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Volatility, Nonstandard Employment, and Productivity: An Empirical Analysis Using Firm-Level Data*

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(Abstract)

This paper empirically analyzes the relationship among the volatility of sales, nonstandard employment, and firm productivity by using panel data of more than 8,000 Japanese firms from 1994 to 2006. Globalization and innovation are highlighted as the forces that increase the volatility of firm performance, which, in turn, increases the demand for flexible labor forces. After controlling for various observable firm characteristics, the volatility of a firm's sales growth is a significant determinant of the ratio of nonstandard employees. This relationship is stronger for manufacturing firms. Among the highly volatile firms, the ratio of nonstandard employees has a positive relationship with productivity. These results suggest that the desirable policy mix for the economy is a combination of the provision of sufficient safety net and training opportunities for nonstandard workers and the enactment of reasonable laws and regulations that enable firms to adjust labor input flexibly.

Key words：nonstandard worker, volatility, productivity

JEL classifications：J23, J69, D24

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1. Introduction

In recent years, the number of nonstandard workers, such as part-time, contract, and temporary agency workers (workers dispatched from temporary labor agencies), has been growing rapidly. An increase in the female labor participation rate, labor market reforms, and prolonged stagnation of the economy, among others, are the factors behind this trend. According to the Labor Force Survey, the number of part-time workers was 8.2 million in 2008, up from 5.1 million in 1990. The number of temporary agency workers was 1.4 million in 2008, an almost fivefold increase from 0.3 million in 1999. However, manufacturing firms' sales dropped drastically in late 2008, hit by the global financial crisis, and the withdrawals of job offers for temporary agency workers became a political issue in Japan. Currently, a revision of the Worker Dispatching Law to make the regulations more stringent is under way.

An increase in the number of nonstandard employees is a common trend among advanced economies. According to OECD statistics, the ratios of part-time and temporary workers to the OECD total are 15.6% and 12.3%, respectively. A number of empirical studies in the field of labor economics focus on nonstandard workers and analyze, for example, wage penalty of these workers by estimating wage functions, and whether or not the experience of nonstandard work is a stepping stone for better labor market outcomes, by using individual-level longitudinal data. Although the rapid increase in nonstandard workers is the result of factors related to the supply and demand of labor as well as institutional changes, studies from the viewpoint of employers' labor demand are relatively scarce. Firms are faced with globalization, rapid technological innovations, shortened product life cycle, and market deregulation, all of which may contribute to instability in performance. Instability and uncertainty in firm performance compel firms to adjust their labor input flexibly, increasing the demand for nonstandard workers. In other words, the productivity of firms facing highly volatile sales will fall if they are unable to adjust labor input quickly in accordance with the change in output.

Against this background, this paper empirically analyzes the relationship between the volatility of sales, nonstandard employment, and firm productivity using 13 years' panel data from the Basic Survey of Japanese Business Structure and Activities spanning the period 1994 to 2006. The Survey collects information on the number of "part-time workers" and "contract and daily workers" from its commencement. From the 2001 Survey, which collects data on firms as of the end of the fiscal year 2000, the item "temporary agency workers" is also added. As a result, comprehensive analysis of nonstandard workers, including temporary agency

workers, has become possible. Specifically, this paper determines whether the ratio of nonstandard workers is related to the volatility of firms' sales, controlling for observable firm characteristics. The estimation is conducted for part-time workers, contract and daily workers, and temporary agency workers separately and nonstandard workers as a whole. Then, we estimate the effect of the use of nonstandard workers on firm productivity, focusing on the relationship with firm-level volatility.

According to our analysis, the jobs of temporary agency workers and contract workers are very unstable. The higher the volatility of firms' sales, the greater their dependence on nonstandard workers. When firms' sales volatility is one standard deviation larger, the ratio of nonstandard workers is about 0.7% point higher. This relationship is clear for agency temporaries and weaker for part-time workers. By industry, this relationship is stronger for manufacturing firms than for non-manufacturing firms. Among highly volatile firms, the ratio of nonstandard employees has a significant positive relationship with total factor productivity (TFP). For a firm with volatility of larger than one standard deviation, a 10% higher nonstandard worker ratio is related to around a 1% point higher TFP. These results suggest that it is inevitable for firms to adjust their labor input quickly, under the pressure of increasing output volatility, and that the desirable policy mix for the economy is a combination of the provision of sufficient safety net and training opportunities for nonstandard workers on the one hand and the enactment of reasonable laws and regulations that enable firms to adjust labor input flexibly on the other hand.

The rest of this paper is organized as follows. Section 2 briefly reviews relevant past studies. Section 3 explains the data used and the method of analysis. Section 4 reports and interprets the results, and Section 5 concludes the study with policy implications.

