of the firm-level average wage in the COMPUSTAT sample. The most striking

[14] 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.

fact about the evolution of the volatility of firms' average wages is its similarity to the evolution of the volatility of firm-level employment, sales, and profits. In particular, the very transitory and persistent variances of firm-level average wage are roughly flat until the early 1970s and trend upward afterward. The weighted and unweighted very transitory variances have increased by 3 and 11 percentage points, respectively. The weighted and unweighted persistent variances of firm-level average wages have increased by about 1.5 and 3 percentage points, respectively.

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.

4.3 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:

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

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:

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

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.

This is a non-trivial question since COMPUSTAT is comprised mostly of very large firms. In 2001, 50 percent of U.S. employees worked for firms with 500 employees or more. In the COMPUSTAT sample, instead, over 99 percent of employees worked in firms with over 500 employees. These large firms represented 50 percent of all firms in our COMPUSTAT sample. Crucially, as shown in **Figures 4A** and **4B**, firm volatility rose substantially more in small firms. As a result, the increment in the weighted average firm-level volatility in COMPUSTAT underpredicts the rise for the US as a whole.

Comin and Mulani [2004] filter the effects of size, age, and a firm-specific constant from the firm-level measures of volatility in COMPUSTAT. After making these corrections, the resulting weighted and unweighted series for firm-specific volatility are very similar to the series for the un-weighted average firm-level volatility.

This exercise suggests that the evolution of unweighted average firm-volatility in the COMPUSTAT sample provides a better fit (in magnitude and path) for firm volatility in the US economy than does the weighted version. Unweighted COMPUSTAT results emphasize the contribution of smaller firms, compensating for their lack of representation in the COMPUSTAT sample. Assigning the same weight to the volatility measures of each COMPUSTAT firm yields a total weight for small firms close to their employment share in the U.S.

For completeness we provide both weighted and unweighted measures in our tables. We draw on both these estimates by averaging the two. Given our previous discussion, we believe this to be a conservative estimate of the increment in firm volatility in the US economy.

The two samples overlap between 1970 and 1993. Between 1970 and 1993, the very transitory variance of real earnings for workers that did not change jobs in the PSID has increased by 5.6 percentage points, while the persistent variance has increased by 2.1 percentage points (see **Tables 6A and 6B)**. On an annual basis, the increments of the very transitory and persistent individual wage volatility have been, respectively, 2.4 and 0.9 tenths of one percentage point.

Between 1970 and 2002, the unweighted very transitory variance of the firm-level average real wage in COMPUSTAT increased by 10.9 percentage points, while the weighted very transitory variance increased by 2.8 percentage points. As can be seen in **Figure 4**, the size of the increments is sensitive to the end-dates chosen, so we choose a long span in order to smooth over the longest period of time.[15] For comparability, we annualize the increments from each data series in the fourth

[15] This strategy is also motivated by very recent analysis conducted by Gottschalk and Moffit that shows that transitory volatility of individual earnings in the PSID has continued to increase up to 2002, the last available year.

row of **Table 6A**. The annual increment in the very transitory volatility of the average wage paid in the firm is 3.4 tenths of one percentage point for the unweighted measure and 9 tenths of one percentage points for the weighted. Based on our previous discussion, we conservatively attribute 88 percent of the increase in the very transitory variance of individuals earnings in the PSID to the increase in the variance of the firm-level average wage paid.

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 (see **Table 6B**). In particular, the unweighted persistent variance of the firm-level average wage increased by 0.03 percentage points per year between 1970 and 2002, while the weighted persistent variance increased by 0.11 percentage points per year. These magnitudes are robust to the variation in the upper margin of the interval. By averaging and annualizing the weighted and unweighted increments, we find that our preferred point estimate for the annual increase in the persistent volatility in firm-level average wages is 7 tenths of one percentage point. This represents 78 percent of the annual average increase in the persistent variance of log earnings in the PSID between 1970 and 1993. Therefore, the increase in the firm-level variance of average wages can in principle be an important part of the increase in the persistent variance of workers' earnings.

These aggregate time series tests support the hypothesis that a very sizeable portion of the increase in transitory wage inequality documented by Gottschalk and Moffitt [1994] reflects higher volatility of the average wage paid in firms. Next, we use panel evidence to evaluate the hypothesis that this is driven by higher firm instability.

5. Determinants of wage volatility in firms

5.1 Determinants of firm-level average wage volatility—COMPUSTAT results

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

$$V_{lwft} = \alpha + \beta V_{lxft} + \gamma X_{ft} + \varepsilon_{ft}, \tag{3}$$

where V_{lxft} is the very transitory variance of a measure of firm performance (employment, sales of profits) 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 both with and without weighting each observation by their share in total employment. **Table 7** reports estimates for various specifications and weighting schemes.

The first six columns of **Table 7** report the coefficients on employment, sales, and profit rate 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 these three variables.

This positive association persists with the addition of several relevant controls, as shown in columns 5 through 8. 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 employment 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. However, neither of these effects diminishes the coefficient on firm volatility.

A third addition, the growth rate of employment in the firm during the relevant 5-year period, controls for compositional changes that affect firm size. Certainly, firms that substantially change size have altered their workforce in some way. We find that wage volatility is lower in fast-growing firms. Controlling for this effect, however, does not affect the magnitude or significance of the association between average wage volatility and employment, sales or profit volatility at the firm level. The relationship between wage turbulence and firm turbulence is, thus, unaffected by the more stringent control for compositional change in the workforce.

The upward trend observed in both employment and wage volatility invites us to add time trends and year fixed effects to show that the positive association between wage and employment volatility is not driven by a spurious correlation. **Table 8** shows that the strength and statistical significance of this association is unaffected by adding a time trend or time dummies.

Another important concern is whether the positive relation between wage and employment volatility results from the differences among firms or from changes within firms. If the co-movement is driven by between-firm variation, the increase in wage volatility could result from a change in the composition of the COMPUSTAT sample towards more volatile firms. By contrast, if 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. Then, the increase in turbulence experienced by the median firm would drive the increase in transitory wage volatility.

To estimate the within-firm association between wage and firm volatility we introduce firm-specific fixed effects in our regression:

$$V_{lwft} = \alpha_f + \delta t + \beta V_{lxft} + \gamma X_{ft} + \varepsilon_{ft} \qquad (4)$$

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 **Table 9**). Thus, we conclude that this association is driven predominantly by within-firm co-movements between wage and employment volatility.

The effect of employment volatility on the volatility of firms' average wages is not only statistically significant but very sizeable. To see this, consider the evolution of employment volatility at the firm level in **Figure 3**. In 1952, the average very transitory variance of firm-level employment was 0.029. In 1970, it was 0.014. In 2002, it was 0.139. Since the coefficient of the variance of employment in regression (1) is 0.57, the increase in firm volatility accounts for a decline of 0.8 percentage points in the variance of the average wage at the firm level between 1952 and 1970 and for an increase of 7 percentage points in average wage volatility between 1970 and 2000. This predicted evolution slightly over-predicts the decline in average wage volatility between 1952 and 1970 (0.8 vs. 0.4 percentage points) and slightly under-predicts the increase in wage volatility over the last 30 years (7 vs. 11 percentage points). Therefore, firm volatility accounts for a substantial part of the evolution of very transitory average wage volatility and specifically for its increase in the last 30 years. Note that this finding is not driven in any way by the design of our analysis since we include time trends in our regressions.

The importance of the effect of firm volatility on employment volatility remains if we focus on the weighted regressions. The weighted variance of firm-level employment declined by 1 percentage point between 1952 and 1970 and increased by 2.3 percentage points between 1970 and 2002. Given the estimate of β from the weighted regressions, it follows that equations (3 and 4) can predict a decline in average wage volatility between 1952 and 1970 of 0.7 percentage points (vs. 0.4 in the data) and an increase between 1970 and 2002 of 1.2 percentage points (vs. 2.7 in the data).

Alternatively, we can compare the size of the effect to the rise in transitory volatility observed in the PSID. The first column of **Table 10A** reports the increase in very transitory earnings volatility from the PSID. The other two columns report the increment in the unweighted and weighted very transitory firm-level volatility of log employment and the predicted increment in the very transitory volatility of average wage at the firm-level based on our estimates from regression (4). Firm volatility can account for about one fourth of the annual increment in very transitory individual earnings volatility using the weighted firm-volatility measure and for the full increase in wage volatility using the unweighted measure. Averaging between these two estimates as a conservative adjustment for the few small firms in the COMPUSTAT sample, we estimate that increased firm volatility may account for about 60 percent of the observed annual increase in the very transitory volatility of individual earnings.

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:

$$V^{P}_{lwft} = \alpha + \beta V^{P}_{lempft} + \gamma X_{ft} + \varepsilon_{ft}. \qquad (5)$$

Table 11 reports the estimates of the parameters in equation (5). In particular, the first two columns correspond to the case where there are no additional controls; columns 3 and 4 control for size (measured by log employment), log real average wage, and the growth in the number of employees in the firm during the 5-year period; columns 5 and 6 add a trend; and columns 7 and 8 add firm-level fixed effects. Our main finding from these regressions is the existence of a significant positive association between the volatility of the persistent component of employment and the volatility of the persistent component of the average wage paid in the firm. This association is robust in size and significance to the various controls. In addition, it predicts a substantial fraction of the evolution of the volatility of the persistent component of the firm-level average wage. Between 1955 and 1970 the unweighted persistent variance of firm-level average wage declined by 1 percentage point, while the weighted declined by 1.5 percentage points.

Given the evolution of the persistent variance of firm-level employment, the estimates of the last two columns in **Table 11** imply that, between 1955 and 1970, the unweighted persistent wage variance should have declined by 0.2 percentage points, while weighted variance should have been roughly constant. For the period 1970-2000, our econometric model predicts an increase in the un-weighted persistent variance of firm-level wages of 1.1, out of the actual increase by 3.4 percentage points. For the weighted persistent variance, the model predicts an increase of about 1 percentage point, while, in the data, the increase was of 1.5 percentage points.

