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Grace Weishi Gu
University of California Santa Cruz

Eswar Prasad
Cornell University, Brookings Institution, NBER and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

New Evidence on Cyclical Variation in Labor Costs in the U.S.*

Employer-provided nonwage benefit expenditures now account for one-third of U.S. firms' labor costs. We show that a broad measure of real labor costs including such benefit expenditures has become countercyclical during 1982-2014, contrary to the conventional view that labor costs are procyclical. Using BLS establishment-job data, we find that even real wages, the main focus of prior literature, have become countercyclical. Benefit expenditures are less rigid than nominal wages, although both components of labor costs have become more rigid. These rigidities, along with the rising relative importance of aggregate demand shocks (including the financial crisis), help explain countercyclical labor costs.

JEL Classification: E24, J32, E32

Keywords: wages, benefits, compensation, economic fluctuations, cyclicality

Corresponding author:
Eswar Prasad
Dyson School of Applied Economics and Management
Department of Economics
Cornell University
440 Warren Hall
Ithaca, NY 14853
USA
E-mail: eswar.prasad@cornell.edu

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1 Introduction

The cyclical behavior of real wages in the U.S. has received a great deal of attention in both the macroeconomics and labor economics literatures. The correlation between real wages and the business cycle has implications for the empirical relevance of different classes of models. For instance, equilibrium real business cycle models are capable of generating moments consistent with actual data only if real wages (and productivity) are strongly procyclical. This implication seemed to run counter to a once widely-held view that real wages are countercyclical or acyclical, a finding that was overturned once researchers accounted for changes in the skill composition of employment over the business cycle. But the debate remains far from settled, with alternative measures of wages often yielding conflicting results.

The evidence brought to bear on such debates has been based mainly on wage or earnings data, which provide at best a partial picture of firms' labor costs and workers' labor income. The share of employer-provided nonwage benefit expenditures in U.S. workers' overall compensation has risen markedly over the last three decades, and stood at over 30 percent by 2014. The increase is partially the result of labor laws that mandate certain benefits and also the consequence of explicit or implicit bargaining between employers and workers.

Overall labor costs—also referred to as compensation and defined as straight-time wages plus nonwage benefit expenditures in this paper—are more closely related than just hourly wages or earnings to the theoretical concepts in the literature on labor market dynamics as well as wage bargaining.[1] The costs of labor that employers face, both in terms of their overall demand as well as hiring choices such as those between offering full-time and part-time employment, are based on total compensation. It is the relevant price that enters into both labor input decisions made by employers and labor supply choices of workers. Consistent with this view, wage bargaining negotiations are typically conducted in the context of overall compensation packages, with pension and insurance benefits often playing equal if not larger roles than wages. Moreover, firms' ability to adjust nonwage benefit expenditures to a greater or lesser extent than wages has implications for rigidities in labor costs and, by extension, for employment adjustment in response to different types of shocks.

Previous literature on the cyclicality of the cost of labor has relied largely on wage or earnings data due to the unavailability of benefit expenditure data at a disaggregated level in a comprehensive manner and on a comparable basis over time. Most existing worker and establishment surveys include only data on earnings, with at best sparse information on firms' nonwage benefit expenditures. For instance, data from sources such as the National Longitudinal Survey (NLS), the Panel Study on Income Dynamics (PSID), and the Current

[1] We use the terms *overall labor costs* and *compensation* interchangeably in this paper.

Population Survey (CPS) all contain data on wages and/or earnings but lack comprehensive information on nonwage benefit expenditures.

The main objective of this paper is to provide what we believe is the first empirical examination of the cyclical behavior of both wages and nonwage labor costs over the business cycle. The data are taken from the quarterly employer cost surveys conducted by the Bureau of Labor Statistics (BLS), which comprise detailed information on various categories of firms' labor costs, including a breakdown of firm-paid employee benefit expenditures. The dataset has a considerable amount of information about the characteristics of the sampled establishments and their jobs, but not about workers. Using this establishment-job level dataset enables us to study the cyclicality of a comprehensive measure of firms' labor costs, in contrast to the previous literature, which provides only a partial picture of the cyclicality of worker compensation.

We use annual establishment-job data from the BLS surveys over the period 1982-2014 to first document a comprehensive set of stylized facts regarding straight-time wages; a broader measure of earnings that includes overtime and cash bonus payments; and firms' expenditures on workers' nonwage benefits, broken down into detailed categories.[2]

We then make three main contributions to the literature. First, we provide a detailed empirical characterization of cyclical variations in total labor cost and its components. Our main result is that real hourly straight-time wages, benefit expenditures, and overall labor costs are all significantly countercyclical, especially for the post-2007 period. The results are consistent across different indicators of the business cycle (based on GDP, employment, the unemployment rate) and are stronger when we use the PPI rather than the CPI as the price deflator. In general, real benefit expenditures appear less countercyclical than real wages or earnings, but this conclusion varies across establishment-job characteristics. We also find that wages and benefit expenditures tend to be the most countercyclical for skilled occupations with higher compensation. Both wages and overall labor costs are more countercyclical in the service sectors compared to the manufacturing sector, while the two variables are procyclical in the fishing and forestry sector.

The second contribution of this paper is to provide explanations for why these new results on the cyclical behavior of labor costs, which use establishment-job level data, differ from those in the prior literature, a majority of which emphasizes the finding of procyclical variation in just wages/earnings using individual-level data. The employer cost surveys do not collect information on individual worker characteristics, precluding us from directly evaluating the bias from differential patterns of cyclical entry and exit of workers of varying

[2] We use annual data instead of quarterly data since this allows us to extend our sample back to 1982. Quarterly data are available on a consistent basis starting only in 2004.

skill levels (or other attributes) that is commonly analyzed in papers based on individual-level surveys.

Since we use establishment-job data, the types of composition bias other authors have studied are largely obviated. Our establishment-job data reflect the underlying wage distribution faced by workers, conditional on their observed and unobserved attributes. This is in line with the concept of the wage structure embedded in theoretical business cycle models and is not contaminated by the composition bias that affects analyses based on individual workers' observed wages. This bias arises from the fact that in datasets based on individual- or household-level data, wages are observed only for employed workers, and employment probabilities are in turn affected by worker attributes.

Nevertheless, in our analysis based on establishment-job units, we control for differential cyclical variations across different jobs and sectors/firms to control for other potential biases. We find that these composition effects do not play much of a role in explaining our countercyclicality findings. We then discuss two additional reasons that are relevant to understanding why our findings differ from those in the existing literature. By distinguishing straight-time wage rates from earnings, we find that the latter measure was indeed procyclical during 1982-2007 as many other papers have concluded, even though wages themselves were acyclical during this period. How wages and earnings are measured clearly has a big impact on results about cyclicality. We also note that systematic cyclical variation in workers' job switching behavior, which can affect observed wages based on worker surveys (but would not affect establishment-job wage observations), might be another reason.

Our third contribution in this paper is that we find increasing countercyclicality for real labor costs since the 2007 financial crisis and present some suggestive evidence for a combination of two factors that could explain this development. First, we document significant (downward) nominal rigidities in wages as well as overall labor costs. Benefit expenditures have lower nominal rigidity than wages, but nominal rigidities in both components of labor costs have risen over time and, more importantly, seem to intensify during recessionary periods. Second, the relative importance of aggregate demand shocks, as reflected in the procyclical behavior of inflation, has increased over the period covered by our sample. In particular, the global financial crisis, which was followed by the Great Recession, led to an upward spike in real wages due to the fall in inflation, intensifying the pattern of countercyclical variation in firms' labor costs. This contrasts with the greater importance of aggregate supply shocks (including oil price shocks) in driving U.S. business cycles during the 1970s, 1980s, and early 1990s, the periods on which much of the previous empirical literature is based.

1.1 Related Literature

In early work using manufacturing sector data for the U.S., Bodkin (1969) and Otani (1978) find that wages are acyclical or weakly procyclical. Using similar data but holding fixed the weights of different industries within the sector, Chirinko (1980) finds that real wages in manufacturing are countercyclical. Applying time series techniques to aggregate data, Neftci (1978) and Geary and Kennan (1982) conclude that the real wage is countercyclical, a finding seen as supportive of Keynesian and neo-Keynesian models of business cycles.[3]

Subsequent work using micro-level data, mostly from the NLS and the PSID, has largely supported the view that real wages (or earnings, depending on the study) are procyclical. Using data from the National Longitudinal Survey of Young Men (NLSY) over the period 1966-1980, Bils (1985) concludes that real wages are strongly procyclical and that real wages are more procyclical for individuals prone to moving between employers or in and out of the work force. Shin (1994) extends these results to examine intersectoral differences and finds that real wages are more procyclical in manufacturing than in the trade or services sectors.

Keane et al. (1988) use NLSY data over the period 1966-81 and control for aggregation bias as well as selectivity bias that arises if workers with high transitory wages are more likely to lose their jobs during recessions. They find that selectivity induces a significant procyclical bias, but that real wages are still procyclical even when aggregation and selectivity biases are accounted for. By contrast, Bils (1985), Blank (1990), and Tremblay (1990) find that such selection effects are not quantitatively significant. In particular, Tremblay (1990) finds that real wages are procyclical for both young men's and young women's samples in the NLS.

Studies based on PSID data generally find that aggregation induces a countercyclical bias in estimates of wage cyclicality. Solon et al. (1994) use PSID data over the period 1967-87 and find that, after correcting for aggregation bias, the real wage is strongly procyclical. They find that low-skill, low-wage workers have more procyclical employment than skilled, higher-wage workers, which induces a countercyclical composition bias in aggregate measures of wage cyclicality. Kydland and Prescott (1988) use PSID data from 1969 to 1982 to construct a skill-weighted index of aggregate labor input and derive a measure of wages per unit of labor input. They find this measure of the price of labor to be strongly procyclical.

Building on the work of Daly et al. (2012), Daly and Hobijn (2016) and Daly and Hobijn (2017) use CPS data over the period 1980-2015 to show that real earnings (including overtime and incentive pay) are procyclical for those who remain fully employed over the business cycle and most of the procyclicality comes from job switchers. However, systematic cyclical

[3]Our survey of the extensive literature on this topic is far from comprehensive. Abraham and Haltiwanger (1995) provide an excellent survey of papers based on U.S. data and reconcile a broad range of findings in the literature. Brandolini (1995) provides a survey of the evidence for a number of other countries.

variations in net exits out of full-time employment among workers with lower earnings impart a countercyclical bias to aggregate real wages. Using CPS data for 1979-2011, Elsby et al. (2016) also find evidence of procyclical earnings (including incentive pay).[4]

In their comprehensive literature survey, Abraham and Haltiwanger (1995) note that the following factors have important effects on the measured cyclicality of the real wage/earnings: (i) time period; (ii) use of consumption versus production deflators; (iii) composition effects; (iv) method of detrending; and (v) the choice of cyclical indicator. In particular, Abraham and Haltiwanger (1995) note that real wages were procyclical even at the aggregate level in the 1970s and 1980s, and acyclical or countercyclical in the 1950s and 1960s. For instance, using aggregate data for U.S. manufacturing, Sumner and Silver (1989) find that real wages were countercyclical over the periods of 1948-71 and 1948-77 but procyclical over the 1966-80 period. The former two periods are studied by Neftci (1978) and Geary and Kennan (1982), who report countercyclical wage variation, and the last period is covered by Bils (1985) and many others who report procyclical wages. Based on their analysis of aggregate data, Abraham and Haltiwanger (1995) also note that, over the period 1949-93, first-differenced and quarterly HP-filtered data yield similar results. In both cases, wages deflated by the CPI are more procyclical than wages deflated by the PPI.[5] Swanson (2004) deflates wages with firm-specific product prices rather than the aggregate PPI and concludes that most industries pay real wages that vary countercyclically with the state of their industry.

The literature we have summarized above tends not to explicitly distinguish between *wages* and *earnings* but considers these two concepts interchangeably. The importance of variable elements of pay, rather than normal hourly wages or salaries, has begun to receive attention relatively recently, although even papers that have flagged this issue have typically not been able to investigate it in depth because of the paucity of relevant data. Using the PSID over the period 1970-91, Devereux (2001) finds weaker evidence of wage procyclicality among job stayers, except for workers paid by piece rate or commissions, for whom wages are highly procyclical. He finds that wage rates are acyclical but earnings, which include overtime payments and bonuses in addition to basic wages, are highly procyclical. Similarly, salaries exhibit little cyclicality but salaried workers with income from incentive pay have procyclical

[4] Another dataset used by some authors to study nominal wage rigidity and wage cyclicality of workers with different characteristics is the Survey of Income and Program Participation (see, e.g., Gottschalk, 2005). In a recent study using SIPP data from 1990 to 2012, Gertler et al. (2016) find that earnings of existing workers and of new hires coming from unemployment are both procyclical. They argue that the apparent excess wage cyclicality among new hires from unemployment can be attributed to cyclical variation in match quality. Hagedorn and Manovskii (2013) report similar findings.

[5] The results by sub-period also differ in some important ways. Whichever deflator is chosen, the HP-filtered series exhibits substantially more procyclicality over the post-1970 period than over the 1949-69 period. The subperiod results using first differences are less clear cut. When wages are deflated using the CPI, the pre-1970 period yields greater procyclicality than the post-1970 period.

earnings. Swanson (2007) confirms, also using the PSID data, that workers' straight-time hourly pay rates have been acyclical while earnings are procyclical. Like Devereux (2001), he attributes this discrepancy to strong procyclical variation in variable pay margins such as bonuses, overtime, late shift premia, and commissions.[6]

Similarly, Shin and Solon (2007), using NLSY data, conclude that job stayers' real hourly earnings are substantially procyclical and that an important portion of that procyclicality is due to compensation beyond base wages.[7] Parker and Vissing-Jorgensen (2010) conjecture that the sharp increase in the cyclical variation of the earned income of high-income households in the U.S. over the last two decades may be attributable to nonwage compensation.

Most of the above papers use the PSID, the NLS(Y), or other worker/household-level data for the period before 1993, with a few exceptions. By using a comprehensive dataset on employer costs of labor compensation at the establishment-job level for the period 1982-2014, our paper distinguishes itself in the following three aspects. First, the use of establishment-job level data enables us to capture the cyclicality of labor costs from the perspective of firms' costs, in addition to allowing us to mitigate contamination of our results by changes in the characteristics of the workforce. Second, given the importance of nonwage benefit expenditures in total labor costs and possible differences in the cyclical behavior of wages by themselves relative to broader measures of earnings as well as benefit expenditures, our study sheds new light on an old debate: the cyclicality of a broad measure of labor costs. Third, with our dataset encompassing three recent decades, the global financial crisis, and the recovery from the Great Recession, we show how changes in the labor cost nominal rigidity in the U.S. labor market since the 1980s may have affected the cyclicality of labor costs relative to earlier periods in response to major macroeconomic shocks.

The analysis in this paper is also relevant to the literature on labor productivity and markups. Although we do not have data on marginal labor costs, the real hourly compensation data that we have is closely related to the marginal product of labor.[8] McGrattan and Prescott (2012) and Gali and van Rens (2015) have documented the "vanishing" procyclicality of labor productivity since the mid-1980s. In a different strand of literature, Bils (1987), Rotemberg and Woodford (1991, 1999), and Gali et al. (2007) show that wage markups are

[6]Similar results of acyclical base hourly wages but procyclical earnings (including overtime, commissions, bonuses, and other types of performance-related pay) have been reported for other countries such as the U.K. (Hart, 2008; Hart and Roberts, 2013) and Germany (Anger, 2011).

[7]Bils (1985) contends that his wage measure from the NLSY dataset includes overtime payments but Keane et al. (1988) refute this, noting that the NLSY does not contain data on overtime earnings and hours in every year. Hart et al. (2009) impute average base and overtime earnings using BLS aggregate data and, using frequency domain analysis, report that basic wages and overtime pay comove with the business cycle.

[8]Karabarbounis (2014) argues that the real wage is more reflective of the marginal product of labor than the household's marginal rate of substitution.

countercyclical, while Nekarda and Ramey (2013) find them to be procyclical.