2. Literature review

Recent empirical studies in the U.S. indicate an upward trend in firm volatility despite the declining volatility of GDP (see, for example, Comin and Mulani, 2006, and Comin and Philippon, 2006). [1] Globalization, rapid technological innovations, shortened product life cycle, and market deregulation are the possible reasons for increased firm-level volatility. For example, di Giovanni and Levchenko (2009) show that sectors more open to international trade are more volatile, although the analysis uses cross-country industry-level data. Bergin et

[1] On the other hand, Davis et al. (2007) found that the rise in volatility is confined to publicly traded firms but volatility is declining among privately held firms.

al. (2009) present evidence that offshore production by U.S. firms is related to the volatility of employment in Mexico. Using U.S. industry-level data, Brynjolfsson et al. (2007) argue that the IT intensity of industry is related to increase in volatility.

Increasing firm volatility, in turn, inevitably affects derived demand—labor demand. Fabbri et al. (2003) and Barba et al. (2003), for example, present evidence that labor demand of multinational firms has become more elastic recently. Klein et al. (2003) indicate that real exchange rate movements significantly affect gross job flows in U.S. manufacturing. Comin et al. (2009) show that rising turbulence in the sales of large U.S. firms has raised their workers' wage volatility.

Under the existence of labor adjustment costs, in order to attain optimal levels of labor input, it would be rational behavior for firms to increase the number of workers whose adjustment cost is low. Segal and Sullivan (1997), who investigate the reason for the increasing number of temporary agency workers, assert that firms' increasing need for flexibility is an important factor behind the increase in the number of temporary agency workers. Houseman (2001), who investigates the reasons for the increase in the number of nonstandard employees by a telephone survey of U.S. establishments, reports that the need to cope with workload fluctuations and staff absences is the main reason for the use of nonstandard employees. According to her estimation results, industry seasonality and cyclicality are positively related to the use of agency temporaries. Ono and Sullivan (2006), who use 1998 and 1999 manufacturing plant-level data (the Plant Capacity Utilization Survey) for the U.S., examine the relationship between plants' use of temporary workers and output fluctuations. Their results indicate that plants with higher output uncertainty and falling expected output tend to use more temporary production workers. This study is most closely related to the present paper. However, their study does not deal with the relationship between the use of temporary workers and productivity, and their sample is limited to manufacturing industry. Vidal and Tigges (2009) also analyze the determinants of using temporary workers in U.S. manufacturing plants. Their data come from a telephone survey of Wisconsin manufacturing plants in 1998, and several estimations are conducted on the use of temporary employees. The results indicate that industry's seasonality is positively related to the use of temporary employees. On the other hand, Gramm and Schnell (2001) reported that the effects of output cyclicality and seasonality are insignificant for the use of flexible staffing arrangements and temporary workers. However, their data are from a survey of establishments located in Alabama, and the effective sample size is less than 100. Most of these studies suggest that output volatility is related to the use of nonstandard workers, but the sample size is generally small or the survey considers only some type of nonstandard workers. They do not analyze the difference between manufacturing and service industries.

If highly volatile firms cannot adjust their labor force quickly when exogenous shocks affect the demand for their products or services, the firms' labor input will diverge from the profit-maximizing level, reducing their productivity. In other words, the higher the volatility of the output, the larger the gains from using nonstandard workers on their productivity. Cunat and Melitz (2007), who theoretically and empirically study the link between volatility, labor market flexibility, and comparative advantage, show that countries with more flexible labor markets specialize in sectors with higher volatility. Several studies, such as Autor et al. (2007) and Lafontaine and Sivadasan (2009), show that stringent labor market regulations negatively affect firm-level productivity. These studies as well as this paper are motivated by similar considerations, but to our knowledge, no previous study analyzes the relationship among firm volatility, nonstandard employment, and productivity.[2]

To summarize, even though the rapid increase in the number of nonstandard workers becomes an important policy agenda, the relationship between firm volatility and nonstandard employment has not yet been analyzed extensively. Furthermore, studies on the link between nonstandard employment and productivity in the context of firm volatility are almost nonexistent.

3. Data and method

The data used in this paper come from the Basic Survey of Japanese Business Structure and Activities (Ministry of Economy, Trade, and Industry). The Survey, an annual statistics begun in 1991, accumulates representative statistics on Japanese firms with 50 or more regular employees, including those engaged in mining, manufacturing, electricity and gas, wholesale, retail, and several service industries. The purpose of this survey is to capture a comprehensive picture of Japanese firms, including their basic financial information—sales, costs, profits, book value of capital, number of employees, etc.—composition of businesses, R&D activities, IT usage, and foreign direct investments. As the sample firms are coded by using perpetual numbers, it is possible to construct a firm-level longitudinal data set. This paper constructs a 13-year panel data set from the Survey, from 1994 to 2006.[3]

[2] Some studies analyze the relationship between the use of nonstandard employment and firm productivity. Boeri and Garibaldi (2007) and Sanchez and Toharia (2000), for example, report negative relationships in Italian and Spanish firms, respectively.

[3] The Basic Survey of Japanese Business Structure and Activities in 2007, for example, collects information on flow figures during the fiscal year 2006 (normally from April to March in Japan) and stock figures at the end of the fiscal year 2006. For simplicity, we express the data as "2006" in this paper.