Table 10B compares these magnitudes to the observed increase in persistent wage volatility in the PSID. Based on the observed increments in persistent employment volatility at the firm-level and on our estimates from regression (5), it follows that firm volatility could account for almost half of the observed annual increase in the persistent volatility of individual earnings.

Thus, we conclude that firm volatility can potentially account for 50 to 60 percent of the increases in the very transitory and persistent variances of firm-level average wages. This assumes, however, that the wage volatility we associate with employment volatility in COMPUSTAT is not due to compositional changes.

5.2 Determinants of wage volatility—Community Salary Survey results

If we control for compositional changes, do more volatile firms pay more volatile wages? In the previous section, we controlled for employment growth in the firm and found that changes in the composition of the firms' workforce that result in a net change in the number of workers do not bias our estimate of β. However, firm-level turbulence could lead firms to alter the composition (and average wage) of their workforce even if they show no trend growth or shrinkage. To determine whether our estimates are capturing the impact of compositional changes we examine the CSS, which contains information on firms' employment and wages at a very disaggregated occupational level.

5.2.1 Volatility regressions at the firm level—comparison of CSS with COMPUSTAT

We begin by comparing the CSS sample to the COMPUSTAT sample. **Table 12** presents means and standard deviations of the variables of interest for the two data sets. The first row shows that the mean very transitory variance of wages is much lower in the CSS sample (0.004 versus 0.033 in COMPUSTAT); the CSS over-samples stable occupations in well-established firms. The mean volatility of log employment in two samples is similar (0.52 versus 0.59 for very transitory variance, for example). However, the similarity may be deceiving because of mismeasurement in the CSS. The volatility of firm employment in the CSS is estimated from the occupations surveyed in firms in a city. Thus, it is a noisier measure of overall firm employment than the COMPUSTAT volatility. Hence, true employment volatility in these firms is likely to be lower than these measures suggest.

Next, we replicate our COMPUSTAT analysis using the CSS data, regressing firm-level wage volatility on the firm's employment volatility. Once again, as in COMPUSTAT, the CSS shows a robust, statistically significant, positive relationship between a firm's employment volatility and high- and low-frequency wage volatility. The weighted and unweighted results for the very transitory and persistent components of volatility all appear in **Table 13.**

We note that estimates of β from COMPUSTAT are approximately between 15 and 25 times larger than those estimated in the CSS (top row of **Table 13**). This difference does not invalidate the ability of the CSS to test whether better controls for compositional changes reduce the size or significance of relationship between wage volatility on firm-performance volatility. Nevertheless, it is instructive to consider the reasons for such differences in estimates, as they suggest that the magnitude of the COMPUSTAT estimates of β is more accurate for calculating the size of the effect under investigation.

The COMPUSTAT sample is much larger, more geographically and industrially representative, and more comprehensive for each firm; it includes all occupations and establishments. We suspect that the more restrictive CSS sample produces a lower β estimate because of mismeasurement, non-linearities in the relationship, and heterogeneity among firms.

First, it is likely that the volatility of firm employment is measured less well in the CSS, which does not cover all occupations and establishments in firms. This noise in the independent variable would bias the CSS estimate of β toward zero. If this explanation is true, the highest values of the independent variable are the most likely to have large errors, so the estimated relationship should be weaker for high employment volatility values. Indeed, when we estimate a quadratic model for the CSS and COMPUSTAT in **Table 13**, we find that the quadratic term is negative for the CSS, as predicted by this explanation. This is in marked contrast to the positive coefficient estimated for the quadratic term in the COMPUSTAT sample.

The positive quadratic term in the COMPUSTAT regressions suggests another reason for the small β in the CSS results; the sample may have a lower β because it is restricted to the range of volatility where β tends to be low. These long-lived, stable employers were willing to participate for long periods in local salary survey.

Fortunately, these biases in the CSS coefficient do not interfere with our tests of whether finer control for compositional effects can reduce or eliminate the positive association between wage volatility and employment volatility.

5.2.2 Very transitory wage volatility regressions at the occupation level

To control for compositional change more precisely we examine the volatility of average wages in an occupation-firm cell. Since the occupations in the Cleveland data set are so disaggregated (with four grades of secretaries, for example), it is hard to argue that changes in their volatility are driven by a change in the composition of occupations in a particular firm.

The first change we make is replacing the dependent variable (volatility of the firm-wide mean wage) with the volatility of the firm's occupation mean wage. Thus, we now measure the volatility of wages for narrowly defined sets of skills and responsibilities.

On the right-hand side, we can introduce an explicit measure of compositional change, the employment volatility at the occupation-firm cell level. This term provides a stringent control for compositional changes at the occupation level in the firm.

More specifically, we run regressions of the following form:

$$V_{lwoft} = \alpha + \beta V_{lempft} + \gamma X_{oft} + \varepsilon_{oft}, \tag{6}$$

where V_{lwoft} denotes the very transitory variance of the average wage in the cell *o-f* during the interval centered around year *t* and V_{lempft} represents the very transitory variance of employment in the firm.

Table 14 reports the estimates of the coefficients in this equation. Columns 1 and 2 report estimates of β for the unweighted and weighted regressions without controls; weights are derived from the share of employment in the occupation-firm cell. Strikingly, the size of the coefficient on firm employment volatility is higher when wage volatility is measured at the occupational level than when it is measured at the firm-level (**Table 13**, columns 1-2). This runs counter to the effect expected if compositional effects were driving the observed association at the firm level.

Columns 3 and 4 of **Table 14** report the estimates when controlling by log employment, log real wage and the growth of employment in the cell. None of the controls reduces the estimated size of the coefficient, even though most have their own independent effects on measured wage volatility.

To test further the robustness of these estimates we introduce fixed effects for year, firm, and occupation (**Table 14**, columns 5-8). As in COMPUSTAT, the effect of firm volatility on wage volatility is almost unaffected (in size or significance) by the introduction of year, firm, and occupation fixed effects. This implies that the effect of firm volatility on wage volatility at the occupation-firm level is not the result of any spurious correlation and is driven mostly by the variation within a firm-occupation cell as opposed to by the variation between cells. This finding reinforces our premise that firm volatility has induced an important increase in the transitory wage volatility of the median worker.

Finally, in columns 9 and 10, we add employment volatility at the cell level ($V_{lempoft}$) as a strong control for compositional changes. Not surprisingly, such compositional changes raise measured wage volatility. However, control for such changes does not substantially reduce the estimates of the magnitude of the link between firm employment volatility and wage volatility.

Our main conclusion is that there is a robust and statistically significant positive relationship between employment volatility in the firm and wage volatility in the firm-occupation cell. The effect of firm volatility on wage volatility does not seem to decrease in significance or size when looking at very narrow occupations within firms or when we control for job volatility at the cell level. This provides strong evidence against the role of compositional change in the observed relationship between firm and wage volatility. Hence, it supports the view that firm volatility raises the volatility of earnings of the average worker in the firm.

5.2.4 Persistent component regressions

We can conduct a similar exploration of the relationship between firm volatility and wage volatility at lower frequencies in the CSS data set. We use our measures of volatility of the persistent components of wages in the firm-occupation cells (V^P_{lwoft}), of employment in the firm (V^P_{lempft}), and of employment in the cell ($V^P_{lempoft}$). Then, we estimate the following regression

$$V^P_{lwft} = \alpha + \beta V^P_{lempft} + \rho T_t + \gamma X_{ft} + \varepsilon_{ft}. \qquad (7)$$

where T_t denotes a set of year fixed effects. The set of controls, X_{ft}, includes log employment, log average wage, and the persistent volatility, all at the firm-occupation cell. In addition, in all our regressions we add firm-specific constants, and in some we also include occupation fixed effects.

Table 15 reports the estimates from regression (7). We find a positive effect of persistent employment variance at the firm-level on the persistent variance of the average wage at the firm-occupation cell. This effect is statistically significant for the unweighted regression, but it becomes insignificant once the observations are weighted by the share of employment at the cell.

However, in contrast to the results for high frequency variation, the low estimates of β for persistent volatility in the CSS suggest low economic significance. When comparing the effects estimated with the CSS data set (**Table 15**) with the effects estimated in COMPUSTAT (**Table 11**) the latter are 18 times larger for the unweighted regressions and 55 times larger for the weighted. Furthermore, unlike the very transitory volatility regressions, this difference cannot be attributed to the difference in the standard deviation of the dependent variables since the standard deviation of the persistent variance of the average wage in COMPUSTAT firms is only twice as large as the standard deviation of the persistent variance of the wage in the CSS cells.

In addition, inclusion of the cell employment volatility in the regression also reduces the size and significance of the coefficient on firm volatility, providing more evidence that compositional changes play a role in the estimated relationship. We conclude that compositional changes are important in accounting for the relationship between employment and wage volatility at lower frequencies. This finding suggests that in the medium term, aggregate conditions are more important than firm-specific shocks for wage changes by firms.

However, the results for very transitory wage volatility suggest that at horizons as long as five years, firm conditions have an important effect on the wages paid to their workers, even with stringent controls for compositional changes. This finding provides evidence in favor of models where agency considerations or hold ups may play an important role in wage determination, at least in the short run at the firm level.

In the next section we discuss further the robustness of this finding and the role that it may have played in the higher earnings risk borne by workers.

6. Causality and pervasiveness

Focusing on the results for very transitory volatility, this section discusses whether the relationship we identify econometrically is causal (from firm turbulence to wage turbulence) and examines the pervasiveness of the phenomenon. Our results give us little reason to doubt that the enhanced firm volatility we see caused a rise in wage volatility and, while the phenomenon appears to hold across the board, we find evidence of some intriguing differences in the strength of the effect across occupational groups and industrial sectors.

