

Gu, Grace Weishi

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The Cost of Benefits, Financial Conditions, and Employment Dynamics in Recent U.S. Recoveries

Weishi (Grace) Gu*

December 23, 2013

Abstract

This paper explores how much firm-paid employee benefits and firms' financial conditions have contributed to delayed employment recoveries relative to output since 1990, using a DSGE model. Empirically, I document the underexplored pro-cyclicality of per worker benefit costs. Post-1990 period differs from before in that: (1) there have been larger increases of such quasi-fixed employment costs at recoveries; (2) tight financial conditions have also persisted longer into recent recoveries. The model generates 3-to-7-quarter delays in employment recoveries for the post-1990 period but no delay for before, consistent with data; and it produces more than 76 percent of employment volatility.

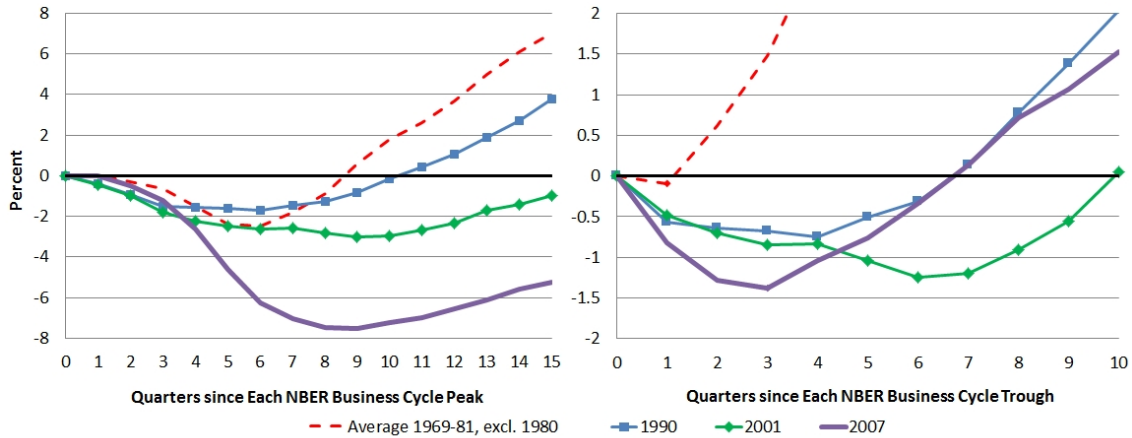
JEL code: E32 - J33 - J21 - C68 - C61

Keywords: Employment recoveries, benefit costs, extensive and intensive margins, financial conditions, enforcement constraint, DSGE model, business cycle, dynamic programming

*Correspondence: Weishi (Grace) Gu, Economics Department, UC Santa Cruz, Engineering 2 Building, Room 463, CA 95060, grace.gu@ucsc.edu. I thank Eswar Prasad, Kevin Hallock, and Viktor Tsyrennikov. I am grateful for the provision of survey data from KFF/HRET, and for the comments from the seminar participants at Cleveland Fed, Penn State University, Cornell, San Francisco Fed, Midwest macro, and UCSC, especially Thomas Lubik, Nicolas Petrosky-Nadeau, and Richard Rogerson. All errors are my own. Also, I declares that I have no relevant or material financial interests that relate to the research described in this paper.

U.S. employment dynamics have changed significantly since the mid-1980s. This is true for both the depth of declines in employment during recessions, and the timing of its recoveries afterwards. In particular, the left panel of Figure 1 plots cumulative employment growth for 15 quarters immediately following NBER business cycle *peaks* into the pre-1990, 1990, 2001 and 2007 recessions, respectively. The 1990 and 2001 downturns suffered employment declines as deep as those in the pre-1990 period, for roughly 3 percent. During the 2007 recession, by contrast, employment plummeted more than twice as much to nearly 8 percent below its previous peak.

Figure 1: Cumulative Employment Growth since Each NBER Business Cycle Peak (Left) and Trough (Right)



Source: BEA, NIPA, BLS CES, and author's calculations.

Moreover, it has taken longer time in the three most recent recoveries for employment to return to its previous peak level, as shown in Figure 1 (left). To examine the timing more closely, the right panel plots cumulative employment growth for 10 quarters following NBER business cycle *troughs*. Point zero is the time of each business cycle trough, and the lowest point on each line is when the actual employment trough occurs. While for the pre-1990 recessions employment recovered at most one quarter later than output did, for the post-1990 recessions employment has reached its troughs 3-to-6 quarters later than the NBER business cycle troughs.¹ Few previous studies have provided convincing empirical support for their theories and closely replicated the employment decline depth and its recovery timing (Andolfatto and

¹The same conclusion follows when I compare employment troughs with actual output troughs.

MacDonald, 2006; DeLoach and Platania, 2008; Bachmann, 2009; Shimer, 2010; Cantore, Levine, and Melina, 2011; Garin, Pries, and Sims, 2011; Berger, 2012; Gali, Smets and Wouters, 2012; Jaimovich and Siu, 2012; Riggi, 2012).² This paper attempts to make progress along these dimensions.

This paper's results cover seven NBER business cycles since 1964. I focus on three factors that have contributed to these changes in the post-1990 U.S. employment dynamics: (1) relatively earlier adjustments to per worker hours than to employment, (2) rising cost of firm-paid quasi-fixed employee benefit costs (including health insurance cost) and the cyclical nature of the costs, as well as (3) firms' financial conditions.³ I build a DSGE model with an explicit role for each of the contributing factors. Particularly, the intuition for the employment impact of benefit costs is simple. Majority of the benefit costs (including health insurance, defined benefit plans, paid leaves) are quasi-fixed, that is, they increase with number of workers but not per worker hours. Hence, changes in per worker benefit costs can alter the tradeoff between per worker hours and employment for firms.

The story of this paper goes as the following. During the early stages of a recession, employers decrease per worker hours and cut employee benefits to reduce labor costs while retaining workers (Richtel, 2008; Hallock, Strain and Webber, 2012). As the recession deepens, firms eventually have to lay off some workers. In the wake of a recovery, benefit costs rise (more in the post-1990 period), firms prefer to increase per worker hours (Schreft, Singh and Hodgson, 2005) and not hire new workers, some even continue laying off existing ones.⁴ Moreover, firms are financially constrained from expanding the workforce. The central feature of my model is the pecking order in firms' labor input adjustment decisions between per worker hours and employment. Increasing hours is preferred to increasing employment in the

²Contributing factors to the recent slow employment recoveries may include increasing imports and immigration, declining union, technological progress, job polarization, industry reallocation, economic and policy uncertainties, and slow output growth. However, a survey by the National Federation of Independent Business finds that high health insurance cost is the most significant problem faced by U.S. small businesses in 2008 and 2012 (*The Economist*, 2012).

³Here, financial conditions refer to a trio of financial constraint, shocks and frictions (Jermann and Quadrini, 2012).

⁴This assumes that all workers receive benefits once hired, which is not exact in reality. Permanent full-time workers are the ones who usually receive firm-paid benefits, therefore, the natural target of this paper. But, given per worker hours data are limited for permanent (from 1990) and for full-time workers, this paper is calibrated to total private employment, also to which the results are compared. This does not hinder the current purpose to examine the employment impact of benefit costs and financial conditions, because the employment cycle of permanent workers and that of full-time workers exhibit similar jobless recovery patterns as total private employment cycle does (Appendix: Figure 17). According to BLS data, non-temporary workers account for on average 97.6 percent of total private industry employment during 1985-2010, full-time workers about 82.3 percent. A separate paper of mine distinguishes workers with and without firm-paid benefits in a heterogeneous agent model.

wake of recent recoveries because of the harsh financial conditions and the rising employment costs.

This paper makes three contributions to the literature. First, I document the underexplored cyclicity of per worker benefit costs and bring it into macroeconomic literature. I show from BLS data that as the trend of benefit costs has soared over the past two decades, there have been larger increases of per worker benefit costs in dollar value at the post-1990 recoveries. This has altered a positive relation between the benefit cost cycle and the labor market employment conditions to become more sensitive to each other's changes. Firm-level evidence is also provided in the extension. Second, I incorporate *dynamic* cyclical benefit costs and their changing relation with labor market conditions into a real business cycle model and find that they are important mechanisms for capturing the recent sluggish employment recoveries. Particularly, the benefit costs alone enable my model to deliver 1-to-6-quarter delays of employment recoveries relative to NBER business cycle troughs following the 1990, 2001, and 2007 recessions.

My third contribution is studying the impact of firms' financial conditions on employment. Many relevant empirical supports have been provided by the literature (Sharpe, 1994; Nickell and Nicolitsas, 1999; Campello, Graham, and Harvey, 2010; Benmelech, Bergman, and Seru, 2011; Duygan-Bump, Levkov, and Montoriol-Garriga, 2011; Calvo, Coricelli, and Ottonello, 2012), but few has incorporated it into a structural business cycle model (exceptions are Jermann and Quadrini, 2012; Garin, 2013).⁵ In this paper, I find financial conditions significant for both the employment's volatility and its delayed recoveries. Together the two mechanisms, benefit costs and financial conditions, enable the model to generate 3-to-7-quarter delays of employment recoveries for the post-1990 period while generating no delay before that. This is in line with the data that has scarcely been matched in the previous literature. The model also delivers more than 76 percent of employment volatility for the post-1990 period, as well as most output and hours volatility.

The benefit cost mechanism employed in this paper share some similarities with DeLoach and Platania (2008) and Bachmann (2009). My model substantially differs, however, in two important dimensions. On one hand, the benefit costs considered in firms' labor input decisions are *dynamic*, reflecting endogenous labor market condi-

⁵One may doubt how important the financial constraint is for big firms that hoard cash. For them the delay in hiring more workers during recent recoveries may have to do with self-austerity and factors other than credit, such as the quasi-fixed employment costs.

tion changes. This generates significantly slower aggregate employment adjustments as in the data than a fixed or stochastic labor adjustment cost can in the existing jobless recovery literature. As we will see later, this model's benefit cost function turns out to be similar to the quadratic employment adjustment cost in Cooper, Haltiwanger and Willis (2004). However, the economic intuition is completely different and their paper is not motivated to explain the recent delays of employment recoveries. On the other hand, the inclusion of financial conditions that interact with benefit costs distinguish this paper from the others. Even though the benefit cost mechanism alone (with productivity shocks) can allow the model to explain up to 49 percent of employment volatility for the post-1990 period, the volatility result is greatly strengthened when I include financial conditions.

The financial condition mechanism in my model is closely related to Jermann and Quadrini (2012). However, they focus upon the impact of financial conditions on total hours rather than employment and its recent slow recoveries. In my model, the financial conditions by themselves (without benefit costs) raise employment volatility too much beyond what is in the data. However, when I factor in the dynamic benefit costs, the financial conditions' impact is smoothed and generates a much closer match with employment data. More specifically, the benefit costs prevent employment from adjusting immediately in response to financial shocks.

The paper is structured as follows. Section I presents empirical facts pertaining to the three contributing factors focused by this paper. Section II proposes a DSGE model that includes firms' dynamic benefit costs, financial conditions, and the tradeoff between extensive and intensive labor margins. Section III studies the quantitative properties of the model, Section IV examines the benefit costs of heterogeneous groups of workers as well as firm-level benefit cost data, and Section V concludes.

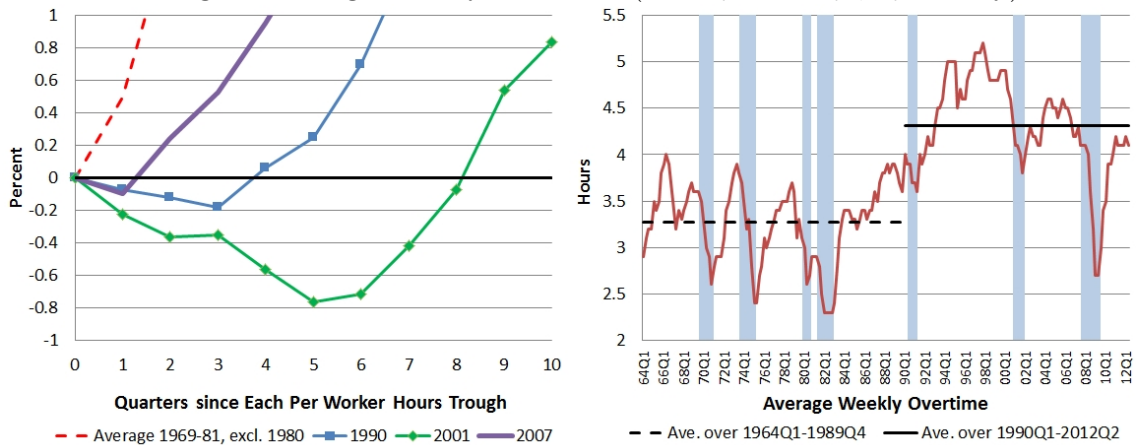
I Three Contributing Factors

A. Per Worker Hours

Figure 2 (left) compares the trough of per worker hours and that of employment for each recession. The former has recovered 1-to-5 quarters earlier than the latter has for the post-1990 period, while they always recovered at the same quarter for the pre-1990 period. Therefore, indeed, in the post-1990 period firms prefer to increase

per worker hours earlier than hiring new workers. Additionally, there has been an upward trend in overtime, from 3.3 hours during the pre-1990 period to 4.3 hours since then (Figure 2, right), which suggests a changing tradeoff between hours and workers. Increasingly, firms would rather raise per worker hours than hire more workers.⁶ Hence, I include both extensive and intensive labor margins in my model to enable firms' choice between them.

Figure 2: Left: Cumulative Employment Growth since Per Worker Hours Troughs and Right: Average Weekly Overtime (1964Q1-2012Q2, Quarterly)



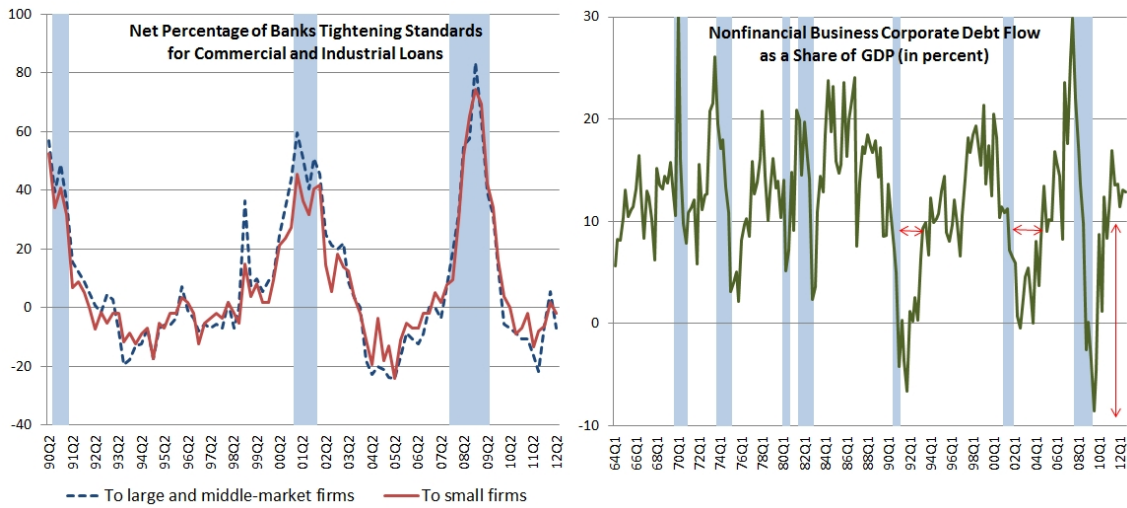
Source: NIPA, CES, BLS, and author's calculations.

B. Financial Conditions

Figure 3 reflects firms' financial conditions from data. Its left panel presents credit supply that has tightened during recessions and gradually loosened in recent recoveries. The right panel depicts for longer period de-facto credit conditions through debt flows as a percentage of GDP. Overall, financial situations exhibit pro-cyclicality. Particularly, during the post-1990 period firms have been much more financially constrained during recessions than the earlier period. More importantly, following the 1990 and 2001 recessions, firms' financial conditions did not improve until two years later.

⁶One may question this insofar as the standard deviation of cyclical per worker hours has declined from 0.0047 before 1990 to 0.0042 since then. In fact, under the Great Moderation, the volatility of per worker hours has increased *relative* to that of employment (Barnichon, 2010). There has been increasing use of per worker hours rather than employment as labor input adjustments.

