Working Paper 9418

# THE EFFECTS OF INFLATION ON WAGE ADJUSTMENTS IN FIRM-LEVEL DATA: GREASE OR SAND?

by Erica L. Groshen and Mark E. Schweitzer

Erica L. Groshen and Mark E. Schweitzer are economists at the Federal Reserve Bank of New York and the Federal Reserve Bank of Cleveland, respectively. The authors thank Kristin Roberts for excellent research assistance and Edward Montgomery and Joseph Ritter for useful discussions. They also thank participants in workshops at Columbia University, the Federal Reserve Banks of New York and San Francisco, Lehigh University, American University, MacMaster University, the City University of New York Graduate Center, and Queens College.



December 1994

## ABSTRACT

This paper studies wage changes in a 37-year panel of occupations and employers drawn from the Federal Reserve Bank of Cleveland Community Salary Survey (CSS). Using an institutional model of the wage-setting process as a guide, we 1) identify wage adjustments in two embedded relative prices and 2) draw inferences about the costs and benefits of inflation from the adjustments in these relative prices.

Typical institutional wage-setting policies manage employer-wide wage adjustments (controlling for occupational wage changes) and interoccupational wage changes (controlling for employer wage changes) separately. In the CSS, we are able to identify large independent employer and occupation components of wage changes. While there is no a priori reason for these adjustments to be altered by inflation (when the average change is subtracted out), variation in both of these terms is positively correlated with inflation.

In the interpretation phase of the paper, we treat employer-wide wage deviations as emphasizing forecasting errors and differences in the speed of adjustment to inflation. In contrast, we argue that occupational wage deviations include a higher concentration of market-driven relative price adjustments. This simple dichotomy, whose robustness we attempt to test, yields two policy-oriented results: 1) Higher inflation and labor productivity appear to increase the rate of occupational wage adjustments ("grease"), although these potential benefits taper off after inflation rises to about 4 percent (assuming 1.5 percent average growth of labor productivity); and 2) Potentially inefficient variations in employer wage adjustments ("sand") continue to mount until inflation reaches rates of 7 to 10 percent (again assuming productivity growth of 1.5 percent).

## 1. Introduction

How does inflation affect the labor market? This paper explores the effects of the level of inflation on the dispersion of wage changes in order to expand our knowledge of the impact and transmission of inflation in the labor market. Our findings add to the literatures on both wage flexibility (or rigidity) and inflation's impact on price adjustments.

This paper's strength--the unusually tight link we forge between our analytic approach and common compensation adjustment practices--is made possible by the data set we study. The Federal Reserve Bank of Cleveland Community Salary Survey (CSS) from 1956 to 1992 offers detailed data on employers' actual wage adjustments. Because the purpose of the data set is to provide participating employers with information on market wage adjustments, it records wages at the level of detail that compensation managers desire for assessing their market position. Thus, the relative wages we consider are the margins of adjustment within which the firms maintain comparability of their wage structure with competitors in their labor market. We find that variability in both occupation- and employer-relative wages increases with inflation.

We draw inferences about the costs and benefits of inflation by examining the association between inflation measures and the dispersion of occupation-wide and employer-wide wage changes. Variation in these terms can be seen as desirable (increased occupational wage flexibility) or undesirable (increased variation between employers). In keeping with the exploratory nature of the exercise, we use statistical procedures to confirm the robustness of the relationship between these terms and inflation, rather than imposing structural restrictions on the associations we detect.

The paper proceeds as follows: The next section applies institutional wage-setting procedures to decompose notional wage adjustments into the terms we analyze. Section three reviews the two strands of relevant literature and contrasts our approach with those previously taken. In the fourth and fifth sections, we describe our data and confirm that the nature of wage adjustments observed is consistent with the model we advance. The sixth section analyzes inflation's effect on the dispersion of occupational and employer wage adjustments and performs several checks on the robustness of our findings. The final section summarizes our findings.

## 2. Institutional Wage Adjustment

Could an inflation-induced hike in the dispersion of wage changes be beneficial, or could it reflect distortions in the labor market? The answer to this question depends on the unobserved motivations of firms. We develop our statistical analysis in the context of the institutional wage-setting practices that the data were designed to inform. We base our institutional model on discussions with personnel executives, compensation textbook descriptions of the process, and compensation managers' responses in Levine's (1993) and others' surveys.

### *a. Typical Compensation Policies*

Fundamentally, observed salaries are bounded on the high end by workers' marginal products and on the low end by employees' outside opportunities. However, these constraints may not determine a unique wage in most corporate settings because both parties have limited current information on individuals' productivity and labor market options. Since employers do not observe labor supply and demand functions, they develop compensation policies to attract and retain qualified employees. Although these policies differ across firms, large employers' practices typically share the following common features: a job evaluation program to rate jobs; salary grades or a wage line to assign earnings to jobs according to their evaluations; and a merit- or seniority-based system to govern wage growth within salary grades.[1]

Annual compensation budgets, and therefore average pay increases, are determined by top management, typically the chief executive officer (Freedman [1976]). After approval (two to six months in advance of the actual salary adjustments), the budget provides the total "pie" for wage increases to be split up among departments, and then within departments in accordance with perceived merit and labor market conditions for particular workers or groups of workers.

[1] Examples of compensation policy references that describe and recommend these practices include Hills (1987), Milkovich and Newman (1990), and Wallace and Fay (1988).

Although the degree of decentralization varies among companies, the basic mechanism usually takes the form described above.[2]

In a 1976 Conference Board survey on corporate compensation setting, compensation executives indicated that a diverse set of factors is important in determining the compensation budget. Table 1 summarizes the prevalence of these factors for industries relevant to those covered in the Cleveland Community Salary Survey (CSS), the source of the data analyzed in this study. While the factors considered vary somewhat among worker categories and industries, several conclusions can be drawn from the table. First, area wage surveys constitute the single most influential factor in compensation budgeting for workers such as those typically covered in the CSS.[3] Second, this list of indicators clearly picks up labor supply and demand conditions as well as the inflationary environment. Third, to an economist's eye, the list also emphasizes the limited information available to firms as they set wages. In an uncertain environment, interemployer variation either in the factors chosen for determining wages or in their reading of these factors could contribute substantially to variation in wage growth rates.

### *b. Statistical Implementation*

If firms foresaw all necessary adjustments and relied completely on wage scales specified by job characteristics (or on a point system based on job characteristics)--adjusted to market wage rates--then any individual's wage change could be decomposed as follows:

(1) $\Delta(\ln W_{it}) \equiv w_{foit} = a_t + F_{ft} + O_{ot} + \varepsilon_{it}$, in each labor market,

[2] For unionized employees, negotiations on more detailed terms and conditions of pay increases (or reductions) take place further in advance because contracts typically last about three years. Nevertheless, the firm completes a prospective compensation budget, similar to nonunion budgeting, prior to negotiations in order to establish the acceptable range of wage adjustments. The data analyzed here include very few unionized employees, because of the occupations surveyed. However, because many of the establishments included are partially unionized, spillover effects are possible.

[3] Area wage surveys are the most commonly mentioned factor for nonexempt salaried workers. In cases where other factors were cited more--union hourly employees (union demands) or executives and officers (companies' financial reports)--area surveys are still frequently cited factors in establishing compensation budgets. See also Levine (1993), which reports that in a survey of 139 compensation executives, wage change recommendations rarely reflect unemployment rates, quit rates, and corporate returns on assets.

where $w_{foit}$ is defined as the change in log wages of worker *i*, in occupation *o*, in firm *f*, at time *t*. While an unconstrained $\varepsilon_{it}$ could obviously specify all wage changes, meaningful underlying concepts are identified by location, firm, and occupation components. General wage increases are picked up by $a_t$ (change of the local log wage baseline). If wage inflation rates do not vary by locality, then this term equals the national rate of wage inflation. $F_{ft}$ represents the change in firm *f*'s "market position" at period *t*; a positive $F_{ft}$ marks a decision to increase employers' overall pay relative to the general market. In the compensation literature, firms are generally viewed as maintaining their average wages at a fixed deviation from other local employers' offers for a variety of reasons, i.e., $F_{ft}$ is typically 0.[4] Next, $O_{ot}$ is the change in the occupational differential for workers in occupation *o*. Competition among firms for employees with specific occupational skills tends to equalize both the levels and the changes in these differentials across firms. Individual-specific adjustments ($\varepsilon_{it}$) include merit and longevity raises.

Lacking full information on the year's realizations of $a_t$ and $O_{ot}$, firms look primarily to each other and to public measures of inflation for guidance, so they may make errors. If we modify equation (1) to allow for mistakes, wage changes become more complicated:

$$(2) \quad w_{foit} = a_t + a^e_{ft} + F_{ft} + O_{ot} + O^e_{fot} + \varepsilon_{it},$$

where $a^e_{ft}$ and $O^e_{fot}$ represent realized employer errors in determining the current local and occupational wage adjustments. The timing of the payroll year may also result in firms leading or lagging their desired market position at a particular date, an outcome that we consider simply another form of error in the firm's attempt to match the local inflation rate. Note that all equilibrium wage adjustments can still be described by varying $\varepsilon_{it}$.

Ideally, we would use individual wage adjustments gathered from a large array of employers to identify the components in equation (2); however, in most years, the CSS records wages not of individuals, but as means or medians for "job cells" which specify the location,

[4] Groshen (1991c) discusses the various explanations for observed wage variation among employers. These include systematic human capital differences, compensating differentials, errors, efficiency wages, and rent-sharing. All of these reasons, except errors, are long-term strategies.

employer, and occupation. Aggregating the individual wages in equation (2) to job-cell averages poses no inherent problem because it simply aggregates the individual-specific error by cell. Thus, the structure of the CSS allows decomposition of wage changes into four terms at most: employers, occupations, cities, and residuals. Specifically, we estimate these components via the following fixed-effects regression:

(3) $w_{fo} = \alpha + \beta D_f + \gamma D_o + \mu_{fo}$, for each locality and year,

where $\beta$ and $\gamma$ are coefficient vectors for matrices of dummy variables ($D_f$ and $D_o$) referring to the cell's firm and occupation, respectively.

The possibility of firm-specific errors for occupations that we highlight in equation (2) (i.e., $O^e_{fot}$) means that we cannot confidently assume that the coefficient vector $\beta$ provides unbiased estimates of the $F_{ft}$'s in equation (1). Furthermore, the lack of restrictions on the individual-specific term ($\varepsilon_{it}$) will confound the direct correspondence between equations (1) and (3) if correlations of the cell mean (or median) with firms or occupations exist. While we have reason to believe that these biases are small, we need to clarify the nature of the potential mis-identifications by the fixed-effects estimation in equation (3) in order to guide robustness checks of our findings.

The primary concerns in our application are $O^e_{fot}$ and $\varepsilon_{it}$. Applying a hypothetical regression of occupation and employer dummy variables on the unobserved term ($O^e_{fot}$) would allow identification of linear employer and occupation components along with a residual. These hypothetical terms (which will be identified by hats, $\hat{O}^e_{fot,f}$ and $\hat{O}^e_{fot,O}$) allocate the misidentified variation. Similarly, the individual differences term ($\varepsilon_{it}$) can be decomposed into the employer and occupational terms. After we allocate and bracket these terms according to which coefficient they would affect, equation (2) becomes the following:

$$
\begin{aligned}
w_{foit} = a_t &+ \left\{ a^e_{ft} + F_t + \hat{O}^e_{fot,f} + \hat{\varepsilon}_{ft,f} \right\} + \left\{ O_t + \hat{O}^e_{fot,O} + \hat{\varepsilon}_{ft,O} \right\} + \\
&\left\{ \left( O^e_{fot} - \hat{O}^e_{fot,f} - \hat{O}^e_{fot,O} \right) + \left( \varepsilon_{ft} - \hat{\varepsilon}_{ft,f} - \hat{\varepsilon}_{ft,O} \right) \right\}.
\end{aligned} \tag{4}
$$

Of the four influences on the β vector of firm effects, $a^e_{ft}$ and $\hat{O}^e_{fot,f}$ represent firm errors (or timing differences). We conjecture that the two other terms are small, and we attempt to ferret out the robustness of our conclusions to this assumption. As we stated earlier, the compensation literature argues that $F_{ft}$ is small because employers make long-run decisions on the quality of employee desired. The fourth term, $\hat{\varepsilon}_{ft,f}$, represents the bias due to the firm's workforce composition. To the extent that employers report wages for many workers and that changes in worker skill levels offset each other (i.e., have a sampling mean of zero), this term will vanish.