We are not the first to use the micro-level dataset from the BLS employer cost surveys, although we are not aware of other papers that have used it to examine the issue of labor cost cyclicality. Other researchers have used it for different purposes. For instance, Gu (2017) and Makridis and Gittleman (2017) examine the relationship between firms' employment and labor costs. Pierce (2001), Pierce (2010), and Monaco and Pierce (2015) find that inequality growth in broader measures of compensation exceeds wage inequality growth (also see Chung, 2003; Lettau, 2003; Gittleman and Pierce, 2013). Lebow et al. (2003) use the BLS data to re-examine the evidence on downward nominal wage rigidity. Other than these papers, BLS data releases and reports, which generally characterize developments in aggregate trends in compensation, constitute the main source of publicly available analysis using the data.

2 Dataset

The BLS employer cost survey is a nationally representative random sample of establishments and jobs in all sectors other than the Federal government.[9] The quarterly survey is administered by the Bureau of Labor Statistics (BLS) and covers all fifty states and the District of Columbia.[10]

The sampling procedure has three stages. First, a probability sample of geographic areas is chosen. Next, within each area, a probability sample of establishments is selected. For the private sector, an establishment usually refers to a single physical location that produces goods or provides services. Even if a sampled establishment is owned by a larger entity with many locations, only that specific establishment is included in the survey.[11] For state and local governments, an establishment can include more than one physical location within a specific geographical area. In the third stage, a probability sample of jobs is chosen from each of the selected establishments. This is done by random sampling from a complete list of employees and their job titles provided by the selected establishments.[12] The number of jobs for which data are collected are based on total employment in the establishment.[13]

[9] Employer cost data were earlier compiled by the BLS under three separate programs: the Occupational Compensation Survey, the Employment Cost Index, and the Employee Benefits Survey. Since 1996, these programs have been merged into the National Compensation Survey (NCS).

[10] Federal and quasi-federal agencies, the military, agricultural workers, private household workers, workers abroad, unpaid workers, the self-employed, and long-term disability compensation recipients are excluded from the survey.

[11] In this paper, we use the terms *establishment* and *firm* interchangeably. The two terms have different connotations, but that difference is not important for much of the analysis and discussion in this paper.

[12] For the period our analysis covers, there were actually a few slightly different sampling designs. But the majority of our period is covered by the procedure described here.

[13] The relationship between an establishment's total employment and number of jobs selected is as follows: 1-49 employees: up to 4 jobs; 50-249 employees: up to 6 jobs; and 250 or more employees: up to 8 jobs. Exceptions include state and local government units, for which up to 20 jobs may be selected.

Job categories are very detailed; they not only distinguish between full-time versus part-time jobs, and supervisory versus non-supervisory jobs, but are also differentiated by tasks performed and skills required. Only "in-scope" employees and establishments are included in the survey. This excludes contractors, owners, and volunteers. In summary, the larger the employment size of an area, an establishment, or a job within an establishment, the greater its chance of being selected.

The basic unit of observation in the dataset is an establishment-job and there is no information about worker characteristics. It is important to note that data on labor costs represent the average across all workers employed in a particular job in a specific establishment. In other words, differences across workers in the same job in a given establishment are averaged out. This is advantageous for our purposes because it eliminates the influence of (observed and unobserved) worker characteristics on wages/earnings, in contrast to individual-level data where these characteristics can determine employment and, therefore, whether a wage is observed or not.

Worker characteristics within an establishment-job unit could arguably change over the business cycle. For instance, the average skill or productivity level of workers at a given job may fluctuate over time. This is possible but unlikely to be important, either in general or specifically for our analysis. For one, job categories in the survey data are very detailed in terms of tasks performed and skills required; it is unlikely that the skill or productivity levels of workers in a given job would change substantially in the short term. For another, even if worker characteristics do fluctuate within an establishment-job unit, this would not be relevant for our analysis as long as the real hourly compensation for the job does not change as a result of the change in worker characteristics. Firms can always adjust the labor utilization rate to align the job's productivity with the demand for output even if worker characteristics were to change.

The employer cost survey does have a considerable amount of information about establishment and job characteristics. Establishment characteristics include employment size and location, the establishment's industry according to the Standard Industrial Classification (SIC) System and the North American Industry Classification System (NAICS), and whether it is privately owned or operated by a State or local government. Job characteristics include BLS standard occupational classifications, whether the job is covered by a union contract, and whether it is part time or full time.

The survey has a rotating panel structure for the private sector establishment-job sample, which means that this sample is divided into five panels that enter and exit the survey on a rotational basis. Each cohort is composed of establishment-job units that represent the population of all in-scope workers throughout the U.S. at the time of sampling, and stays in the survey for about 5 years.[14] In other words, approximately one-fifth of the sample is refreshed each year in order to reflect changes in the distribution of employment across industries and geographic areas. Establishments that go out of business drop out of the sample, while those establishments that decline to participate at some point in the survey period are not replaced but have their data imputed.

The cleaned-up version of the dataset that we use, after dropping some observations with missing or inconsistent data, covers an average of 6,600 establishments each year, with about 4 sample jobs for each establishment. The size of the sample has risen over the period 1982-2014, yielding an average of 4,420 establishment-job observations in each of the first three years of the sample and an average of 41,437 in each of the last three years.

Some of the data collected through this survey are published in aggregated form in BLS publications and provided as part of data series such as the Employment Cost Index (ECI) and the Employer Cost for Employee Compensation (ECEC). External researchers need approval before gaining access to the database onsite at BLS headquarters in Washington, DC with certain confidentiality restrictions.

2.1 Distinguishing Among Different Elements of Compensation

A key and unique feature of our dataset is that it contains separate information on straight-time wages, a broader measure of earnings, and various categories of nonwage benefit expenditures paid by firms. The hourly wage measure that we use is the straight-time hourly rate. Throughout this paper, we use the terms *wage* and *straight-time wage* interchangeably when we discuss our dataset and relevant results. Many previous papers have used weekly or annual earnings (including overtime pay) divided by straight-time hours, which we conjecture can induce a procyclical bias in the measured cyclicality of wages.

A virtue of our dataset is that we can construct a comprehensive measure of hourly earnings that comprises straight-time wages, nonproduction bonuses, (overtime) premium pay, and shift differentials.[15] We show in the empirical results section that this measure of earnings is indeed procyclical over the period 1982-2007. This helps reconcile our results with many previous papers that use earnings data but often have less comprehensive measures than we are able to construct.

We define overall labor costs or, equivalently, compensation, as the sum of wages and

[14] In 2012, the BLS began gradually introducing panels that have a span of only 3 years.

[15] Nonproduction bonuses are cash payments given to employees that might not be directly related to the productivity of the individual worker. According to the BLS, they include Christmas or year-end bonuses, profit-sharing cash bonuses, referral bonuses, hiring bonuses, retention bonuses, and attendance bonuses. Nonproduction bonuses are included in the benefits portion of total compensation. In contrast, a payment directly linked to sales or production is considered a production bonus and is included in wages. Below, we use the terms *bonuses* and *nonproduction bonuses* interchangeably.

nonwage benefit expenditures. This measure of labor costs does not include firms' costs related to searching for or training workers. The main focus of our empirical work will be on compensation, although we also provide results broken down by each of its major components in order to compare and contrast our results with those in the prior literature.

2.2 Stylized Facts

U.S. firms' average benefit expenditures per worker rose from $6,018 in 1982 to $22,216 in 2014 (see Appendix Figure A.1). This represents a 50 percent increase in CPI inflation-adjusted terms.[16] While there is a clear trend in the share of nonwage benefit expenditures in total labor costs, this share does not rise linearly over time and shows a significant amount of variation at business cycle frequencies.

The employer cost surveys provide data on 23 categories of firms' benefit expenditures. Table 1 provides basic information on the share of total compensation accounted for by each of major benefit categories at the beginning and end of the sample. Certain benefits are mandated by law or negotiated, either partly or in full, as part of employment contracts. Payments for social security, Medicare, workers' compensation, and unemployment insurance are mandated by law, at either or both the federal and state levels, and not subject to negotiation. Some of these legally required benefit expenditures can be cyclical due to policy mandates. By contrast, retirement and insurance benefits, as well as vacations and other paid leave, are typically open to negotiation between the employer and employee. These discretionary benefits account for most of the overall benefit expenditures and can also vary over the business cycle, perhaps as a consequence of bargaining outcomes.

Benefits can also be categorized as being quasi-fixed or variable. Quasi-fixed benefit expenditures typically do not depend on wage levels and can be considered as being on the extensive margin of adjusting labor inputs. This distinction could play a role in employers' decisions about whether to adjust labor input at the intensive or extensive margin in response to changes in demand. Unemployment insurance, medical and life insurance, defined benefits, and paid leave (e.g., sick leave, personal leave) are typically quasi-fixed from the employer's perspective.[17] By contrast, social security and Medicare payments, and employer contributions to defined contribution plans are mostly variable in nature (within relevant ranges of earnings), varying with adjustments in the hours or weeks worked by an employee. In 2014, quasi-fixed benefit expenditures accounted for 20 percent of total compensation costs faced by employers, while other benefit expenditures accounted for 11.5 percent.

It is evident from Table 1 that the importance of benefit expenditures in total labor costs

[16] If deflated using the GDP deflator, the increase is 75 percent.

[17] We follow Ehrenberg and Smith (2012) for the quasi-fixed benefit expenditure classification.

Table 1: Average Shares of Benefit Expenditures in Total Compensation

Benefit	**Total Obs.**	**1982**	**2014**		**Mean**	**Std. Dev.**
Legally required benefits:	684105	7.98	8.10	*	8.36	3.11
Social security	869755	5.22	4.55		4.90	1.35
Medicare/railroad retirement	869755	0.12	1.12		0.95	0.61
Workers compensation	869755	1.53	1.37		1.70	2.22
Federal unemployment	869755	0.22	0.12		0.15	0.18
State unemployment	869755	0.84	0.75		0.62	0.82
Other legally required	684105	0.05	0.00	*	0.01	0.10
Discretionary benefits:	684105	19.02	22.64	*	20.89	10.25
Defined benefit/pensions	869755	4.31	2.59		2.32	3.78
Health insurance	869755	3.92	9.45		7.80	5.91
Vacations	869755	3.36	3.24		3.11	2.13
Holidays	869755	2.50	2.09		2.22	1.38
Premium pay	869755	1.41	0.81		1.01	1.63
Sick leave	869755	0.90	1.03		1.00	1.02
Nonproduction bonus	869755	0.67	1.29		1.02	2.89
Life insurance	869755	0.47	0.13		0.20	0.37
Other paid leave	869755	0.32	0.40		0.34	0.57
Shift differential	869755	0.30	0.24		0.29	0.91
Defined contributions	869755	0.29	1.83		1.48	2.10
Minor benefits	684105	0.63	0.28	*	0.39	0.81
Quasi-fixed benefits	869755	16.84	19.79		17.75	8.95
Non-quasi-fixed benefits	869755	10.17	11.50		11.73	4.82
Total benefit expenditures	**869755**	**27.00**	**31.29**		**29.48**	**9.36**
Straight-time wage	869755	73.00	68.71		70.52	9.36
Total earnings	869755	75.38	71.04		72.84	8.66
Total compensation	**869755**	**100**	**100**		**100**	**0**

Notes: Minor benefits include severance pay, supplemental unemployment, railroad unemployment and supplementary retirement, and short-term and long-term disabilities. Data on severance pay and supplemental unemployment data are available up to 2005; railroad unemployment and supplementary retirement data are available up to 1995. Quasi-fixed benefits include vacations, holidays, sick leave, other paid leave, life and health insurances, defined benefit, and federal and state unemployment insurances. Total earnings include basic straight-time wages, premium pay, shift differentials, and nonproduction bonuses. The asterisk denotes entries for which 2013 data were used since data were not available for 2014.

has increased sharply. Moreover, the relative importance of different benefit expenditures in total labor costs has also changed considerably. The costs of benefits such as premium pay, holidays, life insurance, and social security have fallen slightly relative to overall labor costs. There has been a shift away from defined benefit schemes and towards defined contribution schemes. The biggest shift, which accounts for a substantial portion of the overall increase in the share of nonwage benefit expenditures, is accounted for by a nearly 6 percentage point increase from 1982 to 2014 in the share of health insurance costs.

Among different occupations, average annual benefit expenditures over the period 1982-2014 range from \$25,953 for executive and managerial workers to \$8,679 for service workers (see Appendix Figure A.2). The share of benefit expenditures in total labor costs within specific occupational categories ranges from 33 percent for machine operators to 24 percent for sales workers. Among different industries, average annual benefit expenditures over the period 1982-2014 range from \$22,410 in public administration to barely \$5,185 in arts and entertainment, accommodation, and food (see Appendix Figure A.3). The average share of benefit expenditures in total labor costs ranges from 36 percent in public administration to 22 percent in arts and entertainment, and other services.

3 Empirical Framework

The basic empirical model that we use following Bils (1985) posits that the log level of labor costs (C_{ijt}) is related to the characteristics of a specific job (X_j); characteristics of all jobs in a particular establishment (X_i); characteristics that are common to jobs and establishments but vary over time (X_t); and variables that vary across jobs and establishments and over time (X_{ijt}):

$$\ln C_{ijt} = X_i\alpha_1 + X_j\alpha_2 + X_t\beta + X_{ijt}\gamma + \mu_{ijt} \tag{1}$$

The error term can be decomposed as follows:

$$\mu_{ijt} = a_i + b_j + c_t + v_{ijt} \tag{2}$$

where a_i is specific to establishment i; b_j is specific to job j; c_t is specific to time t; and v_{ijt} is specific to establishment i, job j in time period t. We assume that a_i, b_j, c_t, and v_{ijt} are independent of each other, and that v_{ijt} is independent of the regressors X.

First differencing simplifies the model to be:

$$\ln \frac{C_{ijt+1}}{C_{ijt}} = (X_{t+1} - X_t)\beta + (X_{ijt+1} - X_{ijt})\gamma + \mu_{ijt+1} - \mu_{ijt} \tag{3}$$

$$\mu_{ijt+1} - \mu_{ijt} = (c_{t+1} - c_t) + (v_{ijt+1} - v_{ijt}) \tag{4}$$

The establishment and job fixed-effect error components drop out. We assume that the error components of the first-differenced labor costs follow AR(1) processes. Equation 3 is then estimated by generalized least squares (GLS).

The baseline specification that we estimate using our data can be written as follows:

$$\ln \frac{C_{ijt+1}}{C_{ijt}} = b_0 + b_1 t + b_2 \ln \frac{RGDP_{t+1}}{RGDP_t} + \mu_{ijt+1} - \mu_{ijt} \tag{5}$$

In this specification, C_{ijt} is hourly or annual-per-worker real labor costs (adjusted for inflation using CPI) and a unit of time t represents a year. The key variable of interest is $\ln \frac{RGDP_{t+1}}{RGDP_t}$. It equals the change in real GDP from year t to year $t+1$ and is intended to reflect business cycle fluctuations. A positive coefficient b_2 on this variable signifies procyclical labor costs; a negative coefficient implies countercyclical labor costs. In our regressions, we will also experiment with other measures of the business cycle using the same regression. The linear trend term t captures any trend that might exist in the growth of real labor costs over the sample period. The variables $\mu_{ijt+1} - \mu_{ijt}$ are the error terms discussed above.

The first-differenced equation also helps to mitigate composition effects that reflect shifts in the shares of different groups of firms and jobs in the economy over time. Because different groups of firms and jobs incur different levels of labor costs, level regression results can be biased if the shares of higher-labor-cost firms and jobs versus the shares of lower paying counterparts change over the business cycle. For instance, suppose that the former groups of firms and jobs occupy a larger share in the economy during recessions but a smaller share during normal times, then this phenomenon can drive up average labor costs during a recession, not necessarily because most firms and jobs raise their labor costs but because of firm-job composition shifts. In other words, this composition effect would induce a countercyclical bias. Growth rates, however, can reduce such bias, when we assume that even though labor cost levels differ across firms and jobs, the growth rates are not as different. Hence, using growth rates rather than levels as the dependent variable helps reduce the impact of firm-job composition changes over time.