Figure 3: Financial Conditions (Seasonally Adjusted)



Source: Senior Loan Officer Opinion Survey on Bank Lending Practices from the Federal Reserve Board, and CEIC.

C. The Trend and Cyclicity of Benefit Costs

Benefit costs are composed of the items in Table 1. Not all of them are purely quasi-fixed, about 60 percent is, of which health and life insurance and paid leave are the largest components. However, even for the benefit costs that are not purely quasi-fixed, such as defined contribution plans and social security, it rises more rapidly with new hires than with increased hours (Ehrenberg and Smith, 2012).

Moreover, employment-based benefits no longer represent only a fringe cost to firms. A moderate estimation of benefit costs in real terms topped 14,310 USD per employee (25 percent of total compensation) in 2004, from 5,134 USD (14 percent) in 1964 (Figure 4, left). It also has been growing much faster than wages (Figure 4, right). This relative suppression of wages gives firms an incentive to increase per worker hours more than employment in the wake of recent recoveries. Hence, in the model calibration, I apply a larger parameter value for steady state per worker benefit costs to the post-1990 periods than to the period before.

More importantly, Figure 5 shows the cyclicity of real per worker benefit costs (HP-filtered, with a standard deviation of 0.0106), suggesting varying employment-hour tradeoffs during recessions and recoveries. In particular, at the beginning of a recovery, per worker benefit costs rise, increasing the cost of hiring an additional

Table 1: Employment-Based Benefits as a Percentage of Total Compensation
(Private Industries, in Percent, 2012)

Legal required payments	8.3
Social security	4.7
Medicare	1.2
Workers' compensation (for work related illness)	1.5
Unemployment insurance*	0.9
Retirement	3.6
Employment costs based on benefit formulas (defined benefit plans)*	1.5
Employer costs proportional to earnings (defined contribution plans)	2.1
Insurance (medical, life)*	8.2
Paid vacations, holidays, sick and personal leave*	6.8
Others	2.9
Total	29.8

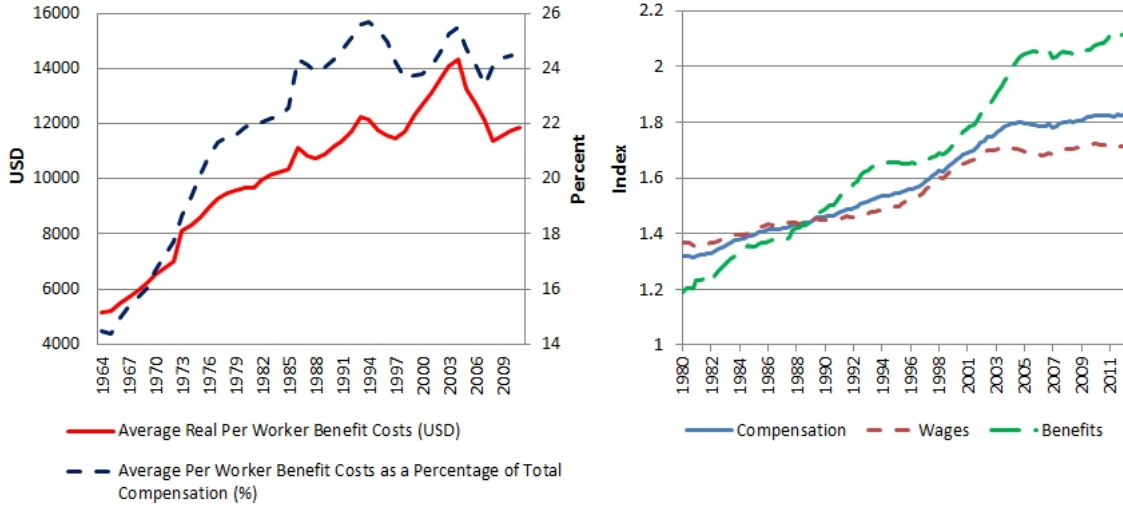
Source: BLS, "Employer Costs for Employee Compensation - December 11, 2012," Table 5, news release USDL-12-2404.

Note: Items with a superscript asterisk are considered purely quasi-fixed, about 60 percent of total benefit costs (Ehrenberg and Smith, 2012). Most life and medical insurance policies have premiums to the employer that are charged on a per-worker basis and are not proportional to the hours worked. Pay for time not worked and defined benefit plans also tend to be quasi-fixed that are usually functions of years of service, not hours of work. Unemployment insurance payroll-tax liability is specific to a percentage of each employee's yearly earning up to a maximum level, which in 2010 was between 7,000 and 15,000 USD in over two-third of all states. Since most employees earn more than 15,000 per year, having an employee work an additional hour per week will not cause any increase in the employer's payroll-tax liability. Therefore, unemployment insurance costs are a quasi-fixed cost to most employers.

employee relative to the cost of increasing existing workers' hours, assuming no overtime wage. Another point worth noting is that even though the fluctuations of per worker benefit costs appear consistent since 1980, it does not mean they have effects on employment evenly over time, given the costs' rising trend. The same percentage increase above a higher trend results in a larger burden of the per worker benefits costs in absolute dollar value on firms to hire new workers. That is to say, the post-1990 period differs from before in that the increases of per worker benefit costs at recent recoveries have become larger.

According to the literature on health insurance underwriting cycles and related premium fluctuations (Newsom and Fernandez, 2010), Kipp, Cookson, and Mattie (2003) find that strong economic growth (as firms seek to attract workers) and low reserve investment return during recessions generally accelerate growth in health insurance costs for the private sector at the beginning of recoveries. Also, Brown and Finkelstein (2008) report the substitution effects between public health insurance programs and the private. The expenditure of the former usually declines during recoveries and is made up by the private sector who pays higher costs. These

Figure 4: Left: Real Per Worker Benefit Costs (1964-2011, Annual) and Right: Real Employment Cost Index (Private Sectors, 1980Q1-2012Q2, Quarterly, Seasonally Adjusted)



Source: Left panel: NIPA (Table 7.8) 1929-2011, Chamber of Commerce Employee Benefits Study 1963-2007, BLS Employer Costs for Employee Compensation (ECEC) 1986-2011, and author's calculations. Right panel: BLS Employment Cost Index (ECI) and author's calculations.

Note: Left panel: Real per worker benefit cost series are calculated by the author using NIPA, Chamber of Commerce, and BLS data, respectively, deflated by the NIPA GDP price index, and then averaged over the three series. NIPA's wage and salary data is used in producing per worker benefit costs as a percentage of total compensation. Right panel: the index data is deflated by NIPA GDP price index.

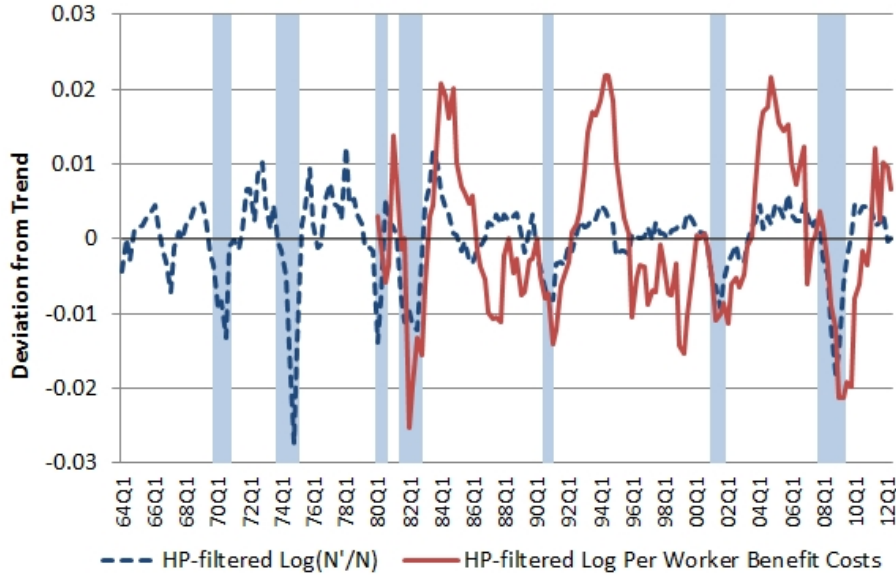
evidence are consistent with the pattern of benefit cost cycle in Figure 5. This paper does not aim to explain the reasons for the cyclicity of per worker benefit costs but to adopt this observation.⁷

Furthermore, Figure 5 displays a positive correlation between the cyclical components of per worker benefit costs and labor market employment growth.⁸ Benefit costs move above its trend at about the same time employment growth does. Based on this observation, I quantify the per worker benefit cost cycle using a dynamic function of employment growth in my model. Better (worse) labor market condi-

⁷Some may argue this cyclicity is due to worker composition effect along business cycle, or wonder whether this is the case at firm level. Recall that health insurance costs and paid leaves are most costly components of firm-paid quasi-fixed employee benefits. Paid leaves are non-working days for which employees are still getting paid. Its per worker cost is naturally procyclical with productivity and wage. Moreover, according to Hallock, Strain and Webber (2012) and Society for Human Resource Management survey report (2009), as more firms are forced to operate with fewer employees and smaller budgets in a downturn, they are also less willing to offer leave of any kind, especially paid leave. At the end of this paper, I also examine more disaggregated data using average per worker benefit costs for full-time versus part-time workers and for workers' in different occupations. Last, I cross-check with firm-level data from Kaiser's Employer Health Benefits Survey (1999-2013).

⁸See Parameterization section and Figure 6 for a more precise measure of their correlation. The patterns are the same if using permanent employment or full-time employment.

Figure 5: Employment Changes and Real Per Worker Benefit Costs (1964Q1-2012Q2, Seasonally Adjusted, HP-filtered)



Source: NIPA, CES, BLS ECI, and author's calculations.

Note: Benefits data start from 1980Q1. N is employment while N' is next period employment. Throughout this paper, Hodrick-Prescott (HP) filter uses a smoothing parameter of 1600.

tions increase (decrease) the marginal benefit costs today but decreases (increases) the costs in the next period. This generates an incentive for expanding firms to keep hiring into the beginning of a recession, while shrinking firms continue layoffs into the wake of a recovery, which is in line with data. This is one of the two main mechanisms (the other is financial conditions) in my model for generating the post-1990 slow employment recoveries.

Figure 5 also shows that after 1989 the same percentage increases above the trend of per worker benefit costs appear to correspond with lower positive employment growth. Intuitively, this is consistent with the abovementioned fact that the level of per worker benefit costs has been trending upwards: the same percentage increase above a higher trend results in a larger burden of the costs in absolute dollar value on firms to hire new workers, which discourages employment growth. In other words, with more benefit cost increases at recoveries, per worker benefit costs and labor market conditions have become more sensitive to each other in recent years. In the model calibration, I confirm and estimate this sensitivity change quantitatively from data and apply a larger parameter value for the benefit-employment relation to the

post-1990 periods than to the period before. This, together with the differentiated pre-1990 and post-1990 per worker benefit cost steady state values (reflecting the rising trend), enables my model to use the same mechanism to deliver the delayed employment recoveries in the post-1990 period but not before.

D. General Quasi-fixed Employment Costs

Benefit costs are only part of the story for the overall costs that are associated with employment. Other quasi-fixed employment costs include costs from hiring, layoffs, and training.⁹ The benefit cost mechanism in this model can also be applied to them. First, there is a rising trend in these other costs too. According to Oi (1962) and Manning (2010), in 1951 hiring and training costs in the U.S. equal to about 5.4-7.3 percent of wages. More recently, from the employee results of the BLS 1995 Survey of Employer Provided Training, I calculate workers' training cost to be about 9 percent of total wages. Manning (2010), using the results from Barron, Berger and Black (1997), estimates the training cost to be within 34-156 percent of monthly wages for U.S. firms between 1980 and 1993.

Second, there also has been evidence for the cyclical behavior of other quasi-fixed employment costs besides the benefit costs (Brunello, 2009). Bils (1987) infers that the marginal employment adjustment cost is cyclical. Majumdar (2007) finds that the probability that U.S. workers receive company training is procyclical. Blatter, Muehleman, and Schenker (2012) confirm that the hiring cost for skilled workers depends on macroeconomic conditions: a one-percentage-point increase in the unemployment rate reduces average hiring costs by more than five percent. This paper calibrates both the benefit costs and the general quasi-fixed employment costs to use them in the model.

The extant empirical literature supports the position that quasi-fixed employment costs affect labor structure, leading firms to increase per worker hours and deter employment growth (Ehrenberg, 1971; Ehrenberg and Schumann, 1982; Gruber, 1994; Beaulieu, 1995; Cutler and Madrian, 1998; Gruber, 2000; Reber and Tyson, 2004; and Baicker and Chandra, 2005 and 2006). In particular, Cutler and Madrian (1998) show that rising health insurance costs have increased the hours worked by up to 3 percent. More recently, Baicker and Chandra (2006) find that a

⁹Benefits and training vary with the net number of workers, while hiring and firing vary with the gross amount. They also have different frequencies of reoccurrences.

10-percent increase in health insurance premiums reduces the probability of being employed by 1.2 percentage points.

However, opponents may argue that employers can respond to the increase of quasi-fixed employment costs by reducing wages, assuming no rigidity (Summers, 1989). But, Currie and Madrian (1999) conclude little empirical evidence for a tradeoff between health insurance costs and wages. Anand (2011) also finds that the pass-through of a health insurance cost increase from firms to workers is only partial. Consequently, firms are forced to absorb some of the cost increase. Moreover, even if the quasi-fixed employment cost increase is offset by wage reductions, it still alters the relative costs of employment and per worker hours, leading firms to substitute workers for additional hours (Cutler and Madrian, 1998).

II Model

This section introduces intensive and extensive labor margins, dynamic benefit costs, and financial conditions to the standard real business cycle model. I start with the description of the environment in which a representative firm operates, as this is where my model diverges from the standard one. Then I present the representative household and define general equilibrium.

A. Firm

Assume there is a representative firm, with a production function $F(z, k, n, h_f) = zk^{1-\theta}[an^\gamma + (1-a)h_f^\gamma]^{\frac{\theta}{\gamma}}$. The variable z is the stochastic level of productivity, k is capital input, n is employment, and h_f is hours per worker. Both k and n are predetermined, while h_f can be changed at the present period. Capital evolves according to $k' = (1 - \delta)k + i$, where k' is next-period capital stock, i is investment and δ is depreciation rate.

In the model's production function, employment and per worker hours are embedded in a general CES function, which is nested in a Cobb-Douglas function with capital. This captures the idea that while capital is more of a substitute for labor input, the substitutability between employment and per worker hours is flexible. As Feldstein (1967) and Rosen (1968) note, the assumption that employment and hours worked enter the production function multiplicatively (i.e., nh_f) may not be a good one. For example, lengthening per worker hours may have diminishing re-

turns because of increased fatigue; rising employment does not increase fatigue but typically dilutes the capital-to-labor ratio. Therefore, adding per worker hours by a given percentage may affect output differently than increasing the number of workers by the same percentage (Bernanke, 1986). Following a general specification as in Bernanke (1986), I choose the CES function for labor inputs.¹⁰

Apart from hourly wages, w , the firm also has to pay benefit costs, $\phi \cdot (n'/n)^g$, for each worker hired next period. Here, n' is tomorrow's employment, and ϕ is steady-state per worker benefit costs. In fact, more precisely, ϕ should be the calibrated parameter for the steady state of overall per worker employment costs, which ideally include quasi-fixed benefit costs, training cost, and other reoccurring quasi-fixed employment costs. The formulation of $(n'/n)^g$ is rooted in the observed positive correlation between the cyclical components of benefit costs and employment growth, as shown in Figure 5. g is the parameter for the endogenous relation between them.

Importantly, the per worker benefit costs are driven by market forces, each individual firm do not believe they can influence them. But since this is a representative model all firms behave the same, together their employment decisions determine the benefit costs per worker. In other words, the benefit cost mechanism is exogenous to individual firms but at the same time endogenous to the overall labor market. $\phi \cdot (n'/n)^g$ produces above-trend per worker benefit costs when market employment increases and below-trend benefit costs when market employment decreases, consistent with the data shown in Figure 5. Different values of ϕ and g can capture the rising trend of benefit costs and the changed relation between the cyclical components of benefit costs and employment growth, respectively.

