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Cost of Living Adjustment and Business Cycles: Disaggregated Evidence

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Abstract

For a sample of US industries, nominal wage and price inflation follow aggregate price inflation closely during economic expansions. Hence, fluctuations in profit markup and real output are moderate in the face of expansionary demand shocks. During recessions, however, industrial nominal wage deflation exceeds that of the aggregate price level. This is in contras to producers' attempt to maintain, or even increase, industrial real price inflation during recessions. Consistently, the increase in the profit markup is correlated with an increase in output contraction and a reduction in workers' real standard of living during recessions.

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I. INTRODUCTION

Cost of living adjustments: are they operative? In a world in which inflation has proven to be unstable, concerns arise for whether nominal wage indexation clauses can be adequately specified, explicitly or implicitly, to insulate agents' real standard of living from fluctuations in inflation over the business cycle.[2] Traditionally, concerns have focused on the ability of indexation clauses to keep up with a rise in price inflation. Nonetheless, the historical evidence of frequent prolonged recessions should also generate concerns for the recessionary effects on workers' real standard of living.[3]

Theoretical models have been built to analyze the effects of nominal wage rigidity on economic fluctuations. In the context of these models, wage indexation was introduced as a labor contract feature that moderates nominal wage rigidity and, in turn, subsequent cyclical fluctuations. Through indexation clauses, the nominal wage may adjust partially or fully to unexpected fluctuations in the price level following contract negotiation. The interest in wage indexation is simple and intuitive. Given workers' concern about the stability of real standard of living in the face of aggregate uncertainty, indexation clauses have become a standard feature in real world contracts (implicit or explicit). Theoretical models incorporating this feature have focused primarily on the moderating effect of indexation on cyclical fluctuations in the face of demand uncertainty.[4]

The analysis of this paper revisits the implications of these models. Of particular interest is to illustrate the implications of nominal wage indexation during expansions and contractions.[5] These implications include fluctuations in workers' real standard of living compared to firms' relative output price and the profit markup. The model will then demonstrate how output

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[2]Labor contracts may be explicit formal agreements as in Gray (1978) and Taylor (1980) or implicit informal agreements of the form specified in Malcomson (1984).

[3]The empirical literature on the cyclical behavior of the real wage can be classified into aggregate and disaggregate studies. The former includes Bodkin (1969), Neftci (1978), Geary and Kennan (1982), Sumner and Silver (1989), Cho and Cooley (1990), Cushing (1990), and Kandil (1996). Disaggregate studies include Bils (1985), Barsky and Solon (1989), Keane, Moffit and Runkle (1989), Solon, Barsky and Parker (1994), Kandil and Woods (1995, 1997) and Kandil (1999a). For a recent survey of the empirical evidence, see Kniesner and Goldsmith (1987), and Abraham and Haltiwanger (1995).

[4]For details, see, e.g., Gray (1978)

[5]Nominal wage indexation may be asymmetric. For a theoretical illustration, see Kandil (1999b). For example, nominal wage indexation may be larger in response to positive demand shocks compared to negative shocks. The asymmetric flexibility of nominal wages may be the result of institutional settings that differentiate salary negotiations in the upward and downward directions. Alternatively, asymmetric nominal wage flexibility may be an endogenous response to stochastic uncertainty.

fluctuations are likely to vary with these indicators if cost of living adjustments are operative over the business cycle.[6]

The empirical investigation seeks to verify the validity of the model's implications during expansions and contractions. To that end, aggregate demand shocks are separated into positive and negative components. Empirical estimates measure the change (increase or decrease) in real standard of living, industrial relative price, the profit markup, and output fluctuations. The results evaluate the implications of cost of living adjustments and accompanying fluctuations over the business cycle.