In addition to the explanatory variables in the baseline specification (Eq.5), in robustness regressions we add a term $X_{ij} \ln \frac{RGDP_{t+1}}{RGDP_t}$ to interact real GDP growth with establishment and job-specific dummy variables (X_{ij}) and test if cyclical variation in real labor costs varies across different establishment and job characteristics, as shown in Equation 6. These characteristics include a job's occupation category, type (full-time or part-time), and union membership, and an establishment's industry, location, ownership, and size.

$$\ln \frac{C_{ijt+1}}{C_{ijt}} = b_0 + b_1 t + b_2 \ln \frac{RGDP_{t+1}}{RGDP_t} + b_3 X_{ij} \ln \frac{RGDP_{t+1}}{RGDP_t} + \mu_{ijt+1} - \mu_{ijt} \tag{6}$$

We use the same empirical framework for analyzing cyclical variation in wages and benefit expenditures.

4 Empirical Results

We begin by presenting a set of baseline results characterizing the cyclical behavior of straight-time wages, nonwage benefit expenditures, and overall labor costs. We then conduct a number of experiments to evaluate the robustness of our results and also use disaggregated data to delve deeper into potential drivers of our key results. Our primary objective is to provide a detailed empirical characterization of cyclical variation in total labor costs and their major components rather than to test any particular theory.

4.1 Baseline Results

Table 2 shows the full-sample results for regressions of growth in straight-time wages, benefit expenditures, and total compensation on real GDP growth and other controls. The top panel shows results based on hourly measures of labor costs while the lower panel shows results for annual per-worker measures. All of the labor cost measures are deflated by the seasonally adjusted CPI for all urban consumers.

Table 2: Baseline Results for Straight-time Wages, Benefits, and Compensation: Hourly and Annual Measures

Explanatory Variables	**(1) H. Wage**		**(2) H. Benefits**		**(3) H. Compensation**	
Log diff RGDP	−0.4950	* * *	−0.3190	* * *	−0.4340	* * *
	(0.0253)		(0.0862)		(0.0425)	
Observations	628942		628893		628942	
R-squared	0.0084		0.0012		0.0062	
Explanatory Variables	**(4) A. Wage**		**(5) A. Benefits**		**(6) A. Compensation**	
Log diff RGDP	−0.5080	* * *	−0.3290	* * *	−0.4460	* * *
	(0.0223)		(0.0858)		(0.0394)	
Observations	571629		571610		571629	
R-squared	0.0075		0.0014		0.0057	

Notes: Dependent variable is log-differenced real hourly or annual cost of labor (deflated by CPI). The top panel is based on hourly measures; the lower panel is for annual measures. All regressions include establish -ment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

The first column of the upper panel shows that hourly real wages are strongly countercyclical. The coefficient estimate indicates that a one percentage point increase in real GDP growth reduces real hourly wage growth by 0.50 percentage points.[18] This result is, at first glance, at odds with the conventional wisdom about real wages being procyclical, but is consistent with recent findings that U.S. labor productivity is no longer procyclical (McGrattan and Prescott, 2012; Gali and van Rens, 2015) and that wage markups have become countercyclical (Nekarda and Ramey, 2013).

[18]The regression specification implies a symmetric and opposite effect when real GDP growth declines, a proposition we will test formally in the next section.

In the next two columns, we show estimates of similar regressions for nonwage benefit expenditures and overall real compensation (i.e., total labor costs), respectively. Compensation (column 3) is also strongly countercyclical, with a coefficient estimate close to the one for wages. A one percentage point increase in real GDP growth reduces growth in real hourly total labor costs by 0.43 percentage points. This suggests that nonwage benefits do not vary systematically in a way that counteracts the countercyclical variation in wages. Indeed, when we run a similar regression for average nonwage benefit expenditures, the coefficient on real GDP growth is again negative (column 2), indicating that benefit expenditures are also countercyclical. The coefficient estimate indicates that a one percentage point increase in GDP growth reduces growth in benefit expenditures by 0.32 percentage points.

The lower panel of Table 2 presents a similar set of results using annual per-worker wages, benefit expenditures, and compensation data. It is possible that employers adjust labor input at the intensive margin and thereby influence the cyclicality of their labor input costs. Weekly hours or weeks worked in a year for existing employees might be easier to adjust in response to cyclical variation in demand than employment levels or hourly wages. In fact, the results using annual measures are similar to those in the top panel, confirming countercyclical variation in wages, nonwage benefit expenditures, and compensation, independent of the frequency of the data. Moreover, in all of the results above, we find both benefit expenditures and overall labor costs to be slightly less countercyclical than wages.

Table 3: Testing for Symmetry in Cyclical Variation

Explanatory Variables	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	−0.5240	***	−0.2700	**	−0.4370	***
	(0.0296)		(0.0971)		(0.0507)	
Log diff RGDP x Dummy for expansion	0.0919	***	−0.1580	*	0.0097	
	(0.0238)		(0.0620)		(0.0306)	
Observations	628942		628893		628942	
R-squared	0.0086		0.0014		0.0062	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

One interesting question is whether our results about countercyclical wages are driven more by wage dynamics during business cycle expansions versus contractions. To explore this question, we conduct a simple experiment, dividing our sample into periods in which GDP is above or below trend, using a measure of trend output constructed using the Hodrick-Prescott filter (Table 3). Periods of business cycle expansion have slightly more procyclical wages and more countercyclical benefit expenditures. In other words, relative to recessionary periods, wage growth increases (or, more accurately, falls less) and benefit growth falls more during expansionary periods. However, these effects tend to cancel out, leaving no statistically significant asymmetry in the cyclical behavior of overall labor costs.

Table 4: Cyclical Variation in Wage and Earning Shares in Labor Costs

Explanatory Variables	**Wage Share (%)**		**Earnings Share (%)**	
Log diff RGDP	−3.7770	**	−2.2350	*
	(1.3640)		(1.0850)	
Observations	628910		628910	
R-squared	0.0009		0.0006	

Dependent variable in first column is first difference of share of hourly wage in total hourly labor costs (in percent). Dependent variable in second column is first difference of share of hourly earnings in total hourly labor costs (in percent). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

To view the results on the relative cyclicality of wages and nonwage benefit expenditures from a different perspective, we also examine how the share of wages in total labor costs changes over the business cycle (Table 4). We find that the wage share is strongly countercyclical. A one percentage point increase in GDP growth reduces the share of wages in total compensation by 3.8 percentage points. This is the opposite of what happens with the share of benefit expenditures in total labor costs (which is one minus the wage share). This is another way of stating our earlier result that nonwage benefit expenditures are less countercyclical than wages. We also looked at the cyclical variation in these shares using data on earnings. The share of earnings in total compensation is less countercyclical than the share of wages. This difference is largely attributable to the strongly procyclical variation in bonuses, which we will show later.

4.2 Robustness

We now evaluate the robustness of our results in a variety of dimensions. The bottom line of these experiments is that our baseline results are confirmed.

In Section 3, we derived an econometric specification that included GDP growth on the right-hand side. We first replace GDP growth with an alternative measure intended to isolate output fluctuations at business cycle frequencies—the cyclical component of real GDP derived using the Hodrick-Prescott (HP) filter. Table 5 shows that the baseline results hold up when we use this measure of the business cycle. The results are similar to those in Table 2, although the coefficients on HP-filtered GDP are larger in absolute magnitude for benefit expenditures and total compensation relative to the corresponding coefficients in Table 2.

Table 5: Robustness Tests: HP-filtered GDP

Explanatory Variables	(1) Wage		(2) Benefits		(3) Compensation	
HP-filtered RGDP	−0.4660	* * *	−0.5820	* * *	−0.5040	* * *
	(0.0192)		(0.0830)		(0.0291)	
Observations	628942		628893		628942	
R-squared	0.00432		0.00207		0.00441	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

We have so far used aggregate GDP as an indicator of the business cycle. In Table 6, we report regression results using aggregate employment growth and changes in the unemployment rate instead. The coefficient estimates in the top panel indicate that a one percentage point increase in aggregate employment growth is associated with a 0.38 percentage point decline in wage growth and a comparable decline in benefit as well as compensation growth. In the lower panel of this table, we use changes in the unemployment rate as the cyclical indicator. A one percentage point increase in the unemployment rate is associated with about a 0.8 percentage point increase in wage and compensation growth. Thus, our baseline results about countercyclical variation in wages and compensation are preserved when we use labor market measures of the aggregate business cycle.

Table 6: Robustness Tests: Alternative Business Cycle Indicators

Explanatory Variables	(1) Wage		(2) Benefits		(3) Compensation	
Log diff agg. Employment	−0.3840	* * *	−0.3520	* * *	−0.3730	* * *
	(0.0120)		(0.0425)		(0.0131)	
Observations	628942		628893		628942	
R-squared	0.0088		0.0026		0.0078	
Explanatory Variables	**(4) Wage**		**(5) Benefits**		**(6) Compensation**	
Diff unemployment rate	0.0084	* * *	0.0061	* * *	0.0077	* * *
	(0.0002)		(0.0009)		(0.0003)	
Observations	628942		628893		628942	
R-squared	0.0099		0.0018		0.0079	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

The coefficient on the change in the aggregate unemployment rate is most directly comparable to the results in many previous papers, highlighting the sharp differences between our results and those in the prior literature. Bils (1985) reports a coefficient of about -1.6 of wage growth for young men on the change in the aggregate unemployment rate over the period 1966-1980, which indicates procyclical wage variation and an effect that in absolute magnitude is about twice what we find. Using a specification similar to that of Bils (1985) but estimated using PSID data for the period 1968-1988, Solon, Barsky, and Parker (1994) report coefficients of about -1.4 for men and -0.5 for women. Both papers use the GNP deflator to convert nominal wages to real wages.

Table 7: Robustness Tests: Alternative Deflators

PPI	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	−2.7530	***	−2.5770	***	−2.6920	***
	(0.1350)		(0.1280)		(0.1320)	
Observations	628942		628893		628942	
R-squared	0.1680		0.0706		0.1630	
PPI	**(4) Manuf Wage**		**(5) Manuf Benefits**		**(6) Manuf Compensation**	
Log diff RGDP	−1.5360	***	−1.1410	***	−1.3730	***
	(0.2130)		(0.3130)		(0.2610)	
Observations	92400		92391		92400	
R-squared	0.1100		0.0231		0.0802	
GNP	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	−0.2470	***	−0.0716		−0.1870	***
	(0.0300)		(0.0933)		(0.0479)	
Observations	628981		628932		628981	
R-squared	0.00394		0.000159		0.00229	
Regional CPI	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	−0.4840	***	−0.3080	***	−0.4230	***
	(0.0268)		(0.0893)		(0.0443)	
Observations	628942		628893		628942	
R-squared	0.0077		0.0011		0.0057	
Medical-care CPI			**(1) Hourly Health Insur.**		**(2) Annual Health Insur.**	
Log diff RGDP			−0.2850	***	−0.2720	***
			(0.0697)		(0.0714)	
Observations			528687		477335	
R-squared			0.0002		0.0002	

Notes: Dependent variable is log-differenced real hourly (unless otherwise specified) cost of labor (deflated by PPI, GNP deflator, regional CPI, and medical-care CPI, respectively). All regressions include establish -ment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

For the next set of experiments, we choose alternative price deflators in place of the aggregate CPI to deflate the wage and compensation data. First, we use the PPI, which may be more relevant for considering the real cost of labor from the firm's perspective. The results in the top panel of Table 7 show that wages and compensation deflated by the PPI are even more strongly countercyclical than the results obtained using the CPI. This echoes the findings of Abraham and Haltiwanger (1995) that using the PPI rather than the CPI to deflate real wages tends to make wage variation look less procyclical. This result is also consistent with Swanson's (2004) finding that a majority of sectors pay real product wages that vary countercyclically with the business cycle state of their industry. In the second panel of Table 7, we constrain the sample to industries in the manufacturing sector and use the PPI for manufactured goods. Wages and compensation are clearly countercyclical in the manufacturing sector as well.

Second, we also experimented with using the GNP deflator in place of the CPI. As noted earlier, this is the deflator used in papers such as Bils (1985) and Solon, Barsky, and Parker (1994). The results using the GNP deflator, shown in the third panel of Table 7, are similar to those using the CPI, which is our baseline deflator and is also the one used by Keane et al. (1988). One difference in the results using this deflator is that nonwage benefits appear acyclical rather than countercyclical.

Third, we attempt to account for the fact that inflation may vary across regions, affecting real wage dynamics in ways different from that when we use aggregate CPI. In order to capture regional variations in price developments, we divide the U.S. into four regions: Northeast, Midwest, West, and South, and then deflate observations on wages, benefit expenditures, and compensation using region-specific CPI indexes. The results in the fourth panel of Table 7 show that real labor costs remain countercyclical.

Our last robustness experiment related to price deflators concerns health insurance benefit expenditures, which constitute one of the largest components of firms' overall benefit expenditures. In recent years, health care costs have followed a different trajectory than the overall CPI. We therefore deflate the health insurance costs paid by establishments using the CPI for medical care. The results, reported in the bottom panel of Table 7, show that, consistent with the results reported earlier for overall benefit expenditures, both hourly and annual per-worker health insurance benefit expenditures are countercyclical.

Lastly, we used observations only from the private sector to remove nonmarket factors that could be influencing our results (see Appendix Table A.1). Wages, benefit expenditures, and compensation were all still countercyclical in this sample, but one significant change relative to the results for the aggregate economy reported in Table 2 is that nonwage benefit expenditures were much less countercyclical. This suggests that benefit expenditures are more countercyclical in the public sector than in the private sector. We study sector-specific cyclicality in more detail later in the paper.

4.3 Composition Effects

One possible interpretation of these countercyclicality results is that they mainly reflect composition effects. Changes in the composition of the employed workforce might vary systematically over the business cycle and cyclical variation of wages and benefits could differ across workers distinguished, for instance, by skill levels. Prior evidence on the size and direction of this composition bias is mixed. For instance, Bils (1985) finds that aggregate data on average real wages have a countercyclical bias. This is induced by the countercyclical average skill level of the employed workforce—employers tend to lay off more unskilled/lower paid workers during recessions.

By contrast, Keane et al. (1988) find evidence of a procyclical bias in aggregate data—their procedure that corrects for sample selection bias yields a measure of real wages that is less procyclical than the average real wage. In their survey, Abraham and Haltiwanger (1995) argue that composition effects by themselves do not have a major influence on measurements of wage cyclicality and, in any case, do not consistently induce a bias in one direction or another in results based on economy-wide averages. Nevertheless, it is an open question whether such composition effects have become more or less important over time. For instance, Daly and Hobijn (2017) find cyclical variation in both the observed and unobserved characteristics of workers exiting and entering full-time employment. Their study, which uses CPS data on hourly and weekly earnings of wage and salary workers, argues that composition effects induce a countercyclical bias in observed wage data.

Our use of growth rates rather than levels of labor costs, in addition to the use of establishment-jobs rather than workers as the units of analysis, partially alleviates potential composition bias associated with worker characteristics. In particular, the compensation data associated with a given establishment-job is the average for all workers in that job in the same establishment; thus, individual worker characteristics are averaged out. However, it is still possible that average worker characteristics within an establishment-job unit fluctuate in a systematic way over business cycle. For instance, the least productive workers at a job may be laid off during recessions, leaving the most productive workers at the job. This can induce a countercyclical composition bias in our empirical results, but only if the hourly compensation paid for doing that same job also varies systematically over the cycle as a result of changes in worker characteristics. Since the job categories in our data are very detailed and differentiated by tasks performed and skills required, it is unlikely that average worker characteristics within a given establishment-job unit fluctuate systematically over the cycle, let alone the associated compensation.

In addition, using growth rates of wages and compensation, rather than levels, helps reduce the impact of firm-job composition changes over business cycles since these growth rates differ less than levels across firms and jobs. Previous studies of real wage cyclicality have also mainly used growth rates, an approach endorsed in the survey by Abraham and Haltiwanger (1995). But this still leaves open the possibility that differences in compensation growth variation over the cycle for different firms and jobs could affect the economy-wide results as the composition of firms and jobs changes over the cycle. Hence, we now attempt to formally evaluate the magnitude of potential composition effects on our results. Given the nature of our dataset, we cannot directly control for cyclical variation in the characteristics of employed workers, but our dataset allows for other approaches that have some advantages.

