General Equilibrium Evaluation of Temporary Employment

Guanyi Yang

the Ohio State University

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Welfare Under Friction and Uncertainty: General Equilibrium Evaluation of Temporary Employment

Guanyi Yang
The Ohio State University

Abstract

This paper studies the response of firms in an environment with heightened idiosyncratic risk and dual labor markets, a regular market with firing rigidity and a frictionless temporary labor market. I find that firing rigidity induces firms to switch from regular employment to temporary employment, and heightened risks amplify such behavior. Efficiency and welfare loss from friction and risk, though alleviated by a small extent, cannot be fully compensated by having temporary employment. This study also first extends the literature of temporary employment by examining its impact in the U.S. labor market.

JEL classification: E24, C68, J30.

Keywords: Labor market misallocation, temporary employment, firing costs, idiosyncratic uncertainty, general equilibrium, heterogeneous agents.

1 Introduction

Many studies have recognized the importance of non-convex cost in factor adjustment (Khan and Thomas, 2003; Hamermesh, 1993; Cooper and Willis, 2001; Hall, 2002); few has quantitatively examined it in a complex labor market, especially with its impact on households' welfare. This study quantitatively investigates the interactive consequences of non-convex labor adjustment cost and dual labor markets with changing idiosyncratic risk, where firms have imperfect substitutability between regular employment (or non-temporary employment) that subjects to the non-convex cost and temporary employment that are free of non-convex cost. I calibrate the benchmark model to the U.S. economy with temporary employment and firing friction (mode of non-convexity in this study), and examine the production efficiency and welfare consequences of having temporary employment while changing the scale of the non-convexity and the level of idiosyncratic risk.

Though temporary employment contributes to a small share of the average employment in the U.S. labor market, it is growing exponentially for the last two decades. Temporary employment exhibits strong cyclicality, and significant leading behavior in recent recessions and recoveries in the U.S.. Nevertheless, few research documents and evaluates its role in the U.S. labor market. Only a handful of quantitative studies on temporary employment, yet exclusively focus on European labor markets with high rigidities, of which results cannot be directly applied to the U.S., because of a relatively *laissez faire* employment environment in the U.S. (Wachter and Estlund, 2012; Lin, 2016; OECD, 2013). This paper takes an initiative to fill the gap.

Studies on temporary employment often exclusively falls in the examination of it with some level of firing cost induced labor rigidity. In addition, I introduce an interaction of idiosyncratic risk change with firing rigidity. I extend the job turnover model from Hopenhayn and Rogerson (1993), and develop a heterogeneous firm model that allows for a simple but effective structure in accounting for changes of idiosyncratic risk, labor market frictions and different nature of employment costs. I employ two labor choices: non-temporary workers and temporary workers. To model the nature of temporary employment in comparison to regular employment, I abstract it by restricting firms to pay a firing cost if reducing regular employment stock, while free for adjusting temporary workers. I calibrate the model to match the U.S. economy. Temporary employment is, by definition, inexpensive and flexible. According to the U.S. Department of Labor (2015), temporary contracts are designed to last within one year, and/or to fulfill a temporary hike of demand. Firms are not obligated to offer the same employment fringe benefits to temporary workers as to permanent workers, and are not subject to firing and hiring related fixed expense to adjust the size of temporary employment. Thus, segmenting labor market into temporary and non-temporary employments endogenously generates asymmetry in the cost bearing to firms. In the U.S. labor market, notwithstanding, we do not observe significant level of rigidities. Except for the Worker Adjustment and Retraining Notification Act (WARN) passed in 1980s, employers in the U.S. can largely adjust labor force based on "at-will" employment (OECD, 2013; Wachter and Estlund, 2012). Despite so, we still observe an increase in the share of temporary employment from less than 0.3% in 1975 to about 2.5% in 2015 in the labor market. Labor market rigidity alone is not a satisfying environment for the study of temporary employment in the U.S. labor market. Empirical documents suggest that firms use temporary employment as a buffer strategy (Schreft and Singh, 2003; Schreft, Singh, and Hodgson, 2005). In particular, firms prefer to hiring and firing temporary workers in an environment with large uncertainty before committing to a permanent hiring. Comin and Philippon (2006) provides empirical background for this study by documenting a continuing increase of idiosyncratic firm level volatility since the beginning of the Great Moderation. This paper is the first one to quantitatively study an economy with temporary employment in the background of increasing idiosyncratic volatility of firms.

I show that capturing heterogeneity in a general equilibrium framework is crucial when there is endogenously generated asymmetries, as supported by Restuccia and Rogerson (2013, 2008). Relative prices faced by different producers matter. Policy regulations on fixed cost generate unbalanced responses in labor market. Thus, it is important to study the welfare consequences in a general equilibrium framework with heterogeneous agents.

The introduction of temporary employment alleviates the efficiency loss from firing tax, but does not fully serve as if a firing tax reduction. The introduction of firing cost leads to firms' inaction of adjusting permanent regular labor freely. The size of inaction band represents the degree of labor market misallocation. The higher the firing cost, the larger such inaction band is. With the introduction of temporary employment, firms turn further away from the willingness to adjust regular workers and move to temporary workers as a buffer strategy in avoiding firing cost.

By raising idiosyncratic uncertainty, the model responds with heightened market activity as increasing job turnovers. But uncertainty alone cannot change employment composition in a frictionless economy, since it does not distort firms' marginal rate of substitution between temporary and non-temporary labor inputs. If combining a small level of fixed cost to regular employment with the raise of idiosyncratic uncertainty, however, firms respond sharply by doubling the amount of temporary workers from just having a fixed cost. Compared to a model without temporary employment, firms reduce labor market activities, and decrease job turnovers in the environment with dual labor markets. Raising uncertainty, in addition to fixed cost, generates a larger inaction band, compared to the response in a model without temporary employment. It further illustrates the significant role of temporary employment as a buffer strategy for firms to avoid paying fixed cost in rising risk.

Fixed cost and high idiosyncratic volatility create large welfare loss to both firms and households regardless of temporary employment. But having temporary employment slightly relieves the loss. First of all, the fixed cost reduces labor market efficiency. Firms hoard excess employees in facing low productivity and refrain from hiring on the other hand. Lower efficiency reduces labor productivity and incurs output cost. Secondly, heightened idiosyncratic risk reduces output. Thirdly, both labor market frictions and rising risk create welfare loss for households, because of reduction of consumption and adjustment in labor supply. Though having temporary employment reduces the welfare loss for firms and households, it cannot reverse the labor market inefficiency created by fixed cost and increased risk. In other words, temporary employment serves as a buffer strategy for firms to reduce misallocation of labor and for households to buffer from substituting completely to unemployment.