As mentioned in the introduction, the number of "temporary agency workers" is added as a survey item from the 2001 Survey. As a result, comprehensive analysis on nonstandard workers, including part-time workers, contract and daily workers, and temporary agency workers, is possible. In the Survey, the number of "regular workers" comprises the total number of paid directors and regularly employed persons. The term "regular employees" is defined as persons, regardless of their titles as full-time or part-time, employed under a contract longer than one month, or persons employed for 18 days or more in two months prior to the end of the latest fiscal year. That is, "regular workers" include both full-time and part-time workers. "Part-timers" are regular workers whose scheduled daily working hours or working days in a week are less than those of full-time workers. In this paper, the number of full-time workers is calculated by subtracting the number of part-timers from the total number of regular workers. It should be noted that "full-time workers" include workers who are not under long-term employment and that some of the "part-time workers" include employees under long-term employment. "Other workers"—contract and daily workers—are persons who are employed for a period of up to one month, or those who are brought in on a daily basis. Finally, "temporary agency workers" are persons who are employed by a worker-dispatching business operator and are engaged in an accepting company's operations under its supervision and command, based on a contract between the accepting company and the worker-dispatching business operator. "Other workers" and "temporary agency workers" are not included in the total number of regular workers.

Although more than 25,000 firms are surveyed every year, there are many entries and exits in the Survey. Since we are interested in calculating time-series volatility at firm level, we restrict the sample to firms that exist through the 13 years and construct a balanced panel. After removing a very small number of outliers, the size of the final sample is 8,716.[4]

Table 1 shows the number of workers by type of employment among the sample firms. In 2006, full-time, part-time, contract and daily, and temporary agency workers numbered 1,642,000, 271,000, 24,000, and 135,000, respectively. Full-time workers are decreasing in number and part-time workers increasing. The number of temporary agency workers has increased rapidly from 47,000 in 2000 to 135,000 in 2006.

By using the data set, this paper first presents some descriptive characteristics on the job flows and the labor adjustment of nonstandard employees. The gross job creation rate (GJCR), gross job destruction rate (GJDR), and gross job reallocation rate (GJRR) for employment type j of firm i are defined as follows (Davis et al., 1996; Davis and Haltiwanger, 1999):

[4] We removed six firms in which the number of part-time workers was larger than that of regular workers at some point in time during the sample period. These were possibly caused by reporting error. In addition one firm in which the number of contract and daily workers is extremely large (40

$$GJCR = \Sigma_i [(E_{ijt} - E_{ijt-1})/(E_{ijt} + E_{ijt-1})/2] \text{ if } (E_{ijt} - E_{ijt-1}) > 0$$
$$GJDR = \Sigma_i [(E_{ijt} - E_{ijt-1})/(E_{ijt} + E_{ijt-1})/2] \text{ if } (E_{ijt} - E_{ijt-1}) < 0$$
$$GJRR = GJCR - GJDR$$

We compare these job flow measures by type of employment to see the degree of instability for nonstandard jobs.

Next, we calculate the elasticity of labor adjustment with respect to changes in firm sales by types of employment. The elasticity (β_1) is calculated simply as follows:

$$\ln(E_{it+n}/E_{it}) = \beta_0 + \beta_1 \ln(Y_{it+n}/Y_{it}) + \beta_2 \ln(W_{it+n}/W_{it}) + \Sigma_y \beta_y \text{ year dummies} + \Sigma_i \beta_i \text{ industry dummies} + u_{it} \quad [1]$$
$$t = 1994\text{–}2006$$

where E_{it}, Y_{it}, and W_{it} denote the number of employees, firm sales, and average wages of firm i at year t.

Then, we analyze the relationship between firm volatility, ratio of nonstandard workers, and TFP. As for the measure of firm volatility, we follow representative past studies measuring firm volatility (Comin and Mulani, 2006; Davis et al., 2007) and calculate standard deviations of annual sales growth through the sample period.[5] Specifically, sales growth (ΔY_{it}), average sales growth (ΔY_i), and the standard deviation (σ_i) of firm i in year t can be expressed as follows. Since the period of analysis is between 1994 and 2006, T=12 in this paper.

$$\Delta Y_{it} = (Y_{it} - Y_{it-1})/[(Y_{it} + Y_{it-1})/2]$$
$$\Delta Y_i = (1/T)\Sigma_t \Delta Y_{it}$$
$$\sigma_i = [(1/T)\Sigma_t(\Delta Y_{it} - \Delta Y_i)^2]^{1/2}$$

The reason $(Y_{it} + Y_{it-1})/2$ is used as the denominator is that expansion and contraction are treated symmetrically, and the result thus obtained is superior to the conventional growth measure, as pointed out in job flow studies (Davis et al., 1996; Davis and Haltiwanger, 1999).