The estimated occupational coefficients (the γ's) represent an agglomeration of market responses ($O_{ot}$) and biases common to a particular occupation across firms ($\hat{O}^e_{fot,O}$ and $\hat{\varepsilon}_{ft,O}$). We expect both of the bias terms to be small when there are many independent employers for an occupation and when the labor force within an occupation has changed minimally over the year. Furthermore, the occupation-specific component of wage adjustments is, arguably, primarily an intentional market outcome. We believe (but not strongly enough to forgo robustness checks) that the intentional responses should predominate.

A priori, there is no reason to expect any particular relationship between variability in these relative wage terms and inflation -- the scaling effect of inflation and real wage growth has been removed by the intercept in the log wage specification.

## 3. Inflation and Wage Adjustment

Extensive literatures describe reasons why relative prices can be altered by purely nominal shocks. However, no research has been applied to the relative wages we consider here. We first review these literatures, then outline our strategy for interpreting hypotheses in this context.

### *a. Wage Rigidity Studies--Inflation as Grease*

Keynesian macroeconomics depends heavily on the assumption of downward nominal price and/or wage rigidity; that is, recessions occur when such stickiness prevents markets from efficiently allocating resources. Keynes explained the stickiness by asserting that workers' notions of fairness make real wage erosion, imposed by inflation, more acceptable than nominal cuts. Thus, general wage and price inflation can be a mechanism to reduce cyclical unemployment and raise economic efficiency.[5] An important corollary of this reasoning, developed by Slichter (see Slichter and Luedicke [1957]) and Tobin (1972), argues that even without large shocks, moderate rates of inflation can "grease the wheels" of the economy, facilitating downward real price changes in response to small shocks. While the neo-Keynesian perspective appears to favor sticky goods prices over sticky wages as the explanation for monetary non-neutrality, this is partly due to empirical concerns about the rigidity of wages (see Ball and Mankiw [1994]).

Within the wide variety of studies that look for empirical evidence of wage rigidity, the largest group examines aggregate real wages for evidence of procyclicality and concludes that real wages are indeed rigid downward (see review in Fischer [1981]). Other studies examine household or employer microdata and mostly reach opposite conclusions. Although Holzer and Montgomery (1990) detect some downward rigidity, most recent micro studies (Bils [1985]; Solon, Whatley, and Stevens [1994]; McLaughlin [1991]; and Lebow, Stockton, and Wascher [1993]) find evidence of substantial nominal wage cuts, which they take as proof that wages are flexible downward.[6] The discrepancy between aggregate and micro results is attributed to composition bias, the impact of overtime and bonus pay, and worker mobility.

We argue that, more important, the existence of nominal wage cuts does not in itself demonstrate that wages are flexible; meaningful wage rigidity occurs when wages do not adjust *adequately* to ensure efficient allocation of resources. We seek to improve on the direct observation of wage adjustments by looking for evidence of *meaningful* wage rigidity. Hence,

[5] Three theories of "fairness" have been advanced to explain why unemployed workers cannot bid down wages in a Keynesian recession: implicit contracts, efficiency wages, and rent-sharing models. Haley (1990) presents a modern review of the microeconomic theories that predict Keynesian-type wage rigidity.

[6] Another group of empirical efforts takes the unusual approach of surveying employers directly about compensation practices; see, for example, Blinder and Choi (1990), Kaufman (1984), Bewley and Brainard (1993), and Levine (1993). These studies uniformly suggest that "fairness" is an important governing principle in wage-setting practices, and that employers refrain from nominal wage cuts except under extreme duress.

we identify and test for an important implication of wage rigidity for the labor market--that is, whether higher inflation facilitates the adjustment of interoccupational (relative) wages to shocks.[7] To state this another way, we look for limited relative wage adjustments during periods of low inflation.

### *b. Relative Price Disruption Studies--Inflation as Sand*

Whereas the wage rigidity story describes how inflation might facilitate necessary price changes among different goods in the market, the relative price disruption story describes how inflation and price/wage rigidity may cause *inefficient* fluctuations in prices. In these stories, inflation entails variation in agents' price adjustments, distorting relative prices. The sources of price/wage rigidities posited in the price dispersion literature are menu costs (i.e., expenses for revising price lists, as in Sheshinski and Weiss [1977]) or consumer search costs (Stigler and Kindahl [1970] and Reinsdorf [1994]). Both imply that inflationary price changes are unlikely to be transmitted uniformly and instantaneously. Such distortions cause market participants to confuse adjustment lags with real shocks, and thereby to misallocate resources and increase risk (Vining and Elwertowski [1976]). In this scenario, inflation acts like sand in the gears of the economy, impairing the interpretation of price signals.

Price dispersion studies measure the extent to which inflation is unevenly distributed and use this to gauge the costs of inflation. Early studies in this genre uniformly show that inflation raises the dispersion of price change indices and industry wage change aggregates. Fischer (1981) and Cukierman (1983) review and extend these studies. This literature is subject to some important limitations. First, as Hartman (1991) shows, increasing price variability with inflation could be an artifact of constant expenditure shares. Second, the sand theory is most compelling in arguing that inflation distorts price relationships among similar or competing goods, rather than among the dissimilar goods represented by price aggregates.

[7] Lebow, Stockton, and Wascher (1993) also address this issue in their study.

Recent research on price adjustment delves into this relationship using product price microdata. One group of studies considers price changes in a single class of goods, generally for low-inflation countries. For example, Cecchetti (1986) studies magazines' cover prices. Other research explores price changes in broader product categories in high-inflation environments. For example, Lach and Tsiddon (1992) study the variation of adjustment to food prices in store-level data from Israel. The proprietary nature of micro-level price data limits the broad applicability of any particular study in this genre, since the results are only for high- or low-inflation countries and for unusual or regulated products. Nevertheless, on balance, the studies suggest that higher inflation increases the variability of price changes. For the United States, during the high and declining inflationary years (1980-82), Reinsdorf (1994) finds that the variation of monthly actual prices within product category (rather than indices or price changes) rose as inflation fell, due to negative inflation surprises. The variation of price changes, however, was positively correlated with inflation.

With respect to wages, Hamermesh (1986), Drazen and Hamermesh (1986), and Allen (1987) find that the cross-industry dispersion of wage-change aggregates falls as inflation rises. They attribute this result to inflation-induced introduction of indexation, formal or informal. Card (1990) reaches similar conclusions in a study of inflation's impact on wages set in long-term union contracts. Transaction-level analysis of adjustments is particularly important in labor markets because the composition of the workforce certainly varies over the business cycle.

This study explores the impact of inflation on the dispersion of a crucial price--labor. By controlling for detailed occupation, we effectively replicate the comparability across goods (intramarket variability) sought in the product price literature. Aside from adding a micro-level wage study to the literature, we extend price dispersion analysis by covering a broad array of prices across the varied inflation history of the United States from the 1950s to the 1990s.

### *c. The Impact of Inflation on Wage Adjustment*

Our estimates of the terms in equation (3) should yield direct information on whether inflation is grease or sand (call these "Story G" and "Story S," respectively). Since these stories are not mutually exclusive, it is possible for either, neither, or both to be true, or they could operate over different levels of inflation.

Story G, which pertains to the wage adjustments of firms with limited downward flexibility, can be described by the following firm's decision problem:

$$\min_w \ \Sigma\alpha(w_i - w_i^*)$$

$$\text{s.t. (1) } \Sigma_i w_i \leq W \qquad \{\text{budget}\}$$

$$\text{(2) } w_i \geq c \ \ \forall i \quad \{\text{downward wage rigidity}\}$$

The firm's goal is to match the market's (or, more generally, some desired) wage movements. We model this as minimizing the weighted sum of differences between wage change offers ($w_i$) and the desired wage changes ($w_i^*$), in the context of an overall wage budget (W) and a rigid wage constraint (c). Without solving for first-order conditions, the two constraints are potentially in conflict. However, when c is a nominal figure (such as 0) and the other parameters respond to inflation, fewer individual wage changes are subject to rigid wage constraint. Thus, inflation relaxes wage rigidity constraints.

Interestingly, downwardly rigid rules may also constrain wage *raises* during periods of low inflation. When the compensation budget (constraint 1) binds, it limits wage adjustments to those that can be balanced elsewhere. Thus, each occurrence of a wage constrained to exceed $w_i^*$ must be made up on other wages. While the traditional story of rigid wages stresses the unemployment consequences, a firm might choose to limit higher-than-average desired increases rather than lay off workers. The simple conclusion we note is that binding downward wage rigidities reduce the variance of wage adjustments in two ways: first, by eliminating many wage cuts and second, by restraining increases in order to balance the compensation budget. These restrictions will be evident in intentional components of wages that require occasional, substantial adjustments. An obvious candidate in equation (4) is occupational wage adjustment, $O_{ot}$.

We propose a simple version of Story S: Employers offer different prices for similar goods in high-inflation periods because they disagree on the expected rate of local wage inflation.[8] That is, firms' compensation administrators err more often in calculating the "correct" adjustments as inflation rises because their uncertainty about inflation rises simultaneously. Widespread reliance on employer salary surveys (rather than direct measures of inflation, such as the CPI or GDP deflator) confirms compensation managers' concerns over matching competitors' actions rather than matching an easily observed level of goods inflation.[9] Uncertainty in market wage adjustments may well exceed that of the goods markets due to the limited samples, retrospective nature, and infrequency of salary surveys. Story S is indicated by growing dispersion among employers' forecasts (i.e., larger $a^e_{ft}$ and $O^e_{ft}$) as inflation rises.

### *d. The Impact of Labor Productivity Increases on the Model*

Finally, the analysis below incorporates the realization that general increases in labor productivity have the same institutional impact on wage adjustments as inflation. Since broad-based productivity increases shift out the demand for labor, employers observe other companies' productivity-based adjustments and include them in nominal firm-wide wage adjustments in the same way as they do inflation adjustments. Thus, productivity increases can substitute for inflation in both the grease and sand stories. In light of this, our independent measure of wage change (dMRP, the aggregate increment in the marginal revenue product of labor) is the sum of change in output prices (CPI-U) plus the general increase in labor productivity (output/hour). Ceteris paribus, this sum should approximate the average nominal wage growth in the economy and leave relative wages unaltered.

This point has policy implications to the extent that the grease and sand relationships, or their welfare costs, are nonlinear. Suppose, for example, that story G is true, and the beneficial impact of rising inflation (plus productivity) has a negative second derivative. In that case, the benefits provided by the additional grease due to inflation are diminishing in environments with

---

[8]By contrast, if employers were to agree on some expected inflation rate that proved incorrect, this rate would effectively operate as the true rate and would not distort relative wages among the individual firms.

[9] This focus makes sense because of regional divergence in wage levels and relativities (and the lack of precision of local CPIs), and because goods price movements understate average nominal wage changes by the growth of labor productivity. Indeed, a firm could well be worse off competitively if it were the only one to correctly forecast and incorporate a higher- or lower-than-expected inflation rate into its wage bill.

rapidly growing productivity. Since productivity growth is indisputably beneficial beyond the factors considered here, we focus on the role of inflation while controlling for the productivity.

### *e. Hypothesis Tests for Grease and Sand*

In summary, the nature of the patterns of wage adjustment depend both on the validity of the "story" and on employer reactions. A priori, though, we know little about the precise functional forms exhibited by these two general relationships. They may be flat or steep; they may accelerate or taper off. Using the standard deviations of estimated wage-change coefficients from equation (3) to measure the dispersion of wage-change components, we test two propositions:

1. If Story G is true, as inflation rises from zero, the ability of employers to adjust occupational wage differentials ($O_{ot}$) grows, so the dispersion of the measured occupational adjustment coefficients (estimated in $\gamma$) grows.
2. If Story S affects the labor market, the disagreement among employers ($a^e_{ft}$ and $O^e_{ft}$) should be higher in years of higher wage inflation. Hence, the dispersion of employer-wage adjustment coefficients (estimated in $\beta$) grows.