Furthermore, the benefit costs $\phi \cdot (n'/n)^g$ delay employment adjustments in a dynamic fashion. If firms are laying off workers, a decrease in the next period employment n' lowers today's per worker benefit costs, i.e., the marginal benefit of further layoff in the current period – so the firms will have less incentive to lay off too many workers right away. But next period $benefit' = \phi \cdot (n''/n')^g$, as n' moves to the denominator of tomorrow's benefit cost function, the marginal benefit of layoff turns relatively higher since n' decreased earlier – so the firm will continue layoff again. Intuitively, the more miserable the labor market is, the more likely the future labor market becomes better than the previous period, at which moment the benefit costs start to pick up. In the context of business cycle, after laying off workers through a

¹⁰Perri and Quadrini (2011) also use a CES formulation for hours and labor utilization.

recession, at the beginning of a recovery, firms may continue reducing employment due to relatively high benefit costs.

An alternative way to interpret the per worker benefit cost formulation is that the total benefit costs $n'[\phi \cdot (n'/n)^g]$ exhibit convexity. It is expensive for a firm to recruit a large number of workers at once. Aggregate employment changes bit by bit, and the adjustment duration is amplified by extended layoff into output recoveries and extended hiring into output recessions, as in the data. In contrast, if the firm faces non-convex employment costs, then the optimal response to a large productivity shock is to adjust employment immediately. However, this is not the case for recent aggregate employment recoveries.¹¹

The firm also issues equity and debt. Equity payout to investors is denoted by d . Since in reality managers are usually concerned about smoothing dividends over time and tend to keep a steady stream of dividend flow, I assume that dividend changes incur a quadratic adjustment cost (Lintner, 1956; Jermann and Quadrini, 2012). Therefore, the actual dividend cost for the firm is $\varphi(d) = d + \kappa(d - \bar{d})^2$, where parameter $\kappa \geq 0$, and \bar{d} is the long-run dividend payout target (steady state). The firm's debt, denoted by b_f , is preferred to equity because of its tax advantage (i.e., debt bias. See Hennessy and Whited, 2005; De Mooij, 2011; Jermann and Quadrini, 2012). Given market interest rate r , the *effective* gross interest rate for the firm is $R = 1 + r(1 - \tau)$, where τ represents the tax discount.

Using its new debt issues $\frac{b'_f}{R}$, the firm partially pays its labor cost, investment, stock shareholders and lenders, but promises to pay the rest upon the realization of output revenue $F(z, k, n, h_f)$. After production, the firm chooses to repay by an amount that is exactly equal to $F(z, k, n, h_f)$ according to its budget constraint (Equation 1), or to default by that same amount (Jermann and Quadrini, 2012).

$$\frac{b'_f}{R} + F(z, k, n, h_f) = k' - (1 - \delta)k + nwh_f + n'[\phi(\frac{n'}{n})^g] + b_f + \varphi(d) \quad (1)$$

In case of a default, the assets left for creditors to take is the market value of the firm's capital stock after deducting its new borrowing, that is, $\varepsilon(k' - \frac{b'_f}{R})$ with ε being a market evaluation factor. The firm would never choose to default if the market value of assets left for creditors to take is larger than its default amount.

¹¹Firm-level data seem to show lumpy employment adjustments. But this paper is using a representative firm to capture aggregate employment, which includes all firms' non-simultaneous employment adjustments and entails gradual adjustments. It would be helpful to use a heterogeneous-firm model in future research.

Therefore, to exclude defaults, the firm is subject to an enforcement constraint:

$$\varepsilon(k' - \frac{b'_f}{R}) \geq F(z, k, n, h_f). \quad (2)$$

On one hand, higher debt and expanding production make the enforcement constraint tighter. On the other hand, higher capital stocks relax the constraint. These properties are shared by most of the enforcement or collateral constraints used in the literature (Jermann and Quadrini, 2012). Because ε affects the tightness of the enforcement constraint and thus the borrowing capacity of the firm, I refer to its stochastic innovations as *financial shocks*. Together, there are two sources of aggregate uncertainty: the productivity, z , and the financial condition, ε .

To see more clearly how ε affects the financial and production decisions of the firm, I rewrite the enforcement constraint Equation 2, using the budget constraint from Equation 1 to eliminate $k' - \frac{b'_f}{R}$:

$$\frac{\varepsilon}{1 - \varepsilon} [(1 - \delta)k - nwh_f - n'\phi(\frac{n'}{n})^g - b_f - d - \kappa(d - \bar{d})^2] \geq F(z, k, n, h_f) \quad (3)$$

At the beginning of each period, k , b_f and n are given. The only variables that are under the control of the firm are the per worker hours, h_f , the next-period employment, n' , and the equity payout, d . Suppose the enforcement constraint is binding, a negative financial shock (lower ε) requires a reduction in the per worker hours, h_f , the next period employment, n' , or the equity payout, d .¹² However, since d is rigid to reduce due to the dividend adjustment cost, the firm has to cut h_f or n' . But between the two, employment adjustment is delayed because of the dynamic benefit costs. Therefore, the firm will first resort to per worker hours, h_f .

Furthermore, a reduction in the per worker hours, in turn, increases the firm's desire to pay a lower wage for additional hours worked. As the hourly wage drops, it deters the firm from hiring new workers because hours become *relatively* cheaper than workers, given that quasi-fixed employment costs remain unchanged. Therefore, wage movements also work like an endogenized cyclical adjustment cost.

Now I write the firm's problem recursively. The endogenous states are capital stock k , employment n , and debt b_f . The exogenous aggregate states are productivity z and financial conditions ε . The firm chooses its per worker hours h_f , dividends

¹²In the results, the enforcement constraint is most time binding but not always, especially near the end of a recession.

d , next-period employment n' , capital k' , and debt b'_f . The optimization problem is subject to the firm's budget and financial constraints.

$$V(z, \varepsilon, k, n, b_f) = \max_{h_f, d, k', n', b'_f} \{d + Em'V(z', \varepsilon', k', n', b'_f)\} \quad (4)$$

subject to

$$\frac{b'_f}{R} + F(z, k, n, h_f) = k' - (1 - \delta)k + nwh_f + n'[\phi \cdot (\frac{n'}{n})^g] + b_f + \varphi(d) \quad (5)$$

$$\varepsilon(k' - \frac{b'_f}{R}) \geq F(z, k, n, h_f) \quad (6)$$

in which $\varphi(d) = d + \kappa(d - \bar{d})^2$, $F(z, k, n, h_f) = zk^{1-\theta}[an^\gamma + (1-a)h_f^\gamma]^{\frac{\theta}{\gamma}}$, and $R = 1 + r(1 - \tau)$.

Function $V(z, \varepsilon, k, n, b_f)$ is the cumulative-dividend market value of the firm, and m' is its stochastic discount factor. The stochastic discount factor, wage and interest rate are determined in the general equilibrium and are taken as given by the firm.

Denoting the Lagrange multiplier associated with the enforcement constraint by μ , the first-order conditions for h_f , n' , k' , and b'_f are:

$$F_h(z, k, n, h_f) = \frac{wn}{1 - \mu\varphi_d(d)} \quad (7)$$

$$Em' \frac{\varphi_d(d)}{\varphi_d(d')} [(1 - u'\varphi_d(d'))F_n(z', k', n', h'_f) - w'h'] = \phi(\frac{n'}{n})^g \quad (8)$$

$$Em' \frac{\varphi_d(d)}{\varphi_d(d')} [1 - \delta + (1 - u'\varphi_d(d'))F_k(z', k', n', h'_f)] + \varepsilon\mu\varphi_d(d) = 1; \quad (9)$$

$$REm' \frac{\varphi_d(d)}{\varphi_d(d')} + \varepsilon\mu\varphi_d(d) = 1 \quad (10)$$

From the optimality condition for h_f (Equation 7), we see that, as usual, the marginal productivity of hours is equalized to its marginal cost. But similar to Jermann and Quadrini (2012), the marginal cost here is all workers' hourly wages augmented by a wedge that depends on the *effective* tightness of the enforcement

constraint, $\mu\varphi_d(d)$. A tighter constraint (i.e., higher μ) raises the costs of per worker hours and decreases its demand. Additionally, from Equations 9 and 10, it is clear that there is a negative relation between ε and the constraint's multiplier μ . That is to say, a negative financial shock to ε makes the multiplier μ higher, the enforcement constraint tighter, and thus the demand for per worker hours lower. Therefore, the main channel through which financial shocks are transmitted to the real economy is labor demand, particularly by affecting per worker hours.

B. Household, Government and General Equilibrium

Assume there is a representative household maximizing its expected lifetime utility V_h subject to its budget. The household is the stock and bond shareholder of the firm. Its optimization problem is shown recursively below. The household chooses hours it would like to work h_h , consumption c , stock and bond shares to hold next period, s' and b'_h , respectively. The household takes stock price q , interest rate r , employment n , wage w , and *tax* as given.

$$V_h(s, b_h) = \max_{h_h, c, s', b'_h} \{U(c, n, h_h) + \beta EV_h(s', b'_h)\} \quad (11)$$

subject to

$$wnh_h + b_h + s(d + q) = c + tax + \frac{b'_h}{1 + r} + s'q \quad (12)$$

The household's utility function takes the form of $U(c, n, h_h) = \ln c + n\alpha \ln(1 - h_h) + n'[\phi(\frac{n'}{n})^g]$. Notice that the household's disutility towards working applies only to those who are employed, and benefits contribute to the entire household's utility but are not counted as a part of disposable income in the budget. Admittedly, in reality benefits from workplace can ease a household's budget constraint and therefore can affect workers' hour supply and labor participation.¹³ However, had firm-provided benefits been counted towards income, it could have further magnified the jobless recovery effect in this model. The reason lies in that total benefits are low at recessions and the beginning of recoveries, the household will shift up hour supply due to wealth effect. This makes hiring extra workers relatively more expensive.

¹³It depends on whether households that are not provided benefits from external sources are willing to spend income on self supply of the absent benefits or not. According to U.S. Census health insurance data, on average from 1987-2012 about 14 percent of total population are not covered by either employment-based or government-provided health insurance and 10 percent of total population directly purchase health insurance for themselves. Even though it does not consist of the majority of the U.S. population, it may be helpful to incorporate benefits into a household's budget constraint in future research.

Whereas at booms benefits are higher, hour supply shifts down, deeming hiring more necessary. Hence, the current result can be considered as a lower bound of employment recovery delays that can be generated by this type of model.

It is also worth noting that hours are the only labor supply decision, employment is provided as much as the firm desires.¹⁴ Therefore, this model is not meant in capturing the supply-side story of employment, but focuses on the demand-side effect. The first-order conditions with respect to h_h , b_h , and s' are:

$$wnU_c(c, n, h_h) + U_{h_h}(c, n, h_h) = 0 \quad (13)$$

$$U_c(c, n, h_h) = \beta \frac{R - \tau}{1 - \tau} EU_c(c', n', h'_h) \quad (14)$$

$$U_c(c, n, h_h)q = \beta E(d' + q')U_c(c', n', h'_h) \quad (15)$$

The first two conditions determine the supply of hours and the interest rate. The last condition determines the prices of stock shares. Using forward substitution I derive:

$$q_t = E_t \sum_{i=1}^{\infty} \beta^i \frac{U_c(c_{t+i}, n_{t+i}, h_{h,t+i})}{U_c(c_t, n_t, h_{h,t})} d_{t+i} \quad (16)$$

The firm's optimization should be consistent with that of the household. Therefore, its discount factor is $m' = \beta U_{c'}/U_c$.

Government collects tax from the household to subsidize the firm's borrowing. B is the total borrowing in the economy by the firm, and the government takes it as given.

$$tax = \frac{B'}{R} - \frac{B'}{1 + r} \quad (17)$$

In equilibrium, all markets clear when $b_h = b_f = B$, $s = 1$, $h_f = h_h$, and $c = F(z, k, n, h_f) - k' + (1 - \delta)k - n'[\phi(\frac{n'}{n})^g] - \kappa(d - \bar{d})^2$. I can now provide the definition of a general equilibrium. The aggregate states are the productivity z , the financial condition ε , the capital k , the bond b , and the employment n .

¹⁴Given that in this model the household's total benefits are contingent on employment (not hours), had household employment decisions entered the model, the cyclical benefits could have two opposite impacts on employment supply. On one hand, substitution effect may cause employment supply to decrease at downturns as per work benefits shrink and increase at booms. On the other hand, wealth effect pushes the employment supply to the other direction. This is an interesting dynamics to explore in future research.

Definition 1. *A recursive competitive equilibrium is defined as a set of functions for (i) a household's policies c , h_h , s' , and b'_h ; (ii) a firm's policies d , h_f , n' , k' , and b'_f ; (iii) the firm's value $V(z, \varepsilon; k, b_f, n)$; (iv) aggregate prices w , r , and m' ; and (v) law of motion for the aggregate states, such that: (i) the household's policies satisfy Equations 13, 14, and 15 ; (ii) the firm's policies are optimal; (iii) the firm's $V(z, \varepsilon; k, b_f, n)$ satisfies Bellman's Equation 4; (iv) the w and r clear the labor and bond markets, $m' = \beta U_c'/U_c$; and (v) the law of motion is consistent with the stochastic processes of z and ε .*

The equilibrium shares some of the same characterization as in Jermann and Quadrini (2012). First, if $\tau > 0$, the enforcement constraint binds in a steady state. Second, with $\tau = 0$ and $\kappa = 0$, changes in ε have no effect on firms' labor and investment decisions. Thus, when $\tau = 0$ and $\kappa = 0$, business cycle fluctuations are driven only by productivity.¹⁵ Third, when $\phi = 0$, no benefit cost mechanism is at play; when $\phi \neq 0$ and $g = 0$, there is no per worker benefit cost cycle, but a fixed per worker cost.

III Quantitative Analysis

The goal of this section is to evaluate the quantitative effects of the dynamic benefit costs mechanism and the financial conditions. Their macroeconomic impacts are captured by the responses of the model to estimated productivity and financial shocks. Results show that the cyclical benefit costs and financial conditions are crucial not only for employment volatility but also for its recent slow recoveries. Yet, the finding does not mean that other economic factors and shocks are not of significance to the U.S. employment dynamics.

A. Parameterization

The period in the model is a quarter from 1964Q1-2010Q4. Some parameters can be calibrated using steady-state targets, several of which are typical in the business cycle literature. The others, including benefit cost function parameter g , stochastic shocks, and dividend adjustment cost parameter κ , cannot be calibrated using such targets, since they do not matter in a steady state.

¹⁵The proof for this equilibrium characterization are derived from Equation 10 and Equation 14. Also see Jermann and Quadrini (2012).

I set $\beta = 0.9798$, implying that the annual steady-state market interest rate is 8.5 percent. Utility function parameter $\alpha = 1.0791$ is chosen to have steady-state per worker hours equal to $\frac{1}{3}$. Labor share in the production function is set to $\theta = 0.7213$. Within labor input, employment share $a = 0.9226$ and the elasticity parameter of the substitution between the hours and the employment is chosen to be $\gamma = -2$ so that steady-state employment is at $\frac{2}{3}$ and the per worker hours and the employment are complements (Konig and Pohlmeier, 1989). The depreciation rate $\delta = 0.0250$.

The tax wedge is set to $\tau = 0.3500$, which is also used by Jermann and Quadrini (2012). The mean value of the financial conditions $\bar{\varepsilon} = 0.1989$ is chosen to match a steady-state ratio of debt over quarterly GDP equal to 2. This is about the average ratio during the period 1964Q1-2010Q4 for the nonfinancial business sector based on the data from the Flow of Funds Accounts (for debt) and National Income and Product Accounts (for GDP). At the same time, the steady-state ratio of capital stock over quarterly GDP equals to about 7 as in the data average for 1964Q1-2010Q4 as well.¹⁶

Next, I calibrate parameters ϕ and g , which are unique to this model. ϕ is the steady-state value of benefit costs, or more precisely, the steady-state value of the quasi-fixed employment costs. Table 2 summarizes the possible range for the quasi-fixed employment costs as a percentage of total wages from three data sources: NIPA, Chamber of Commerce, and BLS.¹⁷ NIPA gives the minimum benefit cost share and BLS gives the highest for the pre-1990 and post-1990 periods (Appendix: Figure 19). The average benefit cost shares are calculated as the average of all three sources. A more detailed description of the data sources is provided in the Appendix.

The training cost estimated for the pre-1990 period comes from Oi (1962) and Manning (2010, Table 2); and the post-1990 period estimate is from BLS (1995) and Manning (2010, Table 2). According to Oi (1962) and Manning (2010, Table 2), in 1951 the hiring and training costs in the U.S. equal to about 5.4-7.3 percent of the wage cost. 7 percent is directly used as the pre-1990 period training cost share in Table 2. Manning (2010) also reports his training cost estimate from Barron, Berger and Black (1997), which is 34-156 percent of monthly wages for U.S. firms between

¹⁶The larger the capital-to-GDP ratio is, the more impact the financial conditions have on employment.