This measure of sales volatility (σ_i) is used as the explanatory variable in regressions to explain the ratio of nonstandard workers to total regular workers. Dependent variables are ratios of nonstandard workers—(1) part-time, (2) contract and daily, (3) temporary agency, and (4) total nonstandard workers (the sum of 1 to 3 above)—to total regular workers. Firm

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times as large as regular worker) is removed.

[5] Standard deviation of sales *level* through the sample period is another possible volatility measure, but the measure takes a large value when sales grow (or shrink) at a constant rate.

size (*size*: log of the number of regular workers) and age (*age*), the ratios of business composition (*composition*), year dummies, and 3-digit industry dummies are used as control variables. Among these controls, the ratios of business composition (*composition*) are the number of workers in (1) administration at the head office (*administration*), (2) the information processing activity (*information*), (3) research and development (*r&d*), (4) the manufacturing activity (*manufacturing*), and (5) the commerce activity (*commerce*). These figures can be calculated from the data on the number of workers by business organization of firms in the Basic Survey of Japanese Business Structure and Activities. Past studies on the manufacturing sector often use non-production (or blue-collar) workers as an important variable, but this is inappropriate for analyzing firms operating in the non-manufacturing sector. Therefore, we construct ratios of workers that may closely reflect the use of nonstandard workers. Year dummies are included to control for the effects of business cycles on the labor market, as well as the changes in labor market rules and regulations.

The basic equation to be estimated can be summarized as follows:

$$\begin{aligned} \text{nonstandard}_{it} = {} & \beta_0 + \beta_1\sigma_i + \beta_2\,\text{administration}_{it} + \beta_3\,\text{information}_{it} + \beta_4\,\text{r\&d}_{it} \\ & + \beta_5\,\text{manufacturing}_{it} + \beta_6\,\text{commerce}_{it} + \beta_7\,\text{size}_{it} + \beta_8\,\text{age}_{it} \\ & + \Sigma_y\beta_y\,\text{year dummies} + \Sigma_i\,\beta_i\,\text{industry dummies} + u_{it} \qquad [2] \\ & t = 1994\text{–}2006 \text{ for part-timers and contract and daily workers} \\ & t = 2000\text{–}2006 \text{ for temporary agency workers an total nonstandard workers} \end{aligned}$$

We expect the coefficient of firm volatility (β_1) to be positive. Estimation is conducted by pooled OLS. In estimating (1) part-timers and (2) contract and daily workers, we use pooled data from 1994 to 2006. Estimations for (3) temporary agency workers and (4) total nonstandard workers are carried out by pooled data from 2000 to 2006. However, as explained earlier, the firm-level volatility measure (σ_i) is calculated from annual sales from 1994 through 2006 for all estimations.

Next, we examine the relationship among firm volatility, use of nonstandard workers, and the firm-level TFP.[6] The dependent variable here is the cost-share-based TFP index number at the firm level, which is calculated in a nonparametric manner that uses a hypothetical representative firm as the reference. The input and output of a hypothetical representative firm are calculated as the geometric means of the input and output of all firms, and the cost shares of labor and capital are calculated as arithmetic means. The TFP for each firm is calculated

[6] We conduct the same regressions by using labor productivity as dependent variable, but the results are essentially the same as the TFP-based results. In this paper, we do not report labor productivity results.

relative to the hypothetical representative firm. The formula for calculating the TFP level of firm i in year t is expressed as follows:

$$\ln TFP_{it} = (\ln V_{it} - \mathit{ln}V_t) - (1/2)\Sigma_j(s^j_{it} + s^j_t)(\ln X^j_{it} - \mathit{ln}X^j_t)$$
$$+ (\mathit{ln}V_t - \mathit{ln}V_0) - (1/2)\Sigma_j(s^j_t + s^j_0)(\mathit{ln}X^j_t - \mathit{ln}X^j_0)$$

where V_{it} denotes the value added of firm i at year t, X^j_{it} the input of factor j (capital and labor) of firm i at year t, and s^j_{it} the cost share of input j. The *italics* imply average values.

The index number TFP is applied to ensure cross-section and time-series comparability of firm-level productivity and to avoid problems of using restrictive functional forms. This procedure was developed by Caves et al. (1982) and is becoming popular in recent productivity studies (Nishimura et al., 2005; Fukao and Kwon, 2006; Morikawa, 2010, among others. Syverson, 2010, presents a good survey on this TFP measurement issue). The data used for calculating TFP are value added, capital (total assets), labor (total hours), and cost of shares of capital and labor. Value added is the sum of operating profits, rent, wage, depreciation, and tax paid. Industry-level deflators to make real values are taken from the National Accounts. Explanatory variables are firm size (*size*) and age (*age*), log of average wage (*lnwage*), ratios of nonstandard workers—(1) part-timers (*part*), (2) contract and daily workers (*contract*), (3) temporary agency workers (*temp*), and (4) nonstandard workers as a whole (*nonstandard*)—to regular workers, year dummies, and 3-digit industry dummies. Firm size and age, industry, and year dummies are ordinary controls. Average wage is a proxy for the quality of workers, which generally has a high correlation with productivity.[7] To summarize, the equation to be estimated is as follows:

$$\ln TFP_{it} = \beta_0 + \beta_1 \,\mathrm{size}_{it} + \beta_2 \,\mathrm{age}_{it} + \beta_3 \,\mathrm{lnwage}_{it} + \beta_4 \,\mathrm{nonstandard}_{it}$$
$$+ \Sigma_y \beta_y \,\mathrm{year\ dummies} + \Sigma_i \beta_i \,\mathrm{industry\ dummies} + u_{it} \qquad [3]$$