Table 8: Composition Effects: Weighted Regressions

Explanatory Variables	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	−0.3890	$***$	−0.2830	$***$	−0.3620	$***$
	(0.0250)		(0.0691)		(0.0314)	
Observations	628942		628893		628942	
R-squared	0.0049		0.0008		0.0038	

Notes: The results in this table represent weighted regressions, based on sample weights that represent the inverse of the probability of an establishment-job unit getting selected into the sample. Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establish -ment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

In Table 8, we report results from weighted regressions using sampling weights. Sampling weights are the product of the inverse of the sample selection probabilities at each stage of sampling, taking into account changes in the employment distribution. These weights can help us account for the fact that, in a recession, when the share of certain firms and jobs (e.g., low skill jobs) declines, their labor costs would receive less weight in the regression. In the absence of an adjustment using sampling weights, such composition effects could drive the apparent cyclical variation of labor costs over the business cycle even if the actual structure of labor costs were to remain stable. Wages and compensation remain countercyclical in the weighted regressions, although the coefficient estimates are smaller (in absolute magnitudes) than in the baseline results in Table 2. Thus, our headline results do not seem to be affected by composition effects related to differential cyclical variation of employment probabilities associated with various firms and job categories.

Table 9: Composition Effects: Occupation-Industry Regressions

Explanatory Variables	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	0.1200		0.1840		0.1270	
	(0.0753)		(0.1440)		(0.0860)	
Post07 x Log diff RGDP	−1.0130	$***$	−0.8670	$*$	−0.9430	$***$
	(0.1880)		(0.3530)		(0.2220)	
Observations	18380		18380		18380	
R-squared	0.0021		0.0013		0.0019	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI) at the occupation-industry level. All regressions include occupation-industry fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

An alternative approach to dealing with composition effects is to aggregate real hourly labor costs at the occupation-industry level for each year and then estimate regressions with the aggregated panel data. The composition of occupation-industry level variables varies less over the business cycle than that of establishment-job units. We use eight occupation categories (the ones shown in Figure A.2); industries are broken down to the three-digit NAICS level. The aggregation for each occupation-industry unit is based on establishment-job sample weights, such that the relevant composition effects within a unit are removed. In addition, we introduce a post-2007 dummy and its interaction with real GDP growth to distinguish the sample before the financial crisis and after. We report the results from this exercise in Table 9. The post-2007 period reveals strong countercyclicality in labor costs while the pre-2008 period does not. This result is consistent with our main results on countercyclicality, but also hints at the intensification of this pattern after the financial crisis, an issue we explore in more detail in the next section.

4.4 Why Do Our Results Differ from Those of Prior Studies?

Our results of countercyclical wages and compensation are in contrast to those of prior studies, which have generally reported procyclical wages (and are based on household/individual surveys). In this section, we discuss two reasons for this discrepancy in findings.

4.4.1 Measurement Issues

Many previous studies use earnings rather than straight-time wages. For instance, the earnings variable in the PSID includes bonus income, which tends to be procyclical. As Shin and Solon (2007) note, job stayers' real average hourly earnings are highly procyclical and an important portion of that procyclicality can be ascribed to labor costs beyond base wages.

In Table 10, we show earnings regressions to approximate the measure used in some previous studies. As in Table 9, the regressions include a post-2007 dummy and its interaction with the business cycle indicator, and use data at the BLS occupation-industry level in order to minimize composition effects. Before 2008, earnings (the sum of hourly wages, bonus, and overtime pay) are procyclical, as many previous papers have found. The procyclicality of earnings may have been driven by the strong procyclicality of bonus payments, which is consistent with the findings of previous studies, such as Devereux (2001). However, since 2008, real bonus payments have become countercyclical, and so has the broad measure of earnings as shown by the coefficients on the interaction terms. When we estimated the regressions with the sample restricted to the post-2007 period, we confirm that earnings are countercyclical. We discuss this change in the pattern of cyclicality in Section 5. The key insight from Table 10 is that when we use earnings, instead of straight-time wages, as the measure of labor costs, our pre-2008 result is consistent with those of many previous papers that also use earnings data but from different sources.

Table 10: Cyclical Variation in Bonuses and Earnings

Explanatory Variables	**(1) Earnings**		**(2) Bonus**	
Log diff RGDP	0.1620	$*$	2.9440	$***$
	(0.0760)		(0.7960)	
Year	0.0005	$*$	-0.0014	
	(0.0002)		(0.0011)	
Post07 x Log diff RGDP	-1.0000	$***$	-4.3770	$**$
	(0.1980)		(1.1783)	
Post07 x Year	0.0053	$*$	0.0272	$*$
	(0.0021)		(0.0124)	
Post07	-10.7200	$*$	-54.6000	$*$
	(4.1940)		(24.9900)	
Constant	-0.9220	$*$	2.8060	
	(0.3530)		(2.1650)	
Observations	18380		15157	
R-squared	0.0019		0.0025	

Notes: Dependent variable is log-differenced real hourly bonuses or earnings (deflated by CPI) at the occupation-industry level. All regressions include occupation-industry fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

4.4.2 Job Switchers

It is worth emphasizing that our paper studies compensation cyclicality from the perspective of firms' costs by using establishment-job level data, while the rest of the literature typically studies wage cyclicality using worker level data. Unlike previous authors, we are able to analyze variations in firms' wage structures, stripping away the effects of job-switching, worker's moves across job ladders, and other aspects of worker mobility into and out of the labor force and across jobs. Such factors, which are determined by both observed and unobserved attributes of workers, complicate the measurement of wage cyclicality using workers' observed wages. Our establishment-job data allow us to directly characterize cyclical variation in the underlying wage distribution that workers face (conditional on their observed and unobserved attributes).

Indeed, Daly and Hobijn (2016) conclude that most of the procyclicality that they document for continuously employed fulltime workers' earnings comes from job switchers. Haltiwanger et al. (2017) show that both mobility across jobs and the wage increases associated with voluntary job-switching tend to fall during recessions. During business cycle expansions, workers climb faster up job ladders, gaining increases in wages and compensation. During downturns, workers tend to stay in their jobs rather than move. This means that using data on earnings of individual workers, which is the norm in previous studies, could induce a procyclical bias in estimates of the cyclicality of actual labor costs paid by firms. Our reliance on establishment-job data obviates such sources of bias.

These explanations help reconcile our results with those of previous papers but leave open the question of why labor costs—whether measured as straight-time wages, earnings, or compensation—have become more countercyclical. We explore this topic in Section 5.

4.5 Extensions

Up to this point, we have established the robustness of our baseline results, shown that they are not driven by composition effects, and reconciled our results with those found in the previous literature. We now extend our baseline results in a variety of dimensions, exploiting the disaggregated data from the BLS employer cost surveys as well as the detailed data that we have on firms' benefit expenditures. We included fixed effects for different establishment-job characteristics (dummies for establishment size, part-time or full-time jobs, occupation, industry, region, metropolitan area or not, union jobs or not, and ownership) and their interactions with real GDP growth. We now highlight some of the main results; to conserve space, we only report statistically significant results in Table 11.

Large and medium-sized establishments have less countercyclical wages, benefit expenditures, and compensation than small establishments.[19] One interpretation of this result is that job-specific human capital is more important for smaller firms, which may also find it costlier to adjust employment over the cycle. Hence, smaller firms (and their employees) accept countercyclical growth in wages in order to maintain stable employment. An alternative interpretation is that larger firms may have more stable employment over the business cycle. These firms may adjust labor costs through more procyclical (or less countercyclical) wages and compensation. Our dataset does not allow us to distinguish between these explanations, so we leave this for future research.[20]

When we compare part-time and full-time jobs, hourly wages appear more countercyclical for part-time jobs while benefit expenditures are less countercyclical for such jobs. This pattern may be accounted for by cyclical shifts in firms' use of part-time and full-time jobs. It may be easier for firms, even small ones, to vary part-time employment over the business

[19] Large establishments are defined as those with at least 749 workers. Medium-sized establishments have at least 117 and at most 748 workers. We set these size thresholds such that there is roughly an equal proportion of small, medium , and large establishments in the sample.

[20] For instance, Gertler and Gilchrist (1994) and Crouzet and Mehrotra (2017) find strong evidence that smaller firms are more sensitive to macroeconomic conditions than large firms. Fort et al. (2013) distinguish between firm size and firm age effects—young/small firms tend to be more cyclically sensitive than older/larger businesses but, among older firms, the cyclical sensitivity of small firms is not systematically different from that of large firms. These authors also document that, during the Great Recession, young/small businesses were hit especially hard. Other authors, by contrast, have found that larger firms suffered greater percentage declines in sales compared to smaller firms (Kudlyak and Sanchez, 2016).

Table 11: Results with Interactions

Explanatory Variables	(1) Wage		(2) Benefits		(3) Compensation	
Log diff RGDP	−0.4590	**	−0.6620	***	−0.5600	***
	(0.1380)		(0.1830)		(0.1140)	
Log diff RGDP x big size	0.0931	*	0.2000	*	0.1510	***
	(0.0372)		(0.0787)		(0.0431)	
Log diff RGDP x mid size	0.0541	*	0.1550	*	0.1060	***
	(0.0230)		(0.0763)		(0.0289)	
Log diff RGDP x part time	−0.0702	*	0.1760	*	−0.0299	
	(0.0317)		(0.0861)		(0.0309)	
Log diff RGDP x prof & tech	−0.3710	***	−0.1530		−0.3070	**
	(0.1070)		(0.1150)		(0.0971)	
Log diff RGDP x exe & mng	−0.3580	**	−0.1130		−0.2820	**
	(0.1140)		(0.1180)		(0.1030)	
Log diff RGDP x clerical	−0.2970	**	−0.1860		−0.2660	**
	(0.1080)		(0.1040)		(0.0985)	
Log diff RGDP x prod & craft	−0.3520	***	−0.0942		−0.2650	**
	(0.1030)		(0.1600)		(0.1010)	
Log diff RGDP x mach oper	−0.4600	***	−0.3520	**	−0.4320	***
	(0.0998)		(0.1190)		(0.0905)	
Log diff RGDP x transp & help	−0.2230	*	−0.1430		−0.1940	*
	(0.0986)		(0.1320)		(0.0895)	
Log diff RGDP x service	−0.3030	**	−0.1440		−0.2560	*
	(0.1080)		(0.1030)		(0.0977)	
Log diff RGDP x fishing	0.8880	***	10.9700	***	4.3020	***
	(0.0662)		(0.1530)		(0.0691)	
Log diff RGDP x mining	0.2370	***	0.1610		0.2360	***
	(0.0596)		(0.1380)		(0.0583)	
Log diff RGDP x manuf	0.4240	***	0.4510	**	0.4640	***
	(0.0826)		(0.1420)		(0.0902)	
Log diff RGDP x trade & transp	0.1470	*	0.3030		0.2020	**
	(0.0654)		(0.2030)		(0.0739)	
Log diff RGDP x info & fina	0.1480	*	0.1130		0.1590	*
	(0.0604)		(0.1570)		(0.0743)	
Log diff RGDP x edu & health	0.1290	*	−0.1030		0.0710	
	(0.0620)		(0.1250)		(0.0607)	
Log diff RGDP x northeast	0.0876	**	0.0198		0.0649	
	(0.0315)		(0.0783)		(0.0406)	
Log diff RGDP x union	−0.0877	**	0.0068		−0.0329	
	(0.0317)		(0.0785)		(0.0378)	
Log diff RGDP x state govt	0.0871	**	0.2450	*	0.1450	**
	(0.0305)		(0.0978)		(0.0480)	
Log diff RGDP x private	0.0536		0.2850	***	0.1360	**
	(0.0684)		(0.0713)		(0.0495)	
part time	−0.0058		−0.0567	***	−0.0127	
	(0.0082)		(0.0155)		(0.0090)	
exe &mng	−0.0073		0.0393	*	0.0066	
	(0.0155)		(0.0182)		(0.0137)	
non-metro	0.0065	***	0.0052		0.0063	***
	(0.0011)		(0.0027)		(0.0013)	
non-union	−0.0020		−0.0255	***	−0.0105	**
	(0.0035)		(0.0062)		(0.0039)	
state govt	0.0052		0.0965	**	0.0392	*
	(0.0053)		(0.0341)		(0.0155)	
local govt	0.0010		0.0204	*	0.0047	
	(0.0068)		(0.0088)		(0.0051)	
Observations	613881		613832		613881	
R-squared	0.0098		0.0026		0.0079	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively. In order to conserve space, statistically insignificant coefficients are not reported in this table.

cycle in response to demand conditions. By contrast, adjusting full-time employment may be costlier, leading to more of the labor cost adjustment taking place through wages in the case of such jobs. Hence, demand for part-time workers rises relative to that for full-time workers in downturns, causing part-time wages to be more countercyclical. Meanwhile, as indicated by the coefficient on the dummy variable for part-time jobs, these jobs tend to have a lower level of benefit expenditure growth, which may in turn result in benefits associated with part-time jobs being more procyclical than those associated with full-time jobs.

The cyclicality results vary across major job categories in a manner that is generally intuitive. Wages and compensation for skilled workers and occupations where job-specific human capital is important—such as executives and managers, professional and technical workers, and machine operators—on average tend to be the most countercyclical. This runs counter to the view that such workers, who typically have higher pay levels than the average worker and, presumably, better access to financial markets that allow them to smooth out labor income fluctuations, would be more willing to accept procyclical wages in return for employment stability. Instead, our findings suggest that highly-skilled workers have more countercyclical wages than less-skilled ones. These results are consistent with Swanson's (2007) finding that the wages of lower-income and less-educated workers exhibit greater procyclicality.

Across sectors, we find wages, benefit expenditures, and compensation to be strongly procyclical in the fishing and forestry sector, while they are countercyclical to varying degrees in the nonagricultural sectors. Among those, wages and compensation are least countercyclical in manufacturing, followed by mining, trade and transportation, information and finance (these statements are based on the sum of the coefficient on Log diff RGDP and its interaction with the relevant industry dummies; statistically insignificant coefficients are not reported in Table 11).

In addition, there are no major systematic differences in the results across different regions of the country or between metropolitan and non-metropolitan areas once we control for industries. Union jobs tend to have more countercyclical wages (and, incidentally, also higher benefit growth rates) compared to non-union jobs. Jobs in both the state government and in the private sector have less countercyclical compensation than jobs in local government, which is consistent with the results for the private sector sample reported in Table A.1. We also ran the regressions with the above establishment-job characteristics interaction terms using just data for the pre-2008 period and the post-2007 period, respectively.[21] The results

[21] In order to facilitate interpretation of the results, we estimated the regression separately over these two non-overlapping periods. To maintain consistency with other tables where we look at changes in correlations after the financial crisis, we also estimated a version of the regressions in Table 11 with a post-2007 dummy and its interactions with relevant establishment-job characteristics. The post-crisis results based on these

are reported in Table A.2 and Table A.3 in the Appendix. Those results show greater evidence of countercyclicality on average in the post-2007 period. We will investigate the differences in results over time in more detail in Section 5.2.

Lastly, we run the baseline regressions for different categories of benefit expenditures (Table A.4 in the Appendix). Over the entire sample period, both quasi-fixed and non-quasi-fixed benefit expenditures are countercyclical. When benefit expenditures are grouped as being required (mandated by law) or discretionary, there is no statistically significant pattern of cyclicality for either of the two groups.

5 Why Have Compensation and Wages Become Countercyclical?

As emphasized earlier, our primary objective in this paper is to provide a detailed empirical characterization of cyclical variation in labor costs rather than to formulate or test any particular theory. Nevertheless, it is worth considering why our results—in stark contrast to previous well-established results on procyclical wage variation during the 1960s-1980s—show that, over the period 1982-2014, both wages and compensation have become countercyclical. To address this, we first show that, even though economy-wide averages for wages and compensation are no doubt subject to composition bias, our results hold up in the aggregate data. Thus, our main results are not simply an artifact of the dataset used in this paper. We then propose an explanation that relies on two sets of empirical findings—increasing nominal rigidities of labor costs and the rising relative importance of aggregate demand shocks.

5.1 Evidence from Aggregate Data

In their survey paper, Abraham and Haltiwanger (1995) attempt to reconcile the differing results across a number of studies by noting that the choice of time period, as well as changes in the relative importance of different macroeconomic shocks over time, could influence the measured cyclical variation in wages. They note that, while the use of micro data is useful and measurement issues such as composition effects are quantitatively important, changes in wage cyclicality can be reasonably well captured even using aggregate macroeconomic data.