¹⁷Notice they are not calculated in terms of total compensation, since once I include other quasi-fixed costs such as the training costs, it is more convenient to calculate the ratios in terms of wages, since wage is cleanly separated from benefits and the total compensation is less well defined.

Table 2: Quasi-fixed Employment Costs as a Percentage of Total Wages $\phi/(\bar{w}\bar{h})$

	Pre-1990			Post-1990		
	Min	Ave.	Max	Min	Ave.	Max
Benefits	16	26	37	22	33	38
Training	7	7	7	9	66	156
Total	23	33	44	31	99	194

Source: Oi (1962) that uses the 1951 study by the International Harvester Company; Manning (2010) Table 2; BLS 1995 Survey of Employer Provided Training (Employee Results) at <http://www.bls.gov/news.release/sept.nws.htm>; and author's calculations.

Note: The average benefits and the maximum total for the pre-1990 and the post-1990 periods are the values used in the model simulations.

1980 and 1993. BLS's Reports on Employer-Provided Training for 1995 conclude that employees who work in establishments with 50 or more workers received an average of 44.5 hours of training in the period May-October 1995.¹⁸ Accordingly, I calculate the training cost to be 9 percent of the total wages.¹⁹ Therefore, in Table 2 for the post-1990 period, the minimum training cost share is my estimated 9 percent of the total wages from BLS, the maximum is 156 percent according to Manning (2010), and the average is calculated from all three numbers – 9 percent from BLS, and 34 percent and 156 percent from Manning (2010). The total quasi-fixed employment cost shares are the sums of the benefit costs and the training cost.²⁰

From the costs shown in Table 2, this paper uses two sets of them, the average benefit costs and the maximum total (bold), to obtain the value of ϕ in the model. More specifically, to examine how sensitive the results are to ϕ values, for the pre-1990 period, I take ϕ as the average benefit costs, 26 percent of total wages, and as the maximum quasi-fixed costs, 44 percent; for the post-1990 period, the average benefit costs of 33 percent of total wages and the maximum quasi-fixed costs of 194 percent are used for ϕ .²¹ The larger ϕ for the post-1990 period reflects a higher steady-state benefit costs and hence a larger effect of benefit cost mechanism. This, in turn, will allow the benefit costs to affects the employment more significantly in

¹⁸ Accessed at <http://www.bls.gov/news.release/sept.nws.htm> on September 30th, 2012.

¹⁹ It is calculated by dividing BLS 44.5 hours by two quarters of hours worked, assuming 40 hours per week, and then multiplying two, which is assumed to be the relative cost of trainers' wage and trainees' opportunity cost over wage.

²⁰ I do not include hiring and layoff costs here due to the fact that they may not apply to existing workers reoccurringly, unlike benefits and training. See Cooper, Haltiwanger, and Willis (2004) for estimations of labor adjustment costs.

²¹ DeLoach and Platania (2008) use 32.2 percent of total compensation, i.e., 47.5 percent of total wages, as the steady-state value of health insurance cost.

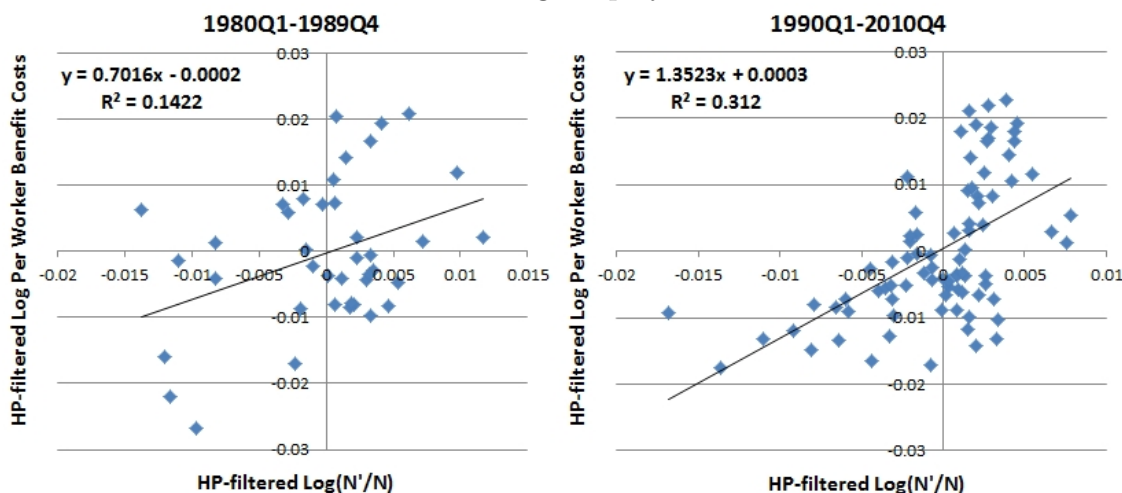
the post-1990 period than in the prior period.

In addition, it remains to estimate the endogenous relation between the cyclical components of employment growth and benefit costs to obtain the parameter value for g in the benefit cost function $\phi(\frac{n'}{n})^g$. I take the log form of the benefit cost function and make the following transformation:

$$\log Benefit - \log \phi = g[\log(\frac{n'}{n}) - \log(\frac{\bar{n}}{\bar{n}})] \quad (18)$$

It is clear that the cyclical components of the benefit costs equal the cyclical part of employment growth multiplied by g . Therefore, to estimate g , I detrend logged real per worker benefit costs by HP filter, and plot it against the HP-filtered logged employment growth, then run an OLS to regress the former on the latter. Figure 6 presents a good idea of how the two are related.

Figure 6: Scatter Plots of HP-filtered Log Benefit Costs and HP-filtered Log Employment Growth



Source: NIPA, CES, BLS ECI, and author's calculations.
 Note: N is employment while N' is next period employment.

First, the detrended benefit costs are strongly positively associated with the detrended employment growth, as in the benefit function form I presumed earlier. Second, the relation between the two indeed has changed over the past two decades. I estimate for pre-1990 period $g = 0.7016$ and post-1990 $g = 1.3523$. The larger g after 1990 indicates that the benefit costs are more sensitive to labor market employment changes (consistent with Figure 5) and in turn affects the firm's employment more

effectively than it did before 1990. One estimation caveat is that since the benefit costs and the employment may be endogenous, the OLS used here is subject to the problem of endogeneity. Therefore, I also regressed the benefit costs on lagged employment growth, and the message remains the same, that is, g increased for the period after 1990. In order to match the model function form, I use in the model the original OLS results for the estimation of g .

For the productivity z , I follow the standard Solow residuals approach and compute the stochastic technology process using the log-linearized production function. To construct the financial conditions ε , I follow a similar procedure but use the enforcement constraint under the assumption that it is always binding, that is, $\varepsilon_t(k_{t+1} - \frac{b_{t+1}}{R_t}) = y_t$. The linearized version of this constraint can be written as $\hat{\varepsilon}_t = \phi_k \hat{k}_{t+1} + \phi_b \hat{B}r_{t+1} + \hat{y}_t$, where $B r_{t+1} = \frac{b_{t+1}}{R_t}$, $\phi_k = -\bar{\varepsilon} \frac{\bar{k}}{\bar{y}}$, and $\phi_b = \bar{\varepsilon} \frac{\bar{B}r}{\bar{y}}$.²² The hat sign denotes percentage deviations from the deterministic trend, and the bar sign denotes the steady-state values. $\hat{\varepsilon}_t$ reflects firms' capacity to issue debt from their existing debt and output after deducting investment expenditure. Figure 7 plots the estimated financial conditions ε_t . The volatility of financial conditions does not change much for the entire period; but there has been more enduring financial tightening during the recovery periods following the 1990 and 2001 recessions, as in the data (Figure 3, right).

After constructing the series of the productivity and the financial conditions, I estimate the autoregressive system:

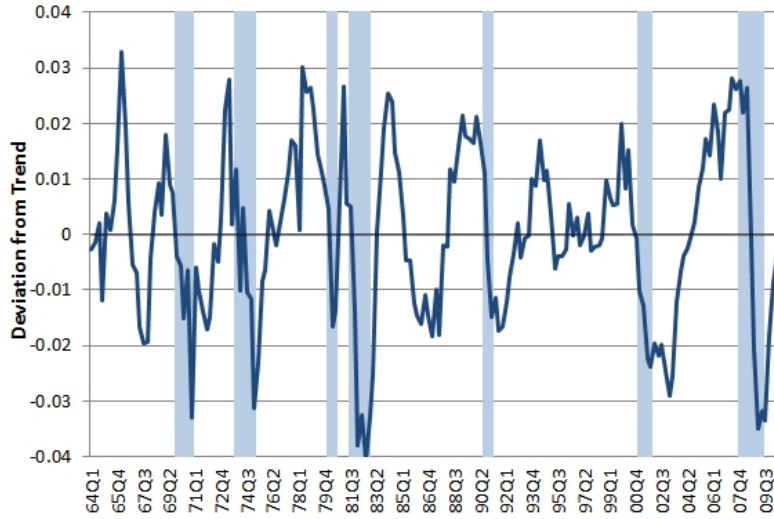
$$\begin{pmatrix} \hat{z}_{t+1} \\ \hat{\varepsilon}_{t+1} \end{pmatrix} = A \begin{pmatrix} \hat{z}_t \\ \hat{\varepsilon}_t \end{pmatrix} + \begin{pmatrix} e_{z,t+1} \\ e_{\varepsilon,t+1} \end{pmatrix} \quad (19)$$

where $e_{z,t+1}$ and $e_{\varepsilon,t+1}$ are i.i.d. with standard deviations σ_z and σ_ε , respectively. At this point, it is only the dividend adjustment cost parameter κ that remains to be calibrated. Its value ($\kappa = 5$) is chosen so that the standard deviation of model-generated equity-payout-to-output ratio is at least as large as that of the data over the period 1964Q1-2010Q4 (0.1057).²³ The full set of parameters is reported in Table 3.

²²With steady-state targets, I determine the coefficients $\phi_k = -1.39$ and $\phi_b = 1.39$. I then use the above equation to construct the time series with empirical measurements for the end-of-period capital, k_{t+1} , the end-of-period liabilities, $B r_{t+1}$, and output \hat{y}_t , which can be easily obtained through detrending the data.

²³Notice that the standard deviation of model-generated equity-payout-to-output ratio, 0.1953, is actually larger than that of the data. This indicates the model has a potential to generate larger employment volatility.

Figure 7: Financial Conditions ε_t
(1964Q1-2010Q4, HP-filtered)



Source: Author's calculations.

Table 3: Parameterization

Description	
Discount factor	$\beta = 0.9798$
Utility parameter	$\alpha = 1.0791^*$
Labor share	$\theta = 0.7213$
Employment share	$a = 0.9226^*$
Elasticity of substitution parameter	$\gamma = -2$
Depreciation rate	$\delta = 0.0250$
Tax advantage	$\tau = 0.3500$
Steady-state financial condition	$\bar{\varepsilon} = 0.1989$
Steady-state average benefit costs before 1990 (26 percent of wage)	$\phi_{pre90ave} = 0.0607$
Steady-state maximum quasi-fixed costs before 1990 (44 percent of wage)	$\phi_{pre90max} = 0.1027$
Steady-state average benefit costs after 1990 (33 percent of wage)	$\phi_{post90ave} = 0.0778$
Steady-state maximum quasi-fixed costs after 1990 (194 percent of wage)	$\phi_{post90max} = 0.4527$
Benefits-employment relation before 1990	$g_{pre90} = 0.7016$
Benefits-employment relation after 1990	$g_{post90} = 1.3523$
Financial structure adjustment cost parameter	$\kappa = 5$
Standard deviation of the productivity shock	$\sigma_z = 0.0086$
Standard deviation of the financial shock	$\sigma_\varepsilon = 0.0092$
Matrix for the shock process	$\begin{pmatrix} 0.7555 & 0.1021 \\ -0.1408 & 0.9248 \end{pmatrix}$

Note: The parameters with * vary slightly with the different values of ϕ . The Values reported in this table are the ones used for the regime where $g_{post90} = 1.3523$ and $\phi_{post90max} = 0.4527$. The shock process matrix's eigenvalue modulus is 0.8444, thus the shock process is stationary.

B. Findings and Sensitivity Check

Figure 8 plots the model results for the post-1990 period using $g_{post90} = 1.3523$ and $\phi_{post90max} = 0.4527$ (194 percent of wage), with cyclical employment data.²⁴

²⁴The patterns are the same if compared with the cycle of permanent employment or that of full-time employment. So are for all the result graphs. They are available upon request

To highlight the importance of the model mechanisms, the figure also reports the responses generated by a standard RBC model without benefit costs or financial conditions. It is obtained by eliminating the dividend payout adjustment cost, the bond market and the benefit costs from my model. The first three subplot graph the results from my full model, from the model with the benefit costs but no financial conditions (i.e., only productivity shocks, $\tau = 0$, and $\kappa = 0$), and from the model with the financial conditions but no benefit costs $\phi = 0$, respectively. The last subplot compares the results of all three model scenarios.²⁵ A quick glimpse of the plots tells us that both benefit costs and financial conditions have contributed significantly to the delayed employment recoveries and employment volatility. The full model is able to generate a much closer match with the data in terms of both dimensions of the employment dynamics than the standard model can.

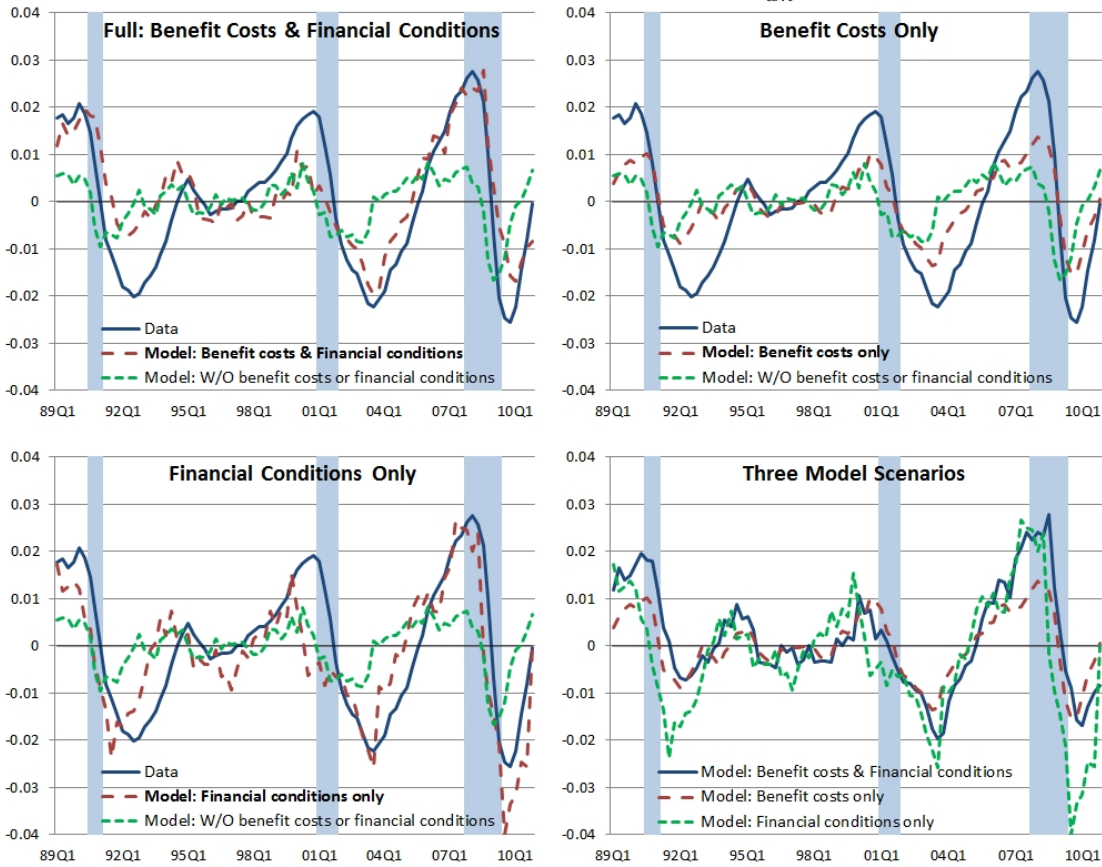
From the subsequent subplot of *Benefit Cost Only* in Figure 8, the benefit cost mechanism alone has contributed significantly to the delayed timing of employment recoveries. The model-generated employment troughs for 2007 and 2009 recessions are in line with those of the data. Yet, Figure 8 also shows that the benefit cost mechanism alone (with productivity shocks) explain 49 percent of employment volatility, marginally larger than the standard model can. To improve this, here comes the role of financial conditions.