6.1 Causality probes

The two alternatives to the hypothesis advanced here for the correlation between firm and earnings volatility are reverse causality (higher earnings volatility caused greater firm instability) and omitted variable bias (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 hypothesis, so we consider this scenario unlikely. First, the positive association between firm and wage volatility is robust to the inclusion of firm and occupation fixed effects. Thus, the relationship is not driven by omitted variables that are roughly constant for firms or occupations. This rules out large classes of possible omitted variables, including persistent differences in compensation schemes across firms that are correlated with their volatility, persistent variation in compensation schemes across occupations, and persistent cross-sectional variation in the occupational composition of firms.

Similarly, the robustness of our COMPUSTAT and CSS 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.

A third type of explanation for the positive association between firm and wage volatility may be that firms which experience more turbulence also promote and demote workers more frequently; as a result of this difference in job turnover, 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 and for those that changed jobs during the 5-year period.[16] Therefore, it seems likely that the main force driving the increase in transitory wage volatility operates within the occupation.

Further evidence in favor of the role of within-occupation-firm-cell mechanisms in the increase in transitory wage volatility comes from the regressions using the CSS data set. The average wage in an occupation-firm cell in the CSS data set can be interpreted as the wage earned by the representative worker that remained in the job for the relevant period. Therefore, the strong positive relationship that we find between firm and wage volatility in an occupation-firm cell shows that the mechanism that drives the positive association between firm volatility and the volatility of transitory wages operates within firm-occupation cells rather than across them. In our view, this severely undermines an argument in favor of the role of turnover and the dispersion of wages across occupations in the increase in the volatility of transitory wages.

Another interesting hypothesis that may constitute an alternative to the one we present in this paper is that the increase in the volatility of transitory wages is not driven by an increase in firm volatility but by rising steepness of incentive schemes. We can test whether this mechanism is at work by allowing for different coefficients on firm volatility before and after 1980 when estimating regressions (3) and (4) in the COMPUSTAT sample.[17] **Table 16** reports the results from these estimates when the dependent variable is either the variance of very transitory average wage (V_{lwft}) or the variance of the persistent component of the average wage at the firm level (V_{lwft}^{P}).

For very transitory variance, we observe no significant increase in the effect of firm volatility on the variance of the average wage. In addition to not being significant, the point estimate of the increment in the slope is not very large. These conclusions hold both for the weighted and un-weighted regressions and are also robust to adding firm-level fixed effects and time trends.

For persistent variance, the point estimate of the increment in the effect of firm volatility on average wage volatility at the firm-level post-1980 is larger than the pre-1980 effect. Furthermore, the incremental effect is significant in three of the four combinations, insignificant only for the weighted regression with firm-level fixed effects and time trends. However, since we suspect that reorganizations may drive the link between persistent firm and wage volatility in COMPUSTAT, this result may simply suggest that firms are more apt to reconfigure their workforce after 1980.

Interestingly, the results for the high-frequency variation suggest a new explanation for firms' introduction of variable pay schemes during the 1980s and 1990s. Adoption of these schemes may have been endogenous if firms instituted new practices in order to maintain their previous degree of risk-sharing in an increasingly risky marketplace. During the less turbulent 1960s and 1970s, risk could be shared without such explicit mechanisms by simply adjusting annual raises.

[16] That fact was first noted by Gottschalk and Moffit [1994].
[17] Since the CSS starts in 1980, we do not conduct this exercise for these data.

However, as the risk grew, firms adopted more bonus and incentive schemes to allow pay fluctuations to expand along with firm volatility.

6.2 Differences across types of firms and workers

To further explore the connection between firm and wage volatility, it is useful to split our samples according to firm and occupation characteristics and allow the effect of firm volatility on wage volatility to differ across these groups. We conclude this section by considering three such groupings: (i) small versus large firms, (ii) manufacturing versus non-manufacturing firms, and (iii) white-, pink- or blue-collar occupations.

Large firms are those with more employees than the median firm in the sample in the year. **Table 17** reports the estimates from adding the small firm dummy interacted with the volatility of employment to the regressions we have run so far in the COMPUSTAT and CSS data base. In the first four columns we focus on the volatility of the very transitory components of employment and average wage at the firm or occupation-firm cell, while columns 5 through 8 focus on the variance of the persistent components. We do not report the results for all the permutations we have explored so far, but the estimates reported are representative.

When looking at the variance of very transitory wages, we find that very transitory employment variance in small firms has a smaller effect on wage volatility than it does in large firms. This differential effect is typically statistically significant. However, the positive effect of firm volatility on wage volatility holds both for large and small firms.

The effect of size in the link between firm and wage volatility provides useful information on the role of liquidity constraints in this relationship. Recall from section 2 that liquidity constraints may lead the variance of firm-level wages to co-move with firm volatility. If this force is at work, we would expect that firms that face more binding liquidity constraints should experience a tighter link between firm variance and wage volatility. Smaller firms are usually regarded as facing more stringent liquidity constraints than large firms (Gertler and Gilchrist [1994]). But in **Table 17** we observe that the effect of very transitory firm volatility on very transitory average wage volatility is weaker for smaller firms. This leads us to think that liquidity constraints are not an important force behind the effect of firm volatility on wage volatility.

At lower frequencies, the effect of firm volatility on wage volatility also varies by firm size but the sign of the small dummy interaction depends on the sample. In our COMPUSTAT sample the relationship between the volatility of the persistent component of employment and the persistent volatility of wages is stronger for large firms, while in the CSS data set, it is stronger for small firms.

Table 18 explores the effect of the firm's sector on the relationship between firm and wage volatility. In particular, we allow for a differential effect of firm volatility for manufacturing firms. For the very transitory variance, we find that the effect of firm volatility on average wage volatility at the firm and at the occupation level is smaller for manufacturing than for non-manufacturing firms. This differential effect is significant. However, we still find that very transitory firm variance has a positive and significant effect on average wage variance at the firm and occupation level in manufacturing. For persistent variance, columns 5 through 8 of **Table 18** show that the differential effect for manufacturing firms is not significant.

These findings shed some light on the role of compositional change in the increase in the transitory variance of wages. One candidate hypothesis is that manufacturing firms do not offer steep compensation schemes to their workers. If so, a change in the composition of firms away from manufacturing would lead to an increase in wage volatility. The previous analysis minimizes the role of such a change in the composition of firms in the increase in the transitory variance of wages.

We conclude our exploration of the effect of firm volatility on wage volatility by studying how it varies across occupations. Specifically, we use the CSS sample to classify occupations according to whether they are white, blue, or pink collar.[18] **Table 19** reports the results from allowing for differential effects of the variance of (log) employment at the firm level for pink- and blue-collar occupations. For very transitory volatility, we find that the effect is slightly smaller for pink-collar occupations. When we run the regression weighting by the number of employees in the occupation-firm cells, we find that the effect of firm volatility on the very transitory volatility of the average wage in a cell is significant for the three types of occupations. When we do not allow for cell-weights, this effect is significant for white- and blue-collar jobs, but not for pink-collar occupations.

These results provide further insight into the mechanism that links firm and wage volatility. The relationship between white-collar workers and their principals are probably accurately described by agency models. Blue-collar occupations, by contrast, are the more highly unionized. Therefore, it is reasonable to think that the wage-setting process in these occupations is similar to the bilateral monopoly model. The fact that the strongest effects of firm turbulence on wage volatility are on white- and blue-collar jobs leads us to think that each of these mechanisms is powerful in the relevant occupations.

Furthermore, the similarity of the effect of firm volatility on wage volatility for white- and blue-collar occupations minimizes the possibility that the increase in transitory wage volatility reflects a change in the composition of occupations towards white-collar jobs and away from blue-collar jobs.

This similarity in volatility patterns contrasts sharply with the disparity in wage growth for blue- and white-collar jobs: average real wages for white-collar workers have risen while blue-collar wages have stagnated or fallen since the 1970s. Thus, blue-collar workers are likely to be worse off now than before when we account for this increased risk. While white-collar workers' wage growth may compensate for the additional volatility, their real wage gains will overstate their welfare gains.

Finally, for the persistent variance, we find no significant difference in the relationship between firm and wage volatility across the three occupation types.

7. Conclusion

Our findings suggest that rising high-frequency turbulence among U.S. firms over the past three decades has raised their workers' high-frequency wage volatility, increasing wage risks for many workers. The effect is very strong and may explain about sixty percent of the increase in very transitory wage variance that workers have experienced in the last thirty years.

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 hiring and firing workers with different skills, we turn to the CSS. Using these linked data, we apply stringent controls for the impact of composition. The positive impact of high-frequency firm

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[18] White-collar jobs are highly-paid professional and managerial occupations. Blue-collar jobs are manual, maintenance, security, and production jobs, traditionally staffed by men. Pink-collar jobs are lower-paid administrative, clerical, and support occupations

turbulence on the volatility of very transitory wage changes lasting five or fewer years is robust to the introduction of compositional controls.

For high-frequency turbulence, these findings argue against the notion that compositional changes in skill sets explain the link between firm turbulence and the turbulence of their average wages. In contrast, application of strong compositional controls suggests that the link between the more persistent components of employment and firm wage volatility, those changes lasting more than five years, probably do reflect reorganizations rather than wage changes for ongoing workers.

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 the exploration of these hypotheses for future work.

With regard to research, the observed connection between firm and wage volatility has important implications for our understanding of labor markets. The finding that for horizons of under five years, firm performance affects wage changes opens the door to the wide array of models that suggest that firms share short-run risks and rewards with their workers on an ongoing basis.

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.

traditionally held by women.