To re-examine if our results hold up using economy-wide aggregates, we use quarterly data (deflated using the CPI) on aggregate wages, nonwage benefit expenditures, and compensation for the period 1980Q1-2016Q4 from the BLS Employment Cost Index. We ran univariate regressions of the cyclical components of hourly wages on business cycle indicators. These regressions were run over rolling (overlapping) 60-quarter windows of quarterly data in order to characterize the temporal evolution of the correlation between real wages and the business cycle. Figure 1 shows the results using two indicators of the business cycle—

interactions were for the most part similar to the results discussed here. In particular, labor costs show a strong increase in countercyclicality in the post-2007 period relative to the pre-2008 period.

employment (first row) and real GDP (second row)—and three time series filters—log first differences (first column), the Hodrick-Prescott (HP) filter (second column), and the Baxter-King (BK) bandpass filter (third column). The lines in the charts are the point estimates of the correlations and the shaded areas cover two standard error bands.

Even in the early part of the sample—the first observation in these charts covers the period 1980Q1-1995Q4—it is hard to make a case for real wages being procyclical. There is at best weak evidence of procyclical wage variation in the period leading up to the mid-2000s and clear evidence of countercyclical wage variation since then. The break is especially sharp using first-differences since, in the last quarter of 2008 and the first quarter of 2009, employment and GDP fell sharply while real wages rose sharply because of the rapid decline in inflation as the Great Recession got underway. The phenomenon of countercyclical wage variation is clearer in columns 2 (HP filter) and 3 (BK filter) and appears earlier in the sample when aggregate employment is used as the measure of the business cycle (row 1) rather than GDP (row 2).

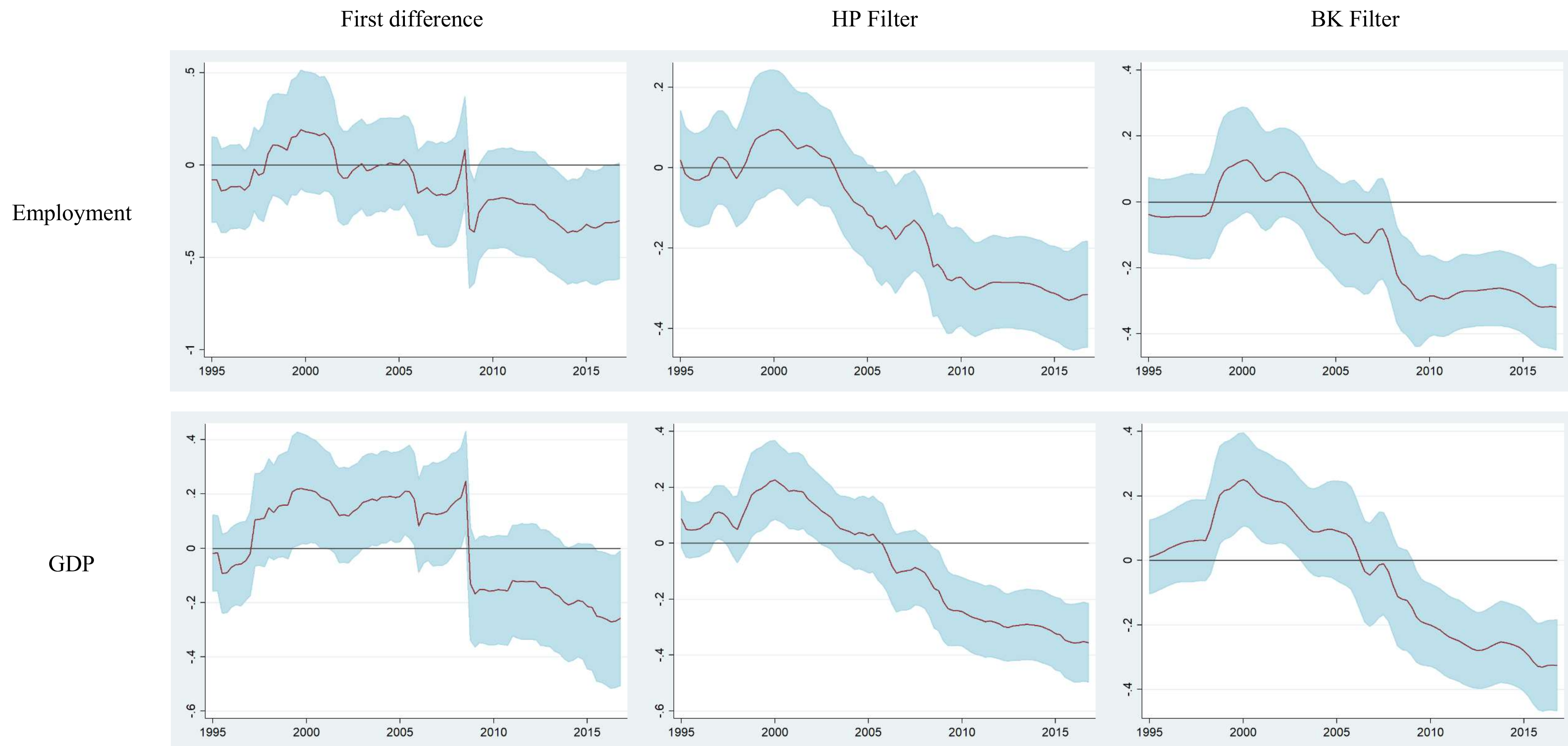
When we repeated this exercise using data on aggregate compensation, the results were similar to those for wages (see Appendix Figure A.4). We also examined the evolution of correlations between real nonwage benefit expenditures and the business cycle. This exercise (see Appendix Figure A.5) showed that benefit expenditures have been either acyclical or, when we use employment as the business cycle indicator, countercyclical over much of the sample, reinforcing the countercyclical behavior of real compensation. In short, our results are not just an artifact of the particular micro data set that we use.

To confirm this conclusion, we conducted a variety of robustness tests that we only briefly summarize here. Consistent with our evidence using the micro-level survey data, the patterns of countercyclicality were stronger and appear even earlier in the sample when we used the PPI rather than the CPI to deflate nominal labor costs. We also experimented with using the Personal Consumption Expenditures (PCE) deflator, the Federal Reserve's preferred gauge of inflation. The results were similar to those using the CPI.

When we used the unemployment rate rather than employment or GDP as the indicator of the business cycle, the evidence of countercyclical variation in labor costs was stronger even before the financial crisis, with a modest subsequent increase in countercyclicality after the financial crisis. Running 15-year rolling window regressions of wage or compensation growth on changes in the unemployment rate yielded coefficients that were generally positive but statistically insignificant through the early 2000s and then turned significantly positive (implying countercyclicality) by the mid-2000s.

We also checked if using alternative sources of aggregate data could influence our results. First, we used CPS data on the median usual weekly earnings of full-time wage and salary

Figure 1: Evolution of the Correlation between Aggregate Real Hourly Wages and the Business Cycle



Notes: This figure shows the evolution of the univariate regression coefficient of the cyclical component of average aggregate real hourly wages (deflated by CPI) regressed on business cycle indicators. The business cycle indicators are aggregate employment (first row) and real GDP (second row). The time series filters applied to the data (in logarithms) before running the regressions are: first differences (first column), the Hodrick-Prescott filter (column 2), and the Baxter-King band-pass filter (column 3). The regressions are estimated over rolling 15-year windows of quarterly data. The shaded areas indicate two standard error bands around the estimated coefficients. The variable definitions and their sources are as follows. **Compensation**: Employment Cost Index: Total Compensation for Private Industry Workers, source: BLS. **Benefits**: Employment Cost Index: Benefits for Private Industry Workers, source: BLS. **Wages**: Employment Cost Index: Wages and Salaries for Private Industry Workers, source: BLS. **CPI**: Consumer Price Index for All Urban Consumers: All Items, source: Federal Reserve Bank of St. Louis. **GDP**: Real Gross Domestic Product, Billions of Chained 2009 Dollars, source: Federal Reserve Bank of St. Louis. **Employment**: All Employees: Total Nonfarm Payrolls, Thousands of Persons, source: Federal Reserve Bank of St. Louis.

workers. Second, we used data on the average hourly earnings of production and nonsupervisory employees from the Current Employment Survey, the dataset used by Abraham and Haltiwanger (1995). We used data from 1980 to the middle of 2017 (2017Q2 for the CPS and 2017M7 for the CES) and a similar variety of detrending procedures and deflators as in the previous exercises. All of these results point to increasing countercyclicality of earnings, especially after the financial crisis.

5.2 The Financial Crisis

While our sample contains multiple business cycles, the dominant event that characterizes the sample is of course the global financial crisis, which set off the Great Recession in the United States. We now directly address the implications of the financial crisis for our results, reverting to the BLS employer cost survey data. In Table 9, we showed that real labor costs have become more countercyclical during the post-2007 sample period, using occupation-industry level data to minimize firm-job composition effects. In Table 12, we report regression results using establishment-job level data with a post-2007 dummy and its interaction with real GDP growth, again confirming the increasing countercyclicality.

Table 12: Results for Pre-Crisis and Post-Crisis Subsamples

Explanatory Variables	(1) Wage		(2) Benefits		(3) Compensation	
Log diff RGDP	−0.0213		0.0368		−0.0112	
	(0.0217)		(0.1320)		(0.0564)	
Post07 x Log diff RGDP	−0.6890	***	−0.5530	***	−0.6570	***
	(0.0225)		(0.0959)		(0.0433)	
Observations	628942		628893		628942	
R-squared	0.0120		0.0021		0.0095	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

The first column of Table 12 shows strong evidence of countercyclical wages in the post-crisis period. Before the crisis, wages are acyclical. Whether before or after the crisis, there is little evidence of the procyclical behavior that is apparent in prior studies conducted using data for the 1960s-1980s. The next two columns of Table 12 show the regressions for benefit expenditures and total compensation, both of which are also acyclical before the financial crisis and strongly countercyclical in the period during and after the Great Recession. We also looked into different benefit expenditures and find that almost all of them have become countercyclical over time. Only two components of compensation packages—other paid leave and state unemployment—have stayed or become more procyclical.

These post-2007 results are consistent with the case made by some authors that the recent crisis had the characteristics and macroeconomic effects of a typical aggregate demand shock (see, e.g., Benguria and Taylor, 2017). One way to investigate changes in the relative importance of demand shocks during the post-2007 period is to examine inflation dynamics, which we turn to in the next section.

5.3 Macro Evidence on Procyclical Inflation

A potential explanation for our results is that the nature of aggregate shocks has changed over time, especially during the financial crisis, in turn influencing inflation dynamics.[22] Together with nominal rigidities in wage and compensation setting, this change could then result in shifts in the cyclicality of real labor costs. To explore this possibility, we look directly at the evolution of the cyclical behavior of inflation. In Figure 2, we plot the univariate regression coefficients of CPI (thin blue line), PPI (thick red line), and PCE (thin dashed line) inflation regressed on the cyclical components of the unemployment rate (upper row) and real GDP (lower row).[23] We run these regressions using rolling (overlapping) 60-quarter windows and the cyclical components of the unemployment rate and real GDP derived from three different time series filters (first differences, the HP filter, and the BK filter).

During the early part of the sample, and even during the 1990s when we use real GDP growth as the indicator of the cycle (lower row), there is some evidence of inflation being countercyclical. This starts to shift by the time our sample rolls over to the mid-1980s to 2000s and then turns into procyclical inflation behavior after the financial crisis. This is true for all three measures of inflation (CPI, PPI, and PCE). PPI inflation is in general more procyclical than inflation based on the other two aggregate price indexes, and the spike in PPI inflation in the aftermath of the financial crisis is greater as well. The pattern remains when we use the change in the unemployment rate as the indicator of the business cycle (upper row). When we use HP-filtered or BK-filtered real GDP or unemployment rate as the business cycle indicator, inflation appears procyclical during the entire sample period and again experiences a sharp increase in procyclicality after the financial crisis.[24]

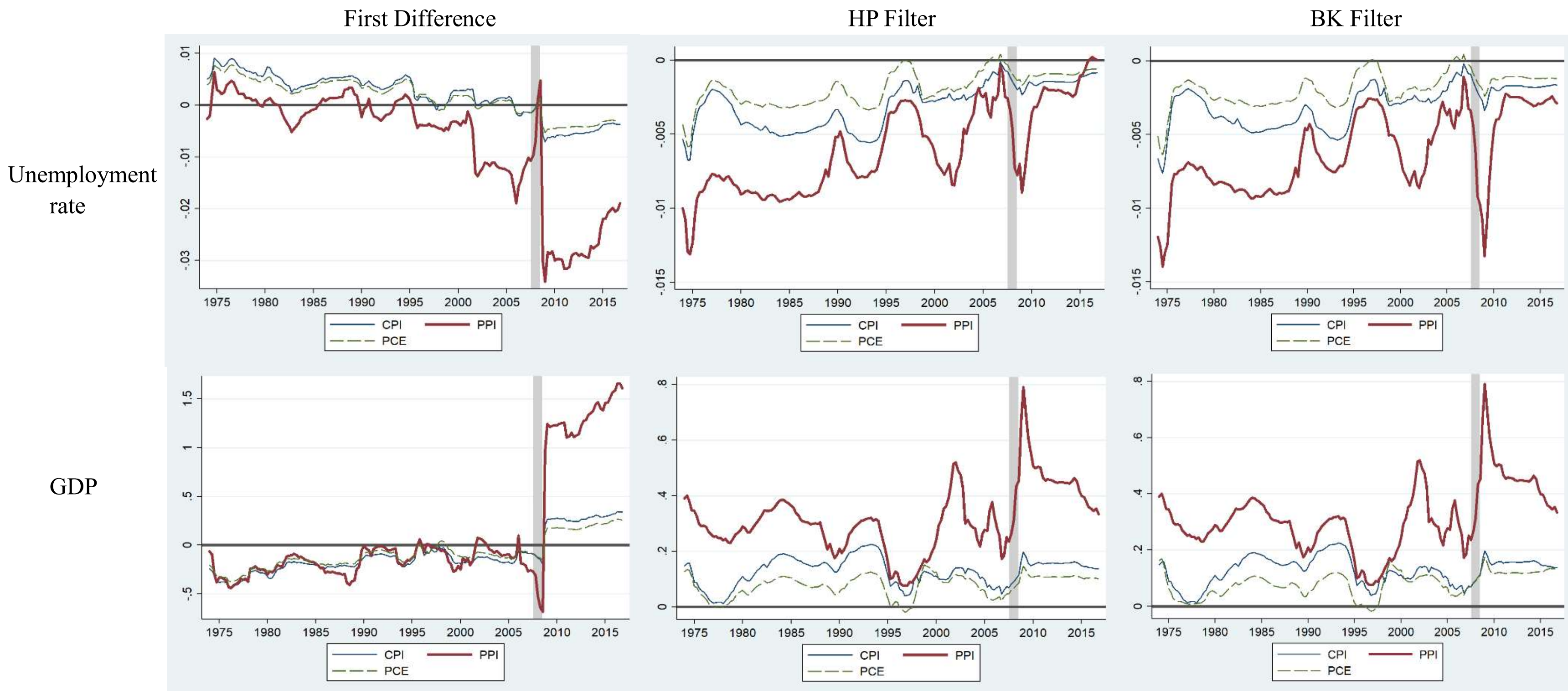
This shift in the cyclicality of aggregate inflation after the financial crisis can be inter-

[22] Cooley and Ohanian (1991) and Smith (1992) document countercyclical variation in prices in the United States during the postwar period and use this to bolster the case for the predominance of technology (supply) shocks in driving postwar U.S. business cycles. Chadha and Prasad (1993, 1994) make the case for looking at the cyclical behavior of inflation rather than just price levels in determining the relative importance of demand and supply shocks. In fact, the results about the increasing procyclicality of inflation were even stronger when we examined the procyclicality of the aggregate price *level* based on the CPI, PPI, and PCE.

[23] Since inflation is stationary, we use inflation levels in the regressions.

[24] Expected inflation increased during the Great Recession (Coibion and Gorodnichenko, 2015), which could in principle affect the correlation between actual inflation and cyclical unemployment rate according to the augmented Phillips curve. This might contribute to the decline in inflation procyclicality at the end of the sample when we use the HP- or BK-filtered unemployment rate.