Looking at the subplot of the results from the model with *Financial Conditions Only*, I find that the financial conditions drive the volatility of employment. However, they deliver too much fluctuations compared with data. This is because capital stock as a large share of output has made financial conditions matter considerably. Moreover, the financial conditions have contributed to the delays of employment recoveries as well. This is mostly due to the fact that there has been enduring financial tightening during the recovery periods following the post-1990 recessions (Figure 3, right panel; and Figure 7). But, financial conditions themselves are not adequate in explaining the slowness of employment recoveries, especially for the one following 1990.

Now, comparing the results from the above *Three Model Scenarios*, we can clearly see that benefit costs delay employment recoveries and help smooth the employment volatility caused by financial conditions. More specifically, at a time when the busi-

²⁵In this section, to keep the terminology simple, I refer to the quasi-fixed employment costs as the benefit costs too. But keep in mind, ϕ_{max} is actually calibrated from the quasi-fixed employment costs, and ϕ_{ave} is the benefit costs. See Table 2.

Figure 8: Employment Cycle Results, Post-1990
 ($g_{post90} = 1.3523$, $\phi_{post90max} = 0.4527$ i.e. $\frac{\phi}{wh} = 1.94$)



Source: BLS, and author's calculations.
 Note: The data is HP-filtered. All results include productivity shocks.

ness cycle is moving towards a trough, financial constraint is tight, so employment is discouraged. At the same time, the benefit costs are below their trend. Hence, the employment decreases but not right away as much as it would have without the relatively low benefit costs. The opposite occurs near peaks. Together the two mechanisms allow this simple model to generate a close match with cyclical employment movement, lining up with the cycle's turning points and explaining 76 percent of its volatility.

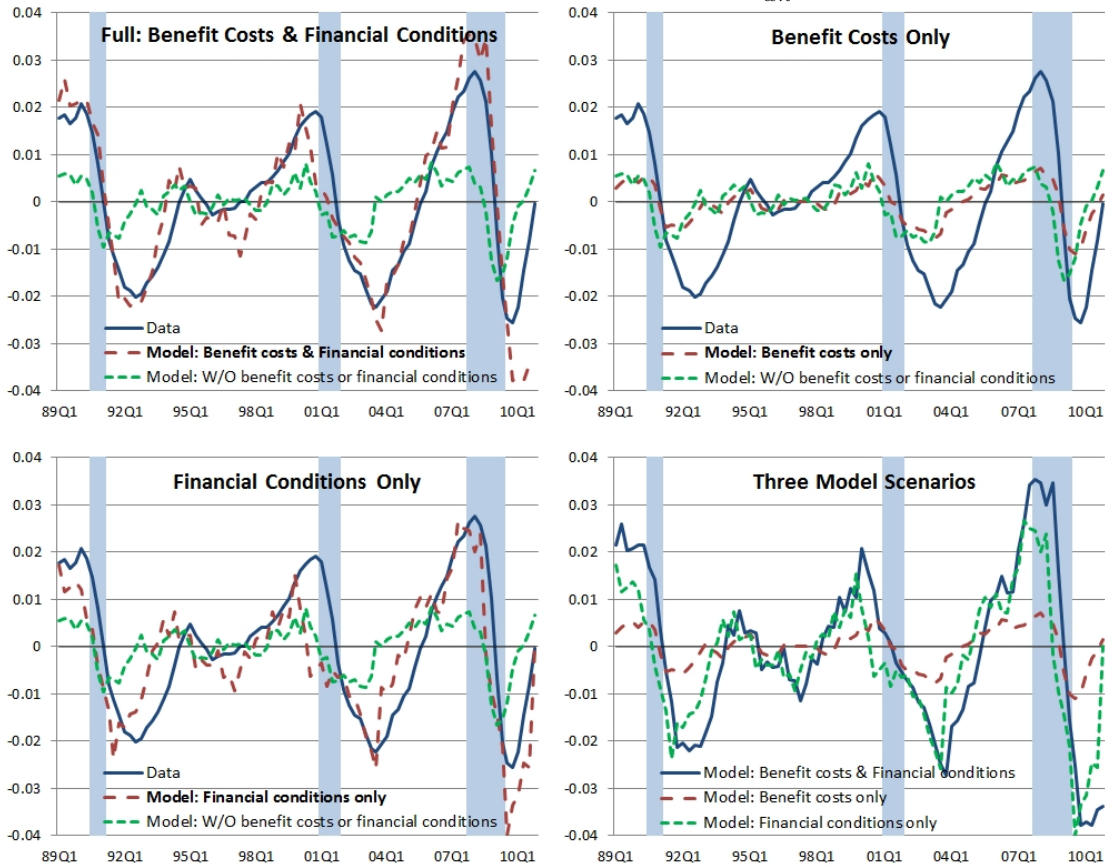
Figure 9 shows the same comparisons for the post-1990 period, except that the model results are computed using the average $\phi_{post90ave} = 0.0778$ (33 percent of wage). Now, as the benefit costs are more moderate, when there is only the pro-

ductivity shock, benefit costs have less effect on magnifying employment volatility and recovery delays than using ϕ_{max} . So the results are closer to the standard RBC model. It is understandable, after all, at an extreme case when $\phi = 0$, the model becomes the standard RBC. Particularly, the reason for larger benefit costs to bring more employment volatility and longer recovery delays is that with a stronger benefit cost mechanism the firm keeps downsizing into recoveries and hiring into recessions. Although the employment adjustments have been paced into smaller steps, the same adjustment directions have also persisted for longer time. When there is also the financial shock, benefit costs function towards smoothing out the excessive employment volatility brought about by the financial shocks. This smoothing effect becomes weaker as the benefit costs become smaller. Yet, there remains the contribution of the moderate benefit costs to the delayed cyclical employment recoveries in Figure 9.

To examine more closely the aggregate employment recoveries (including both trend and cycle), Figure 10 plots the cumulative employment growth since each NBER trough generated by the model, to compare with the right panel of Figure 1 from data. The model is able to generate 3-to-7-quarter delays of employment recoveries relative to output recoveries. In the data, the delays are 3-6 quarters. Particularly, following the 1990 recession, employment recovery delayed for 4 quarters in the data and 3 quarters in my model; for 2001, it was 6 quarters in the data and 7 quarters in my model. The depth of employment declines has also been closely matched for these two recessions at about 1 percent from NBER business cycle trough level. For the Great Recession, the model generates deeper and longer employment decline than data. In terms of both recovery timing and decline depth, this paper has improved upon the existing literature (Bachmann, 2009; Berger, 2012).

Using the average ϕ , the results with benefit cost mechanism alone (with just productivity shocks) become closer to that of the standard RBC model, consistent with the earlier cycle graphs. After all, when $\phi = 0$, the model without financial conditions boils down to the standard RBC model. Therefore, the larger ϕ is, the more severe jobless recoveries are in a model with only productivity shocks. Using the average ϕ , the model with only the productivity shock can still generate delays in employment recoveries during the Great Recession, as well as nearly zero employment growth following the 1990 and 2001 recessions. With financial conditions,

Figure 9: Employment Cycle Results, Post-1990
 ($g_{post90} = 1.3523$, $\phi_{post90ave} = 0.0778$ i.e. $\frac{\phi}{wh} = 0.33$)

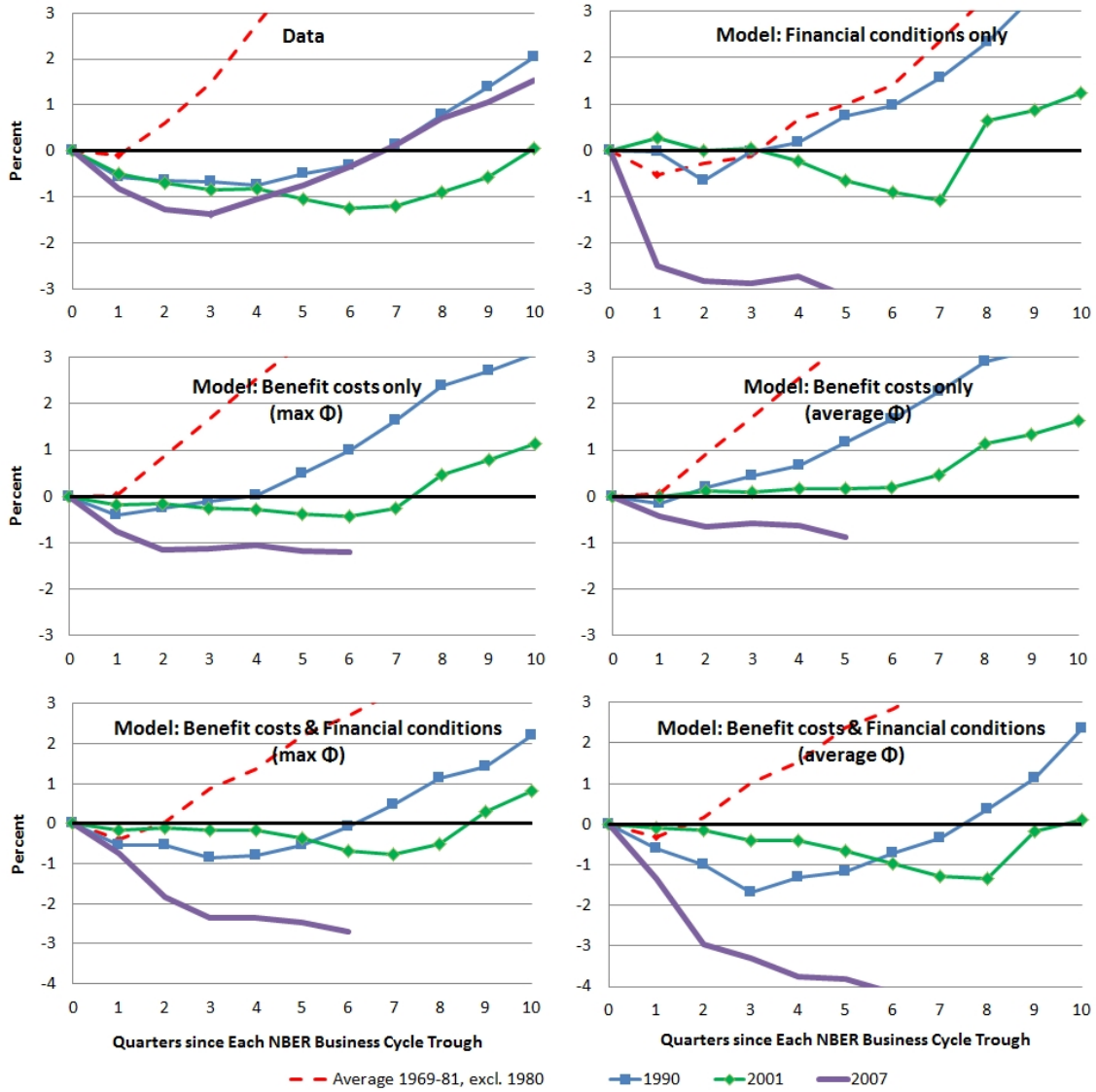


Source: BLS, and author's calculations.
 Note: The data is HP-filtered. All results include productivity shocks.

benefit costs smooth the employment volatility caused by the financial shocks. The smaller ϕ is, the closer the full model result is to that of the model with only financial conditions in Figure 10. Hence, using the average ϕ , the full model is able to deliver deeper employment declines than the full model with ϕ_{max} .

Now we can conclude that the model results of jobless recoveries are not very sensitive to the calibration of ϕ . Additionally, more robustness checks have also shown that the model performance on employment dynamic is not sensitive to the value of g either. Had I used g_{pre90} in the model for the post-1990 period, the model could still have generated 2-7 quarters delay for employment recoveries. Overall, it is the amplifying benefit cost *cycle* mechanism and the two shocks that have worked

Figure 10: Cumulative Employment Growth Results since Each NBER Business Cycle Trough



Source: BLS, and author's calculations.

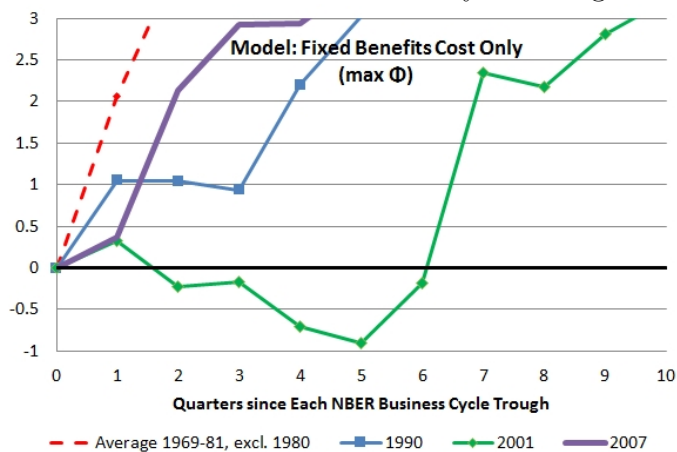
Note: Employment growth results are based on the modeled employment which is calculated by adding the data trend to the model-generated cyclical components of employment. For the model results with maximum ϕ , the pre-1990 results use $\phi_{pre90max} = 0.1027$ (44 percent of total wage) and the post-1990 results use $\phi_{post90max} = 0.4527$ (194 percent of total wage). For the model results with average ϕ , the pre-1990 results use $\phi_{pre90ave} = 0.0607$ (26 percent of total wage) and the post-1990 results use $\phi_{post90ave} = 0.0778$ (33 percent of total wage). All results include productivity shocks.

wonders.

In order to scrutinize how much the *cyclicality* of benefit costs have contributed to

the slow employment growth, I plot in Figure 11 the results from a model with fixed benefit costs only (without financial conditions). Fixed benefit costs cannot deliver jobless recoveries at all following the 1990 and 2007 recessions. Two factors in the cyclicity are driving the slow employment recoveries, which cannot be captured by the fixed benefit costs. On one hand, it is the next period employment, n' , that firms have to decide, with expectations about future. This embeds the idea that firms' hiring and layoff decisions are subject to uncertainties in the economic environment. On the other hand, it is the benefit cost cycle, that is, the increase of benefit costs (i.e., part of the marginal cost of employment) at the beginning of recoveries and its decrease during recessions. Both factors work for the employment impact of this benefit cost mechanism to generate better results than fixed benefit costs can.

Figure 11: Cumulative Employment Growth Results since Each NBER Business Cycle Trough



Source: BLS, and author's calculations.

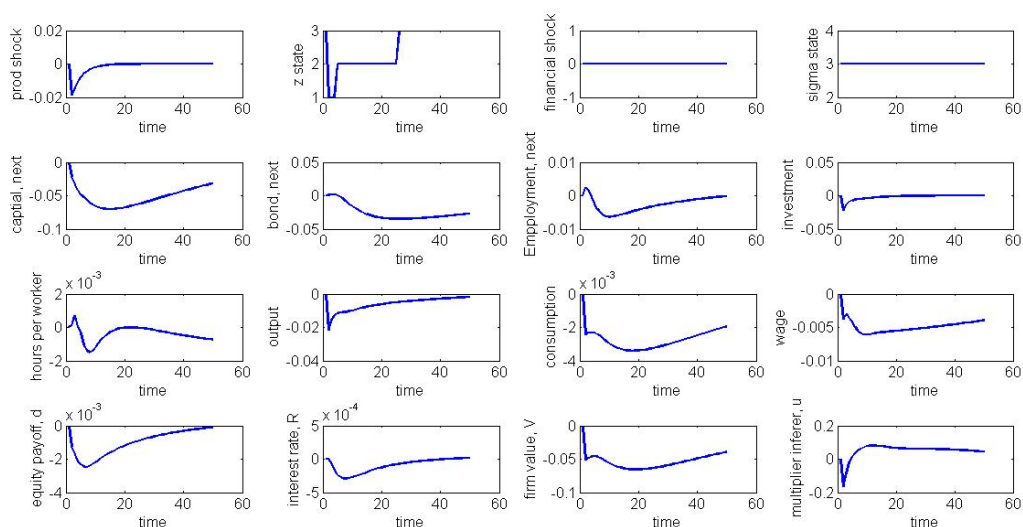
Note: Employment growth results are based on the modeled employment which is calculated by adding the data trend to the model-generated cyclical components of employment. In this plot, the model results use maximum ϕ , the pre-1990 results use $\phi_{pre90max} = 0.1027$ (44 percent of total wage) and the post-1990 results use $\phi_{post90max} = 0.4527$ (194 percent of total wage). All results include productivity shocks, particularly the results here do not include financial conditions nor use n' .