We divide the sample into (1) high-volatility (volatility above the sample median) and (2) low-volatility (volatility below the sample median) firms and compare the coefficients of the ratio of nonstandard workers (β_4). We expect the size of this coefficient to be larger for high-volatility firms.

In addition, we estimate the equation by including the interaction terms of sales volatility and the ratio of nonstandard workers, instead of dividing the sample firms. In this specification, we expect the coefficients of the interaction term (β_4) to be positive.

[7] Average wage is the total wage paid divided by the number of regular employees.

Specifically, the equation can be written as follows:

$$\ln TFP_{it} = \beta_0 + \beta_1 size_{it} + \beta_2 age_{it} + \beta_3 wage_{it} + \beta_4 volatility * nonstandard + \Sigma_y \beta_y year\ dummies + \Sigma_i \beta_i industry\ dummies + u_{it} \quad [4]$$

It should be noted that the ratio of nonstandard workers (therefore, the interaction term in equation [3]) is endogenous and that the OLS results may be biased. Unfortunately, however, it is difficult to find an appropriate instrument that affects the ratio of nonstandard workers but is independent of the error term (u_{it}). To address this possible endogeneity bias, we use the interaction terms of firm volatility and the ratios of business composition (*volatility*administration*, *volatility*information*, *volatility*r&d*, *volatility*manufacturing*, and *volatility*commerce*) as instruments and estimate the equation by two-stage least squares (2SLS), although the instruments are not perfect.[8]

4. Results

4.1 Job flows and labor adjustment of nonstandard workers

Before presenting regression results, it is informative to see some statistical characteristics on job flows and the elasticity of labor adjustment for nonstandard employees. Table 2 shows the gross job creation rate (GJCR), gross job destruction rate (GJDR), and gross job reallocation rate (GJRR) of the sample firms by type of employment. The annual GJRRs for contract and daily jobs and temporary agency jobs are about 15% or more, which is seven to nine times larger than that of full-time jobs (2%). The GJRR of part-time jobs is about 7%—at the middle of temporary agency jobs and full-time jobs. It is obvious that the jobs of temporary agency workers and contract workers are very unstable.

Then, table 3 indicates the elasticity of employment changes by type of employment with respect to the change in firm sales (equation [1]). The estimated elasticity is 0.224 for full-time workers, 0.323 for part-time workers, and 0.521 for temporary agency workers. The result for contract and daily workers is statistically insignificant and is not reported in this table. When the elasticity is calculated at an interval of three to five years, the estimated elasticity becomes larger irrespective of the type of employment (see columns 2 and 3), but the difference in

[8] The interaction term is a natural instrument for an interaction term that has an endogenous variable (see Wooldridge, 2002).

one-year elasticity is larger for full-time workers than nonstandard workers. These figures confirm a general perception that nonstandard workers, especially temporary agency workers, are used for the adjustment of firms' labor input to cope with short-term output changes, which is consistent with the rapid reduction of temporary agency workers just after the global financial crisis in 2008.

4.2 Volatility and nonstandard employment

Table 4 presents regression results for equation [2], which estimates the relationship between firm volatility and the ratio of nonstandard employment. The coefficients for firm volatility are positive and significant for all types of nonstandard workers with the exception of part-time workers. The coefficient is larger for the ratio of temporary agency workers. This is consistent with the fact described in the subsection (1) that the gross job reallocation rate and the labor adjustment elasticity are both smaller for part-time workers and larger for temporary agency workers. This suggests that part-time jobs are relatively similar to full-time jobs and different from other types of nonstandard jobs. Analyzing nonstandard workers as a whole may mask important differences among the types.

Table 5 assesses the quantitative magnitudes of the estimated coefficients. Column 2 indicates that a larger volatility of one standard deviation (0.047) corresponds to a 0.7% point higher nonstandard worker ratio. By type of employment, the figure for temporary agency workers is 0.6% point. Column 4 converts the figures into ratios to the total number of workers by employment type by using the ratio of each worker type as the denominator. A firm-level volatility of one standard deviation corresponds to about 5% more nonstandard workers. These results indicate that firms with higher sales volatility depend on nonstandard workers, especially temporary agency workers, and that the magnitude is economically significant. Large firms tend to use more nonstandard workers, among other explanatory variables, with other factors controlled for. The coefficients for the ratio of administration, information, and R&D workers are generally negative and significant for part-timers and contract workers, but positive for temporary agency workers.