Other factors could also affect the standard deviations of these components. In particular, large demographic shifts or more rapid diffusion of technology could alter the intensity of pressures for interoccupational wage adjustment. The propositions described above and the analysis presented below implicitly assume that the pressures for these changes are uncorrelated with our measures of inflation.

## 4. Description of the Data

Most previous studies of inflation's impact on prices examine price indices or industry aggregates rather than actual prices. This paper examines annual changes in mean wages for a panel of occupations within firms, i.e., job cells. Only a few publicly available wage data sets provide information on employers, and none of these offer occupational detail plus a long period.[10] This study uses a data set with both desired features, constructed from an annual private wage and salary survey conducted in Cleveland, Cincinnati, and Pittsburgh by the Personnel Department of the Federal Reserve Bank of Cleveland (FRBC) for at least 38 years. The purpose of the survey is to assist in annual salary budgeting at the FRBC. In return for their participation, surveyed companies receive result books for their own use.

Table 2 describes the basic dimensions of the CSS wage-change data set. The complete CSS data set has 80,301 job-cell-years of mean wage observations.[11] From these data, we compute annual wage changes for each job cell observed in adjacent years, creating a total of 67,885 wage-change observations.[12] Each observation gives the change in the log of the mean or median salary for all individuals employed in an occupation by an employer in the city.[13] Cash bonuses are included as part of the salary, although fringe benefits are not. From 1956 though 1992, wages increased at the rate of about 5 percent per year, with a standard deviation of 0.083 log wage points.

Participants in each city are chosen by the FRBC to be representative of employers in the area. The number of companies participating on an ongoing basis has grown over time from 66

---

[10]See Hotchkiss (1990) for a summary of data sets with information on employers. For example, the microdata collected in Industry Wage Surveys and Area Wage Surveys by the Bureau of Labor Statistics have occupational detail but are not easily linked over time or preserved for long periods. Unemployment Insurance ES-202 data, when available, report individuals' earnings, not wages, and lack occupational detail. The Longitudinal Research Database, maintained by the Center for Economic Studies, goes back to 1972, but covers only manufacturers and provides only mean establishment earnings for production and nonproduction workers, with no occupational detail.

[11]Unfortunately, books for some cities in some years were not found. Thus, the data set does not include observations on those cities in those years. No observations are available for 1966 and 1970.

[12]Job-cell-year observations where the calculated change in log wages exceeds 0.50 in absolute value are deleted from the sample on the assumption that most of these arise from reporting or recording errors. This eliminates 193 observations. It also considerably reduces the variance of wage changes without causing any qualitative change in the estimated coefficients reported here. Approximately 1,000 observations are imputed from cases where job-cells are observed two years apart. The imputed one-year changes are simply half of the two-year differences. Many of the results reported here were also run without the imputed observations. Their inclusion does not affect the results.

[13]Medians were recorded from 1974 through 1990. Since medians should be more robust to outliers, our results use means through 1974 and medians for the years thereafter. Comparison of the coefficients estimated separately for means and medians for the years where both were available (1974 and 1981-1990) suggests that they are highly correlated (correlation coefficients of .97 to .99). However, coefficients estimated on the medians appear to show more variation than those estimated on means and are more highly correlated over time. The latter two characteristics are consistent with medians being a more robust measurement of central tendency.

to 96 per year. Cincinnati companies usually make up about one-quarter of the sample, with Cleveland and Pittsburgh evenly represented in the balance. Overall, 192 companies have participated in the survey at one time or another, for an average of just under 13 years each (with individual companies' participation ranging from one to as many as 35 years). The number of participating employers per year is shown in table 3.

Each participating firm judges which of its establishments to include in the survey, depending on its internal organization. Some include workers in all branches in the metropolitan area; others report wages for only the office surveyed. The discussion below uses "employer," a purposely vague term, to mean the employing firm, establishment, division, or collection of local establishments for which the participating entity chooses to report wages.[14]

The industries included vary widely, although the emphasis is on obtaining employers with many "matches," i.e., employees in the occupations surveyed. The employers surveyed include government agencies, banks, manufacturers, wholesale and retail trade companies, utilities, universities, hospitals, and insurance firms. These are generally large employers.

The number of occupations surveyed each year ranges from 43 to 100. (In this analysis, each occupation in each city is counted as a separate occupation; thus, the total number of "occupations" exceeds the number surveyed.) On average, each employer reports wages for 27 occupations per year. The surveyed occupations are almost exclusively nonproduction jobs, because these are the jobs that can be found in all industries. They include office (e.g., secretaries and clerks), maintenance (e.g., mechanics and painters), technical (e.g., computer operators and analysts), supervisory (e.g., payroll and guard supervisors), and professional (e.g., accountants, attorneys, and economists) occupations. Many of the occupations are divided into a number of grade levels reflecting different degrees of responsibility and experience. Job descriptions for each occupation are at least two paragraphs long.

[14]Since a participant's choice of the entities to include presumably reflects those for which wage policies are actually administered jointly, the ambiguity here is not particularly troublesome.

One reasonable concern is that the survey could be an unrepresentative sample of the cities' employers. This was checked by comparing wages in the survey to the Bureau of Labor Statistics' (BLS) Area Wage Surveys (AWS) in the same years for the same cities. The AWS also oversamples large employers. Movements of mean wages for similar occupations were highly correlated across the two surveys, and levels were usually within 5 percent of one another.

Although the survey has been conducted annually, the month for which data are collected has changed several times since 1955. Throughout this paper, we observe the following convention: Results for any year refer to the period of time between the preceding survey and the one conducted in that year. In most cases, this is a 12-month span, but occasionally the period is less or more than a year. The appendix lists the periods included in each "year" of the CSS. All data merged in have been adjusted (to the extent possible) to reflect time spans consistent with those in the CSS.

Cleveland, Cincinnati, and Pittsburgh are more urban, have more cyclically sensitive employment, and have undergone more industrial restructuring than the nation as a whole. Prior to the 1980s, wages in these three cities were higher than the national average, but now they are approximately average for the country.

We also use standard measures of inflation and national output per hour in our analysis. As a measure of general inflation experienced in the country, we use percentage changes in the monthly averages of the BLS Consumer Price Index for all Urban Workers (CPI-U).[15] Our productivity measure is the BLS nonfarm business sector output per hour worked.

Annual mean log wage changes for each city appear in table 3. Although some variations are evident, mean wage changes among the three cities are highly correlated. But do they bear any relation to national trends? Figure 1 plots the three-city mean log wage change over time, along with a simple measure of wage flexibility derived from equation (2). This variable, labeled dMRP, equals the sum of inflation (CPI-U) and aggregate labor productivity. CSS mean wage

[15]Experiments with the individual city CPIs yielded very similar results. For ease of exposition, we report only the results obtained with the national CPI.

changes trended steadily downward from 1957 to 1966. During that time, CSS raises exceeded increases in the CPI-U, but productivity was growing fairly rapidly. From 1966 through 1973, wage and CPI-U increases both accelerated (with wages leading the way), despite the 1969-70 recession and a brief respite caused by the imposition of wage and price controls in 1971. The relaxation of controls and the oil embargo in 1974 were followed by a dramatic spurt of wage and price increases, which then subsided until 1978, when price increases again reached into the double digits. Average productivity also dropped during four years of the seventies, and CSS wage increases did not keep up with prices. The 1980 and 1981-82 recessions ushered in a period of declining wage and price increases during which CSS wages grew faster than inflation. In 1987, price increases reversed trend and jumped ahead of CSS wage gains, peaked in 1990, and are now headed back down.

The institutional model presented above suggests that expected or perceived changes in the cost of living and productivity are employers' primary considerations in the structuring of annual wage increases. From a budgetary standpoint, both inflation and productivity increases represent sources of revenue for compensation. Figure 1 confirmed the general synchronization of CSS wage changes with general price increases and productivity gains. This observation can be formalized with overall correlations among the indicators charted in figure 1 (plus expected inflation), as shown in table 4. The correlations between mean CSS wage adjustments and the CPI-U and dMRP (0.84 and 0.74, respectively) are quite high. But changes in labor productivity are negatively, not positively, correlated with wage changes over these four decades. This anomalous correlation has been noted before and is due to the high-inflation, low-productivity recessions of the seventies and early eighties.[16] Nevertheless, figure 1 and table 4 support the characterizations made here about the process of wage setting during the period.

This figure demonstrates that wages in the CSS largely adhere to national trends, and thus may enlighten us about the behavior of wages in the nation as a whole. It also puts the

[16]See Eberts and Groshen (1991) for an example of similar results.

remainder of the analysis in some historical perspective, lest we forget the major influences on wages and prices that underlie our research.

## 5. The Components of Wage Adjustment

In section 2, we argued that wage adjustments have significant, distinguishable employer and occupation components. In the present section, we verify that assertion empirically, with an analysis of variance (ANOVA) of wage adjustments of the CSS sample (see table 5) based on equation (3). The first column lists sources of variation, and the second column lists each source's degrees of freedom. The data include three cities over 37 years. Thus, average annual city-year wage changes absorb 103 degrees of freedom. Since three cities are represented in the sample, occupation and city are interacted (accounting for 5,358 degrees of freedom) to avoid restricting all three cities to have the same occupational wage movements. Employers' mean annual wage movements absorb another 2,771 degrees of freedom.

The third column lists each source's marginal contribution to the model sum of squares (over the contributions of the sources listed above it on the table). We choose this method of presentation because of its parsimony when the data are unbalanced (i.e., the number of observations in each group is not fixed). The results are similar to a stepwise regression. If joint effects are large (such as between occupation and employer in wage levels, as shown in Groshen [1991a, 1991b]), the order of presentation is crucial and a stepwise presentation can be misleading. Surprisingly, estimates of joint effects among these sources of wage-change variation (particularly occupation and employer) are minuscule; thus, the order of presentation is not qualitatively important. Introduction of occupation after employer would change little in this table.

All together, the model accounts for 27.9 percent of the variation in annual wage adjustments. That is, the $R^2$ for the regression shown in equation (3) is .279. The residual variation in wage changes is presumably due to compositional changes and individual merit raises. The fifth column of the table shows that slightly more than one-fifth of the equation's explanatory power is due to changes common to all job cells in each year. Intercity differences, while statistically significant, do not account for much of the variation here. Occupation-wide changes, on the other hand, constitute more than one-quarter of observed variation. By far the strongest effect is employer-wide changes, which account for almost half of the explained variation and 13.1 percent of total variation. F-statistics for these five sources of variation are all significant at the 1 percent level or less.

This decomposition suggests that the institutional model described above may provide a useful framework for understanding wage adjustments. We do observe distinguishable occupation-wide and employer-wide variations in wage changes. In particular, the firm-wide wage movements are interesting because they are such a large component and because employer wage differentials are generally quite stable (Groshen [1991b]), suggesting that these may be errors and corrections.

To the extent that employers consider their company-wide and occupational wage adjustments separately and the relevant information for the two come from independent sources, the standard deviations of these two wage change components will be uncorrelated over time. Table 6 presents correlations of the annual standard deviations of the three components of wage changes, pooling the three cities together. These correlations are all positive, suggesting that some factors affect the variation of the components similarly. However, as the model suggests, the intertemporal patterns of dispersion of the employer and occupation components are only moderately correlated. The higher correlations of the standard deviations of the residual and occupational components suggest that some adjustment of occupational differentials may not occur uniformly across employers.[17]

[17] Alternatively, such shifts in relative wages among occupations may stimulate simultaneous compositional changes among job cells. That is, employers may accompany adjustments in relative wages with some occupational reorganization of their workforces.