Furthermore, impulse responses to a one-time productivity shock and a financial shock are reported in Figure 12 and Figure 13, respectively. These results are based on the model for the post-1990 calibration with $\phi_{post90max}$, but are similar when using ϕ_{ave} . From Figure 12, we see that a negative productivity shock delivers a significantly slower employment recovery than the output recovery. Figure 13 shows that a financial shock generates more volatility in employment and hours

than a productivity shock can. Note that although the employment changes seem to coincide with that of output, it is the next period employment being plotted here. Also, recall Figure 3 (right panel), there has been enduring financial tightening during the recovery periods following the post-1990 recessions. The prolonged tight financial constraint at the beginning of recent recoveries have contributed to the delayed employment recoveries.

Figure 12: Impulse Responses to One-Time Productivity Shock

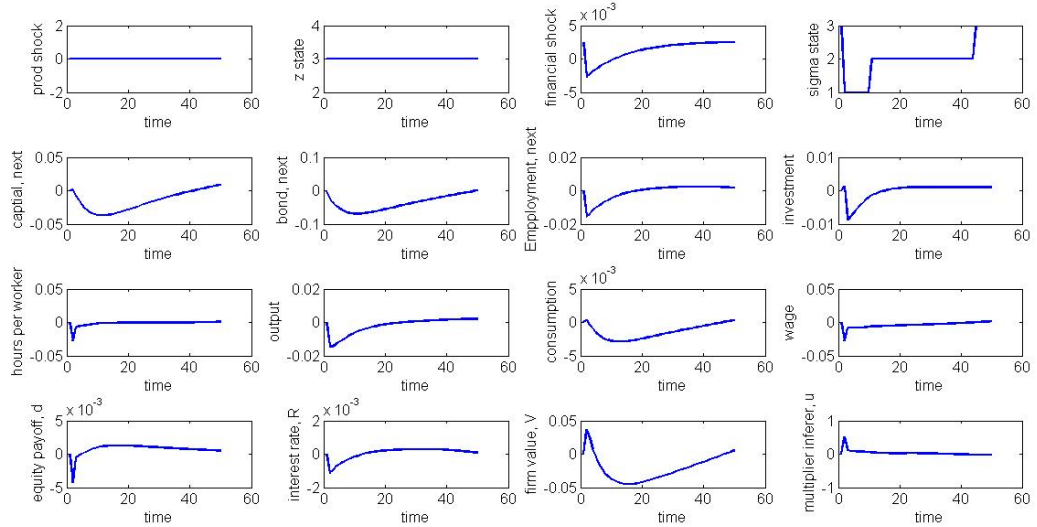
$$(g_{post90} = 1.3523, \phi_{post90max} = 0.4527 \text{ i.e. } \frac{\phi}{wh} = 1.94)$$



Next, Figure 14 plots the model-generated employment cycle using $g_{pre90} = 0.7016$ and $\phi_{pre90max} = 0.1027$ (44 percent of wage) for the pre-1990 period. The model using the average $\phi_{pre90ave} = 0.0607$ (26 percent of wage) generates similar results, as can be seen from Table 5, column (2) and (3). Because of both lower ϕ and smaller g estimated for the pre-1990 period than for the post-1990 period, i.e., a much weaker relation between benefit costs and employment growth, the benefit cost mechanism becomes much less efficacious regarding the delay in employment movement. Financial conditions also do not generate much delay in employment recoveries since tight financial conditions did not continue into recessions during the pre-1990 period. It enables the same model of mine to successfully generate no delay in employment recoveries as in the data for the pre-1990 period. This can also be

Figure 13: Impulse Responses to One-Time Financial Shock

$$(g_{post90} = 1.3523, \phi_{post90max} = 0.4527 \text{ i.e. } \frac{\phi}{wh} = 1.94)$$

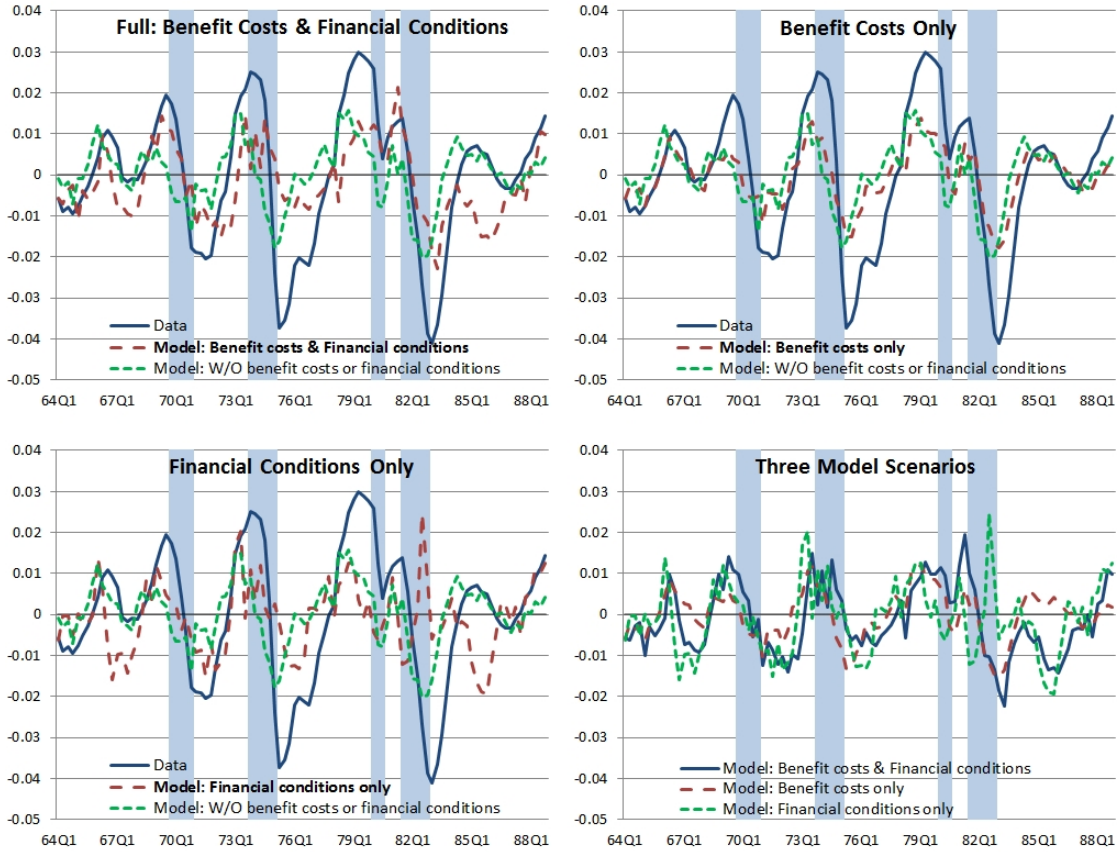


seen from Figure 10: the pre-1990 results of employment recoveries have at most 1 quarter delay, as in the data. However, the model-generated employment volatility is not as high as that of the data.

Table 4 and Table 5 report the specific standard deviations of the data and the model results for output, employment, and per worker hours. The full model is able to explain more than 76 (using $\phi_{post90ave}$ or $\phi_{post90max}$) percent of post-1990 employment volatility in the data. However, the model does not do as well for pre-1990 employment volatility, where I can explain about 50 percent of the data fluctuation. In fact, from the data the pre-1990 period experienced lower dividend payout volatility with a standard deviation of 0.0729 and a larger capital-to-output ratio than the post-1990 period. This could have increased my model-generated pre-1990 employment volatility if I had distinguished the pre-1990 and post-1990 calibration targets for the dividend adjustment cost parameter κ and the steady state of capital-to-output ratio. But in order to focus on the changes brought by benefit costs, I differentiate the values of only those parameters that are related to the benefit costs, i.e., ϕ and g . Additionally, output volatility has been matched well for both periods. However, the fluctuation of per worker hours is larger than

Figure 14: Employment Cycle Results, Pre-1990

($g_{pre90} = 0.7016$, $\phi_{pre90max} = 0.1027$ i.e. $\frac{\phi}{wh} = 0.44$)



Source: BLS, and author's calculations.

Note: The data is HP-filtered. Alternatively, the model using average $\phi_{pre90ave} = 0.0607$, i.e. $\frac{\phi}{wh} = 0.26$, generates very similar results. All results include productivity shocks.

that of the data and that of employment in several cases.

Table 4: Business Cycle Standard Deviations, 1990-2010

	Model			
	(1) Data	(2) Full (ϕ_{max})	(3) Full (ϕ_{ave})	(4) No Friction
Output	0.0149	0.0169	0.0235	0.0161
Employment	0.0142	0.0107	0.0172	0.0054
Per Worker Hours	0.0042	0.0072	0.0236	0.0054

Source: BLS, and author's calculations.

Note: No Friction refers to the standard model without benefit costs nor financial conditions. The data is HP-filtered.

Table 5: Business Cycle Standard Deviations, 1964-1989

	Model			
	(1) Data	(2) Full (ϕ_{max})	(3) Full (ϕ_{ave})	(4) No Friction
Output	0.0235	0.0201	0.0201	0.0229
Employment	0.0166	0.0093	0.0088	0.0076
Per Worker Hours	0.0047	0.0154	0.0146	0.0076

Source: BLS, and author's calculations.

Note: No Friction refers to the standard model without benefit costs nor financial conditions. The data is HP-filtered.

Last, it is important to investigate the model-generated employment recovery delays not only against the NBER business cycle troughs, as I did previously, but also against the output and per worker hours produced by the model. Figure 20 in Appendix shows that the model is able to deliver the lagging relation between the model-generated output and employment for post-1990 recoveries. Using either maximum ϕ or average ϕ does not alter the lagging relation. Figure 21 in Appendix conveys a similar message: in general, the model-generated per worker hours have recovered earlier than employment during the recoveries following post-1990 recessions.

IV Heterogenous Workers and Firms

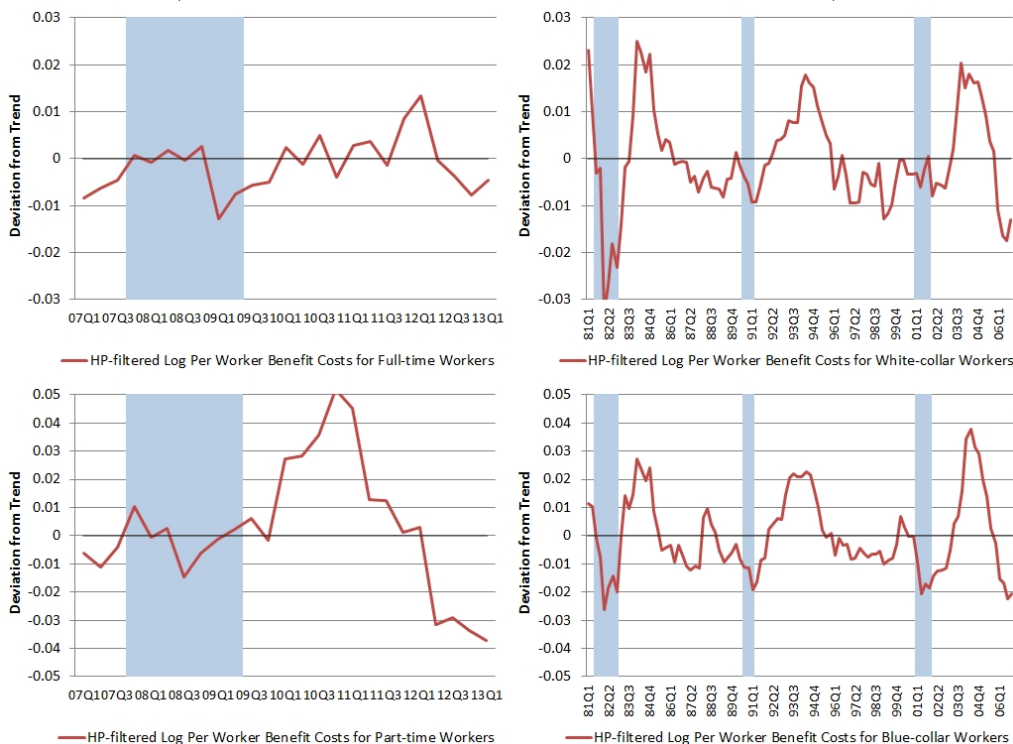
A. Benefit Cost Cyclicity of Different Types of Workers

An important question of the cyclicity of firm-paid employee benefit costs has to do with its cause. Although this paper is not meant to study the cause, it is helpful to address the concern that whether the cycle is a result of worker composition changes through business cycles. Admittedly, different categories of workers may incur different levels of benefit costs (e.g., the benefit costs of full-time workers are about three times as those of part-time workers who are offered benefits, and majority of part-time workers do not have any benefits). Therefore, as full-time/part-time worker composition shifts over business cycles (typically part-time worker proportion rises during recessions), the average per worker benefit costs can be procyclical accordingly. This undermines the current setup of a representative agent model, in which individual benefit costs fluctuate along business cycles.

Given the unavailability of worker-level benefit cost data, this section examines the limited data of benefit costs by worker category: full-time vs part-time,

blue-collar vs white-collar, as well as by occupation. The finding concludes that the cyclical nature of benefit costs remains the same as in the aggregate observation even after decomposing workers into different categories, whose employment may be affected unevenly over business cycles.

Figure 15: Real Per Worker Benefit Costs
(Private Sectors, Quarterly, Seasonally Adjusted)



Source: Full-time and part-time workers' benefit costs are from BLS ECEC and author's calculations. Blue-collar and white-collar workers' benefit costs are from BLS ECI and author's calculations.

Figure 15 shows HP-filtered real per worker benefit costs of full-time and part-time workers (for Great Recession only due to limited data) and those of blue-collar and white-collar workers. We see a clear dip in the costs during the Great Recession for all types of workers, and increasing costs during the recovery. The blue-collar and white-collar worker subplots display a longer time span with a clearer cyclical pattern. Additionally, by occupation, Figure 22 in Appendix shows HP-filtered real per worker benefit costs of 1) natural resources, construction, and maintenance jobs, 2) service jobs, 3) production, transportation, and material moving jobs, and 4) management, professional, and related jobs. All of them display procyclical

fluctuations of per worker benefit costs during the Great Recession.

Having shown that the per worker benefit cost cyclicity indeed exists by different categories of workers, I do not deny the possible impact of worker composition changes on average per worker benefit costs. The message here is that the composition impact is limited. In another paper, I extend this current model to include heterogenous workers to study how benefit cost differences between two types of workers may have contributed to their employment patterns through business cycles.

B. Benefit Cost Cyclicity of Different Firms

This section examines per worker benefit cost at firm level. Data is obtained from annual surveys conducted by Kaiser Family Foundation and the Health Research and Educational Trust (Kaiser/HRET). Among thousands of firms they have surveyed nation wide, 2,067 firms have responded to the surveys during all the years from 1999-2013. The average response rate is about 50 percent each survey. About 90 percent of the responding firms indicated that they offered some sort of health benefits. The response rate for firms that offer health benefits is about 50 percent. Among them, 168 firms have reported total premium and worker-paid shares and 419 firms have reported the percentage of workers being covered under provided health insurance for all the survey years.