When the estimation is done by splitting the sample into manufacturing and non-manufacturing firms, the volatility coefficient is larger for manufacturing firms (see table 6). The volatility of sales at the sample mean (shown in the last row) is higher for manufacturing (0.069) than non-manufacturing firms (0.058). That is, the volatility itself and

its effect on the use of nonstandard employment are both higher for manufacturing firms. Although the ratio of nonstandard employment is generally higher in the service sector compared to the manufacturing sector, the relationship between sales volatility and the ratio of nonstandard employment is stronger in the manufacturing sector. A possible reason for this difference is that manufacturing firms face fierce competition with foreign firms, which forces them to adjust labor input quickly.

4.3 Nonstandard workers and productivity

In this subsection, we report regression results for equations [3] and [4] on the relationship between the use of nonstandard workers and the TFP. The results for equation [3] are presented in table 7. As discussed in the previous section, the sample is divided into high-volatility and low-volatility firms, based on the sample median of the volatility measure (σ). The coefficients for the ratio of nonstandard workers are positive and highly significant for all estimations. However, what is of interest here is the difference between high-volatility and low-volatility firms.

Table 8 summarizes the differences of estimated coefficients for the entire sample and by industry. With firm size, firm age, average wages, year, and industry controlled for, the coefficients of nonstandard workers are larger for high-volatility firms. The difference is especially large for temporary agency workers. To translate the magnitudes into percentage terms, a 10% increase in the ratio of nonstandard workers is related to a 0.3% point higher TFP in high-volatility than low-volatility firms. By type of workers, the figure is large for the ratio of temporary agency workers (1.3% point) and small for that of part-time workers (0.2% point). By industry, this figure is larger for manufacturing than non-manufacturing firms (columns 2 and 3). These results suggest that the productivity performance of volatile firms, especially in the manufacturing sector, significantly depends on how nonstandard workers are utilized.

Finally, table 9 presents the estimation results of equation [4], which do not categorize the sample firms by their volatility. What is of interest here are the coefficients for the interaction terms of firm volatility and the ratio of nonstandard workers. According to OLS estimations, the coefficients of the interaction terms are positive and highly significant for all types of nonstandard workers (column 1 of table 9). The result confirms the previously mentioned findings, and the quantitative magnitude is nontrivial. For a firm with one standard deviation

higher volatility, a 10% higher nonstandard worker ratio is related to a 1.1% point higher TFP. By type of employment, this figure is 1.6% point for part-timers and 1.1% point for temporary agency workers (see table 10). Generally, we do not find large differences between manufacturing and non-manufacturing firms with regard to this specification (see columns 2 and 3 of table 10).

Column 2 of table 9 indicates 2SLS results, which use the interaction terms of firm volatility and the five variables on business composition (*volatility*administration*, *volatility*information*, *volatility*r&d*, *volatility*manufacturing*, and *volatility*commerce*) as instruments. The coefficients for the interaction terms of firm volatility and the ratio of nonstandard workers are generally lower than the OLS results.[9] Although the instruments used here are imperfect, the results suggest that estimations without controlling for endogeneity may overstate the effects of using nonstandard workers on TFP. According to the 2SLS results, for a firm with one standard deviation higher volatility, a 10% higher nonstandard worker ratio is related to a 0.5% point higher TFP (see column 4 of table 10). As regards this specification, the results for non-manufacturing industry are larger than those for the manufacturing industry (see columns 5 and 6 of table 10). As the results by industry are not uniform among the specifications, we cannot assert a decisive conclusion about different productivity effects between manufacturing and non-manufacturing industries.

5. Conclusion

In recent years, the number of nonstandard workers, such as part-time, contract, and temporary agency workers, is growing rapidly in advanced countries. This paper empirically analyzes the relationship among the volatility of firm sales, use of nonstandard employees, and productivity by using panel data of more than 8,000 Japanese firms spanning the period1994 to 2006.

The main results can be summarized as follows:

1) According to the statistical analysis of job flows and the elasticity of labor adjustment, temporary agency jobs and contract and daily jobs are very unstable. Their gross job reallocation rates (GJRRs) are more than seven times higher than the rate of full-time regular jobs. The elasticity of nonstandard employment with respect to sales change is twice as large as that of full-time regular employment.

[9] The difference between OLS and 2SLS is especially large for contract and daily workers, because the correlation between the instruments and the ratio of contract and daily workers is relatively low.

2) Firms facing higher sales volatility depend on a large number of nonstandard workers. When a firm's sales volatility is one standard deviation larger, the ratio of nonstandard workers of the firm is, on average, about 0.7% point higher. This relationship is clear for temporary agency workers, by type of employment, and stronger for the manufacturing industry, by industry.

3) Among the highly volatile firms, the ratio of nonstandard workers has a positive and quantitatively nontrivial relationship with the TFP. For a firm with one standard deviation higher sales volatility, a 10% higher nonstandard worker ratio is related to around 1% point higher TFP.