To avoid generalization implied by aggregate investigations, the analysis focuses on disaggregate data for 28 industries of the United States.[7] In general, the results indicate that workers' real standard of living (industrial nominal wage deflated by the aggregate price) is generally flat in the face of expansionary aggregate demand shocks. In contrast, the reduction in the real wage is pronounced during recessions. That is, the slow-down in industrial nominal wage inflation exceeds that of the aggregate price level during recessions. Industrial relative price (the product price deflated by the aggregate price level) is also generally flat during expansions. In contrast, the increase in relative price is more pronounced during contractions, indicating resistance to lower industrial price inflation despite aggregate recessionary conditions. The combined adjustments in industrial labor and product markets establish asymmetry in the profit markup (industrial product price relative to the nominal wage). Industrial nominal wage and price inflation move closely, stabilizing profit markup inflation during expansions. In contrast, industrial price inflation exceeds nominal wage inflation, increasing profit markup inflation despite recessionary conditions.

The combined implications establish that indexation clauses work effectively to insulate workers' real standard of living during expansions. Attempts by workers to keep up with aggregate price inflation are consistent with producers' efforts to maintain the stability of industrial relative output price and the profit markup. As predicted by theory, wage indexation has worked effectively to moderate output expansion and insulate real magnitudes from the effects of economic booms.

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[6] It is important to emphasize at the outset that the paper's analysis defines business cycles based on aggregate demand shocks. This is to say that the implications concerning wage indexation are relevant for the aggregate demand shocks under investigation. As theory indicates, see, e.g., Gray (1978), the optimal degree of indexation is different in the face of demand and supply shocks.

[7] A major source of controversy at the aggregate level concerns the appropriate measure of the nominal wage. By departing from aggregate data, this investigation aims at establishing the robustness of the evidence using industrial nominal wage data.

In contrast, workers suffer a reduction in real standard of living during recessions. Higher profit markup inflation has exacerbated the adverse effects of recessionary conditions. Accordingly, output contraction remains pronounced despite reduction in agents' real standard of living.

II. The Theoretical Framework

The focus of the paper's analysis concerns the implications of nominal wage indexation for workers' real standard of living during expansions and contractions. In judging these implications, the analysis will focus on the impact of indexation on a given industry's relative output price, the profit markup, and fluctuations in real output. The motivation for this research is to evaluate whether there is asymmetry in nominal wage indexation and how this asymmetry relates to other important economic indicators over the business cycle.

Towards this objective, a theoretical model is presented.[8] In this economy, nominal wage and price decisions are taken not by an auctioneer but by economic agents. As we want to focus on the real wage, we need a model with labor and goods markets. We want agents to choose prices and wages, but no single agent to choose either the aggregate price level or wage level. The simplest assumption is to have many goods, all of them imperfect substitutes, and many types of labor, all of them also imperfect substitutes. Thus, the aggregate economy in our model is characterized with monopolistic competition in the goods and labor markets.

There are m industries, each producing a different good, indexed by $j = 1, \ldots, m$; good j has nominal price p_j. There are m unions, each supplying a different type of labor for industry j. The real wage afforded to workers across the economy is approximated by the nominal wage negotiated between the union and firms in industry j, w_j, deflated by the aggregate price level, p. Industrial real (relative) output price is approximated by the price established in the product market for industry j deflated by the aggregate price level. Industrial profit markup is approximated by the product price relative to the cost of labor, the nominal wage in industry j.

Assume nominal wage and salary negotiations across the economy are governed by contractual agreements. All contracts specify a contract length and a path of nominal wages based on information available at the time contracts were negotiated. This adjustment is

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[8]The theoretical framework synthesizes and extends the contracting models developed by Fischer (1977) and Gray (1978). It takes from Fischer the feature of overlapping, rather than synchronized, labor contracts and from Gray the feature of nominal wage indexation. The model is a generalized version of the theoretical model in Gray and Kandil (1991) that differentiates between demand expansions and contractions and accounts for nominal wage indexation explicitly. More importantly, the model illustrates how nominal wage indexation determines the size of cyclical fluctuations in response to expansionary and contractionary demand shocks.

contingent on unexpected demand fluctuations that are realized after contracts are negotiated. During a boom period, firms expect an increase in the demand for their products which would raise the price of the output produced. Workers demand, however, to be compensated for the higher inflation that is likely to realize during boom periods. In the absence of information about conditions governing wage and price determination in other industries of the economy, firms and workers agree to index nominal wages to observed changes in industrial output price in response to unexpected demand fluctuations.