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Figure 1: Very transitory volatility of log of real earnings in the PSID

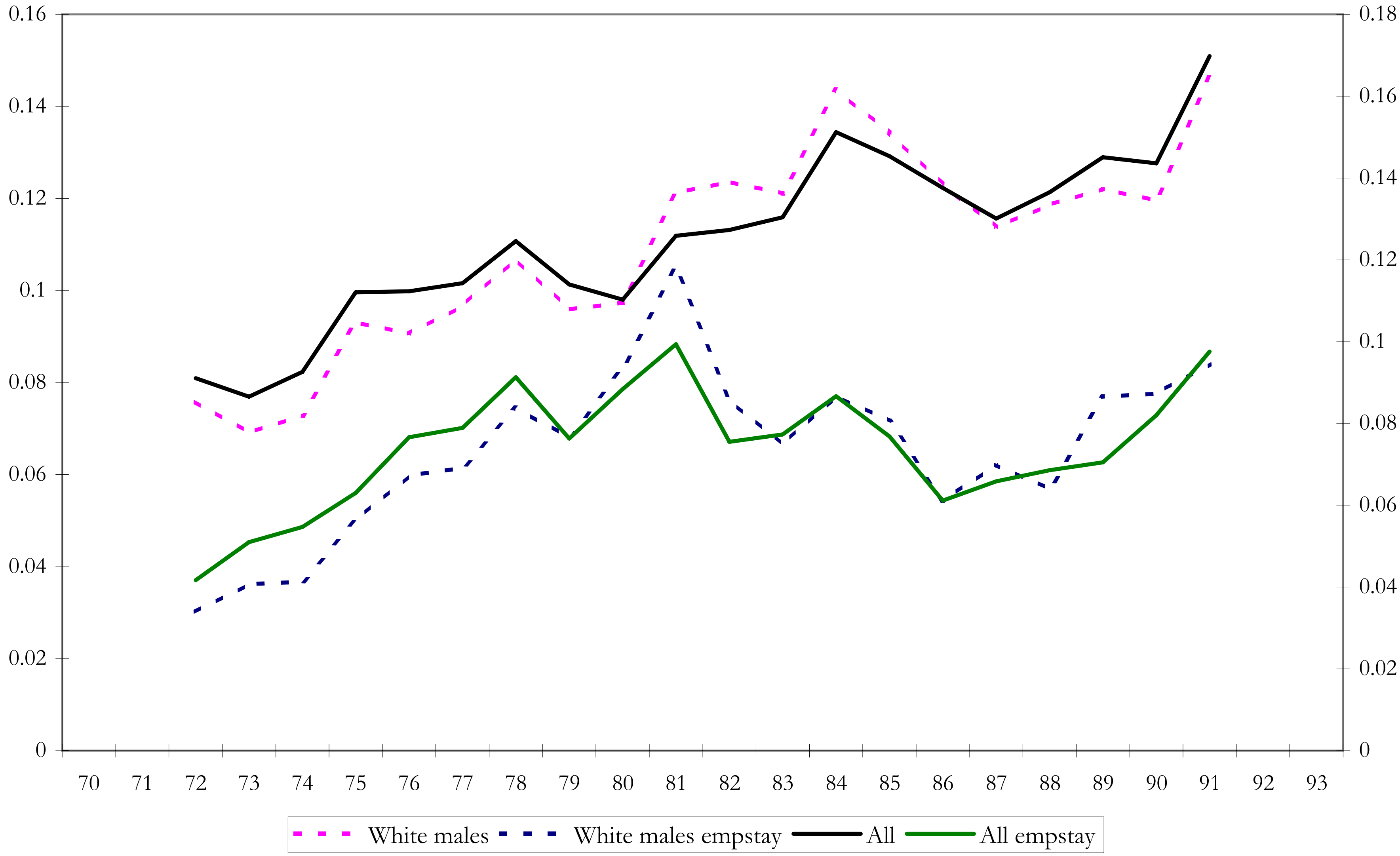


Figure 2: Persistent volatility of log real earnings in the PSID

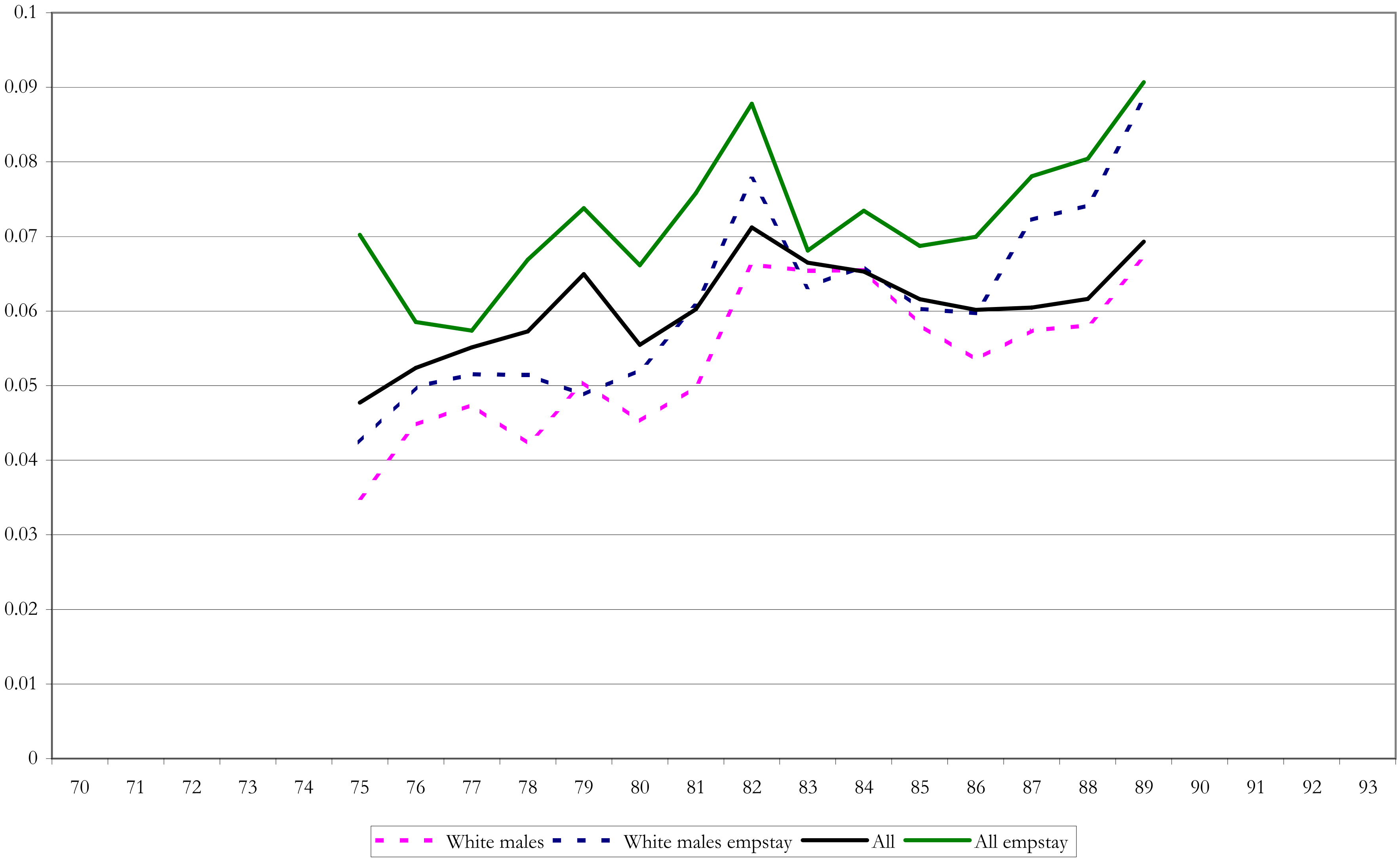
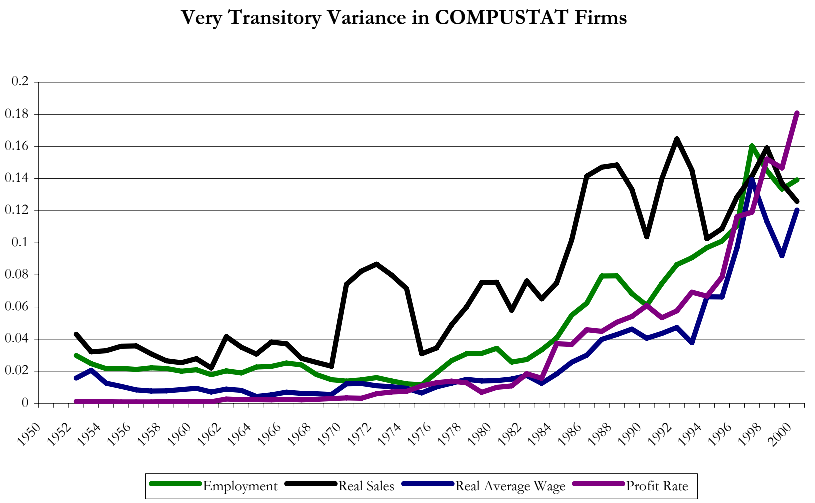
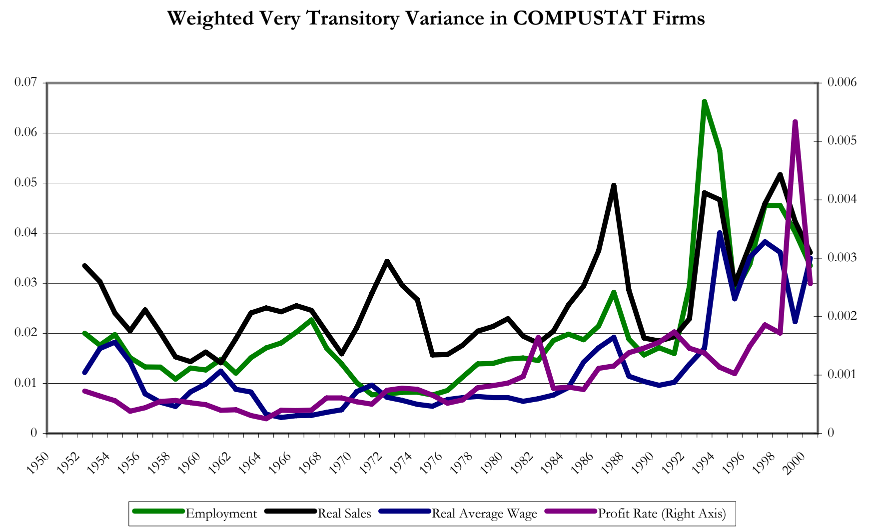
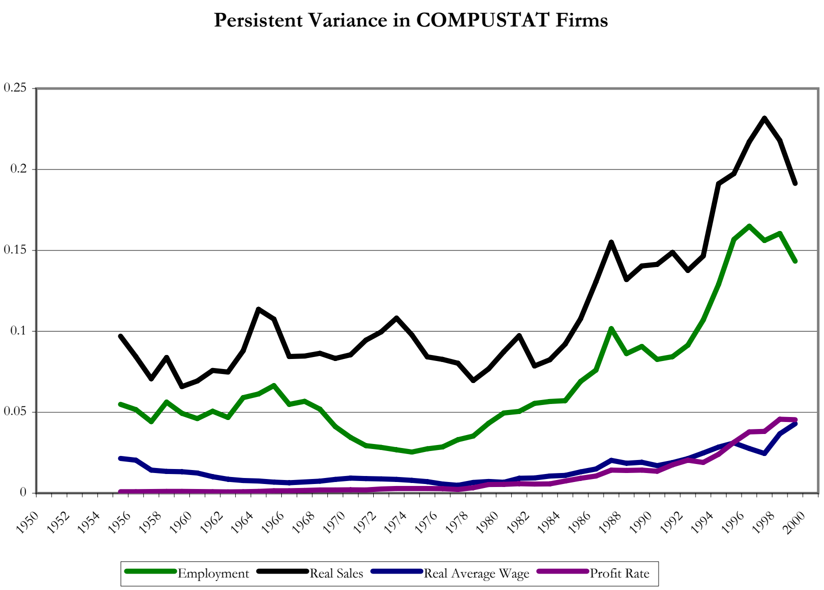