These results come from Japanese firm-level data, but labor adjustment costs of standard and nonstandard workers may differ among countries depending on labor market rules and regulations. The relationship among firm volatility, nonstandard employment, and productivity may also be different by the institutional setting of a country. Empirical studies similar to this paper for other countries may enrich our understanding of the role of labor market regulations.[10]

Today, firms are faced globalization, rapid technological changes, shortened product life cycle, and product market deregulation. All these seem to contribute to the increase in instability and uncertainty of firm output, which, in turn, increases the demand for nonstandard workers whose adjustment cost is low. If firms with high volatility cannot adjust the labor input flexibly, their productivity performance will deteriorate. From a macroeconomic perspective, it is desirable to increase the utilization rate of human resources through their smooth reallocation in accordance with change in output fluctuations. However, it should also be noted that instability of temporary agency jobs and contract jobs are undesirable for these types of individuals.

Multiple policy measures are necessary to achieve two trade-off policy objectives—productivity growth and security of individual workers. The analysis in this paper suggests that the desirable policy mix for the whole economy is a combination of the provision of sufficient safety net and training opportunities for nonstandard workers on the one hand and the enactment of reasonable laws and regulations that enable firms to adjust labor input flexibly on the other hand.

[10] Venn (2009) estimates the employment protection indicators for 30 OECD countries and 10 emerging economies. According to the result, Japan's employment protection level is lower than OECD average, but higher than that of the U.S. and the UK.

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Table 1 Workers by type of employment

	1994		2000		2006	
	Sum	Mean	Sum	Mean	Sum	Mean
Regular workers	2,048,563	235.0	1,940,815	222.7	1,913,308	219.5
Full-time	1,866,766	214.2	1,636,560	187.8	1,642,097	188.4
Part-time	181,797	20.9	229,534	26.3	271,211	31.1
Contract and daily workers	33,726	3.9	27,708	3.2	24,125	2.8
Temporary agency workers	—	—	47,013	5.4	134,829	15.5

Note: Calculated from the balanced panel of 8,716 firms.

Table 2 Gross job flows by type of employment

	Full-time workers	Part-time workers	Contract and daily workers	Temporary agency workers
GJCR	0.9%	4.0%	8.5%	9.4%
GJDR	-1.0%	-3.1%	-8.7%	-5.1%
GJRR	2.0%	7.1%	17.2%	14.5%

Note: The figures are the averages from 2000-2001 to 2005-2006.

Table 3 Elasticity of employment with respect to change in sales

	Intervals		
	1 year	3 years	5 years
Full-time workers	0.224	0.376	0.431
Part-time workers	0.323	0.465	0.497
Temporary agency workers	0.521	0.661	0.628
Nonstandard workers (total)	0.410	0.566	0.630

Note: Elasticity for contract and daily workers is insignificant and is not reported here.

Table 4 Regression results for ratio of nonstandard workers

	(1) Part-timers			(2) Contract and daily workers			(3) Temporary agency workers			(4) Nonstandard workers (total)		
	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
Sales volatility	0.012	0.009		0.032	0.008	***	0.124	0.011	***	0.150	0.020	***
Administration	-0.170	0.005	***	-0.014	0.004	***	0.031	0.007	***	-0.218	0.012	***
Information	-0.096	0.011	***	-0.016	0.010	*	-0.018	0.014		-0.099	0.026	***
R&D	-0.106	0.008	***	-0.017	0.007	**	0.037	0.009	***	-0.089	0.017	***
Manufacturing	0.001	0.003		-0.014	0.002	***	0.033	0.003	***	0.013	0.006	**
Commerce	-0.009	0.003	***	-0.013	0.002	***	-0.009	0.003	***	-0.033	0.006	***
Firm size	0.019	0.001	***	0.000	0.001		0.012	0.001	***	0.032	0.001	***
Firm age	-0.001	0.000	***	0.000	0.000		0.000	0.000	***	-0.001	0.000	***
Year dummies	yes			yes			yes			yes		
Industry dummies	yes			yes			yes			yes		
N	113,308			113,308			61,012			61,012		
Adj R-squared	0.3008			0.0313			0.0821			0.2068		

Note: Pooled OLS results. *significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5 Quantitative assessment of the estimated coefficients

	(1) Estimated coefficients	(2) Coefficients*1 sd volatility	(3) Mean ratio of workers	(4) (2)/(3)
Part-timers	0.012	0.1%	9.7%	0.6%
Contract and daily workers	0.032	0.1%	1.3%	11.6%
Temporary agency workers	0.124	0.6%	4.0%	14.6%
Nonstandard workers	0.150	0.7%	15.5%	4.6%

Table 6 Estimated coefficients for firm volatility by industry

	(1) All industries	(2) Manufacturing	(3) Non-manufacturing
Part-timers	*0.012*	0.022	*0.001*
Contract and daily workers	0.032	0.040	*0.024*
Temporary agency workers	0.124	0.153	0.078
Nonstandard workers	0.150	0.199	0.082
Mean volatility	0.065	0.069	0.058

Note: Figures in *italics* mean insignificant at 10% level.