## 6. Inflation's Impact on Employer and Occupation Wage Adjustments

With this evidence that the proposed framework is reasonably consistent with the CSS data, we turn to asking how these sources of wage adjustment dispersion vary with inflation. All specifications use the ANOVA results shown in table 5. In each city-year, the total variation of wage changes was decomposed into three components, as shown in equation (3): occupation-wide changes, employer-wide changes, and the residual. In this second stage, we regress the standard deviation of the components on the level of general wage increases (the city-year mean CSS wage adjustment) or the sum of inflation and productivity increases (dMRP). For brevity and because we have few unambiguous predictions for the behavior of the composite residual term, we report results only for the occupation and employer components of wage changes. To confirm the robustness of our findings, we also perform nonparametric, filtered, and panel versions of these tests. Each of these enhancements is discussed in turn.

### *a. The Basic Relationship*

Table 7 presents the results of basic quadratic regressions of our two dependent variables (the standard deviation of employer and occupation wage adjustments, whose means are shown in table 6) on the two proxies for overall wage movement. To assist the reader with the slopes over the relevant range, we report the implied value of the independent variable at the maximum or minimum at the bottom of each table.

Column 1 of table 7 suggests a U-shaped (with a minimum at 2.2 percent) relationship between the dispersion of employer wage adjustments and the city-year mean. In contrast, column 2 suggests an inverted U-shape (peaking at 13.4 percent) between employer disagreement and dMRP. Interestingly, mean CSS adjustment--an internal measure of wage change--has less explanatory power (lower R-squared) than dMRP--the external measure.

While neither quadratic term is independently significant, in both cases the combination of the two terms is significantly related, as indicated by the F test for joint significance. Thus, while the exact specification is not strongly supported, there is a clear relationship between the level of inflation and the standard deviation of employer wage adjustments. Indeed, plots of the predicted relationships (as discussed below), over the range in which we actually observe mean CSS adjustment and dMRP (3 to 10 percent), show that the shapes described in columns 1 and 2 track each other fairly well; both slope upward fairly steeply. These results suggest that employer disagreement (including their errors--our measure of the sand story) rises substantially as mean nominal wage increases rise from 3 to 10 percent. However, the lack of consistency between the coefficients on internal (mean CSS change) and external (dMRP) measures of wage increases tempers our ability to say whether the disagreement tapers off or accelerates at higher rates of inflation.

Columns 3 and 4 apply the same analysis to occupational wage changes, estimating the amount of grease added to the system by inflation. In this case, estimates based on the internal and external measures agree on a statistically significant, inverted U-shaped relationship (maximized at 10 to 11 percent) between mean wage changes and occupational wage adjustments. Again, the external measure (dMRP) appears to have more explanatory power. Indeed, both terms in the dMRP specification are significant, providing fairly strong, consistent evidence that while inflation may grease the wheels of occupational adjustments, any benefits are limited.

The relationship between dMRP and the variability of these two components of wage adjustment is best shown graphically. The graphs also allow us to confirm that the quadratic functional form imposed in the basic regressions is reasonable, because we plot nonparametric estimates of the relationships alongside the predictions of the parametric regression.

Figures 2A to 2D plot the implied relationships shown in table 7, along with nonparametric regression predictions.[18] These comparisons suggest that the standard deviations of employer and occupational wage adjustment both increase with dMRP and the CSS mean, and that the basic quadratic specification we employ describes the shapes of the functional

[18] We choose the LOWESS smoother with a bandwidth of one, proposed by Cleveland (1979), for its robustness with respect to both axes. Various bandwidths for 0.2 to 1 were tried, with little variation in effect. Cleveland recommends a bandwidth of 1, due to the tri-cube weighting already included in the LOWESS technique. See Härdle (1990) for comparisons of nonparametric regression techniques.

relationships reasonably closely. The frequency of observations is partly indicated by the density of tick marks for the nonparametric regression: Tick marks are plotted at each observation, but some overlap. Generally, the nonparametric regressions confirm the parametric results; however, the potential importance of outliers in this specification is made clear in figure 2D.

Over the observed range of dMRP and mean CSS changes (3 to 10 percent), each of the plots indicates a positive relationship. The upward slope for employer variability appears markedly steeper than that for occupational variability, particularly at higher rates of inflation. We also note that although the standard deviation of occupational wage changes reaches a maximum at mean wage changes of 10 to 11 percent, the curves' flatness suggests that little is gained beyond rates in the neighborhood of 6 to 7 percent. Allowing for mean productivity annual growth of about 2 percent, these results imply that any benefits conferred by inflation are exhausted after rates of about 4 to 5 percent.

Under the model advanced above, our results suggest that the disruptive sand from additional inflation (as measured by the standard deviation of employer wage adjustments) increases rapidly as the level rises, while the potentially beneficial grease (as measured by the standard deviation of occupational wage adjustments) shows a slower and even diminishing relationship with nominal wage growth.

### *b. Filtered Results*

A significant concern with the basic specification is whether the ANOVA in the first stage correctly identifies the underlying factors we want. That is, are employer wage changes largely short-term errors and corrections, while occupational movements are market-driven adjustments? Equation (4) clearly indicates that undesired terms may creep into terms collected by the ANOVA estimates. Though we give a number of specific reasons why we believe these corrupting factors are small, we explicitly try to correct for them in this section.

We use the nature of the corrupting factors to filter out their effects. Specifically, the potential corruption to the employer component is the possibility that firms alter their long-term "market position," a decision that is treated as uncommon in the compensation literature. This suggests filtering out firms' long-term adjustments to emphasize their higher-frequency errors. Similarly, occupationally correlated errors could corrupt the occupation components. Eliminating high-frequency changes should leave a purer measure of the presumably longer-term adjustments of the occupational wage structure to shifts in supply or demand.

We use the filters on the first-stage regression coefficients obtained from the ANOVA. Then we calculate standard deviations for the filtered employer and occupation components and run the same basic quadratic specifications. The results, shown in figures 3A to 3D, generally confirm the results found for the unfiltered components. A minor exception is figure 3C, where the filtered relationship turns down more steeply. The levels of variation in the filtered components are lower, as would be expected. We take these results as confirmation of the appropriateness of using the ANOVA procedure rather than replacing the unfiltered results, because the filtering process undoubtedly eliminates much of the desired variation in the components.

### *c. Panel Estimates*

Alternatively, the skeptic may fear that the relationships we find stem from a spurious correlation between inflation and wage-change variability, which could arise from some employers adjusting wages biannually, or from sample drift. To address these issues, we obtain panel estimates (rather than measuring associations between aggregates) because the panel specification allows us to control for two classes of spurious correlation.

In contrast to the basic model, the panel estimates correlate the absolute deviations (rather than standard deviations) of occupation and employer components of wage adjustments with inflation. For the occupation regressions, we begin by calculating each occupation's absolute deviation from the mean wage adjustment in the city and year. Employer absolute deviations are constructed similarly. The mean of these terms (the mean absolute deviation) is comparable, though not identical, to a standard deviation. We then regress the absolute deviations of the cells on dMRP and two kinds of controls. The predictions of these regressions are the conditional mean absolute deviations.

We estimate the following regressions:

$$\begin{matrix} abdevoc_{i,t} \\ abdevem_{j,t} \end{matrix} = \begin{bmatrix} \delta_i \\ \delta_j \end{bmatrix} + \theta \begin{bmatrix} abdevoc_{i,t-1} \\ abdevem_{j,t-1} \end{bmatrix} + \varphi_1 dMRP_t + \varphi_2 dMRP_t^2,$$

where $abdevoc_{i,t}$ and $abdevem_{j,t}$ represent the absolute value of the occupation and employer components for a given cell, the δ's are firm or occupation fixed effects, and t-1 indicates the lagged dependent variables. The brackets indicate that those terms are included in only some of the regressions.

In the simplest specification (without fixed effects or lagged terms), the panel estimates roughly duplicate the basic results shown in table 7, because the inflation rate is the same for all cells in a particular year. However, the panel data setting allows us to control for two key types of extraneous covariation: correlation in firm decisions across adjacent years, and fixed occupation or employer effects. Including fixed effects controls for some firms' or occupations' long-run propensity to deviate more or less than others. Lagged terms control for the previous period's adjustment in that occupation or firm. These controls should handle, for example, the case of a firm that adjusts its wages only in alternate years--leading to an oscillation between large positive and negative adjustments relative to other firms that adjust their wages more frequently. The controls also account for sample drift in the survey's occupations or employers over time.

Tables 8A and 8B show the results of these regressions for the occupation and employer components, respectively. The reported regressions are for dMRP. Regressions using the internal wage inflation variable are comparable. Specification 1 in tables 8A and 8B (the panel equivalent of the regressions in table 7) provides a basis for identifying the impact of the controls. Specification 2 includes lagged dependent variables. Specification 3 includes fixed effects for the occupation or employers, in combination with the employer's city. Specification 4 includes both forms of controls.

Not surprisingly, since we are regressing a large cross-section of micro observations on a single macroeconomic series, we obtain a very low $R^2$ in specification 1. While the cell wage components show tremendous heterogeneity, the aggregate relationships we detected earlier between dMRP and the variation in employer and occupation wage adjustment components hold in all specifications. From a statistical view, the correspondence between larger deviations during periods of higher inflation and aggregate productivity is strongly confirmed at the firm and occupation level.

Strikingly, even though adding controls improves the explanatory power of these regressions, coefficients on dMRP and its square prove stable. While the coefficient estimates vary somewhat between specifications, they are consistent with each other and with the previous estimates. The qualitative impact of the specification changes can be noted in the bottom two rows of each table, which show the implied slopes within the observed range of dMRP and dMRP at the implied maxima. Table 8A shows that the slope of the predicted relationship falls by less than 1 percentage point with the introduction of controls. The implied peak shifts back slightly more, from about 7 percent to 5.2 percent. These results imply that the beneficial impact of inflation may be exhausted at lower rates than those indicated in the basic model, but the two sets of findings are otherwise consistent.

Similarly, panel estimates in table 8B support earlier indications that the employer variation is even more strongly affected by inflation in the relevant range (implied slopes being roughly twice those observed for interoccupational variability). Again, lags and employer fixed effects have little qualitative impact on coefficient estimates. According to these results, the disruptive sand caused by inflation continues to mount at least until dMRP levels of 8 to 12 percent--far beyond levels where the beneficial grease is maximized--and shows less evidence of a turndown at high inflation levels.

In summary, the robustness of the results to these panel controls rules out a wide variety of spurious correlations, increasing confidence in our basic results. We have tested more explicitly whether job cell wage-change components deviate more when the level of inflation allows more latitude for wage adjustments, and the results are affirmative.

## 6. Summary and Conclusions

This paper explores inflation's impact on the labor market with an eye toward distinguishing positive effects (greasing the wheels by facilitating real wage adjustments to shocks) from the negative ones (throwing sand in the gears by distorting relative wages). We study wage changes in a panel of occupations and employers (from the Federal Reserve Bank of Cleveland CSS) lasting from 1956 through 1992.

The analysis, governed by an institutional model of wage adjustments, focuses on differences between the behavior of employer wage adjustments and occupation-wide movements. We interpret the former as being more likely to include errors and corrections, or deviations in speed of adjustment, while the latter has a higher concentration of market-driven relative price adjustments. Relying on this distinction to interpret our results, we estimate the relationship between the standard deviation of employer and occupation wage adjustments and two measures (internal and external) of inflation. We also note that in this model, general productivity increases play the same role as inflation, with the same costs and benefits. However, since productivity growth, unlike inflation, has unambiguous benefits beyond the scope of this exercise and is not a direct monetary policy target, we focus on the implications of our research for inflation policy.

We examine the data in various ways to confirm the consistency of the model with observables. In support of the model, we find that in the CSS: 1) As predicted by employers' responses about how they determine wage levels, annual mean wage adjustments are highly correlated with external measures of inflation and productivity growth. 2) An ANOVA of annual wage adjustments among job cells suggests that employer and occupation components of wage changes both play large, statistically strong, independent roles. 3) Over time, the standard deviation of employer adjustments and occupation adjustments has a correlation coefficient of 0.475; this suggests that, while these two types of dispersion may have some common influences, they often move independently of each other.