The degree of indexation determines deviation in the real product wage from its full-equilibrium value.[9] Full indexation maintains the full-equilibrium real wage. In contrast, no indexation allows for the maximum deviation in the real wage from its full-equilibrium value. Bargaining powers in the labor market determine the magnitude of the indexing parameter to be in effect following contract negotiation. Bargaining powers are based, in turn, on supply and demand conditions governing the labor market for the specific industry. A higher elasticity of labor supply and/or demand with respect to the real wage decreases workers' bargaining power (increases firms' bargaining power), decreasing the degree of nominal wage indexation.[10]

The supply side of each industry j consists of a continuum of identical firms i distributed uniformly between zero and one. Only one commodity is produced in each industry; there are no relative prices or quantities.[11] The only thing that distinguishes between firms is the time elapsed since they negotiated their last contract. The signing dates of contracts are assumed to be uniformly staggering. That is, at any instant of time an equal number of firms negotiates a new contract. All contracts in industry j are of length T_j and set a path of the nominal wage rate for the duration of the contract. This path is dependent on the degree of indexation, A_j. Following contract negotiation, the employment decision is entirely at the discretion of the firm. Uncertainty enters the model in the form of disturbances to aggregate demand. More formally, the structure of the model is summarized in equations (1) through (7):

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[9]Agents aim at minimizing deviation in output around its desired level, which corresponds to full employment in the labor market in response to shocks that may realize following contract negotiation.

[10]More elastic labor supply increases the positive response of labor supply to a given degree of indexation. Accordingly, workers are more likely to agree to a smaller degree of nominal wage indexation. More elastic labor demand reinforces the negative response of labor demand to a given degree of indexation. Accordingly, producers are less likely to agree to a larger degree of nominal wage indexation.

[11]That is, firms cannot be distinguished based on size, which eliminates any distinction in output or price among firms.

$$y_{it} = \delta l_{it}, \qquad 0 < \delta < 1 \tag{1}$$

$$l_{it}^{D} = -\mu(w_{it} - p_{jt}) + \mu \ln \delta, \qquad \mu = \frac{1}{(1-\delta)} > 1. \tag{2}$$

$$l_{it}^{S} = \phi(w_{it} - p_{jt}) + \phi, \qquad \phi \geq 0. \tag{3}$$

$$w_{it} = E_{t-s} p_{jt} + A_j (p_{jt} - E_{t-s} p_{jt}), \qquad 0 \leq A_j \leq 1 \tag{4}$$

$$y_{jt} = \frac{1}{T_j} \int_{s=0}^{T_j} \{\alpha_0 + \alpha_1 (1 - A_j)(p_{jt} - E_{t-s} p_{jt})\} ds \tag{5}$$

$$\alpha_0 = \delta\mu \ln \delta, \qquad \alpha_1 = \delta\mu > 0$$

$$y_{jt} = \gamma - \beta p_{jt} + N_t, \qquad \beta > 0 \tag{6}$$

$$N_t = \int_{s=0}^{t} dN_{t-s} ds$$

$$= \int_{s=T_j}^{t} dN_{t-s} ds + \int_{s=0}^{T_j} dN_{t-s} ds$$

$$= N_{t-T_j} + \int_{s=0}^{T_j} dN_{t-s} ds$$

$$= N_{t-T_j} + \int_{s=0}^{T_j} pos_{t-s} ds + \int_{s=0}^{T_j} neg_{t-s} ds \tag{7}$$

Equation (1) describes the log of real output (y_i) as a function of the log of labor input (l_i) for firm i with an elasticity parameter δ. The labor demand and supply schedules are described in equations (2)and (3), where w_{it} is the log of the nominal wage paid by firm i to its workers and p_{jt} is the log of the industry's output price. The labor demand and supply elasticities with respect to the real wage are $-\mu$ and ϕ.