Figure 2: Cyclical Variation in Inflation



Notes: This figure shows the evolution of the univariate regression coefficient of inflation, as measured by the log difference of CPI (thin blue line), PPI (thick red line), or PCE (thin dashed line), regressed on alternative business cycle indicators. The business cycle indicators are cyclical components of the unemployment-rate (first row) and real GDP (second row) based on these time series filters: first differences (first column), the Hodrick-Prescott filter (column 2), and the Baxter-King band-pass filter (column 3). The regressions are estimated over rolling 15-year windows of quarterly data. The shaded area indicates the financial crisis.

preted as an increase in the relative importance of aggregate demand shocks compared to aggregate supply shocks. The relative importance of aggregate supply shocks was greater during the 1970s-1990s, a development that gave rise to a class of equilibrium business cycle models in which supply (or technology) shocks play a dominant role.[25] The countercyclical behavior of inflation during the 1970s-1990s (which appears somewhat sensitive to the choice of price index and business cycle indicator) may have contributed to the procyclical behavior of real labor costs during that period.

By contrast, procyclical variation in inflation—especially during and after the financial crisis—may be contributing to the countercyclical patterns in real labor costs over the last decade. With nominal rigidities in wages and nonwage benefit expenditures, stronger procyclical variation in inflation would result in stronger countercyclicality in real measures of labor costs. Moreover, Figure 2 shows that PPI inflation has become even more strongly procyclical than CPI inflation in the recent period. This observation underpins our findings that the countercyclical patterns in real labor costs are stronger when we compare the results in Table 7 using the PPI as the price deflator to the results in Table 2 using the CPI as the deflator. These differences between CPI- and PPI-deflated wages are also consistent with those of Abraham and Haltiwanger (1995) and Swanson (2004). Thus, the change in the relative importance of aggregate demand and supply shocks may have an important role not only in reconciling our results with those of the previous literature but also in explaining the increase in real labor cost countercyclicality.

5.4 Graphical Evidence on Nominal Rigidities in Labor Costs

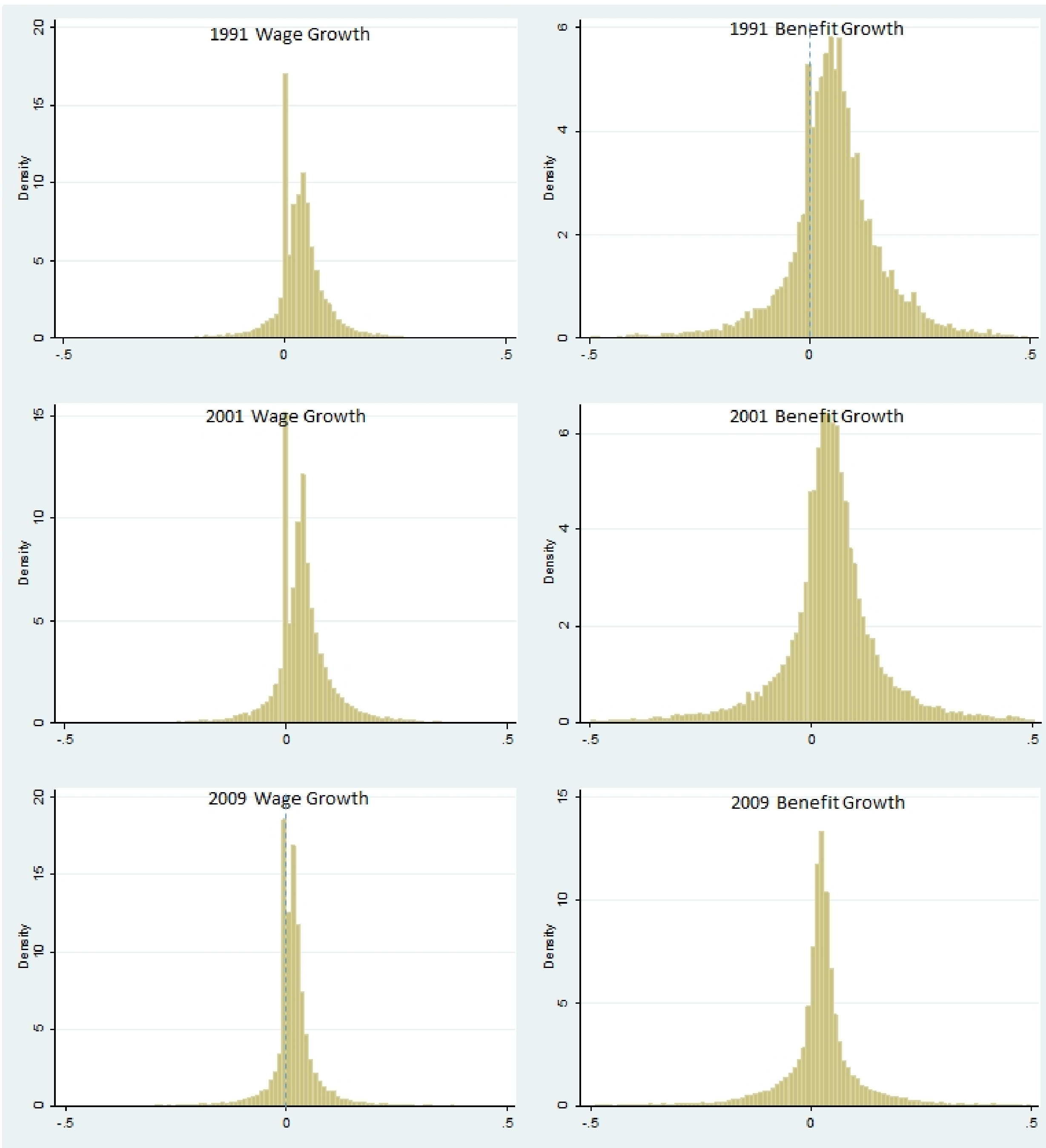
In this section, we examine the degree of nominal rigidities in labor costs both across different components of total labor costs and over time. The former is relevant to comparing the degree of countercyclicality of wages and nonwage benefit expenditures; the latter is relevant to our explanation for real labor costs becoming increasingly countercyclical.

Our econometric results suggest that wages and nonwage benefit expenditures display different degrees of cyclical variation, with wages being more countercyclical in general. One possible explanation is that employers partially buffer workers from the effects of cyclical downturns by distributing labor cost reductions over both nominal wage and nominal benefit expenditures, with the former being decreased less than the latter. After all, wages are explicit, regular payments, while firms' benefit expenditures tend to be relatively opaque to

[25] This is exemplified by the work of Kydland and Prescott (1982) and the subsequent RBC literature that emphasized the role of technology shocks. Basu and Fernald (2001) find that productivity was procyclical in the United States for the post-war period through the end of the 1980s. Such evidence has been interpreted as supportive of the RBC view that technology shocks, which imply procyclical productivity (and, by extension) real wages, are the main drivers of business cycle fluctuations.

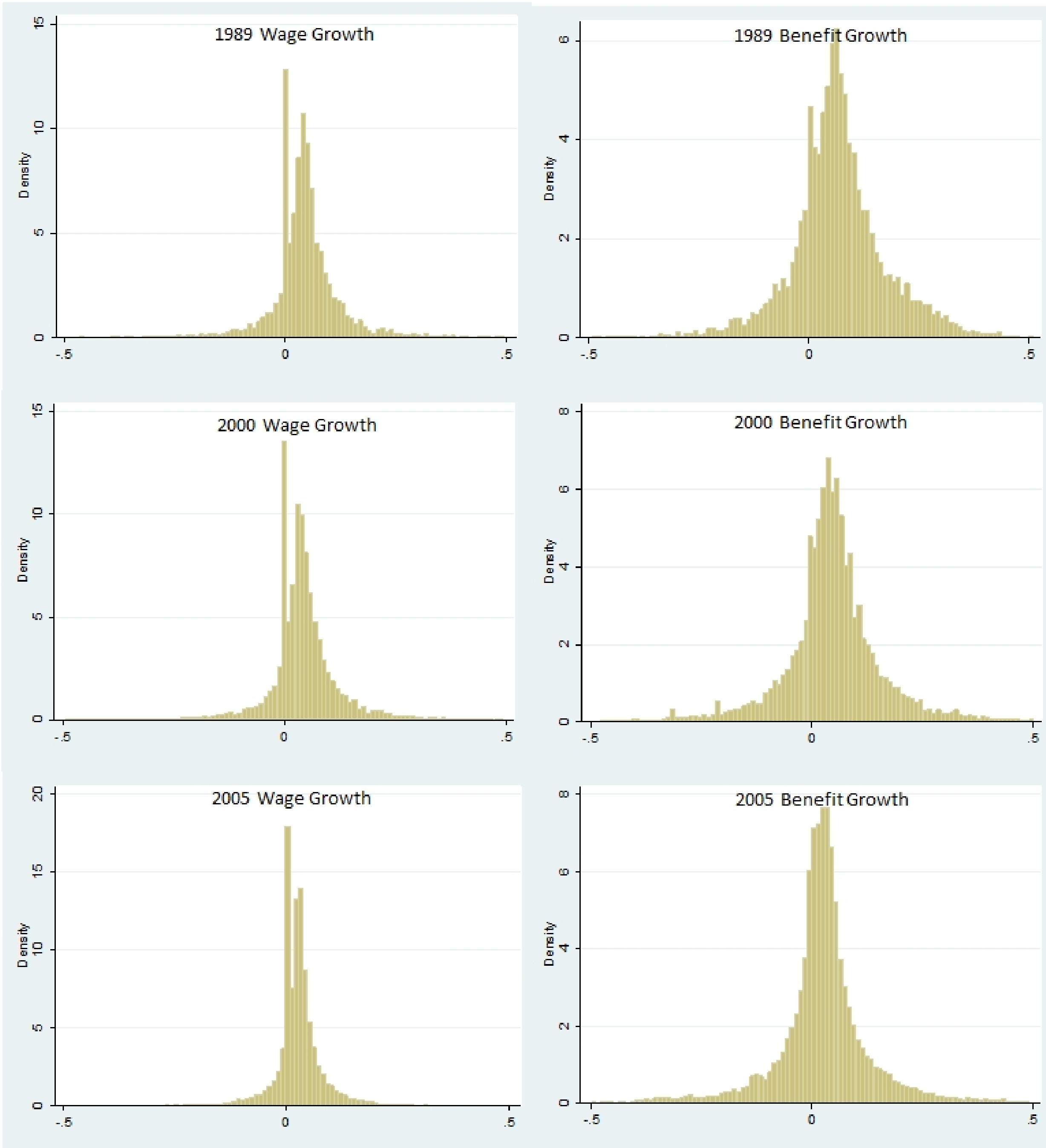
their employees and, therefore, might be easier to adjust. This could imply higher rigidity in nominal wages than nominal benefit expenditures, causing real wages to be more countercyclical than real benefit expenditures.

Figure 3: Histograms for Nominal Wage and Benefit Growth: Recessions



Notes: Each panel shows, for the relevant year in recession, histograms of the growth in nominal hourly wages (or nominal nonwage benefit expenditures) for establishment-job units for which we have data in the current year and the prior year.

Figure 4: Histograms for Nominal Wage and Benefit Growth: Normal Times



Notes: Each panel shows, for the relevant year during normal times, histograms of the growth in nominal hourly wages (or nominal nonwage benefit expenditures) for establishment-job units for which we have data in the current year and the prior year.

Figures 3 and 4 contain histograms for nominal wage growth and nominal benefit growth based on establishment-job data during the last three recessions (growth during 1991, 2001, and 2009) and the preceding years when the economy was not in recession (during 1989, 2000, and 2005).[26] Two observations comparing wage growth and benefit expenditure growth stand out during both recessionary and normal periods. First, benefit growth has much greater variation than wage growth across establishment-job unites. Firms adjust their benefit expenditures to a much greater degree than their adjustments to wages. Second, the highest density for wage growth is always around zero, while the highest density for benefit growth is generally to the right of zero.[27] This indicates that nominal benefit growth does not have as much of a discontinuity at zero as wages do.

Both observations confirm the greater rigidity of nominal wages relative to nominal benefit expenditures, which is consistent with our results that wages are more countercyclical than benefit expenditures. This is also consistent with the findings of Oyer (2005) using BLS data on work stoppages for 1953-1977 and Lebow et al. (2003) using the BLS survey data for 1981-1999. Both studies find that benefit expenditures display less downward rigidity than wages. However, the former study concludes that this benefit flexibility reflects firms' deliberate attempts to circumvent wage rigidity, while the latter suggests that it does not.

Another interesting comparison is across time: between normal times and recessions, as well as over a longer time horizon. Over a long horizon, both wage growth and benefit expenditure growth distributions appear to become narrower in Figures 3 and 4. Wage growth rates pile up higher around zero, while benefit expenditure growth rates also cluster closer towards zero. This suggests increasing nominal rigidity for labor costs. Assuming that inflation is procyclical, this is also consistent with our finding of increasing countercyclicality of real labor costs. Within a business cycle, the highest density bar (at zero) for nominal wage growth is slightly higher in recessions, indicating higher nominal wage rigidity in recessionary periods. This phenomenon is less clear for benefit expenditures' density bar at zero, except for the Great Recession.

To examine the above observations in more detail, we calculate the shares of establishment-job units that registered more than 1 percent nominal wage/benefit declines, more than 3 percent nominal wage/benefit increases, and those in between, respectively, separately during normal times (bars shaded solid) and recessions (patterned bars).[28] It is evident from Figure 5 that, over a business cycle, a significantly larger proportion of establishment-job units register near-zero growth in wages and benefits during recessions than in normal periods. This confirms our prior observation of stronger nominal rigidities in recessions.

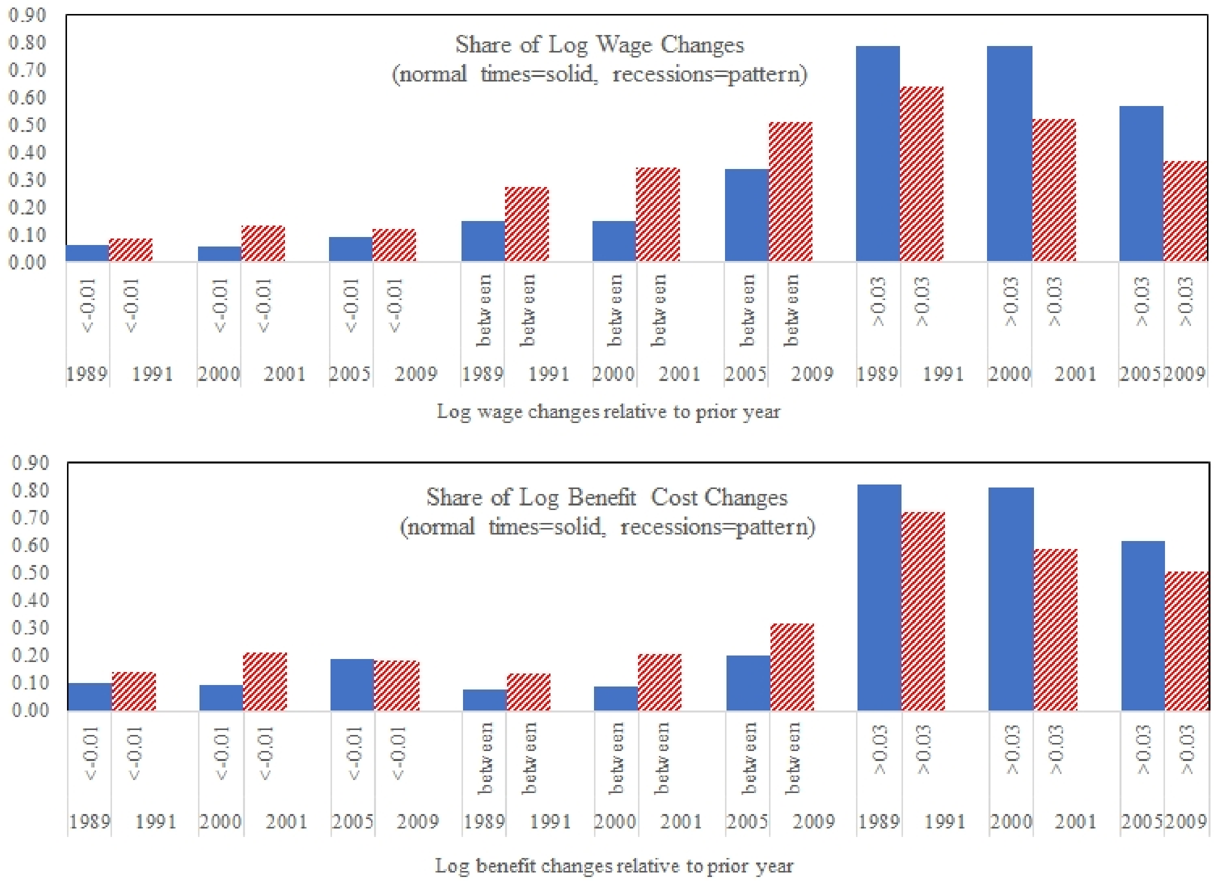
Moreover, across business cycles viewed over a longer time horizon, the proportion of

[26] In these figures, the bin width is 0.01.