Figure 3: Evolution of firm-level volatility measures in COMPUSTAT







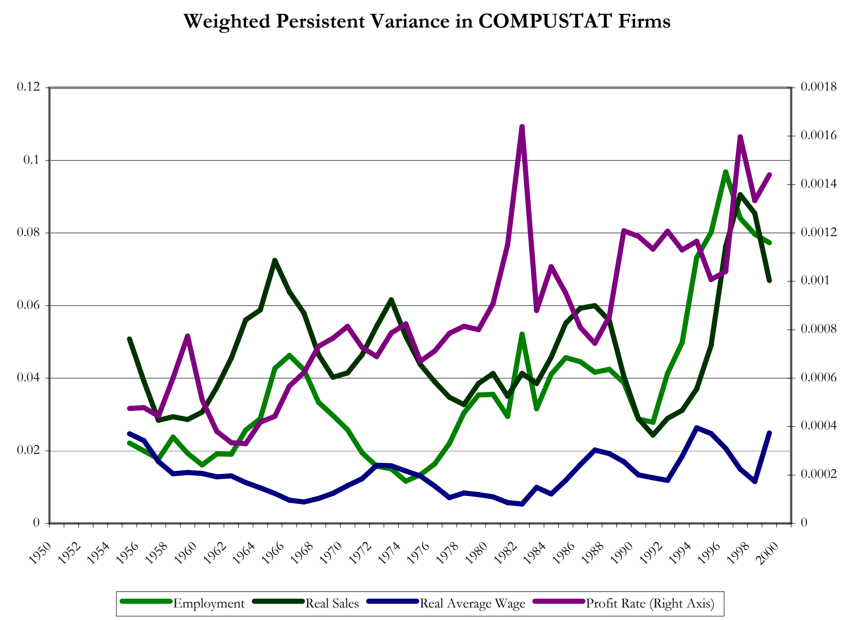


Figure 4A: Very transitory volatility of firm-level average wage by firm size, COMPUSTAT, 1970-2002

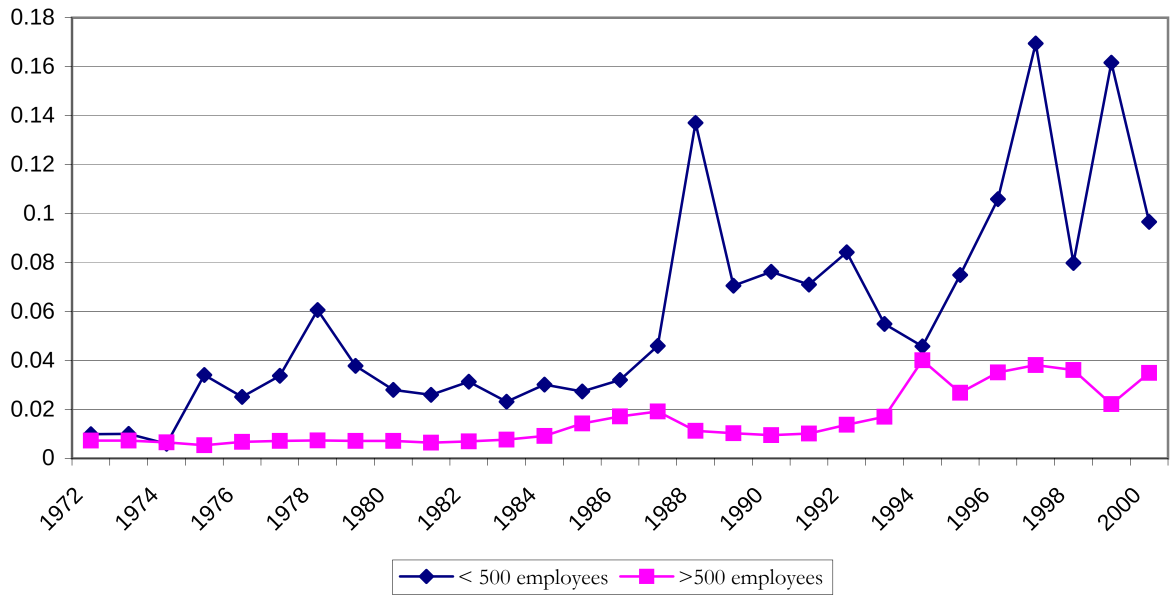


Figure 4B: Persistent volatility of average firm-level wage by firm size, COMPUSTAT, 1970-2002

Table 1: Description of Data Sources

	Panel Study of Income Dynamics (PSID)	COMPUSTAT	Federal Reserve Bank of Cleveland Community Salary Survey (CSS)
Years covered	1970 – 1993	1950 – 2003	1980 - 1999
Unit of observation	Worker (head of household).	Firm	Detailed occupation within firm in a city (employing unit).
Average number of observations per year	Job stayers: 3,611 All workers: 4,013	3,115	Employers: 107 Occupation–firm cells: 3,033
Sample definition	Stratified random sample of families in population drawn in 1968, with attrition since then.	Publicly-held companies, entire corporation.	Local employees in surveyed occupations in firms voluntarily participating in salary survey for Cleveland, Cincinnati and Pittsburgh. Chosen by the FRB-Clev. as representative of major employers in the three cities.
Source of information	Annual interviews with participating families.	Standard and Poor collects and aggregates data from Securities and Exchange Commission annual report forms, other public information, and contact with the company.	Personnel department records submitted by participating employers.
Wage concept	Annual earnings of the worker in primary job, with no fringe benefits.	Total wage bill (including bonuses and fringe benefits expenditures) divided by total employment.	Average annual wage per worker in surveyed occupation, including cash bonuses, but not fringe benefits.
Documentation website	http://psidonline.isr.umich.edu/	http://www.compustat.com	None

Table 2: Earnings volatility for white male heads of household in the PSID, various age adjustment schemes

Age adjustment	None				Gottschalk-Moffitt				Annual			
Demographic weights	No		Yes		No		Yes		No		Yes	
	All	Job stayers	All	Job stayers	All	Job stayers	All	Job stayers	All	Job stayers	All	Job stayers
1970-1979	0.118	0.085	0.104	0.076	0.098	0.060	0.096	0.058	0.131	0.093	0.121	0.088
1984-1993	0.164	0.129	0.175	0.140	0.161	0.119	0.166	0.125	0.189	0.144	0.202	0.157
Increment	0.046	0.044	0.071	0.064	0.063	0.059	0.069	0.067	0.058	0.051	0.081	0.069
Percent change (logs)	33	42	52	62	50	68	54	77	37	44	51	58
Percent change	39	52	68	85	64	98	72	115	44	55	67	79

Notes:
Volatility is measured by the average variance of log of real earnings over the time period specified.
Gottschalk-Moffit age adjustment removes a quartic in age for each 10-year period.
Annual age adjustment allows the coefficients in the age quartic to vary by year.

Table 3a: Very transitory (5-year) earnings volatility for white male heads of household in the PSID, for various age-adjustment schemes

Age adjustment	None		Gottschalk-Moffitt		Annual	
Period	All	Job stayers	All	Job stayers	All	Job stayers
1970-1979 mean	0.070	0.020	0.065	0.018	0.086	0.046
1984-1993 mean	0.103	0.043	0.098	0.043	0.135	0.069
Increment	0.033	0.023	0.034	0.025	0.049	0.023
Percent change (logs)	38	76	42	85	45	41
Percent change	47	114	52	134	56	51

Notes: Volatility is measured by the average variance of log real earnings over five years for the period noted, using PSID demographic weights. Gottschalk-Moffit age adjustment removes a quartic in age for each 10-year period. Annual age adjustment allows the coefficients in the age quartic to vary by year.