There is only a small literature on temporary employment with inconclusive results, albeit all about European labor markets. Booth, Francesconi, and Frank (2002), da Silva, Turrini, et al. (2015), and Holmlund and Storrie (2002) give evidence that temporary jobs are less desirable with lower wage rate. Boeri (1999) shows that market with temporary employment serves against unemployed workers. Houseman and Heinrich (2015); Autor and Houseman (2010); Kilcoyne (2005); Peck and Theodore (2007); Melchionno (1999) look at the U.S. labor market and documents similar facts. Güell (2000) uses an efficiency wage model and argues for a negative welfare consequences of temporary employment. Other mainstream studies involve partial equilibrium frameworks. Aguirregabiria and Alonso-Borrego (2014) argue that increasing temporary employment reduces labor market misallocation, similar to a reduction of firing tax. Bentolila and Saint-Paul (1992) and Cabrales and Hopenhayn (1997) acknowledge that temporary employment increases total employment in economic booming and dampens business cycle fluctuations in aggregate employment. Search models are also frequently used. Many of such work argue that temporary employment increases unemployment and have negative welfare consequences (Blanchard and Landier, 2002; Cahuc and Postel-Vinay, 2002). On the other hand, Faccini (2014) further introduces firm's screening motive in utilizing temporary employment, and generates positive welfare and a permanent decrease of unemployment. Seliski (2015) and Blanchard and Landier (2002) provide counter-argument that temporary employment prevents workers from transitioning to high paid stable permanent jobs, which creates life-time welfare loss. These studies, however, often exogenously fix the relative ratio of temporary workers to regular workers in the labor force, and does not allow endogenous movement for workers and firms to adjust such ratio. Alvarez and Veracierto (2006) and Veracierto (2000) incorporate undirected search in a Lucas-Island environment and show that the size and length of temporary contracts matter. Alonso-Borrego, Fernández-Villaverde, and Galdón-Sánchez (2005) extend such hybrid model with complex features in an incomplete market, and conclude that temporary employment increases unemployment and reduce output.

2 Stylized facts

There are few literature documenting the stylized facts of temporary employment in the U.S. labor market. Given its small share in the labor force, there is also a lack of systematic and comprehensive aggregate data record for temporary employment. Following the practice by Schreft et al. (2005), Schreft and Singh (2003), Melchionno (1999), and Kilcoyne (2005), I use Current Establishment Survey from Bureau of Labor Statistics to document related facts. Specifically, I use employment data from Personnel Supply Services for an approximation of temporary employment from 1972 to 1990, and Temporary Help Services from the Employment Services category for data since 1990. These categories collect data from companies that supply temporary workers to other firms. Such data overestimate the temporary employment by counting non-temporary staff members in the service agencies, and underestimate independent contractors and temporary employees hired directly by each firm. Schreft and Singh (2003) argue that the overestimation should be small; Kilcoyne (2005) argue that temporary help services account for more than 70% of total temporary employment. Given it the best aggregate data available, I proceed with caution.

It is triking to see the rate of growth of temporary employment in the U.S. Figure 1 plots the average share of temporary employment using monthly data from 1972 to 2015. Despite of its small share, it grew from about a quarter percent of total employment in 1972 to about 3% in 2000. With big fluctuations in the recent two recessions, it is still catching up to over 2.5% in 2015.

I take natural log of the data and bandpass-filtered each series to remove fluctuations higher than 18 months (Christiano and Fitzgerald, 2003). Figure 2 plots the time series of log-detrended data for temporary employment, nontemporary employment, total employment and GDP. Given the dominant share of non-temporary employment, it almost replicates total employment. Throughout history, we observe large cyclical flucuations of temporary employment. Table 1 further documents the volatility and cyclicality of temporary employment to GDP (in comparison to total employment). GDP has a standard deviation of 0.015. Temporary employment is four times as volatile as GDP; while the standard deviation of total employment is only 80% of GDP.