In our analysis of the relationship between inflation (along with labor productivity increases) and these two kinds of wage change dispersion, we find the following:

(1) *Is inflation grease?* Higher inflation and labor productivity appear to increase the range of occupational wage adjustments, although these potential benefits taper off after inflation rates of about 4 percent (assuming labor productivity growth of 1.5 percent, the average rate over the period observed).

(2) *Is inflation sand?* Higher inflation and labor productivity are associated with higher, potentially inefficient variation in employer wage adjustments. The variation between employer wage adjustments rises about twice as quickly as occupational variation with respect to inflation and shows less evidence of a turndown at high inflation levels.

Thus, we conclude by answering the question posed in the title with "yes, on both counts; inflation can act as both grease and sand." Evidence from the CSS suggests that moderate inflation (below about 4 percent) speeds the transmission of interoccupational wage adjustments. But inflation also exacerbates potentially confusing errors and corrections, or lagged adjustments, in employers' wage policies. These costs of inflation have a steeper slope and a later peak over the range observed in this study, suggesting that inflation's costs continue to rise long after its potential benefits have been exhausted.

We think these findings add a unique micro-level perspective to aggregate-level research on the relationship between inflation and productivity or income growth--studies that skip over the mechanisms involved but presumably measure the net impact of grease plus sand on the entire economy. Rudebusch and Wilcox (1994) review and extend these analyses on U.S. (and international) time series data. They tentatively conclude that the level of inflation had a negative correlation with productivity growth from 1954 through 1993, suggesting that the disruptive impact of inflation outweighs benefits obtained from greasing the wheels.[19]

Since we do not consider impacts of inflation beyond the labor market, our study cannot estimate inflation's net effect on overall productivity. However, within the labor market, our

[19] Interestingly, if monetary authorities acted as if they were aware of the relationships identified in this study, they might be most likely to allow moderate inflation during periods of exogenously low productivity growth. Such considerations would also generate a negative correlation between inflation and productivity, as observed by Rudebusch and Wilcox (1994).

study is the first to investigate the labor market mechanisms involved and to measure the relevant ranges for the grease and the sand hypotheses simultaneously.

Suppose a monetary authority took our results at face value, neglecting other effects of inflation.[20] These findings suggest that optimal inflation targets depend on general labor productivity growth. In times of high growth (say, over 4 percent), inflation's costs in the labor market are virtually certain to outweigh its benefits, so inflation should be kept close to zero. Only during periods of low productivity growth might the benefits of "greasing" the labor market with mild inflation (5 percent or less) be supported.

[20] We also finesse the problem of weighting costs and benefits in the welfare function in order to determine a strategy. Arbitrarily, the rest of the paragraph assumes roughly equal weights between benefits and costs, as measured by raising occupational and firm variability, respectively. Less symmetric weighting schemes would shift the policy recommendations accordingly.

## Appendix

| Salary Survey Year | Salary Survey Coverage |
|---|---|
| 1956 | March 1955 - March 1956 |
| 1957 | March 1956 - March 1957 |
| 1958 | March 1957 - March 1958 |
| 1959 | March 1958 - March 1959 |
| 1960 | March 1959 - March 1960 |
| 1961 | March 1960 -March 1961 |
| 1962 | March 1961 - March 1962 |
| 1963 | March 1962 - March 1963 |
| 1964 | March 1963 - March 1964 |
| 1965 | March 1964 - March 1965 |
| 1966 | March 1965 - March 1966 |
| 1967 | March 1966 -March 1967 |
| 1968 | March 1967 - March 1968 |
| 1969 | March 1968 - March 1969 |
| 1970 | March 1969 - March 1970 |
| 1971 | March 1970 - March 1971 |
| 1972 | March 1971 - March 1972 |
| 1973 | March 1972 - March 1973 |
| 1974 | March 1973 - September 1974 |
| 1975 | September 1974 - September 1975 |
| 1976 | September 1975 - September 1976 |
| 1977 | September 1976 - September 1977 |
| 1978 | September 1977 - September 1978 |
| 1979 | September 1978 - July 1979 |
| 1980 | July 1979 - August 1980 |
| 1981 | August 1980 - June 1981 |
| 1982 | June 1981 - June 1982 |
| 1983 | June 1982 - June 1983 |
| 1984 | June 1983 - April 1984 |
| 1985 | April 1984 - April 1985 |
| 1986 | April 1985 - April 1986 |
| 1987 | April 1986 - April 1987 |
| 1988 | April 1987 - April 1988 |
| 1989 | April 1988 - July 1989 |
| 1990 | July 1989 - July 1990 |
| 1991 | July 1990 - July 1991 |
| 1992 | July 1991 - July 1992 |

## References


Allen, Steven G. "Relative Wage Variability in the United States 1860-1983," *Review of Economics and Statistics*, vol. 69, no. 4 (November 1987), pp. 617-626.

Ball, Laurence and N. Gregory Mankiw. "A Sticky-Price Manifesto," National Bureau of Economic Research Working Paper No. 4677, March 1994.

Bewley, Truman and William Brainard. "A Depressed Labor Market, as Explained by Participants," Cowles Foundation, Yale University, mimeo (February 1993).

Bils, Mark J. "Real Wages over the Business Cycle," *Journal of Political Economy*, vol. 93, no. 4 (1985), pp. 666-689.

Blinder, Alan S. and Don H. Choi. "A Shred of Evidence on Theories of Wage Stickiness," *Quarterly Journal of Economics*, vol. 105 , no. 4 (November 1990), pp. 1003-1015.

Card, David. "Unexpected Inflation, Real Wages, and Employment Determination in Union Contracts," *American Economic Review*, vol. 80, no. 4 (September 1990), pp. 669-688.

Cecchetti, Stephen G. "The Frequency of Price Adjustment," *Journal of Econometrics*, vol. 31 (April 1986), pp. 255-274.

Cleveland, William S. "Robust Locally Weighted Regression and Smoothing Scatter Plots," *Journal of the American Statistical Association*, vol. 79 (1979), pp. 829-836.

Cukierman, Alex. "Relative Price Variability and Inflation: A Survey and Further Results," *Carnegie-Rochester Conference Series on Public Policy*, vol. 19 (Autumn 1983), pp. 103-58.

Drazen, Allan and Daniel S. Hamermesh. "Inflation and Wage Dispersion," National Bureau of Economic Research Working Paper no. 1811, January 1986.

Eberts, Randall and Erica L. Groshen. "Overview," in R. Eberts and E. Groshen, eds., *Structural Changes in U.S. Labor Markets* (M.E. Sharpe: Armonk, NY, 1991), pp. 1-12.

Fischer, Stanley. "Relative Shocks, Relative Price Variability, and Inflation," *Brookings Papers on Economic Activity*, vol. 12, no. 2 (1981), pp. 381-442.

Freedman, Audrey. *The New Look in Wage Policy and Employee Relations*, The Conference Board, Report No. 865, 1976.

Groshen, Erica L. "Sources of Intra-Industry Wage Dispersion: How Much Do Employers Matter?" *Quarterly Journal of Economics*, vol. 106, no. 3 (1991a), pp. 869-84.

Groshen, Erica L. "Do Wage Differences among Employers Last?" Federal Reserve Bank of Cleveland, Working Paper 8906, June 1989 (revised 1991b).

Groshen, Erica L. "Five Reasons Why Wages Vary among Employers," *Industrial Relations*, vol. 30, no. 3 (Fall 1991c), pp. 350-81.

Haley, James. "Theoretical Foundations for Sticky Wages," *Journal of Economic Surveys*, vol. 4, no. 2 (1990), pp. 115-155.

Hamermesh, Daniel S. "Inflation and Labour-Market Adjustment," *Economica*, vol. 53 (February 1986), pp. 63-73.

Härdle, Wolfgang. *Applied Nonparametric Regression* (Cambridge University Press: Cambridge, 1990).

Hartman, Richard. "Relative Price Variability and Inflation," *Journal of Money, Credit, and Banking*, vol. 23, no. 2 (May 1991), pp. 185-205.

Hills, Frederick S. *Compensation Decision Making* (The Dryden Press: Hinsdale, IL, 1987).

Holzer, Harry J. and Edward B. Montgomery. "Asymmetries and Rigidities in Wage Adjustments by Firms," National Bureau of Economic Research Working Paper No. 3274, March 1990.

Hotchkiss, Julie L. "Compensation Policy and Firm Performance: An Annotated Bibliography of Machine-Readable Data Files," *Industrial and Labor Relations Review*, vol. 43, no. 3 (February 1990), pp. S274-289.

Kaufman, Roger T. "On Wage Stickiness in Britain's Competitive Sector," *British Journal of Industrial Relations*, vol. 22, no. 1 (1984), pp. 101-112.

Lach, Saul, and Daniel Tsiddon. "The Behavior of Prices and Inflation: An Empirical Analysis of Disaggregated Price Data," *Journal of Political Economy*, vol. 100, no. 2 (1992), pp. 349-389.

Lebow, David E., David J. Stockton, and William L. Wascher. "Inflation, Nominal Wage Rigidity, and the Efficiency of Markets," Division of Research and Statistics, Board of Governors of the Federal Reserve System, mimeo, August 1993.

Levine, David I. "Fairness, Markets, and Ability to Pay: Evidence from Compensation Executives." *American Economic Review*, vol. 83, no. 5 (December 1993), pp. 1241-1259.

McLaughlin, Kenneth J. "Rigid Wages?" unpublished working paper, University of Rochester, April 1991.

Milkovich, George T. and Jerry M. Newman, *Compensation* (BPI-Irwin: Homewood, IL, 1990).

Reinsdorf, Marshall. "New Evidence on the Relation between Inflation and Price Dispersion," *American Economic Review*, vol. 84, no. 3 (June 1994), pp. 720-731.

Rudebusch, Glenn D. and David Wilcox. "Productivity and Inflation: Evidence and Interpretations," Federal Reserve Board, Washington, D.C., unpublished paper (May 1994).

Sheshinski, Eytan and Yoram Weiss. "Inflation and Costs of Price Adjustment," *Review of Economic Studies*, vol. 44, no. 2 (June 1977), pp. 287-303.

Slichter, Sumner and Heinz Luedicke. "Creeping Inflation--Cause or Cure?" *Journal of Commerce*, 1957, pp. 1-32.

Solon, Gary, Warren Whatley, and Ann Huff Stevens. "Real Wage Cyclicality between the Wars: Evidence from the Ford and Byers Companies," University of Michigan, unpublished paper, March 1994.

Stigler, George J. and James K. Kindahl. *The Behavior of Industrial Prices*, National Bureau of Economic Research General Series No. 90 (New York: Columbia University Press, 1970).

Tobin, James. "Inflation and Unemployment," *American Economic Review*, vol. 62, no. 1 (March 1972), pp. 1-18.

Vining, Daniel R. and Thomas C. Elwertowski. "The Relationship between Relative Prices and the General Price Level," *American Economic Review*, vol. 66, no. 4 (September 1976), pp. 699-708.

Wallace, Marc, J., Jr., and Charles H. Fay, *Compensation Theory and Practice*, (PWS-Kent: Boston, 1988).

Table 1

## Factors Influencing Wage and Salary Budgets

| | Nonexecutive, Exempt | | | Nonunion, Hourly | | |
|---|---|---|---|---|---|---|
| | Manufacturing | | | Manufacturing | | |
| | Consumer | Industrial | Banks | Consumer | Industrial | Banks |
| Area surveys | 48% | 41% | 57% | 46% | 40% | 39% |
| Cost-of-living index | 39 | 30 | 24 | 26 | 25 | 18 |
| Corp. financial results | 31 | 50 | 45 | 21 | 19 | 30 |
| Corp. financial prospects | 30 | 37 | 41 | 16 | 18 | 30 |
| Internal equity among employee groups | 27 | 27 | 15 | 24 | 10 | 8 |
| Worker productivity | 15 | 16 | 34 | 9 | 5 | 20 |
| Increases given by industry leaders | 30 | 35 | 13 | 23 | 11 | 3 |
| Ability to hire | 15 | 19 | 11 | 8 | 11 | 6 |
| Nationally bargained settlements | 6 | 5 | 1 | 20 | 17 | 3 |
| Union demands | 10 | 4 | – | 15 | 17 | – |

Note: Multiple answers were allowed, so percentages do not sum to 100.
Source: Freedman (1976).