Table 3b: Persistent earnings volatility for white male heads of household in the PSID, for various age-adjustment schemes

Age adjustment	None		Gottschalk-Moffitt		Annual	
Period	All	Job stayers	All	Job stayers	All	Job stayers
1970-1979	0.035	0.055	0.027	0.038	0.035	0.042
1984-1993	0.073	0.097	0.048	0.048	0.067	0.088
Increment	0.038	0.041	0.022	0.011	0.032	0.046
Percent change (logs)	75	56	60	24	65	73
Percent change	111	75	82	28	92	108

Notes: Volatility is measured by the average variance of log real earnings over five years for the period noted, using PSID demographic weights. Gottschalk-Moffit age adjustment removes a quartic in age for each 10-year period. Annual age adjustment allows the coefficients in the age quartic to vary by year.

Table 4a: Very transitory volatility of individual earnings in the PSID

	White males	White males Job stayers	All	All Job stayers	All KOP**	All KOP** Job stayers
1970-1974	0.076	0.030	0.091	0.042	0.063	0.037
1975-1979	0.097	0.061	0.114	0.079	0.107	0.090
1980-1984	0.124	0.076	0.127	0.076	0.130	0.072
1984-1988	0.123	0.054	0.138	0.061	0.174	0.079
1989-1993	0.147	0.084	0.170	0.098	0.180	0.064
Increment	0.071	0.054	0.079	0.056	0.117	0.027
Percent change (log)	66	102	62	85	105	55
Percent change	93	178	87	134	186	74

Notes: Volatility is measured by the average variance of log real earnings over five years for the period noted, using PSID demographic weights, and annual wage adjustments. Job stayers: workers that did not change jobs in the 5 year period. KOP: workers living in Kentucky, Ohio and Pennsylvania.

Table 4b: Persistent volatility of individual earnings in the PSID

	White males	White males Job stayers	All	All Job stayers	All KOP**	All KOP** Job stayers
1970-1979	0.035	0.042	0.048	0.070	0.042	0.057
1980-1989	0.058	0.060	0.062	0.069	0.066	0.078
1984-1993	0.067	0.088	0.069	0.091	0.072	0.091
Increment	0.032	0.046	0.022	0.020	0.030	0.034
Percent Change (logs)	65	73	37	26	54	47
Percent Change	92	108	45	29	71	60

Notes: Volatility is measured by the average variance of log real earnings over five years for the period noted, using PSID demographic weights, and annual wage adjustments. Job stayers: workers that did not change jobs in the 5 year period. KOP: workers living in Kentucky, Ohio and Pennsylvania.

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

	Very transitory volatility							
	Unweighted				Weighted			
Period	Employment	Sales	Profits/sales	Mean wage	Employment	Sales	Profits/sales	Mean wage
1950-1954	0.0297	0.0431	0.0012	0.0158	0.0200	0.0335	0.0007	0.0122
1970-1974	0.0160	0.0867	0.0060	0.0110	0.0079	0.0344	0.0007	0.0072
1998-2002	0.1392	0.1257	0.1709	0.1204	0.0335	0.0361	0.0034	0.0350

	Persistent volatility							
	Unweighted				Weighted			
Period	Employment	Sales	Profits/sales	Mean wage	Employment	Sales	Profits/sales	Mean wage
1950-1959	0.0548	0.0970	0.0009	0.0215	0.0221	0.0508	0.0005	0.0247
1970-1979	0.0254	0.0977	0.0028	0.0079	0.0116	0.0515	0.0008	0.0144
1993-2002	0.1433	0.1913	0.0454	0.0429	0.0773	0.0669	0.0014	0.0249

Notes:
Employment, sales and mean wage are taken as logs.
Very transitory volatility is measured by the average variance across firms over five years for the period noted.
Persistent volatility is measured by the average variance across firms between five-year means for the period.
Weighted estimates are weighted by firms' shares of employment in the sample.

Table 6A: Share of the annual increase in very transitory volatility of workers' wages in the PSID accounted for by increased very transitory volatility in firms' average wages in COMPUSTAT

	PSID		COMPUSTAT	
Period		Period	Unweighted	Weighted
1970-1974	0.042	1970-1974	0.011	0.007
1989-1993	0.098	1998-2002	0.120	0.035
Increment	0.056	Increment	0.109	0.028
Annual increment	0.24%		0.34%	0.09%
Between-firm share of increase in wage volatility			140%	36%
Conservative estimate of between-firm share of increase in wage volatility			88%	

Notes:
The conservative estimate is the average of the weighted and unweighted between-firm shares.
Very transitory volatility is measured by the average variance over five years for the period.
COMPUSTAT weighted estimates are weighted by firms' shares of employment in the sample.
PSID results are from Table 4a, col. 4: all job stayers, annual wage adjustment, demographic weights.
COMPUSTAT results come from Table 5, upper panel, columns 4 and 8.

Table 6B: Share of the annual increase in persistent volatility of workers' wages in the PSID accounted for by increased persistent volatility in firms' average wages in COMPUSTAT

	PSID		COMPUSTAT	
Period		Period	Unweighted	Weighted
1970-1979	0.07	1970-1079	0.008	0.014
1984-1993	0.091	1993-2002	0.043	0.025
Increment	0.021	Increment	0.035	0.011
Annual increment	0.09%		0.11%	0.03%
Between-firm share of increase in wage volatility			120%	36%
Conservative estimate of between-firm share of increase in wage volatility			78%	

Notes:
The conservative estimate is the average of the weighted and unweighted between-firm shares.
Persistent volatility is measured by the average variance between five-year means.
COMPUSTAT weighted estimates are weighted by firms' shares of employment in the sample.
PSID results are from Table 4b, col. 4: all job stayers, annual wage adjustment, demographic weights.
COMPUSTAT results come from Table 5, lower panel, columns 4 and 8.

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	10	11	12
v (log employment$_f$)	0.574	0.722					0.580	0.722				
	(0.065)	(0.131)					(0.065)	(0.124)				
v (log sales$_f$)			0.220	0.160					0.219	0.163		
			(0.054)	(0.02)					(0.055)	(0.022)		
v (profit rate$_f$)					0.033	0.871					0.03	0.841
					(0.015)	(0.196)					(0.014)	(0.177)
growth employment$_f$							-0.089	-0.067	-0.057	-0.037	-0.04	-0.025
							(0.015)	(0.022)	(0.022)	(0.018)	(0.022)	(0.018)
log real wage$_f$							-0.035	-0.010	-0.038	-0.015	-0.025	-0.019
							(0.010)	(0.007)	(0.014)	(0.009)	(0.013)	(0.01)
log employment$_f$							-0.003	-0.002				
							(0.001)	(0.002)				
log real sales$_f$									-0.004	-0.002	-0.006	-0.001
									(0.002)	(0.001)	(0.002)	(0.001)
constant	0.004	-0.001	0.016	0.007	0.026	0.011	0.130	0.043	0.169	0.073	0.15	0.088
	(0.003)	(0.003)	(0.004)	(0.001)	(0.002)	(0.001)	(0.035)	(0.029)	(0.045)	(0.003)	(0.039)	(0.03)
No. of obs:	28,125	28,125	27,906	27,906	27,325	27,325	28,125	28,125	27,906	27,906	27,325	27,325
F-stat:	77.09	30.38	16.57	60.73	4.55	19.73	41.78	13.51	15.33	16.21	12.24	8.84
Prob > F:	0.0000	0.0000	0.0000	0.0000	0.0300	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Weighted	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes:
Standard errors (in parentheses) are Newey-West with five lags.
Regressions with employment variance as independent variable are weighted by employment share.
Regressions with sales or profit rate variance as independent variable are weighted by sales share.

Table 8: Relationship between very transitory variance of average wage and employment at the firm level in COMPUSTAT, with time trends and year fixed effects

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

Variables	1	2	3	4	5	6	7	8
v (log employment$_f$)	0.571	0.721	0.570	0.719	0.577	0.721	0.575	0.719
	(0.066)	(0.132)	(0.066)	(0.130)	(0.065)	(0.125)	(0.065)	(0.123)
growth employment$_f$					-0.089	-0.066	-0.092	-0.070
					(0.015)	(0.022)	(0.015)	(0.023)
log real wage$_f$					-0.037	-0.011	-0.036	-0.010
					(0.011)	(0.007)	(0.011)	(0.007)
log employment$_f$					-0.003	-0.002	-0.002805	-0.002391
					(0.001)	(0.002)	(0.001)	(0.002)
constant	-1.305	-0.439	0.033	0.053	-1.542	-0.330	0.166	0.095
	(0.477)	(0.355)	(0.019)	(0.023)	(0.547)	(0.421)	(0.041)	(0.039)
No. of obs:	28,125	28,125	28,125	28,125	28,125	28,125	28,125	28,125
F-stat:	59.74	18.83	4.74	2.67	44.56	10.98	6.18	2.50
Prob > F:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Weighted by employment share	No	Yes	No	Yes	No	Yes	No	Yes
Time trend	Yes	Yes	No	No	Yes	Yes	No	No
Year fixed effects	No	No	Yes	Yes	No	No	Yes	Yes

Notes:

Standard errors (in parentheses) are Newey-West with five lags.