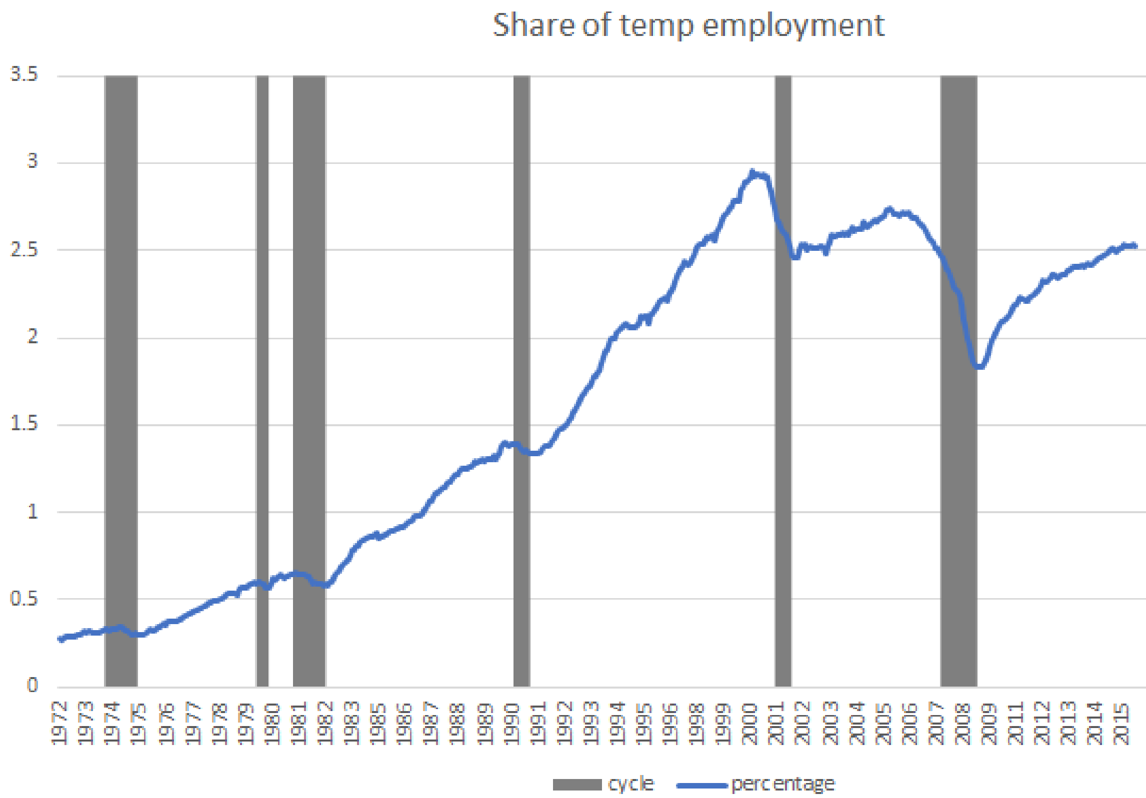

Figure 1: Share of temporary employment

Table 1: Volatility of temporary employment

	output	total employment	temporary employment
Std to Output	(0.015)	0.814	4.096
contemporaneous correlation to output		0.701	0.774
1st order autocorrelation	0.876	0.945	0.932
2nd order autocorrelation	0.693	0.793	0.747

Note: Std to output at the first column is just the standard deviation of output.

It is natural to project such high volatility from the quality of temporary employment, inexpensive to fire. Though it is not the focus of the quantitative practice of this paper, Table 2 documents some important behavior of temporary employment in recent business cycles. Temporary employment in general leads total employment change in both recession and recovery by more than one month. Such leading pattern is becoming more significant in recent recessions, with the increasing share of temporary employment. During the initial job loss and job recovery, temporary employment, despite being small in share of total employment, accounts for a significant portion of total job loss and total job gain.

With the extremely high volatility and fast growing pattern, as well as its role in the

Table 2: Temporary employment in business cycles

		1975	1980**	1982	1991	2001***	2009
Recession	total emp drop	1.62%	1.06%	3.08%	1.14%	1.19%	5.34%
	total temp drop	12.60%	5.93%	12.84%	5.57%	11.10%	29.71%
	total drop accounted by temp	2.61%	3.32%	2.38%	6.82%	25.64%	13.73%
	months before trough total starts to drop	12	11	16	9	10	14
	months temp preceeds total to drop	1	-1	0	1	5	14
Recovery*	total gain	6.19%	1.96%	8.11%	1.31%	0.41%	0.71%
	temp gain	45.41%	15.94%	59.96%	23.41%	7.04%	21.27%
	total gain accounted by temp	2.19%	4.59%	4.35%	23.84%	42.22%	54.99%
	months started to recover from trough	5	2	2	7	25	4
	months temp preceeds total to recover	1	1	2	2	8	3

Note: *recover compares employment level 24 months after trough date to trough level; **1980 recovery compares employment level at June 1981 to trough date; ***2001 recovery compares employment level 30 months after trough date to trough date level.

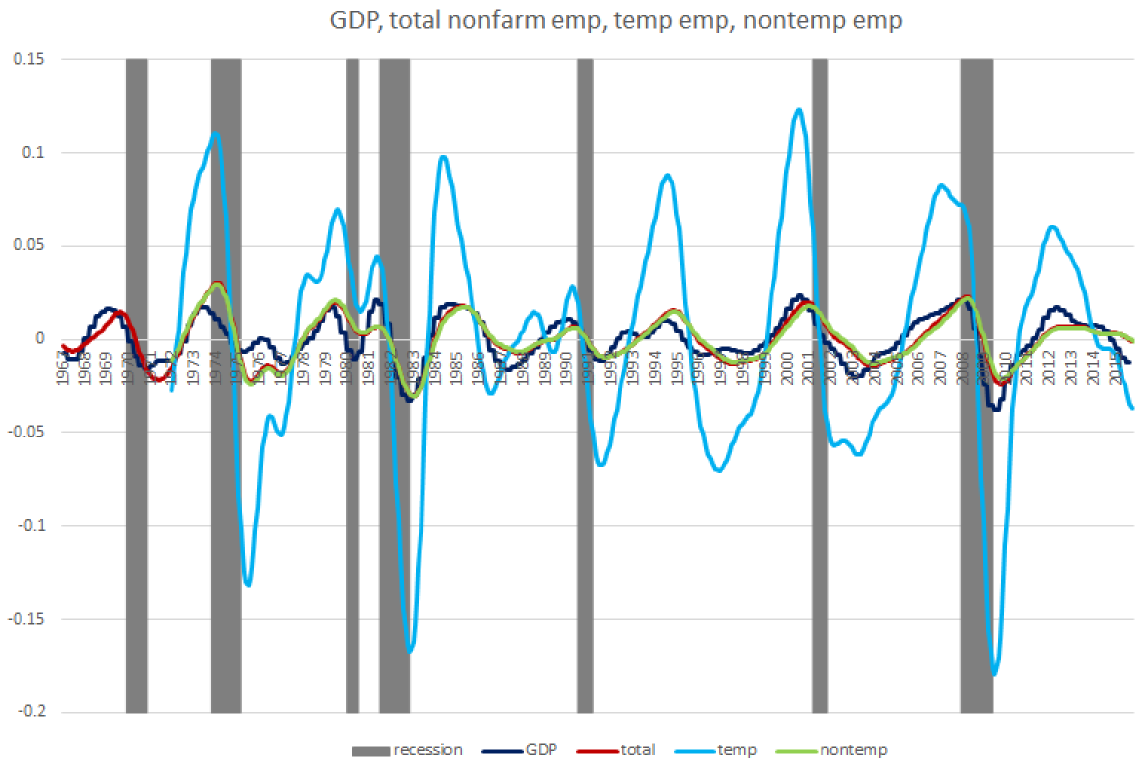

Figure 2: Business cycle fluctuations

business cycle, it is important to evaluate at temporary employment in the U.S. labor market.

3 Model

To explore the impact of fixed term contract on the economy, I build a dynamic general equilibrium model with heterogeneous firms and a representative household. The model extends from Hopenhayn and Rogerson (1993), with a main feature incorporating two different labor factors: temporary labor and non-temporary labor. The main difference of the two types of labor comes from the difference in labor productivity and the fixed cost. Every period, if a firm decides to reduce the stock of non-temporary employees, it pays a cost, indexed to the wage rate. A firm is free to adjust temporary employees without such fixed cost.