Table 7 TFP estimation results for high-volatility and low-volatility firms

(1) Part-timers

	High-volatility firms			Low-volatility firms		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.032	0.002	***	0.010	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.920	0.005	***	0.881	0.004	***
Part-time ratio	0.453	0.013	***	0.430	0.009	***
Year dummies		yes			yes	
Industry dummies		yes			yes	
N		52,087			52,708	
Adj R-squared		0.4806			0.5562	

(2) Contract and daily workers

	High-volatility firms			Low-volatility firms		
	Coef.	Std. Err.	P>t	Coef.	Std. Err.	
Firm size	0.041	0.002	***	0.027	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.858	0.005	***	0.794	0.004	***
Contract and daily worker ratio	0.055	0.015	***	-0.026	0.010	***
Year dummies		yes			yes	
Industry dummies		yes			yes	
N		52,087			52,708	
Adj R-squared		0.4684			0.5367	

(3) Temporary agency workers

	High-volatility firms			Low-volatility firms		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.061	0.003	***	0.041	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.847	0.007	***	0.793	0.005	***
Temporary agency worker ratio	0.195	0.017	***	0.071	0.020	***
Year dummies		yes			yes	
Industry dummies		yes			yes	
N		26,021			26,584	
Adj R-squared		0.4893			0.5631	

(4) Nonstandard workers (total)

	High-volatility firms			Low-volatility firms		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.056	0.003	***	0.031	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.873	0.007	***	0.827	0.005	***
Nonstandard worker ratio	0.234	0.010	***	0.205	0.008	***
Year dummies		yes			yes	
Industry dummies		yes			yes	
N		26,021			26,584	
Adj R-squared		0.4967			0.5723	

Note: Pooled OLS results. *significant at 10%; ** significant at 5%; *** significant at 1%. High-volatility firms and low-volatility firms are divided by the median volatility of the sample firms.

Table 8 TFP estimation results by industry

	(1) All industries	(2) Manufacturing	(3) Non-manufacturing
Part-timers	0.023	0.117	-0.072
Contract and daily workers	0.081	0.136	0.058
Temporary agency workers	0.124	0.210	0.153
Nonstandard workers	0.029	0.120	-0.038

Note: The figures represent the differences of estimated coefficients for high- and low-volatility firms.

Table 9 TFP estimation results with the interaction term

(1) Part-timers

	(1) OLS			(2) 2SLS		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.029	0.001	***	0.032	0.001	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.867	0.003	***	0.842	0.007	***
Volatility*part-time ratio	3.462	0.081	***	1.129	0.236	***
Year dummies	yes			yes		
Industry dummies	yes			yes		
N	104,795			104,795		
Adj R-squared #	0.5034			0.4936		

(2) Contract and daily workers

	(1) OLS			(2) 2SLS		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.033	0.001	***	0.034	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.830	0.003	***	0.812	0.004	***
volatility*contract ratio	0.531	0.112	***	14.763	1.813	***
Year dummies	yes			yes		
Industry dummies	yes			yes		
N	104,795			104,795		
Adj R-squared #	0.4883			0.4104		

(3) Temporary agency workers

	(1) OLS			(2) 2SLS		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.049	0.002	***	0.050	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.823	0.004	***	0.825	0.004	***
volatility*temp ratio	2.286	0.123	***	1.109	0.485	***
Year dummies	yes			yes		
Industry dummies	yes			yes		
N	52,605			52,605		
Adj R-squared #	0.5163			0.5180		

(4) Nonstandard workers

	(1) OLS			(2) 2SLS		
	Coef.	Std. Err.		Coef.	Std. Err.	
Firm size	0.046	0.002	***	0.048	0.002	***
Firm age	-0.003	0.000	***	-0.003	0.000	***
Average wage	0.846	0.004	***	0.836	0.004	***
volatility*nonstandard	2.329	0.071	***	1.016	0.192	***
Year dummies	yes			yes		
Industry dummies	yes			yes		
N	52,605			52,605		
Adj R-squared #	0.5243			0.5224		

Note: *significant at 10%; ** significant at 5%; *** significant at 1%. # Adjusted R-squared for OLS and R-squared for 2SLS. 2SLS estimations use the interaction term of volatility and the ratios of business composition as instruments.

Table 10 Estimated effects of 10% increase in the ratio of nonstandard workers on TFP for firms with one standard deviation higher sales volatility (by industry)

	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
	All industries	Manufacturing	Non-manufacturing	All industries	Manufacturing	Non-manufacturing
Part-timers	1.6%	1.6%	1.7%	0.5%	0.1%	1.4%
Contract and daily workers	0.3%	0.2%	0.3%	7.2%	4.8%	15.0%
Temporary agency workers	1.1%	1.0%	1.7%	0.5%	1.0%	7.1%
Nonstandard workers	1.1%	1.0%	1.2%	0.5%	0.5%	1.4%

Note: Calculated from the regression results.