Table 2

**Description of the Annual Wage Adjustment Data Set**
**Drawn from the CSS, 1956-1992**

| | |
|---|---|
| Total Number of Job-Cell Wage Adjustments Observed | 67,885 |
| Number of Years | 36 |
| Average Number of Observations Per Year | 1,886 |
| Mean Log Wage Adjustment | 0.050 |
| Standard Deviation of Log Wage Adjustment | 0.083 |
| Number of Occupations Ever Observed | 166 |
| Number of Occupation*City*Year Observations | 5,271 |
| Avg. No. of Occupation*City Observations Per Year | 146 |
| Number of Employers Ever Observed | 192 |
| Number of Employer-years | 2716 |
| Average Number of Employers Per Year | 75 |

Note: All numbers reported are for the first-differenced data set.
Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Table 3

**Description of Data by Year**

| | Number of: | | | Mean Log Wage Adjustment in: | | |
|---|---|---|---|---|---|---|
| End Year | Job cells | Occupations | Employers | Cleveland | Cincinnati | Pittsburgh |
| 1957 | 1,336 | 94 | 73 | 0.051 | 0.046 | 0.045 |
| 1958 | 1,557 | 94 | 83 | 0.049 | 0.054 | 0.050 |
| 1959 | 1,714 | 103 | 88 | 0.040 | 0.048 | 0.070 |
| 1960 | 1,669 | 103 | 86 | 0.036 | 0.032 | 0.034 |
| 1961 | 1,701 | 103 | 88 | 0.039 | 0.035 | 0.036 |
| 1962 | 1,881 | 109 | 93 | 0.024 | 0.022 | 0.024 |
| 1963 | 1,910 | 112 | 90 | 0.019 | 0.026 | 0.024 |
| 1964 | 2,032 | 113 | 96 | 0.026 | 0.022 | 0.023 |
| 1965 | 2,123 | 124 | 95 | 0.021 | 0.026 | 0.010 |
| 1966 | 1,965 | 125 | 89 | 0.040 | 0.045 | 0.038 |
| 1967 | 1,967 | 125 | 89 | 0.037 | 0.042 | 0.035 |
| 1968 | 2,128 | 124 | 94 | 0.046 | 0.044 | 0.042 |
| 1969 | 1,972 | 114 | 97 | 0.066 | 0.050 | 0.049 |
| 1970 | 853 | 49 | 36 | 0.068 | * | * |
| 1971 | 854 | 49 | 36 | 0.061 | * | * |
| 1972 | 1,262 | 66 | 38 | 0.061 | * | * |
| 1973 | 1,477 | 90 | 57 | 0.056 | 0.095 | * |
| 1974 | 1,335 | 96 | 73 | 0.126 | 0.084 | 0.139 |
| 1975 | 1,379 | 101 | 73 | 0.074 | 0.063 | 0.090 |
| 1976 | 1,391 | 104 | 72 | 0.065 | 0.057 | 0.078 |
| 1977 | 789 | 60 | 72 | 0.030 | 0.021 | 0.052 |
| 1978 | 1,674 | 197 | 68 | 0.052 | 0.063 | 0.066 |
| 1979 | 2,418 | 267 | 75 | 0.064 | 0.071 | 0.069 |
| 1980 | 2,689 | 295 | 79 | 0.095 | 0.074 | 0.087 |
| 1981 | 2,196 | 186 | 83 | 0.086 | 0.089 | 0.059 |
| 1982 | 2,185 | 193 | 82 | 0.072 | 0.092 | 0.078 |
| 1983 | 2,013 | 190 | 75 | 0.050 | 0.055 | 0.073 |
| 1984 | 2,274 | 213 | 80 | 0.047 | 0.058 | 0.063 |
| 1985 | 2,272 | 212 | 79 | 0.040 | 0.044 | 0.042 |
| 1986 | 2,396 | 220 | 82 | 0.042 | 0.044 | 0.037 |
| 1987 | 2,437 | 226 | 80 | 0.031 | 0.037 | 0.038 |
| 1988 | 2,401 | 222 | 82 | 0.036 | 0.037 | 0.023 |
| 1989 | 2,407 | 225 | 81 | 0.045 | 0.041 | 0.036 |
| 1990 | 2,505 | 222 | 84 | 0.052 | 0.046 | 0.024 |
| 1991 | 2,536 | 223 | 89 | 0.038 | 0.045 | 0.035 |
| 1992 | 2,187 | 222 | 80 | 0.039 | 0.045 | 0.043 |
| Total | 68,839 | 5,462 | 2,875 | 0.050 | 0.052 | 0.048 |

* In 1970-72, the CSS is missing Cincinnati; in 1970-73, the CSS is missing Pittsburgh.
Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Table 4

**Correlation Coefficients between CSS Wage Adjustments and Relevant Economic Indicators**

| | CSS Mean Log Wage Adjustment | Current CPI-U | dMRP | Labor Productivity |
|---|---|---|---|---|
| Current CPI-U* | 0.839<br>(0.000) | | | |
| dMRP* (CPI-U + Prod.) | 0.737<br>(0.000) | 0.861<br>(0.000) | | |
| Labor Productivity* | -0.482<br>(0.003) | -0.601<br>(0.000) | -0.112<br>(0.510) | |
| Mean<br>(Standard Deviation) | 0.051<br>(0.022) | 0.046<br>(0.035) | 0.062<br>(0.028) | 0.015<br>(0.018) |

*Percent change experienced during the period.

Note: Numbers in parentheses below the reported correlation coefficients are the probability that the correlation coefficient equals 0. Total number of observations: 37.

Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Table 5

**ANOVA of Annual Wage Adjustments in the CSS, 1957-1992**

| Source of Variation | Degrees of Freedom | Marginal Contribution to Sum of Squares | Percent of Total Sum of Squares | Percent of Model Sum of Squares | Stepwise F-Statistic |
|---|---|---|---|---|---|
| City | 2 | 0.1 | 0.0 | 0.1 | 10.3 |
| Year | 35 | 27.7 | 6.0 | 21.5 | 123.5 |
| Year*City | 63 | 3.2 | 0.7 | 2.5 | 8.0 |
| Occ*Year*City | 5,270 | 37.5 | 8.1 | 29.1 | 1.2 |
| Employer*Year | 2,716 | 60.4 | 13.1 | 46.9 | 4.5 |
| Model | 8,086 | 128.8 | 27.9 | 100.0 | |
| Residual | 59,798 | 333.3 | 72.1 | | |
| Total | 67,884 | 462.1 | 100.0 | | |

*The three cities are Cleveland, Cincinnati, and Pittsburgh. The years are 1956-1957 through 1991-1992. Overall, 166 occupations are ever surveyed; in the ANOVA, each occupation is counted separately for each city in each year. Similarly, a total of 192 employers are ever observed.

Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Table 6

**Standard Deviations and Correlations of Components of Annual Wage Changes**

| | **Total** | Occupation | **Component:** Employer | Residual |
|---|---|---|---|---|
| Mean Standard Deviation of Wage Adjustments | 0.0775 | 0.0273 | 0.0333 | 0.0670 |
| (Std. Dev.) | (0.0191) | (0.0108) | (0.0130) | (0.0164) |
| **Correlation of Standard Deviation with:** | | | | |
| Occupation Std. Dev. | 0.766 | | | |
| Employer Std. Dev. | 0.676 | 0.475 | | |
| Residual Std. Dev. | 0.965 | 0.719 | 0.479 | |

Note: All correlations are significant at the 0.0001 level. Total number of city-year observations: 104.
Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Table 7

**Wage Inflation and the Standard Deviation of Employer and Occupation Nominal Wage Adjustments**

| | Dependent Variable | | | |
|---|---|---|---|---|
| | Standard Deviation of Wage Adjustment Components: | | | |
| | **Employer** | | **Occupation** | |
| **Model** | **1** | **2** | **3** | **4** |
| Intercept | 0.029<br>(0.006) | 0.012<br>(0.007) | 0.012<br>(0.004) | 0.004<br>(0.005) |
| CSS Mean Adjustment | -0.089<br>(0.176) | | 0.281<br>(0.122) | |
| Squared CSS Mean Adjustment | 2.008<br>(1.328) | | -1.267<br>(0.917) | |
| dMRP* | | 0.394<br>(0.198) | | 0.458<br>(0.136) |
| Squared dMRP* | | -1.475<br>(1.227) | | -2.293<br>(0.843) |
| **Adjusted R-Squared** | 0.107 | 0.138 | 0.111 | 0.151 |
| No. of Observations | 101 | 101 | 101 | 101 |
| F Stat. for joint test, 1% cutoff ≈ 4.82 | 7.01 | 8.97 | 7.22 | 9.86 |
| **Implied Extrema** | | | | |
| CSS Mean Adjustment | Min: 2.2% | | Max: 11.1% | |
| dMRP* | | Max: 13.4% | | Max: 10.0% |

*dMRP is the sum of the annual change in the BLS Consumer Price Index for all Urban Workers (CPI-U) and the BLS Nonfarm Business Sector Output per Hour Worked.
Note: Numbers in parentheses are standard errors.
Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Table 8A

**Wage Inflation and the Standard Deviation of Occupation Nominal Wage Adjustments**

| | Dependent Variable | | | |
|---|---|---|---|---|
| | Absolute Value of the Occupational Wage Adjustment Term: | | | |
| **Model** | **1** | **2** | **3** | **4** |
| Intercept | 0.006<br>(0.0004) | 0.006<br>(0.0004) | 0.009<br>(0.0004) | 0.011<br>(0.0004) |
| Lagged Adjustment | | 0.222<br>(0.0037) | | 0.002<br>(0.0038) |
| dMRP* | 0.245<br>(0.0120) | 0.142<br>(0.0119) | 0.182<br>(0.0107) | 0.117<br>(0.0119) |
| Squared dMRP* | -1.104<br>(0.0749) | -0.578<br>(0.0745) | -0.797<br>(0.0662) | -0.410<br>(0.0680) |
| Fixed Effects Included | None | None | Occupation x City | Occupation x City |
| **Adjusted R-Squared** | 0.0158 | 0.066 | 0.254 | 0.250 |
| No. of Observations | 67,885 | 62,871 | 67,885 | 62,871 |
| **Implied Slope with respect to dMRP*** | | | | |
| Mean ± one STD | 5.45% | 4.29% | 4.45% | 4.62% |
| Min. and max. of data | 6.99% | 5.10% | 5.57% | 5.20% |

*dMRP is the sum of the annual change in the BLS Consumer Price Index for all Urban Workers (CPI-U) and the BLS Nonfarm Business Sector Output per Hour Worked.
Note: Numbers in parentheses are standard errors.
Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