3.1 Firm's Problem

The economy is populated by infinitely lived firms with their total mass summing up to one. There is no entry or exit in the economy. The only input to production is the two types of labor, n_1 and n_2, with n_1 being non-temporary regular labor, and n_2 being temporary labor. I assume firms having a CES production function with decreasing returns to scale. Therefore, the period production function has the following format:

$$f(n_1, n_2) = (\lambda n_1^\gamma + (1-\lambda) n_2^\gamma)^{(\alpha/\gamma)} \tag{1}$$

In the model, non-temporary employment is an idiosyncratic endogenous state variable. At the beginning of every period before production, each firm decides to increase, decrease, or intact the current stock of non-temporary employees. If a worker is hired to be an non-temporary worker, her contract lasts indefinitely to the future, unless fired by the firm. Temporary employment, on the contrary, is indexed to each period. Firms hire n_2 number of temporary workers at the beginning of each period before production, and their contracts end by the end of the period. The firm needs to hire them again as a new contract if it needs temporary workers the next period.

To capture the essential difference of temporary and non-temporary workers, I assume firms pay a fixed firing cost at coefficient τ as a percentage of the wage rate, if it reduces the size of non-temporary workers. Firms pay no fixed cost for reducing the size of temporary workers. Such firing cost is an abstract of a variety of rigidities in regular employment compared to temporary employment. Garibaldi and Violante (2005) define firing cost as a combination of transfers between the employer and the laid-off worker and outside of employer-employee pair as a form of tax. In European labor market, τ largely represents the level of employment protection legislation (as a firing tax). Though there is minimum employment protection legislation in the U.S. labor market, it hardly means a lack of labor market frictions. Compared to temporary employment, τ represents non-legislative frictions, such as severance pay, unemployment insurance, cost of emotions in the workforce, cost of reorganization to a permanent position, etc. The firing cost is modeled as:

$$g(n_1, n_1') = \tau w_1 (n_1 - n_1'), \text{ if } n_1 > n_1' \tag{2}$$

Every period, each firm draws an idiosyncratic productivity shock s before production, and the firm observes s from a standard log-normal AR(1) process before making current period employment decisions[1]. In summary, each firm earns period profit:

$$\Pi = s f(n_1', n_2) - w_1 n_1' - w_2 n_2 - g(n_1, n_1') \tag{3}$$

In a dynamic environment, firms discount future value by factor β_f. We can write firms'

[1] $\ln s' = \rho \ln s + \epsilon$, where $\epsilon \sim N(0, \sigma_e)$

problem as:

$$W(s, n_1; \mu) = \max\{W_d(s, n_1; \mu), W_u(s, n_1; \mu)\} \tag{4}$$

Each firm chooses whether to downsize the level of non-temporary employment or up-size it. The value of a downsizing firm has:

$$\begin{aligned} W_d(s, n_1; \mu) = \max_{n_1', n_2}\{ & sf(n_1', n_2) - w_1 n_1' - w_2 n_2 - \tau w_1 (n_1 - n_1') \\ & + \beta_f E_s W(s', n_1'; \mu')\} \end{aligned} \tag{5}$$

And the value of an up-sizing/inaction firm has:

$$W_u(s, n_1; \mu) = \max_{n_1', n_2}\{sf(n_1', n_2) - w_1 n_1' - w_2 n_2 + \beta_f E_s W(s', n_1'; \mu')\} \tag{6}$$

From the firm's problem, we can define an individual firm's inter-temporary decision rule as:

$$n_1' = h(s, n_1) \tag{7}$$

And decision rule for hiring temporary employment:

$$n_2 = \psi(n_1', s, \mu) \tag{8}$$

In a stationary equilibrium, although price doesn't change, firms face idiosyncratic productivity risk every period. There is constant up-sizing and downsizing in the model. I track the distribution of firms on the size of non-temporary employment stock, n_1, and the idiosyncratic productivity shock, s, by the probability measure μ defined on the Borel Algebra, $\mathcal{S}$, generated by the open subsets of the product space, $\mathcal{S} = \mathbb{R}_+ \times \mathbb{R}_+$. Aggregate decision rule μ evolves as:

$$\mu'(s', n_1') = \Gamma(\mu(s, n_1)) \tag{9}$$

In aggregate, non-temporary labor demand has:

$$L_{n_1}^d(\mu') = \int h(s, n_1') d\mu' \tag{10}$$

and temporary labor demand has:

$$L_{n_2}^d(\mu') = \int \psi(s, n_1') d\mu' \tag{11}$$

3.2 Household's Problem

To simplify the model, I choose one representative household in the economy. The household is endowed with one unit of time deciding to supply temporary jobs and one unit of time in supplying labor to non-temporary jobs. It values utility differently for the time from temporary jobs and from non-temporary jobs. I assume log utility for household from consumption and from leisure. Every period, the household chooses how many hours to allocate to each type of job, and pools the wage earned from different jobs to enjoy consumption. Household has period utility:

$$\log(c_t) + a\log(1 - n_{1t}) + b\log(1 - n_{2t}) \tag{12}$$

The household owns the firms, hence receives profit rebate Π, as well as government tax rebate Υ in a lump sum every period. I do not explicitly model asset in the model. By setting discounting factor $\beta = \frac{1}{1+r}$, the household's decision becomes static in a stationary equilibrium.

Following Hansen (1985) and Rogerson (1988), I assume indivisible labor. Therefore, the household acts as if choosing the share of its members supplying to temporary jobs and the share to non-temporary jobs. We have the household's problem as:

$$\begin{aligned} U(C, 1-N_1, 1-N_2) = \max_{C,N_1,N_2} \{\log(C) + a\log(1 - N_1) + b\log(1 - N_2)\} \\ s.t. \\ C \leq w_1 N_1 + w_2 N_2 + \Pi + \Upsilon \end{aligned} \tag{13}$$

3.3 Equilibrium

With the above definitions, the stationary competitive equilibrium of this economy should have a consistency between firm's choice and household's optimality conditions, cleared by the price. More formally, the recursive equilibrium is a set of functions for prices, quantities, and values:

$$\{w_1, w_2, r, n'_{1f}, n_{2f}, L^d_{n_1}, L^d_{n_2}, n_{1h}, n_{2h}, N_1, N_2, c, C, Y, W, U\} \tag{14}$$

1. Firms maximize W for Equation (4) with n'_{1f} and n_{2f} their associated policy functions.
2. The household maximizes U for Equation (13) with n_{1h}, n_{2h}, and c its associated policy functions.
3. Prices w_1, w_2, r are competitively determined (I set $r = 1/\beta - 1$ without loss of generality).
4. Markets for two labors and final goods clear.