Table 9: Relationship between very transitory variance of average wage and employment at the firm level in COMPUSTAT, with firm fixed effects

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

Independent variables	1	2	3	4	5	6	7	8	9	10	11	12
v (log employment$_f$)	0.587	0.824					0.587	0.819				
	(0.105)	(0.097)					(0.103)	(0.093)				
v (log sales$_f$)			0.137	0.187					0.143	0.170		
			(0.038)	(0.057)					(0.037)	(0.025)		
v (profit rate$_f$)					0.075	0.88					0.072	0.761
					(0.032)	(0.143)					(0.03)	(0.125)
growth employment$_f$							-0.072	-0.067	-0.083	-0.071	-0.054	-0.037
							(0.017)	(0.027)	(0.034)	(0.043)	(0.022)	(0.022)
log real wage$_f$							-0.008	0.005	-0.016	-0.010	-0.037	-0.041
							(0.023)	(0.007)	(0.011)	(0.004)	(0.036)	(0.016)
log employment$_f$							-0.009	0.029				
							(0.024)	(0.012)				
log real sales$_f$									-0.011	0.001	0	0
									(0.014)	(0.002)	(0.000)	(0.000)
constant	0.002	0.003	0.002	0.003	-0.001	0.000	0.001	0.0005	0.001	0.0003	0.001	0
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of obs:	25,053	25,053	24,866	24,866	27,325	27,325	25,053	25,053	24,866	24,866	27,325	27,325
F-stat:	31.20	71.44	13.23	10.66	5.48	37.69	8.83	25.17	4.75	12.85	2.84	14.36
Prob > F:	0.0000	0.0000	0.0003	0.0011	0.0192	0.0000	0.0000	0.0000	0.0008	0.0000	0.0229	0.0000
Weighted	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes:
Standard errors (in parentheses) are Newey-West with five lags.
All regressions contain firm fixed effects and a time trend.
Regressions with employment variance as independent variable are weighted by employment share.
Regressions with sales or profit rate variance as independent variable are weighted by sales share.

Table 10A: Summary of the annual increase in very transitory volatility of workers' wages in the PSID accounted for by predicted increase in very transitory volatility of firms' average wages in COMPUSTAT

	PSID		COMPUSTAT	
Period		Period	Unweighted	Weighted
1970-74	0.042	1970-74	0.016	0.0078
1989-93	0.098	1998-02	0.139	0.035
Increment	0.056	Increment	0.123	0.0272
		Increment*coefficient in Table 7 (cols. 7 and 8)	0.070	0.020
		Annualized predicted increments	0.22%	0.06%
Annual increment	0.24%	Average predicted increment in the very transitory volatility of workers' wages	0.14%	
		Share of PSID increment explained by rise in firm volatility	58%	

Notes:
Very transitory volatility is measured by the average variance over five years for the period.
COMPUSTAT weighted estimates are weighted by firms' shares of employment in the sample.
PSID results are from Table 4a, col. 4: all job stayers, annual wage adjustment, demographic weights.
COMPUSTAT results come from Table 5, upper panel, columns 4 and 8.

Table 10B: Summary of the annual increase in persistent volatility of workers' wages in the PSID accounted for by predicted increase in persistent volatility of firms' average wages in COMPUSTAT

	PSID		COMPUSTAT	
Period		Period	Unweighted	Weighted
1970-79	0.07	1970-79	0.025	0.0116
1984-93	0.091	1993-2002	0.143	0.077
Increment	0.021	Increment	0.118	0.0654
		Increment*coefficient in Table 11 (cols. 7 and 8)	0.013	0.014
		Annualized predicted increments	0.04%	0.04%
Annual increment	0.09%	Average annual predicted increment in the persistent volatility of workers' wages	0.04%	
		Share of PSID increment explained by rise in firm volatility	46%	

Notes:
Persistent volatility is measured by the average variance between five-year means.
COMPUSTAT weighted estimates are weighted by firms' shares of employment in the sample.
PSID results are from Table 4b, col. 4: all job stayers, annual wage adjustment, demographic weights.
COMPUSTAT results come from Table 5, lower panel, columns 4 and 8.

Table 11: 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	4	5	6	7	8
v of persistent component (log employment$_f$)	0.112	0.159	0.110	0.158	0.109	0.157	0.109	0.216
	(0.032)	(0.059)	(0.032)	(0.059)	(0.033)	(0.060)	(0.039)	(0.071)
log employment$_f$			-0.001	0.001	-0.001	0.001	-0.014	0.026
			(0.001)	(0.001)	(0.001)	(0.001)	(0.015)	(0.015)
log real wage$_f$			-0.001	-0.007	-0.002	-0.007	0.009	0.004
			(0.005)	(0.004)	(0.005)	(0.004)	(0.018)	(0.011)
cons	0.006	0.007	0.010	0.024	-0.416	-0.013	0.0003	-0.001
	(0.002)	(0.002)	(0.017)	(0.012)	(0.168)	(0.149)	(0.001)	(0.0004)
No. of obs:	17,226	17,226	17,226	17,226	17,226	17,226	15,601	15,601
F-stat:	12.33	7.31	10.50	4.12	14.29	3.26	2.75	5.08
Prob > F:	0.0004	0.0069	0.0000	0.0063	0.0000	0.0111	0.0412	0.0016
Weighted	No	Yes	No	Yes	No	Yes	No	Yes
Time trend	No	No	No	No	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No	Yes	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 12: Comparison of volatility measures in COMPUSTAT and the CSS

		CSS		COMPUSTAT	
Very transitory volatility					
v (log avg. real wage$_f$)	Average	0.004	0.004	0.033	0.016
	Std. Dev.	0.006	0.005	0.298	0.213
v (log employment$_f$)	Average	0.059	0.056	0.052	0.023
	Std. Dev.	0.1175	0.101	0.3	0.16
Persistent volatility					
v^p (log avg. real wage$_f$)	Average	0.006	0.006	0.137	0.013
	Std. Dev.	0.011	0.011	0.063	0.04
v^p (log employment$_f$)	Average	0.093	0.09	0.066	0.037
	Std. Dev.	0.34	0.37	0.216	0.118
Number of observations		835-851		17,235-28,130	
Weighted by employment shares		No	Yes	No	Yes

Table 13: Relationship between volatility of average wage and employment at the firm level in the CSS and COMPUSTAT

Dependent variable	*very transitory volatility--v (log average real wage $_f$)*						persistent volatility--v^P (log average real wage$_f$)					
Data set	CSS		Compustat		CSS		CSS		Compustat		CSS	
Independent variables	1	2	3	4	5	6	7	8	9	10	11	12
v (log employment$_f$)	0.020	0.013	0.216	0.258	0.037	0.042	0.0114	0.006	0.121	0.196	0.026	0.006
	(0.005)	(0.003)	(0.066)	(0.141)	(0.008)	(0.009)	(0.007)	(0.005)	(0.06)	(0.095)	(0.013)	(0.009)
v (log employment$_f$)^2			0.044	0.057	-0.037	-0.058			-0.003	0.007	-0.011	0
			(0.006)	(0.015)	(0.013)	(0.014)			(0.017)	(0.031)	(0.005)	(0.005)
No. of obs:	835	835	25,053	25,053	835	835	851	851	15,601	15,601	851	851
F-stat:	5.27	5.43	34.07	27.3	4.48	5.7	11.88	14.55	2.03	5.17	6.39	6.84
Prob > F:	0.0003	0.0003	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0868	0.0004	0.0000	0.0000
Weighted	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Note: Standard errors (in parenthesis) are Newey-West with five lags.
All regressions include firm-level fixed effects and a time trend.
Regressions 7-12 also include the log of employment in the cell and log of average wage as controls.
Regressions 1-6 also control for the growth in employment in the firm during the relevant 5 year period.
Weights are employment shares.

Table 14: Relationship between very transitory volatility of average wage and employment at the occupation-firm level in the CSS

Dependent Variable: v (log average real wage$_{of}$)

Independent variables	1	2	3	4	5	6	7	8	9	10
v (log employment$_{f}$)	0.035	0.028	0.036	0.028	0.031	0.022	0.036	0.027	0.031	0.023
	(0.010)	(0.014)	(0.010)	(0.014)	(0.010)	(0.012)	(0.011)	(0.014)	(0.010)	(0.013)
v (log employment$_{of}$)									0.008	0.004
									(0.002)	(0.001)
log employment$_{of}$			-0.002	-0.0005	-0.002	-0.0004	-0.002	0.0001	0.000	0.000
			(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0003)	(0.0004)	(0.000)	(0.000)
log real wage$_{of}$			0.003	0.004	0.004	0.005	0.001	0.004	0.002	0.006
			(0.001)	(0.016)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
growth employment$_{of}$			0.0006	-0.002	0.0003	-0.002	0.0005	-0.001	0.0002	-0.001
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
cons	0.005	0.003	-0.023	-0.035	0.010	0.022	0.007	0.039	0.020	0.051
	(0.000)	(0.000)	(0.009)	(0.017)	(0.005)	(0.003)	(0.017)	(0.024)	(0.0168)	(0.024)
No. of obs:	15,191	15,191	15,191	15,191	15,191	15,191	15,191	15,191	15,191	15,191
F-stat:	12.38	3.68	39.13	12.42	10.29	12.29	13.53	1.99	8.42	2.32
Prob > F:	0.0004	0.0500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0929	0.0000	0.0411
Weighted	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Occupation fixed effects	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors (in parenthesis) are Newey-West with five lags.
Weighting are employment shares in occupation-firm cell.