[27] This observation concerning the distribution of nominal wage growth is consistent with that of McLaughlin (1994), Kahn (1997), and Fallick et al. (2016).

[28] We regard any change between $[-0.01, 0.03]$ as being in effect a near-zero change in light of possible measurement errors and inflation rates being around $2-3\%$ for most of the sample period.

Figure 5: Potential Rigidities in Nominal Wages and Benefits



Notes: Each panel shows, for the relevant year during normal times (solid bars) and during recessions (patterned bars), three groups of the annual growth rates in nominal hourly wages (or nominal nonwage benefit expenditures) for establishment-job units. The three groups of growth rates are lower than -1%, higher than 3%, and between -1% and 3%. We use "potential rigidities" in the title because it is possible that zero wage/benefit-expenditure changes are an equilibrium outcome.

establishment-job units that register little change in their wages and benefit expenditures has been rising (even during normal times), while the proportion of those that register increases in their wages and benefit expenditures has been declining, especially from the 2000-2001 cycle to the 2005-2009 cycle. This confirms our prior observation that distributions of growth in wages and benefit expenditures have become tighter and nominal rigidities in these variables have increased over time, especially since the middle of the 2000s. This, together with procyclical inflation, is consistent with our empirical results that real labor costs turn significantly countercyclical for the latter years in our sample.

In addition, and also consistent with the previous figures, nominal wages appear to display a higher degree of rigidity than benefit expenditures. The share of near-zero changes in wages is larger than for benefit expenditures (about 13-20 percentage points more). Another interesting observation based on Figure 5 is the prevalence of downward nominal rigidities for both wages and benefit expenditures, as the proportions of establishment-job units that experience negative growth in wages or benefit expenditures are quite small both in normal times and during recessions.

6 Concluding Remarks

Nonwage benefit expenditures now account for one-third of overall labor costs for U.S. workers' total compensation packages. Using wage and earning data, as is the case in the extensive prior literature on this topic, therefore provides an incomplete picture of the dynamics of the price of labor. The main contribution of this paper is to provide the first set of results concerning the cyclical behavior of total labor costs.

We find that, over the period 1982-2014, real total labor costs have become countercyclical, especially since the financial crisis. This is also the case for the components of labor costs—real wages and nonwage benefit expenditures—contradictory to the conventional wisdom that real wages are procyclical. Our results about countercyclical variation in real labor costs are stronger when we use the PPI rather than the CPI as the price deflator.

Consistent with a different strand of literature, we find evidence of (downward) rigidities in nominal wages. We show that nominal benefit expenditures also exhibit (downward) nominal rigidity but to a lesser extent. Moreover, nominal rigidities in both directions appear to have intensified over time, especially since the mid-2000s. We provide suggestive evidence that our finding of countercyclical variation in real labor costs over the last three decades may reflect a combination of stronger nominal rigidities and procyclical inflation, reflecting the rising relative importance of aggregate demand shocks especially since the financial crisis. Our findings provide a different perspective on the puzzle of the vanishing procyclicality of labor productivity (McGrattan and Prescott, 2012; Gali and van Rens, 2015) and have significant implications for the effectiveness of monetary policy in counteracting increases in unemployment during business cycle downturns.

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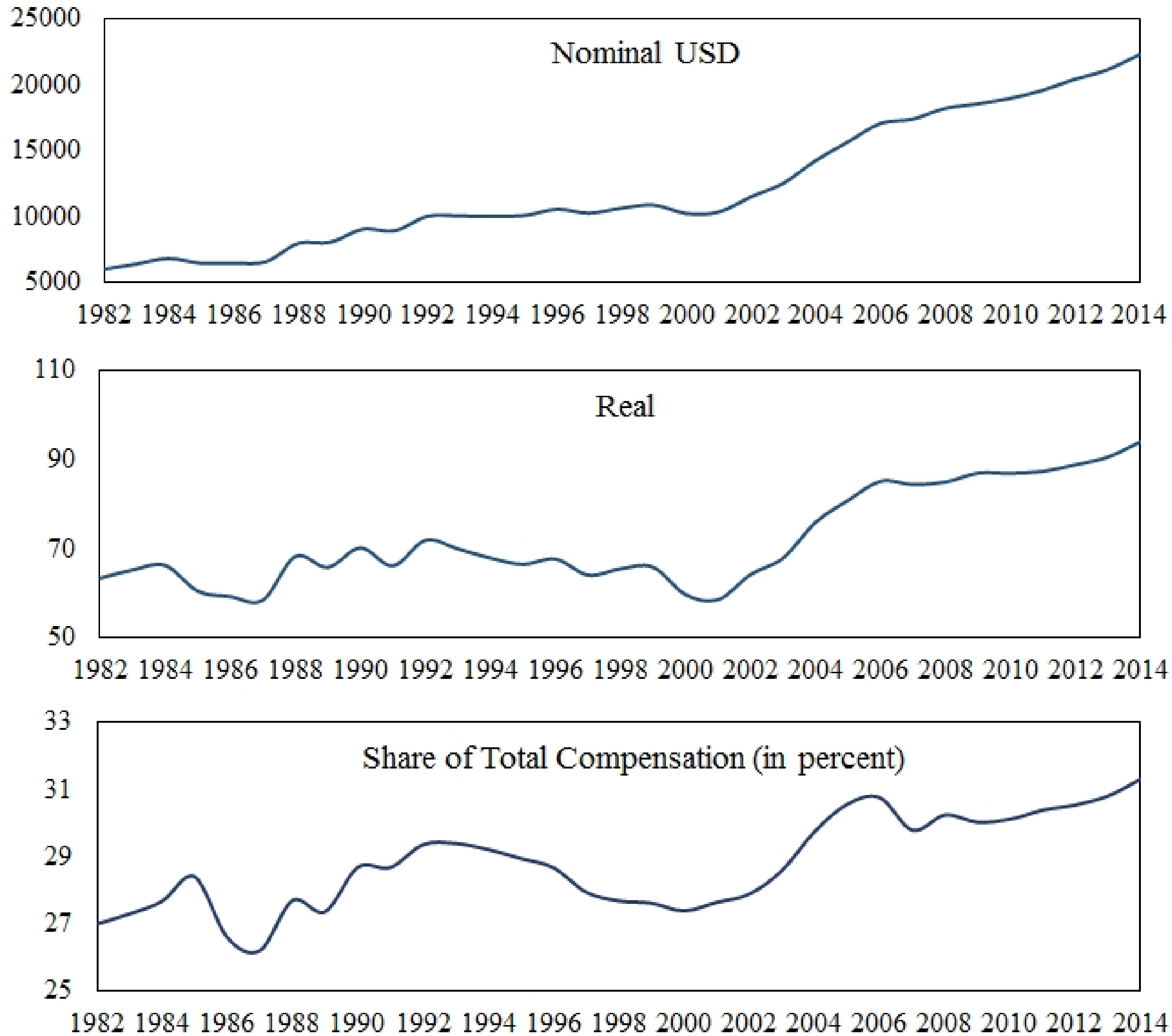
A Appendix: For Online Publication

Figure A.1: Total Benefit Expenditure Trend



Notes: The top panel shows firms' average annual nonwage benefit expenditures per job. In the second panel, real benefits represent benefits adjusted for inflation using the CPI for all urban workers. The third panel shows the average ratio of nonwage benefit expenditures to firms' total labor costs.

Figure A.2: Total Benefit Expenditures by Occupation

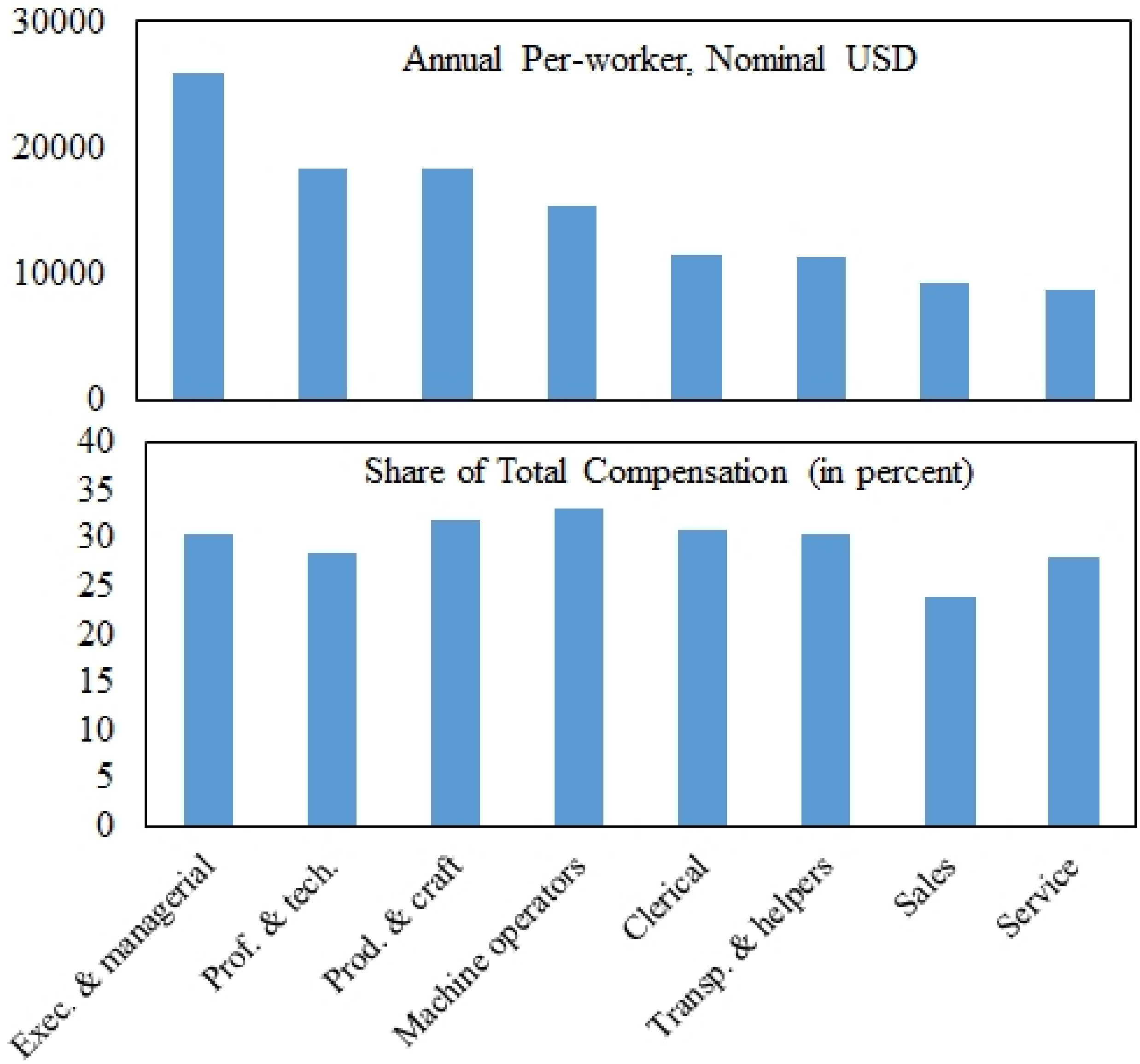


Figure A.3: Total Benefit Expenditures by Industry

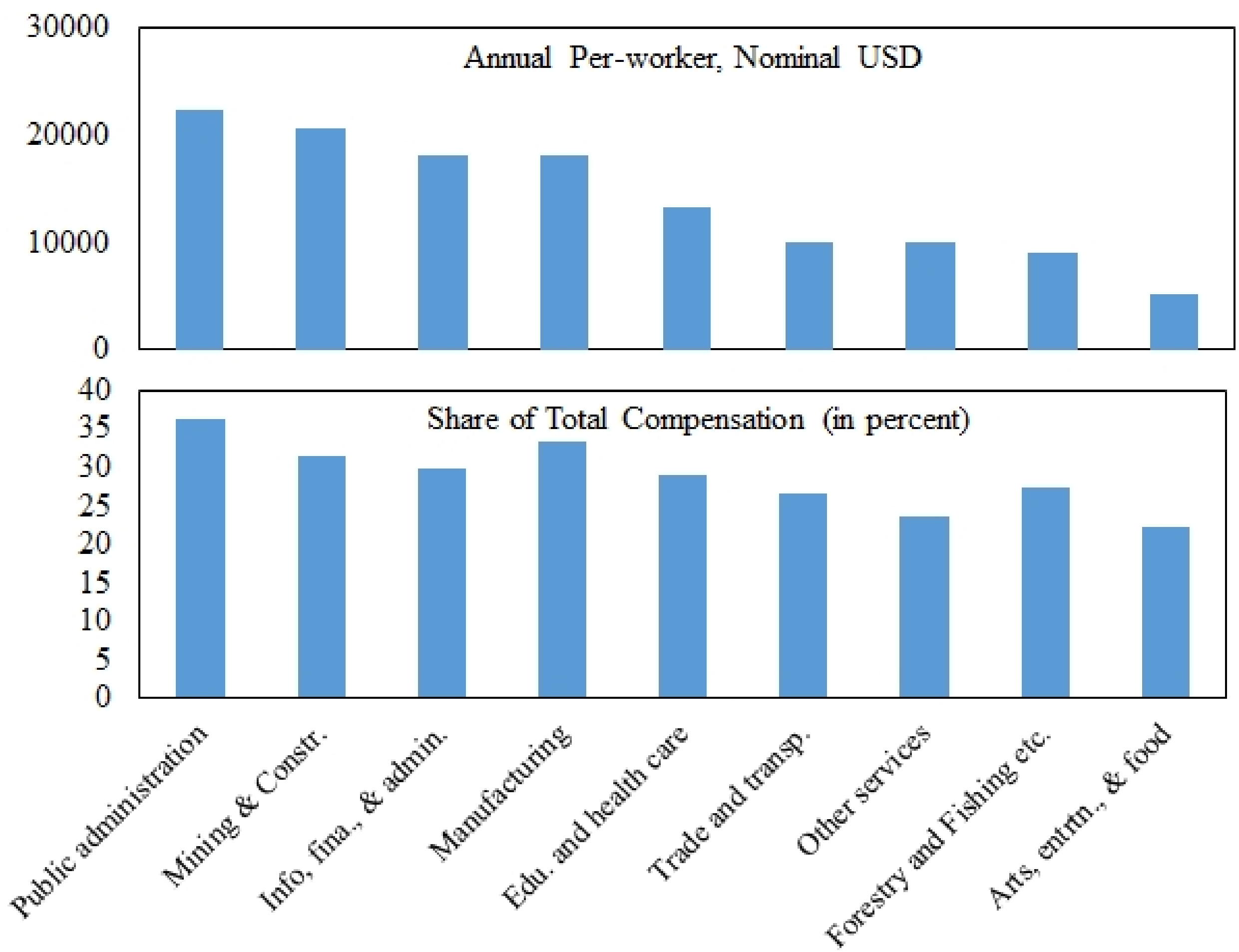


Table A.1: Cyclical Variation of Labor Costs in the Private Sector

Explanatory Variables	(1) Wage		(2) Benefits		(3) Compensation	
Log diff RGDP	−0.4700	$***$	−0.1760	$*$	−0.3730	$***$
	(0.0293)		(0.0825)		(0.0449)	
Observations	509528		509483		509528	
R-squared	0.0058		0.0004		0.0038	

Notes: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). The results in this table are based on a sample restricted to private sector establishments. All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