5. Laws of motion for aggregate state variables are consistent with individual decisions.

As there is no heterogeneity in household, its consumption and labor supply decisions can be written as a function of aggregate state: $C(\mu)$, $N_1(\mu)$, and $N_2(\mu)$.

4 Calibration

Despite the growing importance of temporary employment in the U.S. labor market, there has been no research quantitatively assess its role in the U.S. economy. With limited micro observations, it is also difficult to find data reporting details of temporary employment across U.S. firms. Therefore, I rely certain calibration targets on reports and empirical work done on temporary employment in the U.S. as a rough baseline for the benchmark model estimation.

In this economy, I choose model period to be one year. It is consistent with the U.S. Department of Labor (2015) definition of temporary contracts being within one year. Due to the model setup, I cannot account for the quits and firings of temporary workers within one year. I set β equals to 0.96 in order to match the annual interest rate of 4%. The idiosyncratic firm productivity follows a Markov Chain with 20 values. According to Hopenhayn and Rogerson (1993), it is necessary to have such grid size for precision. I discretize the Markov Chain using Tauchen (1986)'s method. Calibration for the idiosyncratic productivity shock process, as dictated by ρ and σ_e, targets the average firm size distribution as reported by the Longitudinal Business Database from 1977 - 2013.

Table 3: Benchmark Parameter Values

β	λ	γ	α	ρ	σ_e	τ	a	b
0.96	0.961	0.29	0.692	0.9791	0.259	0.6	1	1.1417

The essential qualities of temporary employment, being inexpensive and flexible, also predict that temporary workers are in general less productive. Houseman and Heinrich (2015), Autor and Houseman (2010), and Kilcoyne (2005) document that majority of the U.S. temporary labor force are composed with low skilled workers. Houseman and Heinrich (2015) provide further evidence that temporary workers tend to have lower soft skills and have less trainings provided by the employers. Consequently, we often observe a lower wage rate paid to temporary workers than to a non-temporary worker, even with the same job responsibility. Albeit inexpensive to hire and fire while facing uncertainty, it becomes unclear if hiring more temporary employees is beneficial.

Traditional line of research following Hopenhayn and Rogerson (1993), such as Veracierto (2008) and Lin (2016), follows a path of calibration to a *laissez-faire* benchmark and applying different values of τ for experiment. I calibrate the benchmark model, instead, with friction according to the U.S. economy. This is also a realistic approach given the relatively low and steady τ in U.S. labor market. For the purpose of this study, in the investigation of changing idiosyncratic volatility, it is also more appropriate to have τ calibrated to the U.S. economy. Firms are assumed to follow a standard decreasing return to scale CES production function with two kinds of labor inputs. The scale of production α is calibrated to match the average post-war labor share of output 0.64. According to Houseman and Heinrich (2015) and Autor and Houseman (2010), majority of temporary employment in the U.S. are low skilled workers. I approximate the elasticity of substitution $1/(1-\gamma)$ between temporary and non-temporary labors using the value 1.4 from David, Katz, and Krueger (1997) between low skilled and high skilled workers. As for the productivity efficiency parameter λ, I need to match the marginal rate of transformation between the two types of labor to the wage ratio and the average share of temporary employment in the U.S. data. Meanwhile, λ is also jointly determined with the firing cost τ. Since firms with different size respond to τ differently, changing τ also moves the distribution of firms. In addition, according to Hopenhayn and Rogerson (1993) and Atkenson, Khan, and Ohanian (1996), firing cost has a close relationship to the job turnover rate. Therefore, I need to jointly calibrate the two AR(1) parameters, τ, α, and λ.

Household's parameters are much simpler in calibration. Since I do not model employment level in the economy, only the ratio of two disutility parameters matters. I normalize a to be 1, and calibrate b to match the wage ratio of about 0.7 (Kilcoyne, 2005). Table 3 reports all the parameter values calibrated for the study.

To check for robustness of the calibration, Table 4 provides calibration targets and the model generated values. Tail end of firms size distributions is less ideal in matching. Given the simplicity of the model, it's within reasonable range (Hopenhayn and Rogerson, 1993).

5 Analysis

With the benchmark model calibrated to the U.S. annual data, I was able to conduct several experiments to study two changes, growing labor market rigidities and rising idiosyncratic risk, that may lead to an increase in temporary employment in the U.S., and to examine the aggregate consequences from it.

Figure 3 documents the key mechanism that causes labor misallocation. It shows decision rules at one idiosyncratic productivity level for three economies with difference in firing cost.

Table 4: Robustness Check

	Data	Model
labor share of output	0.64	0.642
wage ratio	0.7	0.7
average share of temporary employment	0.0208	0.0201
job turnover	0.318	0.3002
firm size distribution		
1-19	0.8559	0.8234
20-99	0.1201	0.1204
100-499	0.0212	0.0342
500-999	0.0017	0.0000
1000+	0.001	0.022

The horizontal axis represents the current level of non-temporary employment, and the vertical axis shows the next period level of non-temporary employment. In an economy without firing cost, the decision rule is a horizontal line. Without capital, the most efficient employment decision responds perfectly to the size of productivity shock, independent from previous level of employment. Firms hire and fire depending only on the productivity level. As we introduce a positive τ to the firm's firing decision, it becomes costly to reduce the size of employment. The firm has to consider current stock of employment before deciding how many workers to keep next. In order to avoid paying such firing cost, firms refrain from hiring even if there is a demand for labor, because of the fear of firing them the next period; and hoard an excess of labor on the other hand.

Such behavior creates inefficiency. The mechanism produces an inverse "Z-shape" inaction band. The size of the band positively depends on the idiosyncratic shock value and the level of the firing cost. If current employment is above the upper bound or below the lower bound, (i.e. the horizontal tails of the inverse Z), the firm's employment decision is (conditionally) independent from the current level of employment. For the current employment level within the upper and lower bounds, the number of employees to keep the next period relies on current employment level. As we raise the size of firing cost, the size of inaction band increases.

Compare the decision rules between model with temporary employment and without temporary employment (only non-temp workers), the size of inaction band expands further. This illustrates the "buffer strategy" of firms' using temporary employment. Allowing for temporary employment gives firm a chance to adjust labor force, albeit to a lower productive factor, in avoidance of paying the fixed cost. Thus, it creates a stronger incentive for firms to avoid hiring and firing in non-temporary jobs.