Employment by firm i at time t depends on the nature of contracts as well as the labor market conditions embodied in equations (2) and (3). A contract signed at τ specifies a contract length, T_j, and a path of nominal wages, w_{it}, from τ to $\tau + T_j$. Negotiating contracts entails a fixed cost (transaction costs) which rules out the possibility of continuous recontracting; T_j is strictly positive. The contractual wage path is determined by solving equations (2) and (3)for the market-clearing nominal wage and taking expectations based on information available to firm i at the time of contract negotiation. This yields equation (4) which describes the rule firm i follows in deciding on a path of the nominal wage, w. The contract wage is assumed to be set at the value that is expected to clear the labor market in each period of the contract using available information at the time contracts are drawn up, $t - s$, where s denotes the length of time elapsed since firm i negotiated its last contract. In addition, each contract stipulates an indexing parameter A_j, allowing for an additional adjustment in the nominal wage that is contingent on unexpected changes in the industry's price level after contracts are negotiated.

Substituting equations (2) and (4) into equation (1) and rearranging produces the representative firm's supply function. Maintaining the assumptions of identical firms and uniformly staggering contracts, an index of total industry -wide output in equation (5), y_{jt}, is obtained by integrating over the output of individual firms.

The demand side of the industry is represented by equation (6). The demand shift, N_t, is intended to capture a variety of possible disturbances to aggregate demand, including changes in the money supply, velocity, government spending, private consumption, and private investment. In equation (7), N_t is assumed to follow a Wiener process, the continuous time counterpart of a random walk where N_{t-s} denotes unit innovations in the demand process that occur between the time history begins (time zero) and the present time (time t). The innovations are zero mean and the integral of their values from time zero to time t defines N_t. Note that the demand shift, N_t, can be further decomposed into anticipated (N_{t-T_j}) and unanticipated components ($\int_{s=0}^{T} dN_{t-s} ds$) based on information at the time of contract negotiation, $t - T_j$. Unanticipated fluctuations can be distinguished into positive innovations, pos_{t-s}, and negative innovations, neg_{t-s}.

The procedure used in solving the model is described in the appendix to Gray and Kandil (1991) and is available in more details upon request. The resulting expressions for industrial real output, the price level, and the nominal wage are as follows:

$$y_{jt} = \alpha_0 + \int_{s=0}^{T_j} \chi(T_j, A_j, s) dN_{t-s} \tag{8}$$

$$p_{jt} = \frac{1}{\beta}(\gamma - \alpha_0) + \frac{1}{\beta} N_{t-T_j} + \frac{1}{\beta} \int_{s=0}^{T_j} \{1 - \chi(T_j, A_j, s)\} dN_{t-s} \tag{9}$$

$$\begin{aligned} w_{jt} &= \frac{1}{\beta}(\gamma - \alpha_0) + \frac{1}{\beta} N_{t-T_j} + \frac{1}{\beta} \int_{s=0}^{T_j} \{1 - \alpha_2(T_j, A_j, s)\} dN_{t-s}, \\ \chi(T_j, A_j, s) &= \frac{\delta(1 - A_j)(T_j - s)}{\beta(1-\delta)T_j + \delta(1 - A_j)(T_j - s)}, 0 \le \chi(T_j, A_j, s) < 1 \\ \alpha_2 &= \frac{\beta(1-\delta) + \delta}{\delta} > 1 \end{aligned} \tag{10}$$

The solution of each variable has two components. The first set of terms on the right hand side (those appearing prior to the integral) gives the full-equilibrium value of the variable. These terms represent the outcome that would be achieved if wages were fully flexible and thus provide a measure of the "desired" outcome. The full equilibrium solution of the model exhibits a natural response to aggregate demand disturbances. Desired output does not respond to anticipated demand shifts, N_{t-T_j}, whereas the full equilibrium values of the price level and the (average) nominal wage rate do, with a size that equals the inverse of β, the elasticity of industrial demand with respect to the output price.[12]