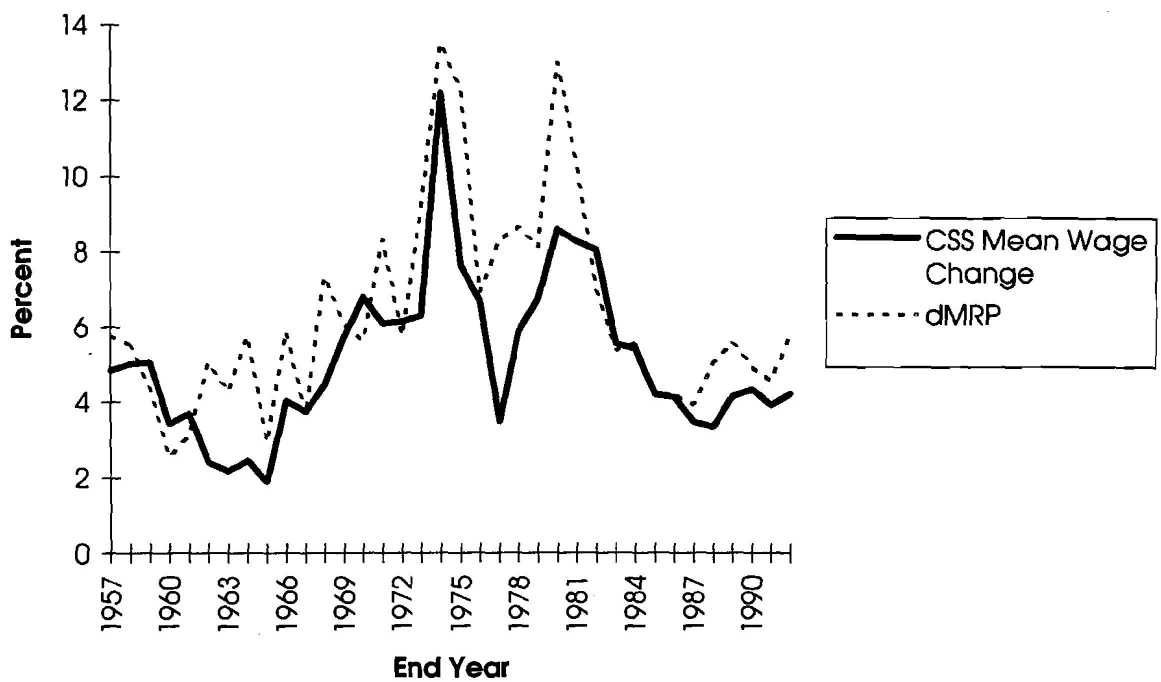
Table 8B

## Wage Inflation and the Standard Deviation of Employer Nominal Wage Adjustments

| | Dependent Variable | | | |
|---|---|---|---|---|
| | Absolute Value of the Employer Wage Adjustment Term: | | | |
| **Model** | **1** | **2** | **3** | **4** |
| Intercept | 0.013<br>(0.0006) | 0.012<br>(0.0005) | 0.013<br>(0.0005) | 0.012<br>(0.0005) |
| Lagged Adjustment | | 0.180<br>(0.0036) | | 0.115<br>(0.0036) |
| dMRP* | 0.148<br>(0.0158) | 0.086<br>(0.0156) | 0.159<br>(0.0153) | 0.116<br>(0.0152) |
| Squared dMRP* | -0.225<br>(0.0986) | -0.028<br>(0.098) | -0.238<br>(0.0946) | -0.134<br>(0.0953) |
| Fixed Effects Included | None | None | Employer x City | Employer x City |
| **Adjusted R-Squared** | 0.0185 | 0.054 | 0.120 | 0.133 |
| No. of Observations | 67,885 | 62,553 | 67,885 | 62,553 |
| **Implied Slope with respect to dMRP*** | | | | |
| Mean ± one STD | 10.94% | 8.07% | 11.85% | 9.33% |
| Min. and max. of data | 11.26% | 8.11% | 12.18% | 9.52% |

*dMRP is the sum of the annual change in the BLS Consumer Price Index for all Urban Workers (CPI-U) and the BLS Nonfarm Business Sector Output per Hour Worked.
Note: Numbers in parentheses are standard errors.
Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

**Figure 1: CSS Mean Wage Change Versus dMRP**




Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Figure 2A: Standard Deviations of Occupational Adjustments Associated with dMRP: Nonparametric and Regression Predictions

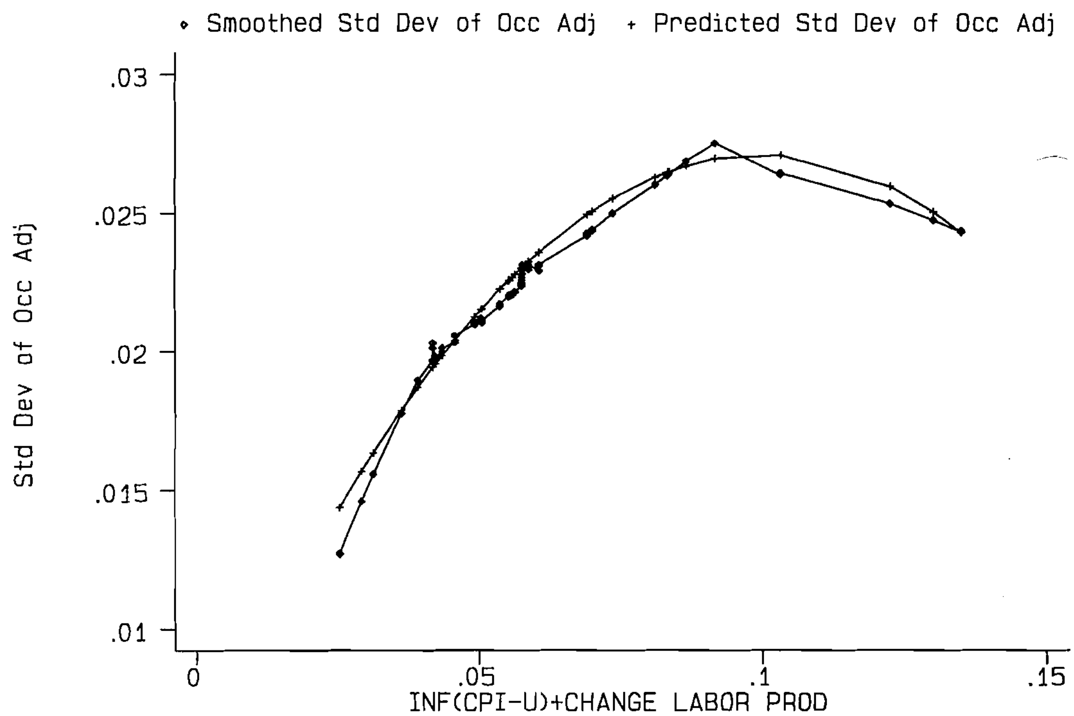
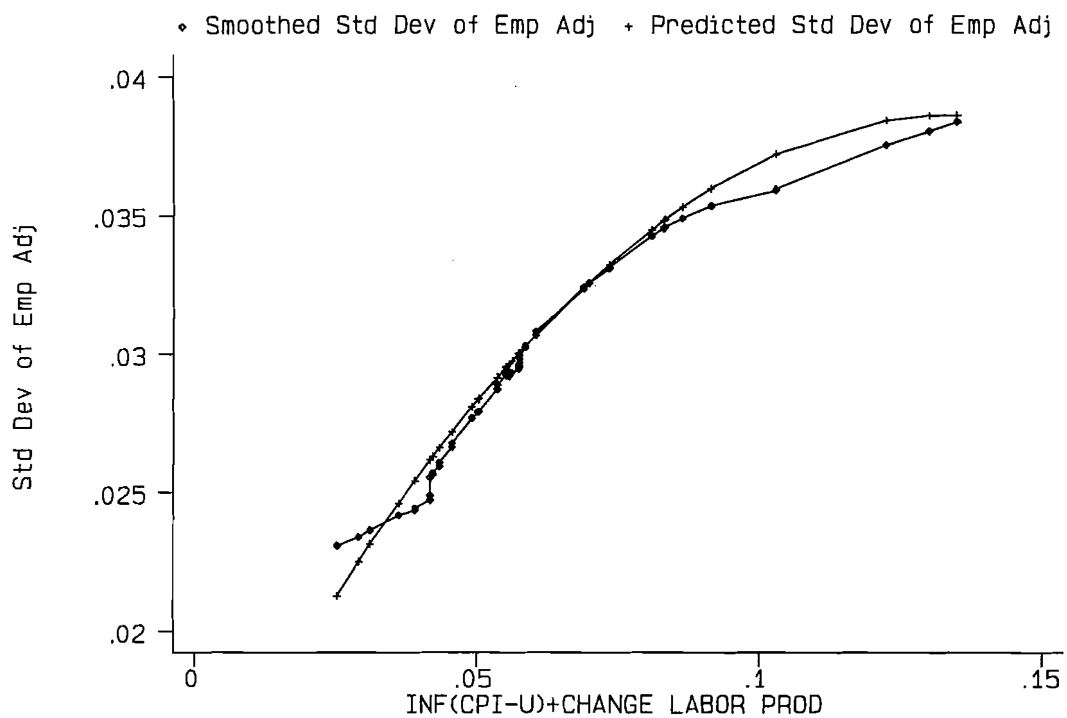



Figure 2B: Standard Deviations of Employer Adjustments Associated with dMRP: Nonparametric and Regression Predictions




Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Figure 2C: Standard Deviations of Occupational Adjustments Associated with CSS Mean Wage Change: Nonparametric and Regression Predictions

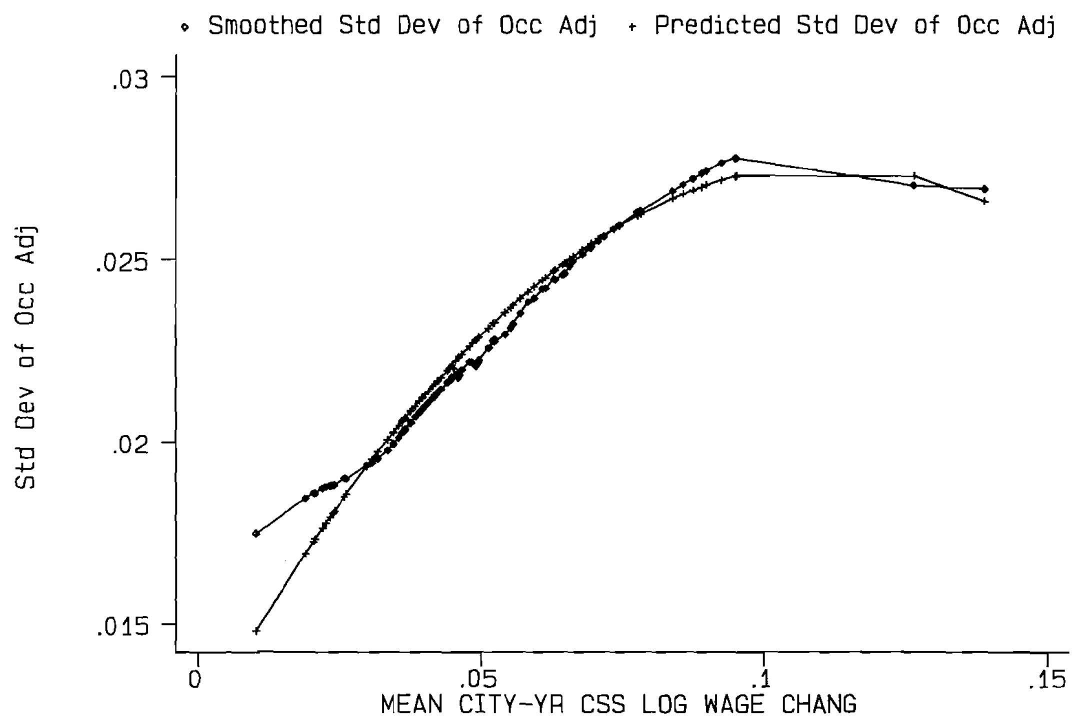
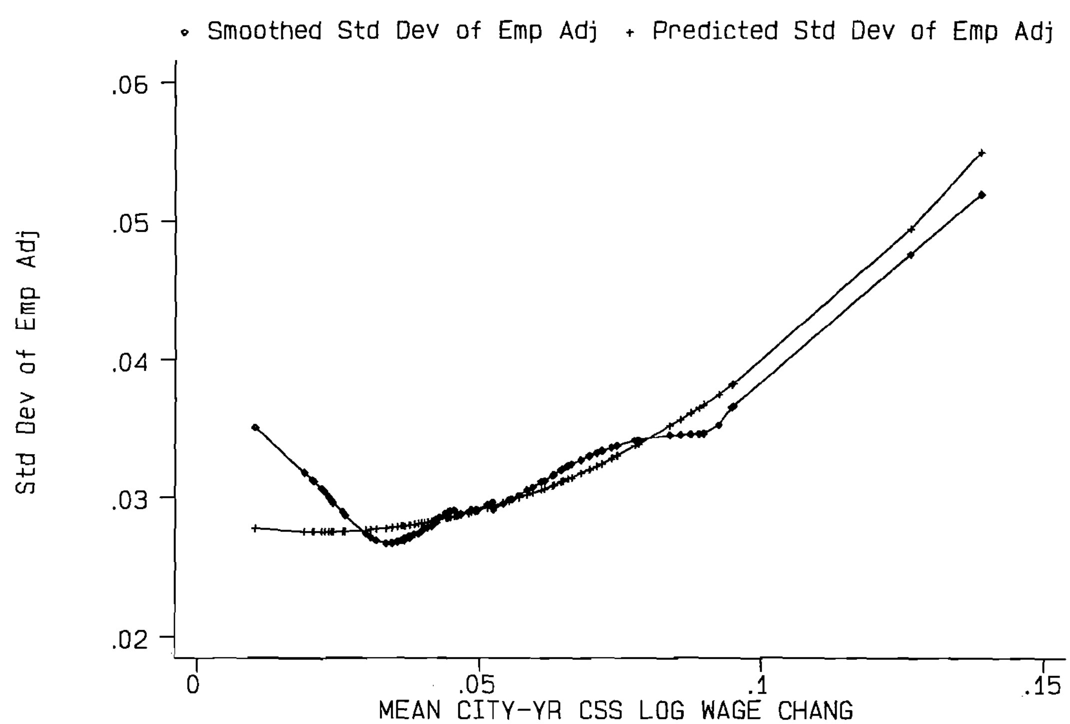