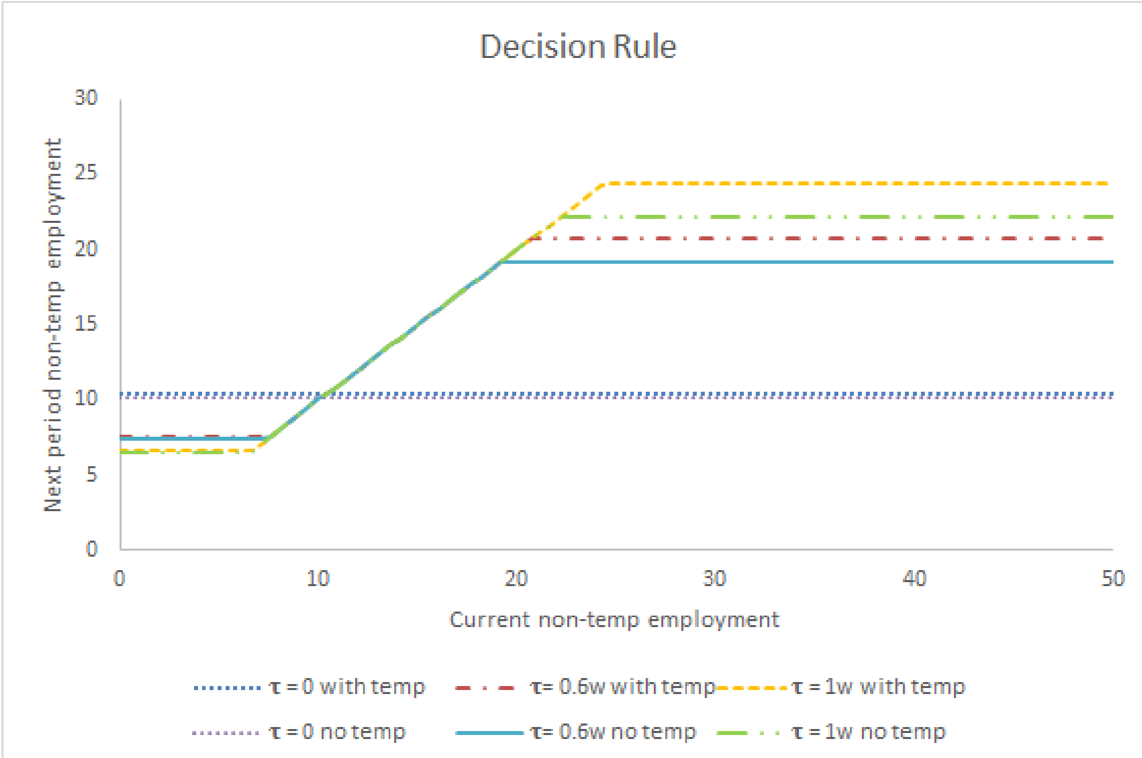

Figure 3: Decision rule and Inaction band

5.1 Firing cost and temporary employment

Most research on temporary employment establishes on a change of legal background. The conclusions, however, are often quite conflicting. In this section, I conduct an experiment by almost doubling the benchmark model firing related cost from 7.2 months to one year of wage. According to Wachter and Estlund (2012), the increase of the U.S. labor market regulations in late 1980s caused a doubling of labor market rigidities in all index documented. Regardless, the size of firing cost is still quite small comparing to it in Italy that varies between 1.5 years of wage and 3.4 years of wage (Garibaldi and Violante, 2005).

I report the general equilibrium results of increasing firing cost in Table 5. In the benchmark model, I calibrated the firing cost to be 7.2 months of wage ($0.6w$). Column 1 and Column 3 show the results with zero firing cost and with a firing cost equals to one year of wage rate, respectively. Though with such a simple model, we see strong and significant effects from the consequences of job reallocation. With higher firing cost, low productive firms hoard too many workers, as represented by a decrease of job destruction rate (JDR); and high productive firms are reluctant to hire, as indicated by a large decrease of job creation rate (JCR) across Column 1 to Column 3. The average firm size is also decreasing (from 20% without firing cost to 88% with $\tau = 1$). This is opposite from Hopenhayn and Rogerson

(1993), because of elimination of entry and exit. Inefficiency created by firing cost with no opportunity to exit leads to a large concentration of smaller firms, rather than dropping out of the market.

In order to separate firms' response from households', I compare the results to partial equilibrium results in Column (4) and (5) of Table 5. I fix the wage rates at benchmark level. In the perfectly efficient model without firing cost, the share of temporary employment is low (92% of Column (2) value). Firms prefer using non-temporary workers than temporary workers, due to the difference of labor productivity. With an increase of firing cost, such behavior flipped. Though firms reduce the level of employment for both temps and nontemps, the share of non-temporary employment increases from 91.56% to 102.42%. This tells that firms are willing to sacrifice labor productivity by hiring more temporary workers in order to avoiding paying firing cost. Despite so, temporary employment cannot compensate the cost of efficiency loss. Therefore, we see a drop of output and profit in both general equilibrium and partial equilibrium results.

By including household's preference, general equilibrium shows a more dampened impact due to price adjustment. One difference, however, is the level of temporary employment. We not only observe an increase in the share of temporary employment (from 94.6% to 101.5%), but also in the level of temporary employment (from 97.9% to 100.7%). With the level of distortion and inactivity in the market of non-temporary employment, households substitute non-temporary labor supply to leisure and to temporary jobs; consequently, firms are able to hire more temporary workers in general equilibrium than in partial equilibrium (100.68% compared to 93.44%). Such comparisons also foretell the importance of considering general equilibrium price effect in the study of welfare consequences.

To investigate how much including temporary employment in a model contributes to the general equilibrium result, I compare the original model (dual-labor model from now on) to a single-labor economy with only permanent employment. I keep everything else the same but shutting down the option of hiring temporary workers. I recalibrate the production parameters (essentially α) to make the single-labor economy producing the same level of output as the dual-labor model at $\tau = 0$. Table 6 reports results from the comparison.