Stochastic integrals capture cyclical movements in the variable or fluctuations in response to unanticipated demand shocks following contract negotiation. Following contract negotiation, realized demand shocks deviate the ex-post real wage from its market clearing value, prompting producers to adjust the output supplied in response to demand shocks and decreasing the nominal effects of the shocks on industrial nominal wage and price. This is consistent with the coefficients in the stochastic integrals in the model's solutions. In each case, cyclical movement is a weighted average of the innovations in aggregate demand (the dN_{t-s}) that have occurred over the preceding T_j periods. The weights depend on the time elapsed since an innovation has occurred, the length of contracts and the degree of indexation. Cyclical effects diminish with time; $\chi(T_j, A_j, s)$ is a decreasing function of s; and a shock that occurred more than T_j periods ago has no cyclical impact today.[13]Cyclical effects increase with contract length; $\chi(.)$ is increasing function of T_j. That is, at a given point of time, cyclical effects are larger the longer contracts are.[14] Furthermore, cyclical effects diminish with the degree of indexation. If wages are fully indexed, $A_j = 1$, all cyclical effects are eliminated and the industry realizes its "desired" outcome.

Nominal wage indexation is likely to differentiate industries across the economy based on agents' real standard of living, industrial relative price, industrial profit markup and output fluctuations. Let p_t be the aggregate price level.[15] During expansions,

$$dN_t = pos_t > 0 \rightarrow p_t \uparrow$$

[12]Workers incorporate anticipated demand shifts into contract negotiation, raising prices by the value of anticipated demand shifts.

[13]As time elapses following the occurrence of a shock, the proportion of firms that have recontracted subsequent to the shock increases. As firms recontract and nominal wage rates are adjusted to reflect the shock, the industry moves toward full equilibrium.

[14]This is because the number of firms that recontract during any given interval decreases as contract length increases. Note that T_j exacerbates contemporaneous fluctuations in the face of demand shocks and prolongs variables' adjustments towards their full-equilibrium values.

[15]The aggregate price level is the average of industrial prices. The flexibility of this average in the face of aggregate demand shocks is likely to exceed p_j for a given industry j where $A_j = 0$ provided that $A_j > 0$ for at least one other industry in the economy.

For industry j, if $A_j = 0$,[16]

$$\Delta w_{jt} = 0, \quad p_{jt} \uparrow,$$

$$\Delta w_{jt} < \Delta p_{jt} < \Delta p_t$$

Implications:[17]

$$\Delta \frac{w_{jt}}{p_t} < 0, \quad \Delta \frac{p_{jt}}{p_t} < 0, \quad \Delta \frac{p_{jt}}{w_{jt}} > 0,$$

$$\left\{ \frac{w_j}{p} \downarrow, \frac{p_j}{p} \downarrow, \frac{p_j}{w_j} \uparrow \right\} \rightarrow y_j \uparrow$$

In the absence of indexation, the nominal wage does not adjust in the face of a contemporaneous demand shock following the last contract negotiation. Given nominal wage rigidity, a demand shock induces its maximum effect on employment which maximizes its expansionary effect on output and moderates its inflationary effect on price. Accordingly, workers in industry j experience a reduction in their real standard of living. Concurrently, firms in industry j experience a reduction in the relative price of the output produced. The former channel is consistent with a reduction in labor cost. The latter channel is likely to increase the relative demand for output of industry j.[18] Both channels are bound to maximize

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[16]Allowing $s, A_j = 0, \chi = \dfrac{\delta}{\delta + \beta(1-\delta)}$. Upon plugging χ into the solution for w_{jt}, the response of w_{jt} to $dN_t = 0$. Upon plugging χ into the solution for p_{jt}, the response of p_{jt} to $dN_t = (1 - \chi) > 0$.