Table A.2: Interaction Results: Pre-2008

Explanatory Variables	(1) Wage		(2) Benefits		(3) Compensation	
Log diff RGDP	−0.2020		−0.1880		−0.2690	
	(-0.2890)		(-0.4590)		(-0.3280)	
Log diff RGDP x fishing	0.4820		10.4600	$***$	3.8600	$***$
	(-0.2850)		(-0.4370)		(-0.3200)	
Log diff RGDP x non-metro	0.1810	$***$	−0.0534		0.1170	$*$
	(-0.0441)		(-0.1270)		(-0.0466)	
Log diff RGDP x union	−0.1430	$**$	−0.1560		−0.1190	$*$
	(-0.0526)		(-0.1290)		(-0.0542)	
Log diff RGDP x private	−0.0040		0.4900	$*$	0.1740	$*$
	(-0.0542)		(-0.2050)		(-0.0810)	
part time	−0.0033		−0.0634	$**$	−0.0124	
	(-0.0086)		(-0.0228)		(-0.0114)	
prof & tech	−0.0206		−0.0850	$**$	−0.0543	$**$
	(-0.0173)		(-0.0285)		(-0.0182)	
sales	−0.0452		−0.0377		−0.0599	$*$
	(-0.0237)		(-0.0414)		(-0.0273)	
clerical	−0.0390		−0.0234		−0.0469	$*$
	(-0.0258)		(-0.0397)		(-0.0225)	
transp & help	−0.0664	$*$	−0.0680		−0.0768	$**$
	(-0.0326)		(-0.0420)		(-0.0228)	
service	−0.0483	$*$	−0.0350		−0.0614	$*$
	(-0.0229)		(-0.0476)		(-0.0245)	
non-union	−0.0096	$*$	−0.0312	$***$	−0.0171	$***$
	(-0.0041)		(-0.0085)		(-0.0048)	
state govt	0.0048		0.1130	$***$	0.0460	$**$
	(-0.0067)		(-0.0261)		(-0.0138)	
Observations	344985		344951		344985	
R-squared	0.0009		0.0017		0.0011	

Note: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

Table A.3: Interaction Results: Post-2007

Explanatory Variables	**(1) Wage**		**(2) Benefits**		**(3) Compensation**	
Log diff RGDP	−0.7420	***	−0.6820	**	−0.7170	***
	(-0.1420)		(-0.2170)		(-0.1420)	
Log diff RGDP x small size	−0.0568		−0.1320		−0.0906	**
	(-0.0293)		(-0.0716)		(-0.0315)	
Log diff RGDP x prof & tech	−0.3350	*	−0.1420		−0.2860	*
	(-0.1440)		(-0.1240)		(-0.1270)	
Log diff RGDP x exe & mng	−0.3800	*	−0.1200		−0.3050	*
	(-0.1530)		(-0.1260)		(-0.1310)	
Log diff RGDP x clerical	−0.3470	*	−0.2340		−0.3140	*
	(-0.1450)		(-0.1190)		(-0.1290)	
Log diff RGDP x prod & craft	−0.3810	**	−0.1370		−0.2960	*
	(-0.1400)		(-0.1410)		(-0.1240)	
Log diff RGDP x mach oper	−0.3940	**	−0.3270	*	−0.3740	**
	(-0.1360)		(-0.1320)		(-0.1180)	
Log diff RGDP x transp & help	−0.2540	*	−0.2240		−0.2350	*
	(-0.1250)		(-0.1730)		(-0.1090)	
Log diff RGDP x service	−0.3010	*	−0.1160		−0.2450	
	(-0.1400)		(-0.1190)		(-0.1240)	
Log diff RGDP x mining	0.2580	***	0.1750		0.2610	***
	(-0.0542)		(-0.1810)		(-0.0749)	
Log diff RGDP x manuf	0.1880	***	0.1570		0.1970	*
	(-0.0523)		(-0.1580)		(-0.0772)	
Log diff RGDP x info & fina	0.2010	**	0.1370		0.2080	*
	(-0.0640)		(-0.1570)		(-0.0856)	
Log diff RGDP x public adm	0.0782	*	−0.1400		0.0468	
	(-0.0385)		(-0.1810)		(-0.0706)	
Log diff RGDP x northeast	0.0494		0.1120		0.0745	*
	(-0.0300)		(-0.0837)		(-0.0371)	
Log diff RGDP x midwest	0.0066		0.1630	*	0.0617	
	(-0.0248)		(-0.0769)		(-0.0316)	
Log diff RGDP x south	−0.0544	*	0.0474		−0.0133	
	(-0.0271)		(-0.0860)		(-0.0370)	
Log diff RGDP x non-union	0.0993	**	−0.0507		0.0284	
	(-0.0357)		(-0.1020)		(-0.0456)	
Log diff RGDP x state govt	0.0831	***	0.3590	***	0.1800	***
	(-0.0234)		(-0.0687)		(-0.0296)	
Log diff RGDP x private	0.1190	***	0.2370	*	0.1580	***
	(-0.0319)		(-0.0988)		(-0.0367)	
prof & tech	0.0026		0.0502	*	0.0211	
	(-0.0116)		(-0.0234)		(-0.0145)	
exe &mng	−0.0027		0.0688	**	0.0234	
	(-0.0144)		(-0.0258)		(-0.0163)	
clerical	0.0228		0.0537		0.0361	*
	(-0.0130)		(-0.0278)		(-0.0163)	
transp & help	0.0248	*	0.0499		0.0350	*
	(-0.0114)		(-0.0276)		(-0.0147)	
service	0.0075		0.0597	*	0.0231	
	(-0.0138)		(-0.0240)		(-0.0158)	
non-metro	0.0035	**	−0.0017		0.0023	
	(-0.0013)		(-0.0037)		(-0.0019)	
state govt	0.0354	***	−0.0829		0.0102	
	(-0.0084)		(-0.1400)		(-0.0392)	
Observations	268896		268881		268896	
R-squared	0.0383		0.0079		0.0310	

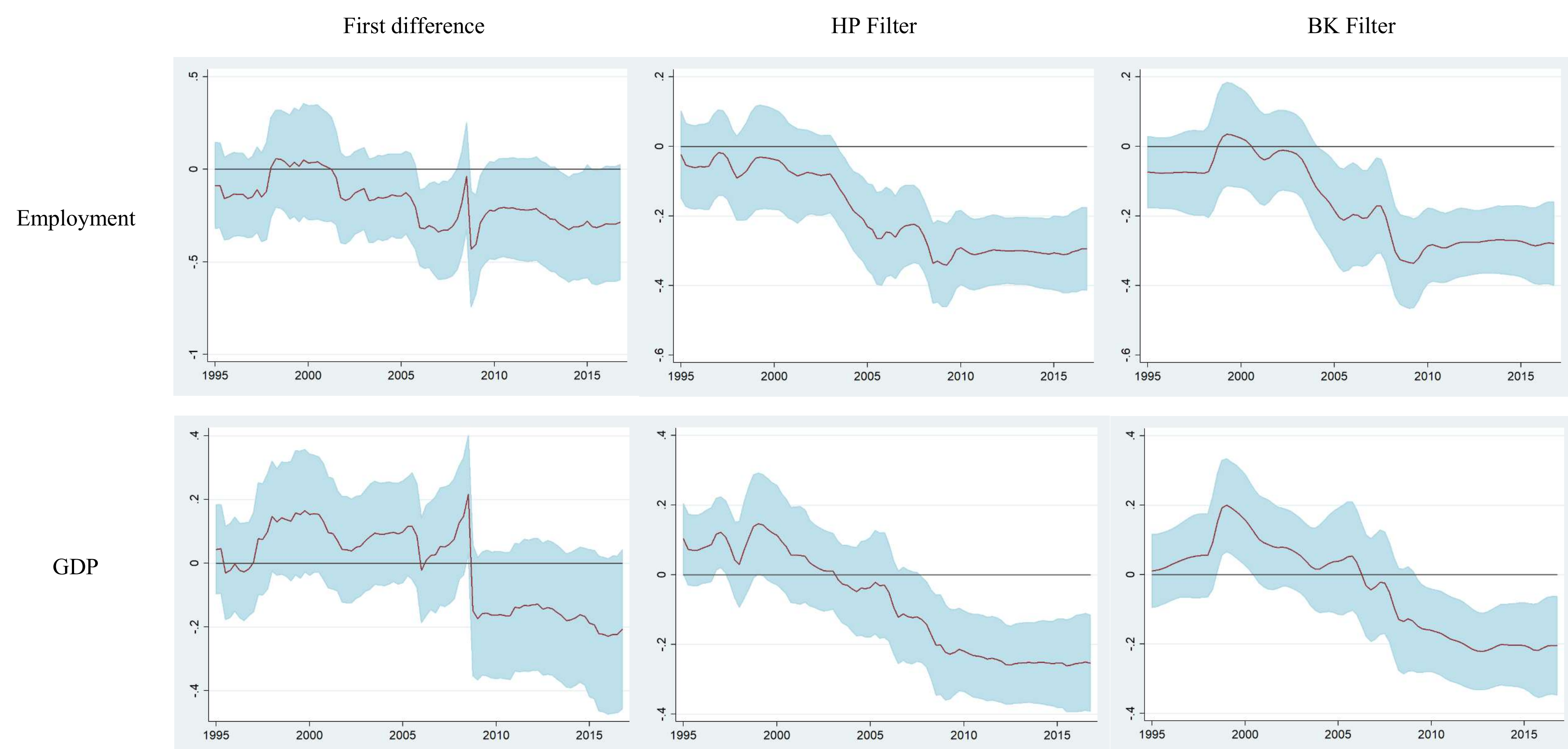
Note: Dependent variable is log-differenced real hourly cost of labor (deflated by CPI). All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively.

Table A.4: Cyclical Variation in Different Categories of Hourly Compensation

Explanatory Variables	**(1) Earnings**		**(2) QF Benefits**		**(3) Non-QF Benefits**	
Log diff RGDP	−0.4700	***	−0.2240	*	−0.3370	***
	(0.0320)		(0.1090)		(0.0766)	
Observations	628942		627766		628870	
R-squared	0.0075		0.0002		0.0012	
Explanatory Variables	**(4) Req. Benefits**		**(5) Disc. Benefits**		**(6) Minor Benefits**	
Log diff RGDP	0.1340		−0.0304		0.1790	
	(0.1100)		(0.1690)		(0.4590)	
Observations	472566		458172		286627	
R-squared	0.0001		1.4E-06		0.0007	

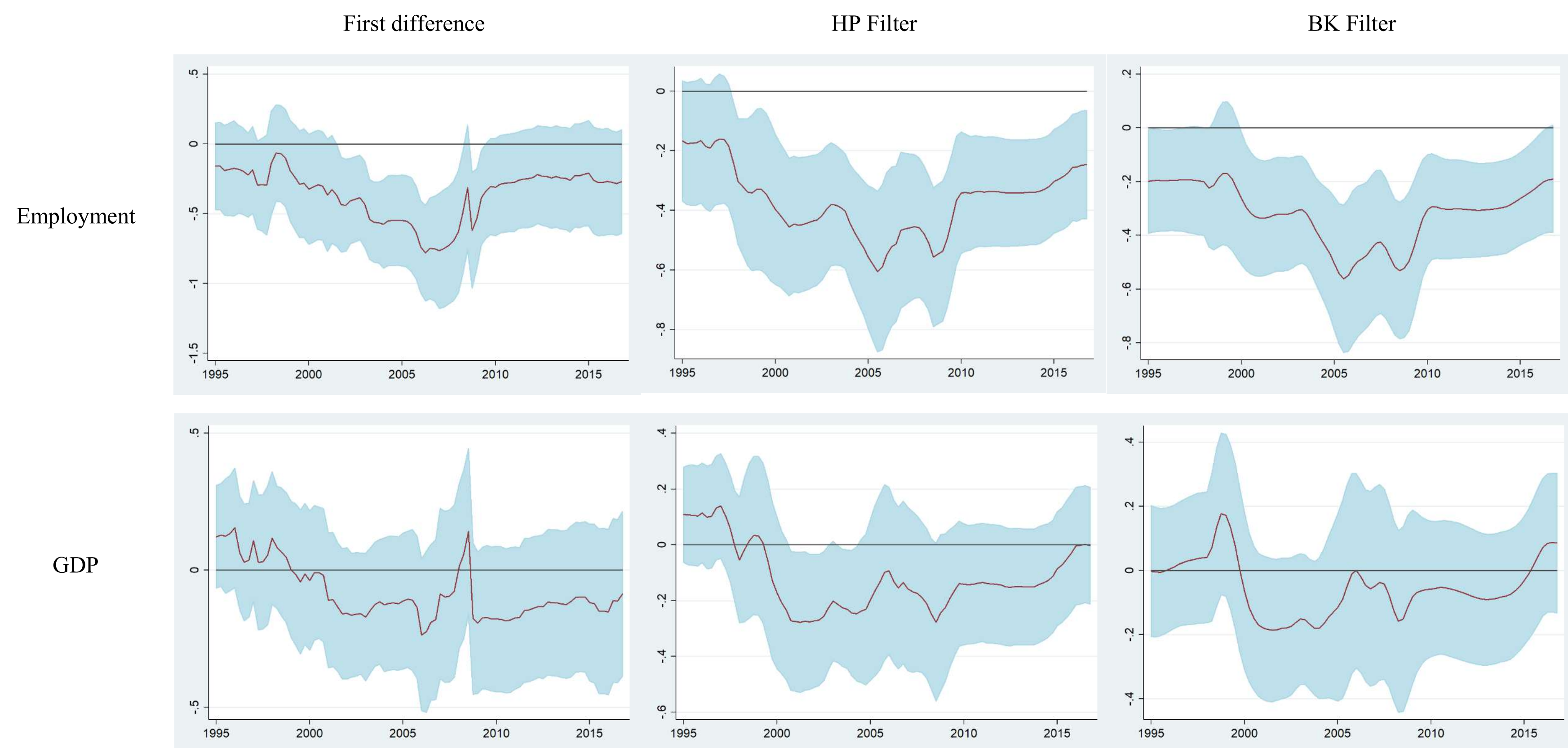
Notes: Dependent variable is log-differenced measure of relevant category of real hourly labor costs (deflated by CPI). QF benefits are quasi-fixed benefits, including vacations, holidays, sick leave, other paid leave, life/health insurances, defined benefits, and federal/state unemployment. Req. benefits are legally required benefits, including social security, medicare, workers compensation, federal/state unemployment and other legally required. Disc. benefits are discretionary benefits that firms can adjust. Minor benefits are severance pay, supplemental unemployment, railroad supplementary retirement, railroad unemployment, and short term and long term disability. All regressions include establishment-job fixed effects and a linear trend. In parentheses below coefficient estimates, we report robust standard errors that are clustered at the 3-digit NAICS industry level. The symbols *, **, and *** denote statistical significance at the 5 percent, 1 percent, and 0.1 percent levels, respectively. If the sample is divided by period, the results are similar to Table 12, i.e., only post-2008 period has statistically significant countercyclicality in earnings, QF benefits, and non -QF benefits.

Figure A.4: Evolution of the Correlation between Real Hourly Compensation and the Business Cycle: Macro-level Data



Notes: This figure shows the evolution of the univariate regression coefficient of the cyclical component of average aggregate real hourly compensation (deflated by CPI) regressed on business cycle indicators. The business cycle indicators are aggregate employment (first row) and real GDP (second row). The time series filters applied to the data (in logarithms) before running the regressions are: first differences (first column), the Hodrick-Prescott filter (column 2), and the Baxter-King band-pass filter (column 3). The regressions are estimated over rolling 15-year windows of quarterly data. The shaded areas indicate two standard error bands around the estimated coefficients.

Figure A.5: Evolution of the Correlation between Real Hourly Nonwage Benefits and the Business Cycle: Macro-level Data



Notes: This figure shows the evolution of the univariate regression coefficient of the cyclical component of average aggregate real hourly nonwage benefits (deflated by CPI) regressed on business cycle indicators. The business cycle indicators are aggregate employment (first row) and real GDP (second row). The time series filters applied to the data (in logarithms) before running the regressions are: first differences (first column), the Hodrick-Prescott filter (column 2), and the Baxter-King band-pass filter (column 3). The regressions are estimated over rolling 15-year windows of quarterly data. The shaded areas indicate two standard error bands around the estimated coefficients.