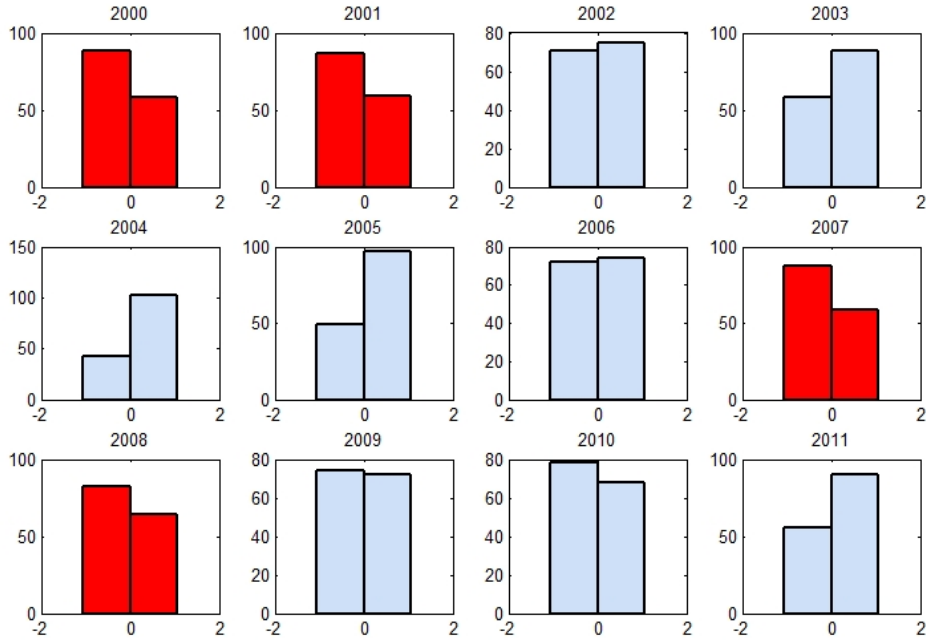
As expected there are a good amount of heterogeneity among the firms. First, using all the private firms that have reported the percentage of workers being covered under firm-provided health insurance for 1999-2013, I do not find significant coverage distribution difference between downturns and booms over 1999-2013 (Appendix: Figure 23). Yet, the share of firms that dropped health insurance programs for employees slightly varies by year. During 2000-2001, about 18 percent of the firms in the sample did not offer health insurance, whereas on average about 6 percent during the rest of the years up to 2012. The sample does not show a significant increase of insurance program withdrawals during the Great Recession.

Second, using all the private firms that have reported total premium and worker-paid shares for 2000-2011, I plot for each available year the histograms of HP-filtered firm-paid real per worker health insurance cost for single plans (Figure 16).²⁶ They show that during the years with below-trend employment growth (i.e., 2000, 2001,

²⁶Consistent with the theoretical model, I do not compare health insurance costs with firm-level employment changes but with labor market conditions.

2007 and 2008) the majority of the firms have per worker health insurance cost below their own trend too, whereas it is the opposite for the other years. Although a great deal of heterogeneity are present in the distribution, this shift of firm mass towards lower costs during recessions and towards higher costs during recoveries is prevailing. The histograms for family plans tells a similar story (Appendix: Figure 24), and so do the histograms by firm size and by industry (including manufacturing and services).²⁷ Hence, for the majority of the firms in the sample, the per worker health insurance costs in individual firms do fluctuate with business cycle: their costs decrease during recessions and increase during recoveries.

Figure 16: Histogram of HP-filtered Firm-paid Per Single Worker Health Insurance Cost (Single Plans, Private Industry)



Source: Kaiser Family Foundation and the Health Research and Educational Trust (Kaiser/HRET) Health Benefits Survey, and author's calculations.

²⁷They are available upon request.

V Conclusion

Are flexible hours, financial conditions, rising benefit costs and the cyclical nature of those costs important for recent employment dynamics in the U.S.? The analysis of this paper suggests that they are. I propose a simple DSGE model that explicitly incorporates these factors, in which they each play an important role in generating business cycle labor market movements.

Using the dynamic employment benefit costs and financial conditions, I show that they are crucial for capturing not only the recent slow employment recoveries but also employment volatility. In particular, with the benefit costs alone, my model can deliver 1-to-6-quarter delays relative to NBER business cycle troughs for the employment recoveries after the 1990, 2001, and 2007 recessions. It can also generate about 49 percent of the volatility in the post-1990 employment data. Moreover, together with the financial conditions, the impacts of the two mechanisms enable my model to explain more than 76 percent of the employment volatility in the data for the post-1990 period. Also, they together generate 3-to-7-quarter delays of employment recoveries relative to NBER troughs during the post-1990 period, while generating no delay for the pre-1990 period. This is consistent with the data that has scarcely been matched in the literature. My results match well with the cyclical movement of output too.

Having shown the significant employment impact of benefit costs and financial conditions, this paper does not intend to interpret the results such that benefit costs and financial conditions are the sole drivers of the recent jobless recoveries. As noted earlier, there are other contributing factors that are absent in this model. The main unique point of this paper is that benefit cost and financial cycles do have an important effect on the tradeoff that firms face between adjusting per worker hours and employment. This paper raises some important policy concerns. It would be helpful to employment to reduce benefit cost trend and mitigate their cyclical nature for private firms, especially to prevent them from rising at the beginning of a recovery. Moreover, favorable financial conditions are crucial for timely employment recoveries; curtailing the financial conditions' procyclical movements can reduce employment volatility.

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For Online Publication

A Appendix: Data Sources

Employment: Total private, all employees, quarterly averages, seasonally adjusted. From Bureau of Labor Statistics (BLS) Current Employment Statistics Survey (National) (CES). 1964Q1-2012Q3. The employment of temporary workers is from CES seasonally adjusted employment services industry, 1985Q1-2012Q3. Permanent worker employment is the difference between total private employment and the temporary worker employment. Full-time worker employment is employment for 16 year old and over from CPS, seasonally adjusted, 1968Q1-2012Q3.

Per worker hours: Total private, average weekly hours, production/nonsupervisory employees, quarterly averages, seasonally adjusted. From BLS CES. 1964Q1-2012Q3.

Wage: (1) Total private, average hourly earnings of production/nonsupervisory employees, 1982-84 dollars. From BLS CES. 1964Q1-2012Q2. (2) For Figure 4 right panel: BLS Employment Cost Index (ECI).

Consumption and investment: Chained 2005 dollars, seasonally adjusted. From Bureau of Economic Analysis (BEA) National Income and Product Accounts (NIPA) Table 1.1.6. 1964Q1-2012Q2.

GDP: seasonally adjusted at annual rates. From BEA NIPA Table 1.3.5. 1964Q1-2012Q2.

Price index: 2005=100, seasonally adjusted. From BEA NIPA Table 1.3.4, Nonfarm business sectors. 1964Q1-2012Q2.

End-of-period debt stock (b_{t+1}/R_t): Initial debt stock (1951Q4, from LA144104005.Q) + Nonfinancial business; credit market instruments; liability (LA144104005.Q) + its net increase (FA144104005.Q). From Federal Reserve System, Flow of Funds Accounts. 1964Q1-2012Q2.

Dividends: Farm business; net dividends paid (FA136121073.Q) + Nonfinancial corporate business; net dividends paid (FA106121075.Q) - Nonfinancial noncorporate business; proprietors' equity in noncorporate business (net worth) (FA112090205.Q) - Nonfinancial corporate business; corporate equities; liability (FA103164103.Q). From Federal Reserve System, Flow of Funds Accounts. 1964Q1-2012Q2.

Capital stock: Initial capital stock (1951Q4, from NIPA Table 5.7.5A + NIPA Table 6.1) + Nonfinancial business; total capital expenditures (FA145050005.Q)

- Nonfinancial business; consumption of fixed capital, equipment, software, and structures, current cost basis (FA146300005.Q). From NIPA, and Federal Reserve System, Flow of Funds Accounts. 1964Q1-2012Q2.

Federal funds effective rate: Quarterly. From Federal Reserve System, data series H15/H15/RIFSPFF N.M. 1964Q1-2012Q2.

Bond yield: Bank of America Merrill Lynch US Corporate Master Effective Yield, daily. Available at <http://research.stlouisfed.org/fred2/data/BAMLC0A0CMEY.txt>. Together with the Federal funds effect rate, I estimate the annual bond interest rate to be about 8.49 percent. December 31st 1996-October 9th 2012.

Overtime: Manufacturing, average weekly overtime, production/nonsupervisory employees, quarterly averages, seasonally adjusted. From BLS CES. 1964Q1-2012Q2.

Benefit costs: (1) NIPA Table 7.8 Supplements to Wages and Salaries 1929-2011, total benefit costs per year; (2) Chamber of Commerce Employee Benefits Study 1963-2007, per worker benefit costs per year; (3) BLS Employer Costs for Employee Compensation (ECEC) 1986-2011, per hour benefit costs, all workers, private industry, annual data; (4) BLS Employment Cost Index (ECI) 1980Q1-2012Q2, per hour benefit costs, seasonally adjusted; (5) Full-time/part-time workers: BLS Employer Costs for Employee Compensation (ECEC) 2002Q1-2013Q1, per hour benefit costs, private industry, quarterly data; seasonally adjusted by the author using moving average; (6) White/blue collar: BLS Employment Cost Index (ECI) 1980Q1-2006Q4, per hour benefit costs, private industry, quarterly data, seasonally adjusted; (7) By occupation: BLS Employment Cost Index (ECI) 2002Q1-2013Q1, per hour benefit costs, private industry, quarterly data, seasonally adjusted; (8) KFF/HRET and the Survey of Employer Health Benefits public use files, 1999-2013, firm level, firm-paid health insurance premium, annual data. All series are converted to per worker benefit costs by the author with the BLS employment and per worker hours data.

Training cost: (1) Oi (1962), with the 1951 study by the International Harvester Company, (2) Manning (2010) Table 2, and (3) BLS 1995 Survey of Employer Provided Training (Employee Results) at <http://www.bls.gov/news.release/sept.nws.htm>.

Credit market tightness: The measures of credit market tightness used to construct panels in Figure 3 are from Federal Reserve Board and CEIC database. In particular, the left panel data are from the Net Percentage of Domestic Respondents Tightening Standards for Commercial and Industrial Loans for Small

and Large Firms obtained from the Senior Loan Officer Opinion Survey on Bank Lending Practices from the Federal Reserve Board. The right panel data are from CEIC's data series 57229201, U.S. Quarterly Seasonally Adjusted Nonfinancial Business Corporate Debt Flow, and data series 211484102, U.S. Quarterly Seasonally Adjusted Nominal GDP.

B Appendix: Computation

I use numerical methods since the model cannot be solved analytically with the occasionally binding constraint. I approximate the conditional expectations in Equations 4, 8, 9, 10 and 14 nonlinearly, with piecewise-linear functions that interpolate linearly between the grid points of a five-dimensional state space $(z, \varepsilon, k, n, b)$. Starting with initial guesses for the conditional expectations at each grid point, I compute all variables of interest by solving a system of nonlinear equations. I also use the Garcia and Zangwill (1981) technique to tackle the occasionally binding enforcement constraint.²⁸

At the same time, I make sure that the system of the nonlinear equations at each grid point is truly solved by checking the reasons that the solving algorithm terminates.²⁹ Once I have solved the equation system for all the grid points, I update the guesses for the conditional expectations through Gauss-Hermit Quadrature (z and ε are lognormal) and keep iterating until the changes in all policy functions convergence at 0.001. There are 10 grid points in total for each endogenous state of k , n and b , and 5 for each exogenous state of z and ε . The difficulty of this computation lies in its high dimensionality of the state space. The approximation errors for the first order conditions range from $-2.2204e-16$ (on the grid point) to 0.0395 (between grid points). To get a sense of the scale of the largest error, it is 8.6 percent of the minimum employment value in the result (note: the largest error does not necessarily occur where the employment value hits its minimum).

²⁸With uncertainty, the constraint may not be always binding as in steady state, because the firm could reduce its borrowing in anticipation of future shocks.

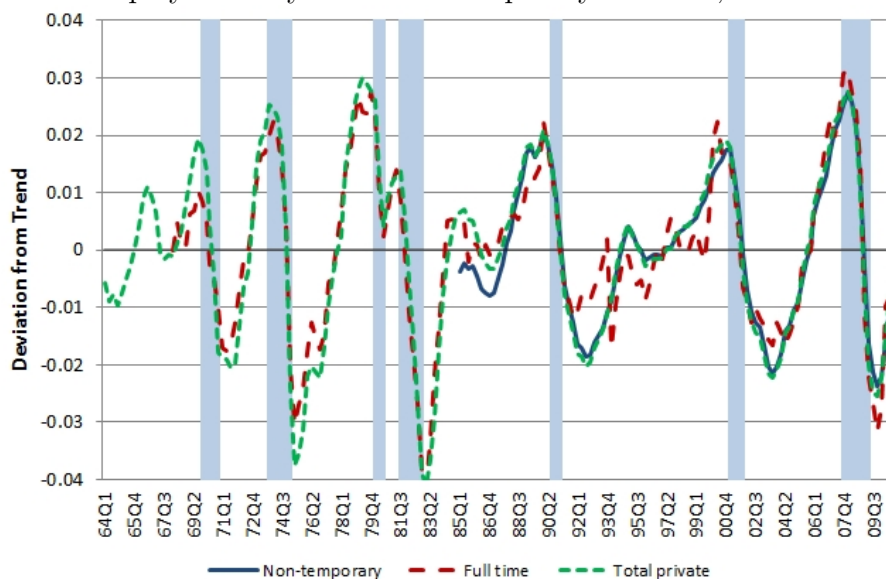
²⁹Matlab R2012b and Fortran are used in the computation.

C Appendix: Graphs

A. Permanent and Full-time Workers

The employment cycle of permanent workers and that of full-time workers exhibit similar jobless recovery patterns as total private employment cycle does (Figure 17).

Figure 17: Employment Cycle of Non-temporary Workers, Full-time Workers



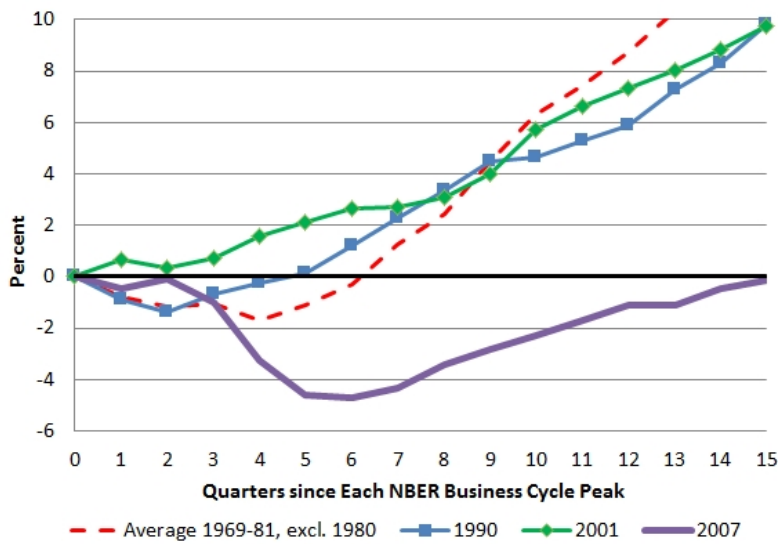
Source: Non-temporary employment is calculated from seasonally-adjusted total private employment and that of employment services industry data by Current Employment Statistics Survey. Full-time employment is seasonally-adjusted and from Current Population Survey.

B. Employment and Output Recoveries

This section further confirms that in post-1990 period employment indeed has recovered slower than output and it is not only because that output has recovered equally slowly. Figure 18 shows that while 2007 financial crisis suffered the deepest output decline and has experienced the slowest recovery, the 1990 and 2001 recessions were followed by output recoveries as fast as the average of the pre-1990 period. However, recall that in Figure 1 the employment recoveries from the 1990 and 2001 recessions have been delayed significantly compared with the pre-1990 period. Therefore, factors other than slow output recoveries should have driven the sluggish employment recoveries, at least following the 1990 and 2001 recessions.

Moreover, the correlation between the average cumulative growth of employment and that of output following NBER business cycle peaks is 0.95 before 1990, but it drops to merely 0.41 after 1990.³⁰ The relation between output and employment indeed has changed. Yet, it is not to say that the slow output recoveries have not contributed to the slow employment recoveries, especially the latest one. Since output and employment are endogenous, it is difficult to untangle how much of the former may actually be caused by the latter, as well as the other way around.

Figure 18: Cumulative Output Growth since Each NBER Business Cycle Peak



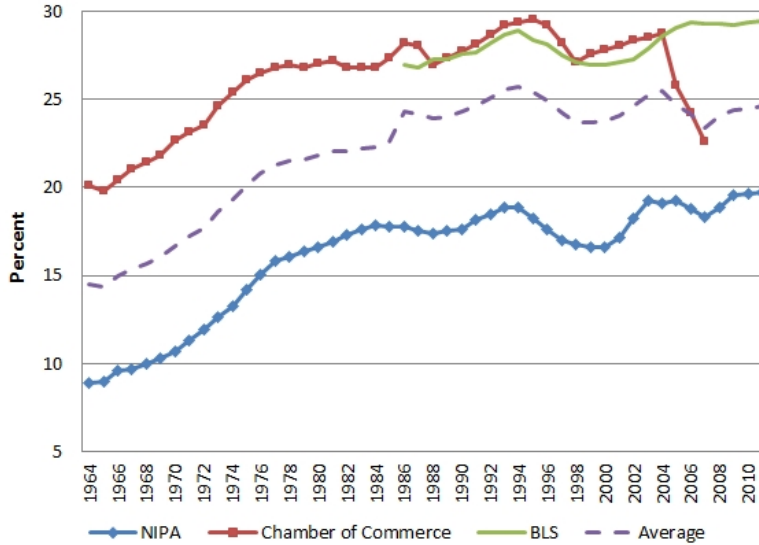
Source: NIPA, BLS CES and author's calculations.