After increasing firing cost from $\tau = 0$ to $\tau = 1$, both models show losses of labor market activities and output. In particular, I calculate the welfare as the level of utility enjoyed by households for each model. Increasing firing cost leads to a loss of households' welfare. Comparing to the model without temporary employment, however, dual-labor model compensates such welfare loss by a about 1.3%. In other words, having a market with temporary employment reduces the welfare punishment from high firing cost to households. Such improvement comes from both a lesser reduction of the output (to 95.25% from 93.92%)

Table 5: Effect of firing cost

	General Equilibrium			Partial Equilibrium	
	$\tau = 0$	$\tau = 0.6w$	$\tau = 1w$	$\tau = 0$	$\tau = 1w$
nontemp wage	107.51%	100.00%	97.68%	100.00%	100.00%
temp wage	104.97%	100.00%	98.17%	100.00%	100.00%
wage ratio ($\frac{W_{temp}}{W_{nontemp}}$)	97.64%	100.00%	100.50%	100.00%	100.00%
total nontemp	103.63%	100.00%	99.21%	131.02%	91.19%
total temp	97.94%	100.00%	100.68%	119.76%	93.44%
total employment	103.51%	100.00%	99.24%	130.80%	91.24%
share of temp	94.62%	100.00%	101.45%	91.56%	102.42%
total output	104.99%	100.00%	98.16%	123.44%	92.53%
tax revenue	0.00%	100.00%	127.51%	0.00%	119.53%
total profit	109.29%	100.00%	95.75%	128.51%	90.72%
job destruction rate	183.12%	100.00%	81.85%	178.92%	81.72%
job creation rate	182.96%	100.00%	81.89%	178.76%	81.76%
average firm size	120.81%	100.00%	88.37%	150.85%	82.02%
	(1)	(2)	(3)	(4)	(5)

Note: Column 1, Column 3, Column 4 and Column 5 are in comparison to Column 2.

and total employment (to 96.6% from 95.7%). Households substitute labor supply completely to leisure in single-labor model, as in the illustration of reduction of total employment. But in the dual-labor model, a lesser reduction of total employment represents a small amount of substitution happening to temporary employment rather than entirely to leisure. With the option of creating temporary jobs to avoid firing cost, JDR and JCR reduce by a lesser amount in the dual model (54% tahn 41%). In summary, Table 6 presents evidence that temporary employment provides households a small buffer to the reduction of market activities from firms.

To summarize the exercises, I find that firing cost leads to misallocation of labor factor in production, which results in a large efficiency loss. Firms sacrifice labor productivity by becoming inactive and by hiring more temporary workers to avoid firing cost. Economy with temporary employment reduces welfare loss for households in the event of increasing firing cost. General equilibrium matters by including labor supply preferences of households, which is reflected through price clearing.

5.2 Idiosyncratic risk and temporary employment

Comin and Philippon (2006) utilize an array of indicators to measure idiosyncratic volatil-

Table 6: With and without temporary employment in the increase of firing cost

	With temp		Without temp	
	$\tau = 0$	$\tau = 1w$	$\tau = 0$	$\tau = 1w$
nontemp wage	100.00%	93.02%	100.00%	91.36%
temp wage	100.00%	95.26%		
total nontemp	100.00%	96.50%	100.00%	95.78%
total temp	100.00%	102.10%		
total employment	100.00%	96.60%	100.00%	95.78%
total output	100.00%	95.25%	100.00%	93.92%
total profit	100.00%	91.50%	100.00%	88.42%
job destruction rate	100.00%	54.61%	100.00%	41.29%
job creation rate	100.00%	54.66%	100.00%	41.35%
average firm size	100.00%	82.77%	100.00%	85.19%
welfare	100.00%	96.51%	100.00%	95.26%
	(1)	(2)	(3)	(4)

Note: Column 2 is in comparison to Column 1; Column 4 is in comparison to Column 3.

ity of firms in the last 50 years. They show that idiosyncratic volatility for firms about doubled during the great moderation. In this exercise, I follow their empirical evidence and double the idiosyncratic risk of firms in benchmark model and compare the response of firms in having temporary employment.

Table 7 presents results of increasing idiosyncratic volatility in general equilibrium and partial equilibrium. The first two columns exhibit changes in a frictionless environment. Doubling idiosyncratic volatility directly leads to an increase in job turnover rate (to 109% for both JDR and JCR). Higher idiosyncratic risk reflects in higher volatility in the firm's revenue and market share turnover (Comin and Philippon, 2006). Therefore, the firm needs to adjust the labor stock more often in response to a more frequent change of idiosyncratic shock. With the rigidity effect as described in previous subsection, the direction of change in the rise of volatility compounds with the effect of firing cost reallocation. Partial equilibrium results give similar information as partial equilibrium in Table 5.

Table 8 recollects results from frictionless dual market, benchmark model, and benchmark model with doubled volatility. It gives a more direct perspective of the compound effect of increasing firing cost and idiosyncratic volatility. From Column 2 to Column 3, increasing volatility revitalize the labor market activities through increasing job turnover rates (from 54% to 77%) that was suppressed by motives of firing cost avoidance. Despite the decrease of both wage rates, higher volatility increases the relative wage of temporary workers compared

Table 7: Effect of doubling idiosyncratic volatility

	General Equilibrium				Partial Equilibrium
	$\tau = 0$		$\tau = 0.6w$		$\tau = 0.6w$
	$\sigma_e = 0.259$	$\sigma_e = 0.3663$	$\sigma_e = 0.259$	$\sigma_e = 0.3663$	$\sigma_e = 0.3663$
nontemp wage	100.00%	90.13%	100.00%	87.83%	100.00%
temp wage	100.00%	90.14%	100.00%	89.19%	100.00%
wage ratio ($\frac{W_{temp}}{W_{nontemp}}$)	100.00%	100.00%	100.00%	101.54%	100.00%
total nontemp	100.00%	100.00%	100.00%	97.61%	63.88%
total temp	100.00%	100.00%	100.00%	100.83%	66.96%
total employment	100.00%	100.00%	100.00%	97.67%	63.94%
share of temp	100.00%	100.00%	100.00%	103.23%	104.74%
total output	100.00%	90.13%	100.00%	89.18%	66.53%
tax revenue			100.00%	125.92%	94.96%
total profit	100.00%	90.14%	100.00%	90.25%	67.33%
job destruction rate	100.00%	109.87%	100.00%	141.16%	142.90%
job creation rate	100.00%	109.86%	100.00%	141.08%	142.88%
average firm size	100.00%	102.78%	100.00%	112.71%	70.58%
	(1)	(2)	(3)	(4)	(5)

Note: Column 2 is in comparison to Column 1; Column 4 is in comparison to Column 3; Column 5 is in comparison to Column 3.

to non-temporary workers on top of the existing effect from firing cost (from 102% to 104%). The changes of employment level and of labor market composition (share of temp from 105% to 109%) further demonstrate that firms use temporary employment as a buffer strategy. With higher volatility, total non-temporary employment drops (from 96% to 94%). The increase of temporary employment share almost doubles from having just firing cost. With declining output and non-temporary employment, augmenting both firing cost and volatility leads to a further punishment of consumer's welfare (from 97% to 83%).