Figure 2D: Standard Deviations of Employer Adjustments Associated with CSS Mean Wage Change: Nonparametric and Regression Predictions




Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Figure 3A: Standard Deviations of Long-Run Occupational Adjustments Associated with dMRP

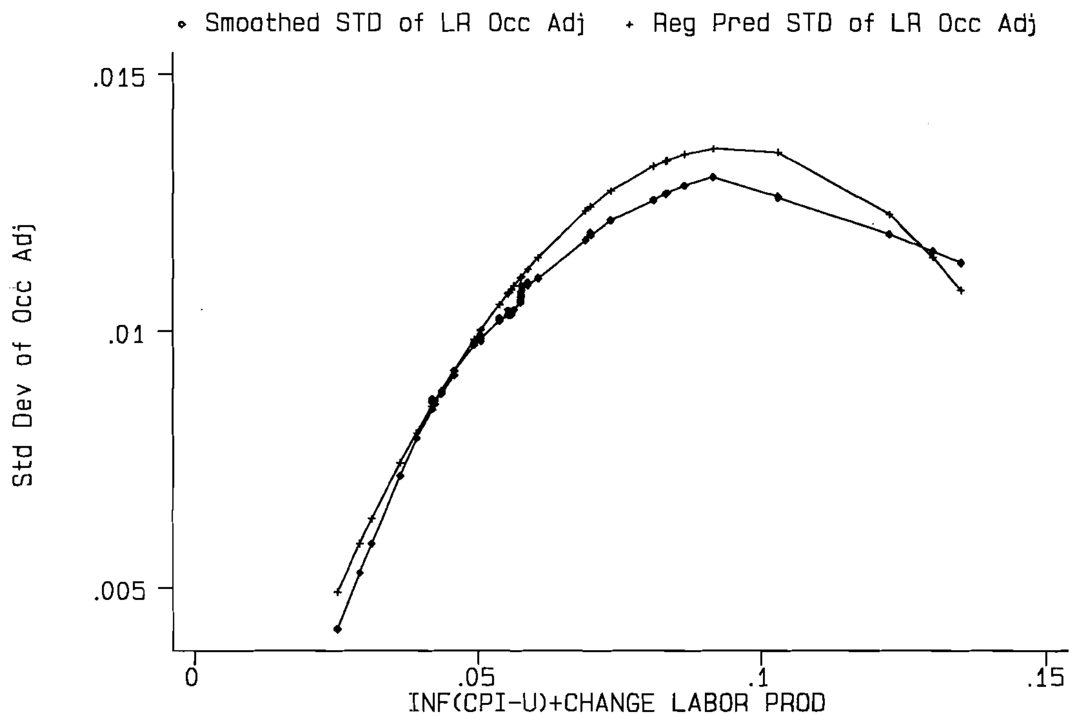
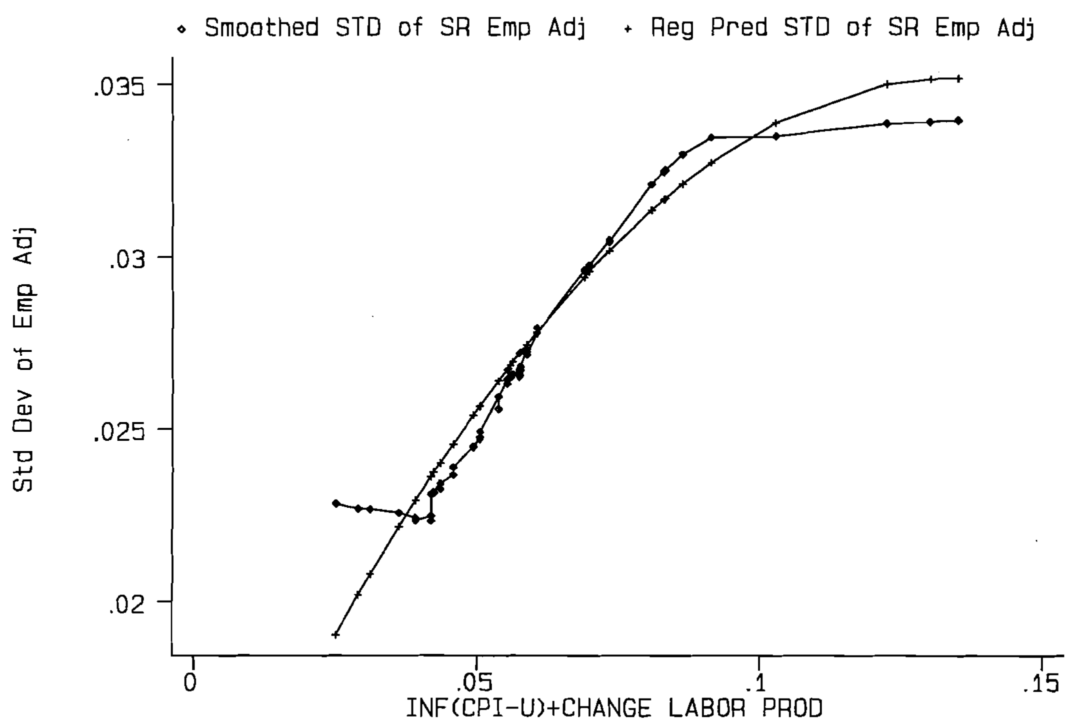



Figure 3B: Standard Deviations of Short-Run Employer Adjustments Associated with dMRP




Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.

Figure 3C: Standard Deviations of Long-Run Occupational Adjustments Associated with CSS Mean Wage Change

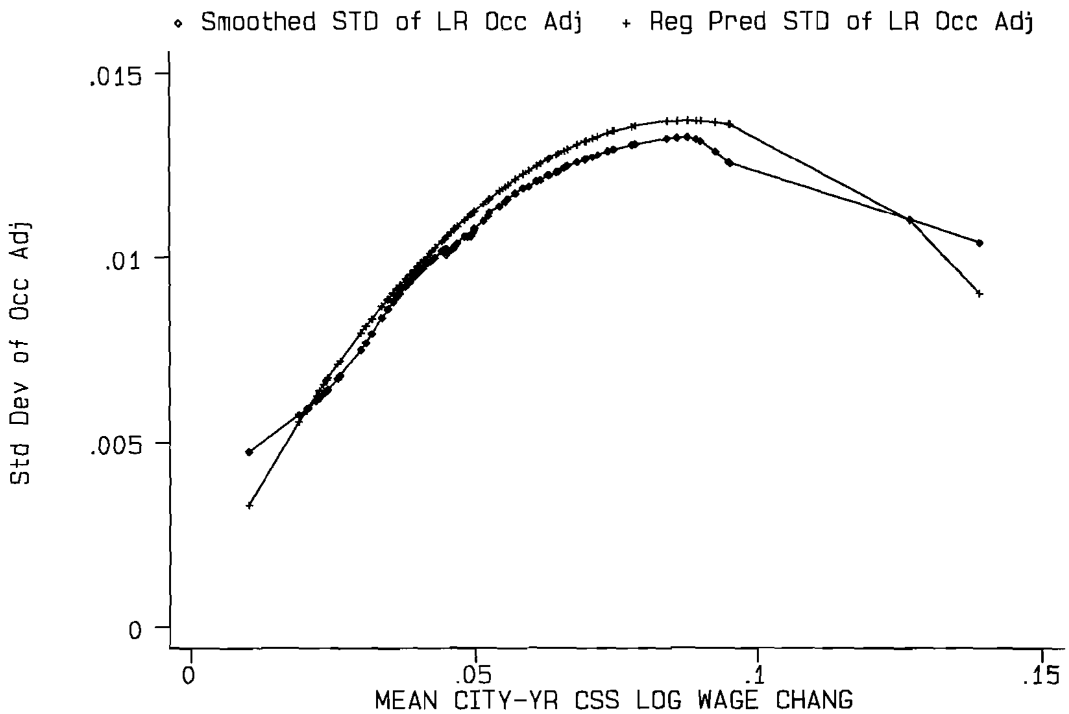
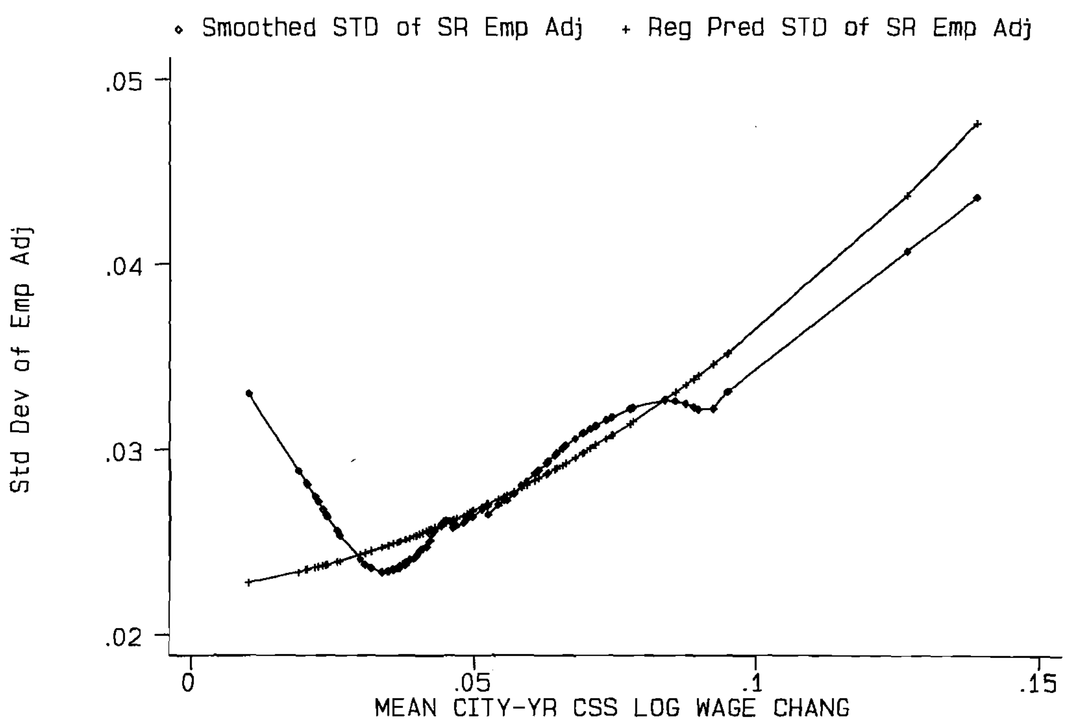



Figure 3D: Standard Deviations of Short-Run Employer Adjustments Associated with CSS Mean Wage Change




Source: Authors' calculations from the Federal Reserve Bank of Cleveland Community Salary Survey.