Table 15: Relationship between persistent volatility of wage and employment at the occupation-firm level in CSS, with firm and occupation-level fixed effects

Dependent variable: variance of persistent component of (log average real wage$_{of}$)

Independent variables	1	2	3	4	5	6
v of persistent component (log employment$_{f}$)	0.006	0.004	0.006	0.003	0.003	-0.001
	(0.003)	(0.005)	(0.003)	(0.004)	(0.003)	(0.003)
v of persistent component (log employment$_{of}$)					0.007	0.002
					(0.002)	(0.001)
log employment$_{of}$	-0.002	-0.001	-0.002	-0.00002	-0.002	-0.0004
	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.000)	(0.0004)
log real wage$_{of}$	0.007	0.003	0.004	-0.004	0.003	-0.005
	(0.002)	(0.001)	(0.005)	(0.007)	(0.005)	(0.007)
cons	0.001	0.0003	0.030	-0.051	0.020	-0.052
	(0.001)	(0.001)	(0.053)	(0.066)	(0.052)	(0.065)
No. of obs:	18,077	18,077	18,077	18,077	18,077	18,077
F-stat:	10.58	6.94	4.32	2.96	11.23	2.26
Prob > F:	0.0000	0.0000	0.0000	0.0001	0.0000	0.0600
Weighted:	No	Yes	No	Yes	No	Yes
Occupation fixed effects	No	No	Yes	Yes	Yes	Yes

Note: Standard errors (in parentheses) are Newey-West with ten lags.
All regressions include year and firm fixed effects.

Table 16: Time variation in the relationship between volatility of average wage and employment at the firm level in COMPUSTAT

Dependent variable:	*very transitory--v (log average real wage $_f$)*				persistent--v^P (log average real wage$_f$)			
Independent variables	1	2	3	4	5	6	7	8
v (log employment$_f$)	0.422	0.537	0.400	0.554				
	(0.1)	(0.117)	(0.11)	(0.122)				
v (log employment$_f$)*I(year≥1980)	0.163	0.189	0.193	0.268				
	(0.11)	(0.163)	(0.148)	(0.161)				
v^P (log employment$_f$)					0.023	0.029	0.007	0.084
					(0.009)	(0.018)	(0.029)	(0.02)
v^P (log employment$_f$)*I(year≥1980)					0.098	0.16	0.11	0.143
					(0.031)	(0.06)	(0.054)	(0.085)
growth employment$_f$	-0.086	-0.064	-0.07	-0.063				
	(0.015)	(0.023)	(0.016)	(0.028)				
log real wage$_f$	-0.036	-0.01	-0.008	0.005	-0.002	-0.008	0.008	0.003
	(0.01)	(0.006)	(0.024)	(0.006)	(0.005)	(0.003)	(0.017)	(0.011)
log employment$_f$	-0.003	-0.002	-0.009	0.027	-0.001	0.001	-0.015	0.0255
	(0.001)	(0.001)	(0.024)	(0.012)	(0.001)	(0.001)	(0.016)	(0.015)
constant	0.134	0.046	0.001	0.000	-0.017	0.031	0.000	-0.001
	(0.035)	(0.028)	(0.001)	(0.001)	(0.016)	(0.01	(0.001)	(0.000)
No. of obs:	28,125	28,125	25,053	25,053	17,226	17,226	15,601	15,601
F-stat:	34.62	13.88	9.27	24.08	7.45	3.92	2.53	7.76
Prob > F:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	0.0000	0.0000
Weighted by employment share	No	Yes	No	Yes	No	Yes	No	Yes
Time trend	No	No	Yes	Yes	No	No	Yes	Yes
Firm fixed effects	No	No	Yes	Yes	No	No	Yes	Yes

Note: Standard errors (in parentheses) are Newey-West with five year lags for transitory wages and 10 year for persistent.

Table 17: Firm size variation in relationship between the volatility of average wage and employment at the firm and firm-occupation levels in the CSS

	Very transitory firm		Very transitory firm-occup.		Persistent firm		Persistent firm-occupation	
Dependent variable:	*v (log average real wage $_f$)*		*v (log average real wage $_{of}$)*		v^P (log average real wagef)		v^P (log average real wageof)	
Independent variables	1	2	3	4	5	6	7	8
v(log employment$_f$)	0.800	0.828	0.049	0.029				
	(0.069)	(0.09)	(0.016)	(0.016)				
v(log employment$_f$)*I(small firm)	-0.48	-0.504	-0.033	-0.011				
	(0.08)	(0.098)	(0.014)	(0.012)				
v^P(log employment$_f$)					0.197	0.220	0.003	-0.002
					(0.099)	(0.074)	(0.005)	(0.004)
v^P(log employment$_f$)*I(small firm)					-0.129	-0.181	0.004	0.009
					(0.102)	(0.079)	(0.006)	(0.004)
growth employment$_f$	-0.064	-0.066						
	(0.013)	(0.027)						
log real wage$_f$	-0.008	0.004			0.008	0.004	0.003	-0.005
	(0.02)	(0.006)			(0.016)	(0.01)	(0.005)	(0.006)
log employment$_f$	-0.009	0.028			-0.010	0.026	-0.001	0
	(0.023)	(0.012)			(0.0145)	(0.015)	(0.000)	(0.000)
growth employment$_{of}$			0	-0.001				
			(0.000)	(0.001)				
log real wage$_{of}$			-0.001	0.004				
			(0.002)	(0.002)				
log employment$_{of}$			-0.002	0				
			(0.000)	(0.000)				
constant	0.001	0.001	0.005	0.038	0.000	-0.001	0.190	-0.058
	(0.001)	(0.001)	(0.017)	(0.023)	(0.001)	(0.000)	(0.053)	(0.065)
No. of obs:	25,053	25,053	15,191	15,191	15,601	15,601	18,077	18,077
F-stat:	38.23	37	10.96	3.63	3.54	4.29	9.2	2.22
Prob > F:	0.0000	0.0000	0.0000	0.0028	0.0070	0.0018	0.0000	0.0645
Weighted by employment share	No	Yes	No	Yes	No	Yes	No	Yes
Occupation fixed effects	No	No	Yes	Yes	No	No	Yes	Yes

Note: Standard errors (in parentheses) are Newey-West with five-year lags for transitory wages and 10-year lags for persistent volatility.
Time trend and firm fixed effects included in all regressions.

Table 18: Sectoral variation in the relationship between the volatility of average wage and employment at the firm and firm-occupation levels in the CSS

	Very transitory firm		Very transitory firm-occup.		Persistent firm		Persistent firm-occupation	
Dependent variable:	*v (log average real wage $_f$)*		*v (log average real wage $_{of}$)*		v^P (log average real wage$_f$)		v^P (log average real wage$_{of}$)	
Independent variables	1	2	3	4	5	6	7	8
v (log employment$_f$)	0.622	0.838	0.039	0.039				
	(0.1)	(0.085)	(0.012)	(0.019)				
v (log employment$_f$)*I(manufacturing)	-0.39	-0.511	-0.025	-0.042				
	(0.11)	(0.106)	(0.01)	(0.020)				
v^P (log employment$_f$)					0.105	0.135	0.004	0.001
					(0.046)	(0.094)	(0.002)	(0.004)
v^P (log employment$_f$)*I(manufacturing)					0.017	0.161	0.0003	-0.003
					(0.066)	(0.099)	(0.009)	(0.005)
growth employment$_f$	-0.068	-0.075						
	(0.016)	(0.024)						
log real wage$_f$	-0.009	0.004			0.009	0.002	0.003	-0.005
	(0.023)	(0.006)			(0.018)	(0.01)	(0.005)	(0.006)
log employment$_f$	-0.01	0.026			-0.014	0.015	-0.001	0
	(0.024)	(0.012)			(0.0151)	(0.010)	(0.000)	(0.000)
growth employment$_{of}$			0	-0.001				
			(0.001)	(0.001)				
log real wage$_{of}$			0.001	0.004				
			(0.002)	(0.002)				
log employment$_{of}$			-0.002	0				
			(0.000)	(0.000)				
constant	0.001	0.000	0.007	0.040	0.000	-0.001	0.025	-0.058
	(0.001)	(0.001)	(0.017)	(0.024)	(0.001)	(0.000)	(0.052)	(0.065)
No. of obs:	25,053	25,053	15,191	15,191	15,601	15,601	18,077	18,077
F-stat:	11.65	36.11	10.9	1.7	3.43	24.91	2.96	0.33
Prob > F:	0.0000	0.0000	0.0000	0.1300	0.0083	0.0000	0.0185	0.8600
Weighted by employment share	No	Yes	No	Yes	No	Yes	No	Yes
Occupation fixed effects	No	No	Yes	Yes	No	No	Yes	Yes

Note: Standard errors (in parentheses) are Newey-West with five-year lags for transitory wages and 10-year lags for persistent volatility.
Time trend and firm fixed effects included in all regressions.

Table 19: Occupation variation in the relationship between volatility of average wage and employment at the firm-occupation level in the CSS

	Very transitory firm-occupation		Persistent firm-occupation	
Dependent variable:	*v (log average real wage $_{of}$)*		*v^P (log average real wage $_{of}$)*	
Independent variables	1	2	3	4
v (log employment$_f$)	0.026	0.015		
	(0.006)	(0.004)		
v (log employment$_f$)*I(pink collar)	-0.022	-0.006		
	(0.006)	(0.0045)		
v (log employment$_f$)*I(blue collar)	0.000	-0.006		
	(0.002)	(0.004)		
v^P (log employment$_f$)			0.005	-0.003
			(0.005)	(0.005)
v^P (log employment$_f$)*I(pink collar)			0	0.006
			(0.004)	(0.002)
v^P (log employment$_f$)*I(blue collar)			-0.001	-0.0126
			(0.008)	(0.008)
growth employment$_f$	0	0		
	(0.000)	(0.000)		
log real wage$_f$	0.001	0.004	0.003	-0.004
	(0.002)	(0.002)	(0.005)	(0.007)
log employment$_f$	-0.002	0	-0.001	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
constant	0.000	0.029	0.025	-0.054
	(0.016)	(0.02)	(0.052)	(0.066)
No. of obs:	11,754	11,754	18,077	18,077
F-stat:	17.24	4.44	2.97	12.99
Prob > F:	0.0000	0.0002	0.0110	0.0000
Weighted by employment share	No	Yes	No	Yes

Note: Standard errors (in parentheses) are Newey-West with five-year lags for transitory wages and 10-year lags for persistent volatility.
All regressions contain firm and occupation fixed effects.