Table 8: Compound impact

	$\tau = 0$ $\sigma_e = 0.259$	$\tau = 0.6w$ $\sigma_e = 0.259$	$\tau = 0.6w$ $\sigma_e = 0.3663$
nontemp wage	100.00%	93.02%	81.70%
temp wage	100.00%	95.26%	84.96%
wage ratio	100.00%	102.41%	103.99%
total nontemp	100.00%	96.50%	94.19%
total temp	100.00%	102.10%	102.94%
total employment	100.00%	96.60%	94.35%
share of temp	100.00%	105.69%	109.11%
total output	100.00%	95.25%	84.94%
total profit	100.00%	91.50%	82.57%
job destruction rate	100.00%	54.61%	77.09%
job creation rate	100.00%	54.66%	77.11%
average firm size	100.00%	82.77%	93.29%
welfare	100.00%	96.51%	82.66%
	(1)	(2)	(3)

Note: Column 2 and Column 3 are in comparison to values in Column 1.

As with before, I compare the dual labor model with a single labor model, in order to separate the effect from having temporary employment. Table 9 presents the comparisons. Column (5)-(8) show that the model with temporary employment responds to increasing volatility in the environment of firing cost by a lesser reduction of wage rate (88% vs 86%), employment (98% vs 97%), output (89% vs 87%) and welfare (86% vs 84%) than model without temporary employment. Similar reason as before, firms can use temporary employment as a buffer strategy in the event of high firing cost and high uncertainty; and households use it as an option in the event of decreasing market activity. However, it shows an opposite direction of the job turnover (141% vs 156%). In Table 6, the option of having temporary employment increases job turnover when firing cost hikes. But in the event of higher volatility, such increase in job turnover decreases compared to the single labor market. This reflects the dominating effect from inaction band. As in Figure 3, economy with temporary employment has a wider inaction band because of the intense use of temporary employment as a buffer strategy. Though from single-labor model, a growing volatility exacerbates job turnover, as a result of dominating effect from the constant need of changing production factor over an opposite effect from fixed cost avoidance; by allowing the temporary workers, the motive of fixed-cost avoidance increases.

In summary, from the exercise of changing idiosyncratic volatility, we further demonstrate the use of temporary employment as a buffer strategy for firms. With the compound of firing cost and increasing idiosyncratic volatility, firms show a stronger interest in using temporary workers. Households can also benefit from having temporary employment opportunities by having lesser reduction of utility when there is high market uncertainty.

6 Conclusion

Temporary employment has not been thoroughly studied in the literature. Quantitative study in evaluating the role of temporary employment in the U.S. labor market has been mostly empty, despite a growing importance in data. This paper contributes to quantitative literature of labor market misallocation through a new lens of growing idiosyncratic uncertainty for firms, in addition to simply raising labor market rigidities. Moreover, it constructed a simple Walrasian framework to fill the gap in literature and evaluate temporary employment in the U.S. labor market.

In particular, I constructed a simple general equilibrium model with heterogeneous firms that hire both temporary and non-temporary workers. By calibrating the model to the U.S. economy, I found that increasing firing related cost distorts the allocation of labor factor. I further introduce a raise of idiosyncratic risk to firms. Change of idiosyncratic risk alone to a frictionless economy does not distort the allocation. It merely leads to a heightened job turnover. By combining the two forces together, however, it generates a larger efficiency loss. Idiosyncratic uncertainty amplifies the distortion from firing cost. Firms avoid paying firing cost by creating an inaction band in their decision rule. Higher uncertainty enlarges the inaction band. Comparing the model with and without temporary workers, firms utilize temporary workers as a buffer strategy to avoid paying fixed cost. Firms sacrifice regular employment to temporary employment. Thus, the size of inaction band increases further with the introduction of temporary employment under friction. Though it offers firms a chance to compensate inaction from adjusting only regular employment in a single labor market, by allowing small adjustments to frictionless temporary employment; it does not

Table 9: Effect of temporary employment in doubling volatility

	$\tau = 0$			
	with temp		without temp	
	$\sigma_e = 0.259$	$\sigma_e = 0.3663$	$\sigma_e = 0.259$	$\sigma_e = 0.3663$
nontemp wage	100.00%	90.13%	100.00%	88.50%
temp wage	100.00%	90.14%		
total nontemp	100.00%	100.00%	100.00%	100.00%
total temp	100.00%	100.00%		
total employment	100.00%	100.00%	100.00%	100.00%
total output	100.00%	90.13%	100.00%	88.51%
total profit	100.00%	90.14%	100.00%	88.54%
job destruction rate	100.00%	109.87%	100.00%	109.98%
job creation rate	100.00%	109.86%	100.00%	109.96%
average firm size	100.00%	101.83%	100.00%	106.97%
welfare	100.00%	85.53%	100.00%	83.42%
	(1)	(2)	(3)	(4)
	$\tau = 0.6w$			
	with temp		without temp	
	$\sigma_e = 0.259$	$\sigma_e = 0.3663$	$\sigma_e = 0.259$	$\sigma_e = 0.3663$
nontemp wage	100.00%	87.83%	100.00%	86.03%
temp wage	100.00%	89.19%		
total nontemp	100.00%	97.61%	100.00%	97.09%
total temp	100.00%	100.83%		
total employment	100.00%	97.67%	100.00%	97.09%
total output	100.00%	89.18%	100.00%	87.57%
total profit	100.00%	90.25%	100.00%	89.27%
job destruction rate	100.00%	141.16%	100.00%	156.62%
job creation rate	100.00%	141.08%	100.00%	156.56%
average firm size	100.00%	112.71%	100.00%	112.21%
welfare	100.00%	85.66%	100.00%	83.81%
	(5)	(6)	(7)	(8)

Note: Column 2 (6) is in comparison to Column 1 (5); Column 4 (8) is in comparison to Column 3 (7).

function as a reduction of fixed cost, and allowing temporary employment cannot recover the efficiency loss from fixed cost and increased uncertainty. Despite so, having temporary employment alleviates output loss, total employment loss, and households' welfare cost in the event of increasing firing cost and heightened uncertainty.

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