C. Benefit Cost Trend

Estimated steady state benefit costs come from three data sources: NIPA, Chamber of Commerce, and BLS (Figure 19). All the sources show a rising trend of firm-paid benefit costs. NIPA gives the smallest estimates, while BLS and Chamber of Commerce gauge much higher costs.

³⁰Cumulative employment growth for 15 quarters following each NBER business cycle peak since 1964 is calculated (except for the short 1980 recession). Then, together they are averaged over the pre-1990 and post-1990 cycles, respectively. The same is done for output.

Figure 19: Per Worker Benefits as a Percentage of Total Compensation, (1964-2011, Annual)



Source: NIPA (Table 7.8) 1929-2011, Chamber of Commerce Employee Benefits Study 1963-2007, BLS ECEC 1986-2011, and author's calculations.

Note: Real per worker benefit cost series are calculated by the author using NIPA, Chamber of Commerce, and BLS data, respectively, deflated by the NIPA GDP price index, and then averaged over the three series. NIPA's wage and salary data is used in producing per worker benefit costs as a percentage of total compensation.

D. More Model Results for Employment, Output, and Hours

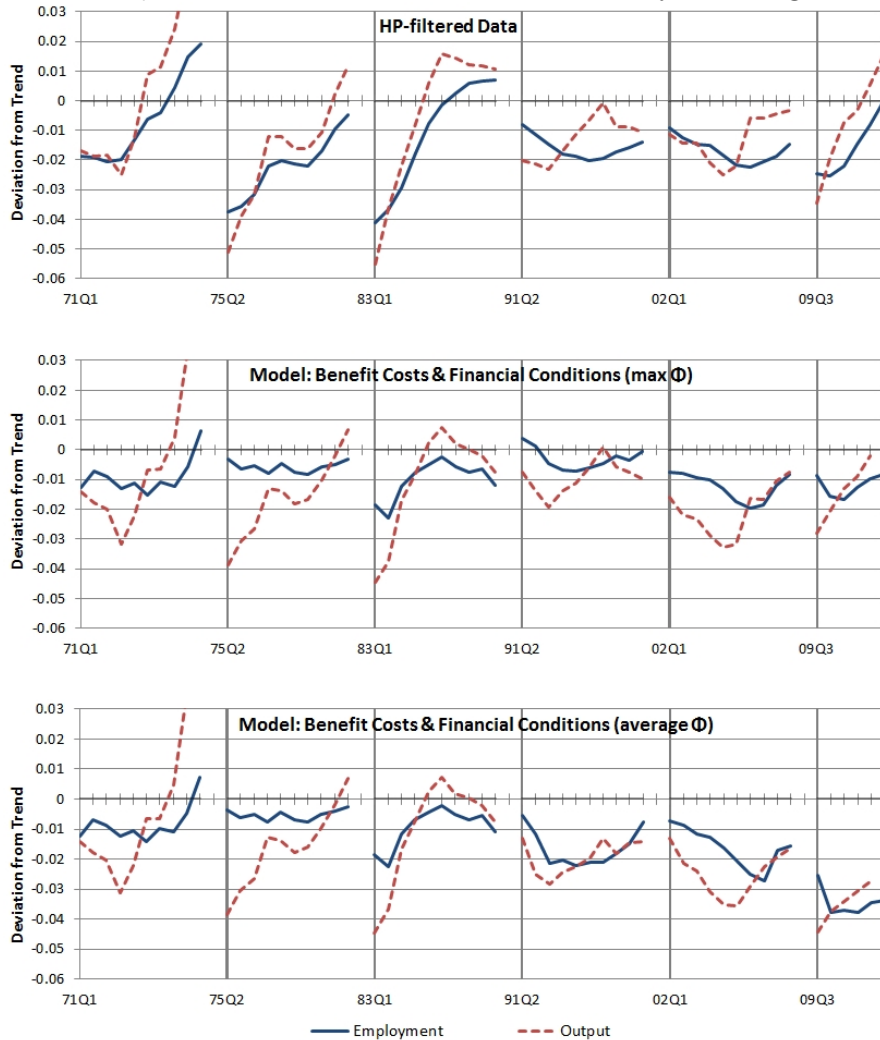
It is important to investigate the model-generated employment recovery delays against the model-generated output and per worker hours. Figure 20 shows that the model is able to deliver the lagging relation between the model-generated output and employment for post-1990 recoveries.³¹ Using either maximum ϕ or average ϕ does not alter the lagging relation. Figure 21 conveys a similar message: in general, the model-generated per worker hours have recovered earlier than employment during the recoveries following post-1990 recessions.

E. Benefit Cost Cycle by Occupation

By occupation, Figure 22 in Appendix shows HP-filtered real per worker benefit costs of 1) natural resources, construction, and maintenance jobs, 2) service jobs, 3) production, transportation, and material moving jobs, and 4) management, profes-

³¹Notice the difference between results here and those shown in Figure 10. Figure 10 uses the growth rates calculated from employment level with trend. Here is only HP-filtered, no trend added.

Figure 20: Employment and Output Cycle Results,
10 Quarters since Each NBER Business Cycle Trough

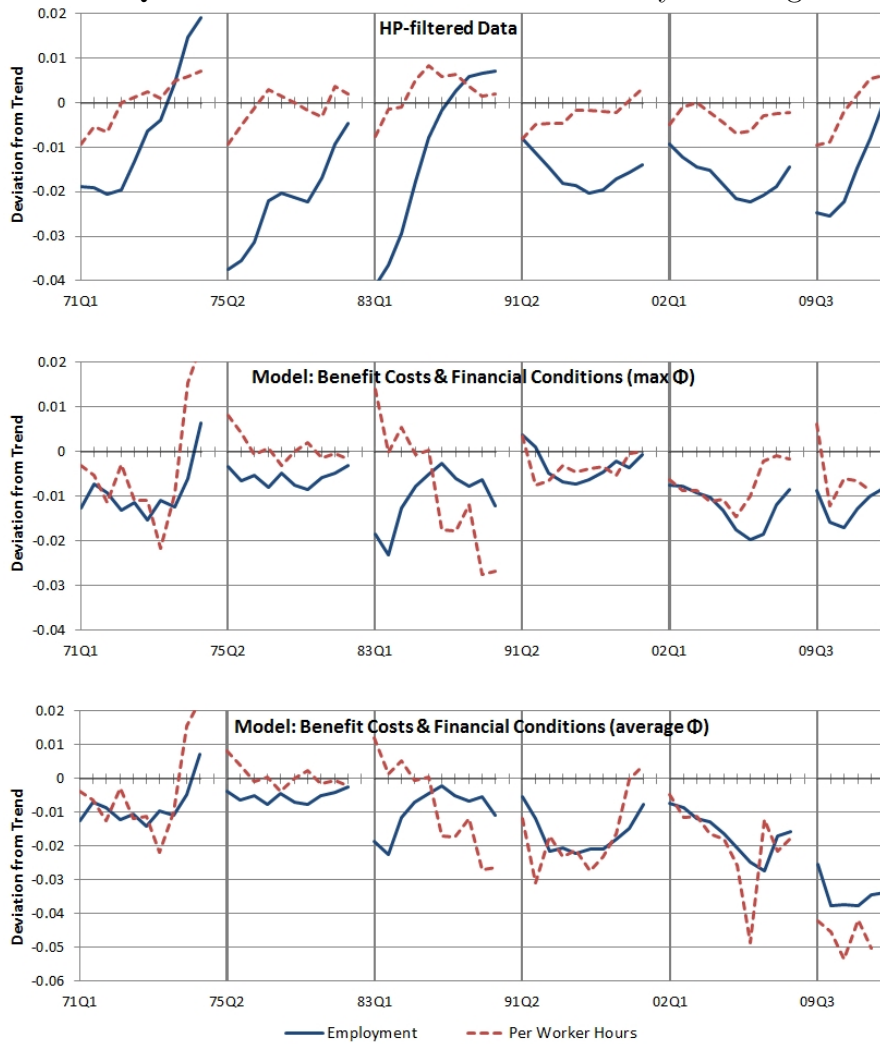


Source: BLS, NIPA, and author's calculations.

Note: For the model results with maximum ϕ , the pre-1990 results use $\phi_{pre90max} = 0.1027$ (44 percent of total wage) and the post-1990 results use $\phi_{post90max} = 0.4527$ (194 percent of total wage). For the model results with average ϕ , the pre-1990 results use $\phi_{pre90ave} = 0.0607$ (26 percent of total wage) and the post-1990 results use $\phi_{post90ave} = 0.0778$ (33 percent of total wage). All results include productivity shocks. Also notice the difference between results here and those shown in Figure 10. Figure 10 uses the growth rates calculated from employment level with trend. Here is only HP-filtered, no trend added.

sional, and related jobs. All of them display procyclical fluctuations of per worker benefit costs during the Great Recession.

Figure 21: Employment and Per Worker Hours Cycle Results, 10 Quarters since Each NBER Business Cycle Trough



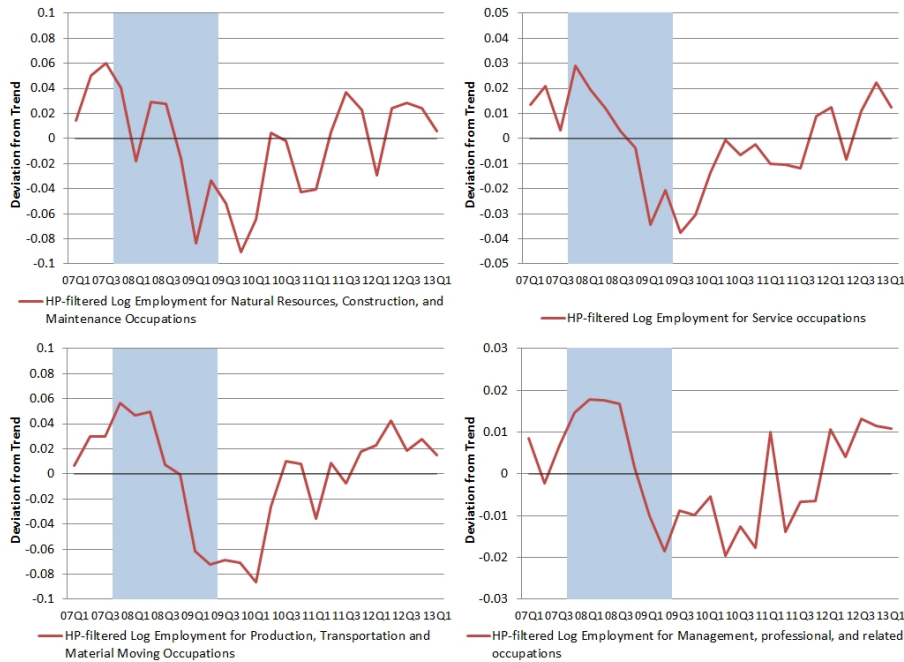
Source: BLS, and author's calculations.

Note: For the model results with maximum ϕ , the pre-1990 results use $\phi_{pre90max} = 0.1027$ (44 percent of total wage) and the post-1990 results use $\phi_{post90max} = 0.4527$ (194 percent of total wage). For the model results with average ϕ , the pre-1990 results use $\phi_{pre90ave} = 0.0607$ (26 percent of total wage) and the post-1990 results use $\phi_{post90ave} = 0.0778$ (33 percent of total wage). All results include productivity shocks. Also notice the difference between results here and those shown in Figure 10. Figure 10 uses the growth rates calculated from employment level with trend. Here is only HP-filtered, no trend added.

F. Kaiser/HRET Survey Data

Kaiser/HRET drew its sample from a Survey Sampling Incorporated list (based on an original Dun and Bradstreet list) of the nation's private employers and from the Census Bureau's Census of Governments list of public employers with

Figure 22: Real Per Worker Benefit Costs by Occupation
(Private Sectors, Quarterly, Seasonally Adjusted)



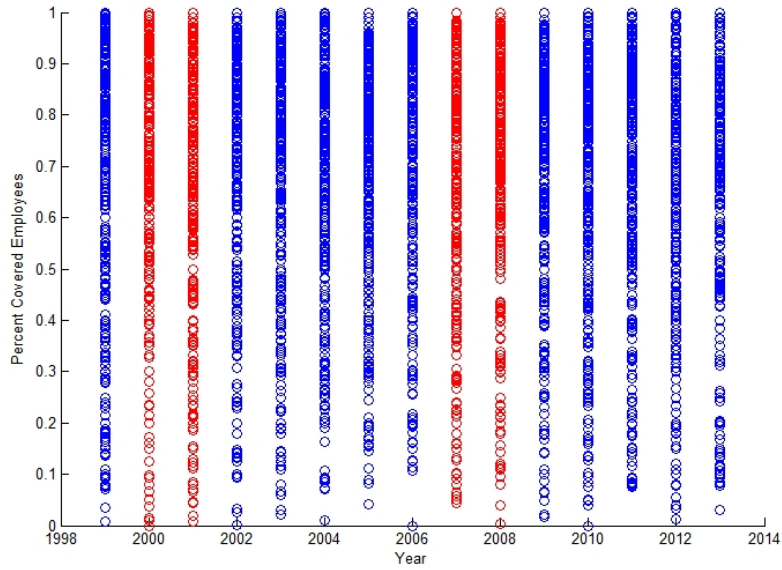
Source: Workers' benefit costs by occupation are from BLS ECI and author's calculations.

three or more workers. To increase precision, Kaiser/HRET stratified the sample by ten industry categories and six size categories (from firms of 3-24 workers to 5000+). They attempted to repeat interviews with prior years' survey respondents. Kaiser/HRET asked each participating firm as many as 400 questions about its largest health maintenance organization (HMO), preferred provider organization (PPO), point-of-service (POS) plan, and high-deductible health plan with a savings option (HDHP/SO). More details about their survey are available upon request.

As expected there are a good amount of heterogeneity among the firms. Using all the private firms that have reported the percentage of workers being covered under firm-provided health insurance for 1999-2013 (about 419 firms), I do not find significant coverage distribution difference between downturns and booms over 1999-2013 as shown in the Figure 23. The distribution of coverage ratios do not seem to vary by the business cycle.

Besides the single plans in the main text, I plot histograms of HP-filtered firm-paid per worker health insurance cost for family plans in private industry by year

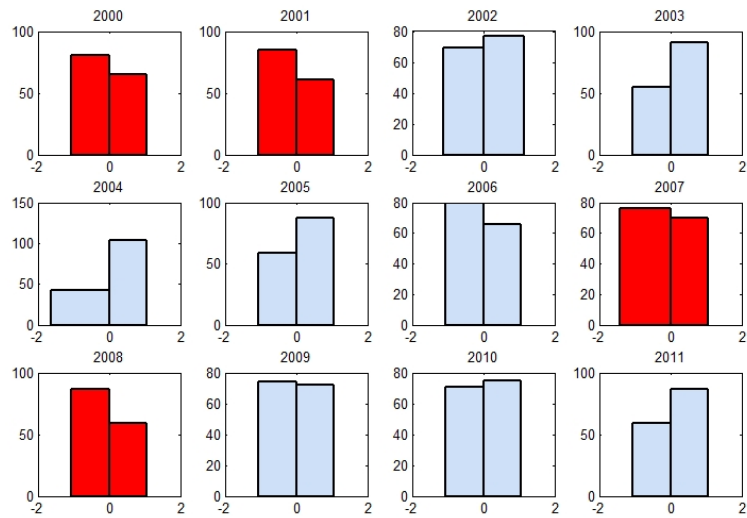
Figure 23: Firm Health Insurance Coverage Percentage (Private Industry)



Source: Kaiser Family Foundation and the Health Research and Educational Trust (Kaiser/HRET) Health Benefits Survey.

(Figure 24). I find during the years with below-trend employment growth (i.e., 2000, 2001, 2007 and 2008) the majority of the firms have per worker health insurance cost below their own trend too, whereas it is the opposite for the other years. This is consistent with the histogram for single plans.

Figure 24: Histogram of HP-filtered Firm-paid Per Worker Health Insurance Cost (Family Plans, Private Industry)



Source: Kaiser Family Foundation and the Health Research and Educational Trust (Kaiser/HRET) Health Benefits Survey.