[17]For a positive χ, price flexibility, $\frac{1}{\beta}(1-\chi)$, exceeds wage flexibility, $\frac{1}{\beta}(1-\alpha_2\chi)$, where $\alpha_2 > 1$. A shorter labor contract T_j and/or a higher degree of wage indexation decreases χ, moderating the cyclical gap $(\alpha_2 - 1)\chi$ between price flexibility and wage flexibility. Accordingly, the positive response of the profit markup to demand shocks decreases the smaller χ is. Also χ decreases with time, closing the gap between price and wage flexibility as the profit markup adjusts towards its full-equilibrium value.

[18]Goods across industries j are imperfect substitutes. Nonetheless, the demand for output of industry j varies negatively with p_j in (6). The smaller the rise in p_j relative to p_k, the bigger the positive effect of N_t on the demand for y_{jt} compared to y_{kt} provided that the elasticity of industrial demand, $-\beta$, is equal in industries j and k.

the expansionary effect of an increase in aggregate demand on the output produced in industry j. Further, firms are likely to gain from the increased output price relative to the labor cost, i.e., the profit markup per unit of the output produced. It is expected, therefore, that an increase in the degree of nominal wage indexation will improve workers' real standard of living while moderating the reduction in industrial relative price. Further, higher nominal wage indexation moderates output expansion and the rise in the profit markup per unit of the output produced.

During Contractions,

$$dN_t = neg_t < 0 \rightarrow p_t \downarrow$$

For industry j, if $A_j = 0$

$$\Delta w_{jt} = 0, \quad p_{jt} \downarrow$$

$$|\Delta w_{jt}| < |\Delta p_{jt}| < |\Delta p_t|$$

Implications:

$$\Delta\frac{w_{jt}}{p_t} > 0, \Delta\frac{p_{jt}}{p_t} > 0, \Delta\frac{p_{jt}}{w_{jt}} < 0,$$

$$\left\{\frac{w_j}{p}\uparrow, \frac{p_j}{p}\uparrow, \frac{p_j}{w_j}\downarrow\right\} \rightarrow y_j \downarrow$$

During recessions, aggregate demand decreases, decreasing the aggregate price level. In the absence of indexation in industry j, the nominal wage is downwardly rigid, which maximizes the reduction in employment in the face of contractionary demand shocks. Consequently, the contractionary effect of recessions is maximized on output which moderates the deflationary effect on the price of the output produced in industry j. The combined effect allows for an increase in agents' real standard of living and industrial relative output price during recessions. Both channels are likely to exacerbate the contractionary effect of recessions on the output produced in industry j through the increased cost of labor and the reduction in the relative demand for the output produced. Recessionary conditions are made worse by the reduction in the profit markup in industry j. An increase in the degree of nominal wage indexation implies, therefore, less protection for workers' real standard of living during recessions. Likewise, firms face a higher risk of reduction in their relative price during recessions. Further, the downward flexibility of the nominal wage moderates industrial output contraction and the reduction in the profit markup during recessions.

III. Empirical Models and Testable Implications

The focus of the investigation will concern fluctuations in real standard of living over the business cycle. Of particular interest is to investigate whether nominal wage adjustment appears adequate to protect workers' real standard of living given fluctuations in the aggregate price level over the business cycle. The starting point for the empirical investigation is the specification of empirical models for the cyclical behavior of workers' real standard of living, industrial relative output price, the profit markup, and real output.[19] Fluctuations in business conditions are approximated by expansionary and contractionary shocks to aggregate demand. To complete the specification of empirical models, the variables under investigation are assumed to vary in the face of demand and supply shifts. Assuming rationality, demand and supply shifts can be further decomposed into anticipated and unanticipated components based on agents' conditional expectations.[20]

The stationarity of variables is tested following the suggestions of Nelson and Plosser (1982). Based on the results of the Dickey-Fuller test for stationarity (see, e.g., Dickey and Fuller (1981)), the variables under investigation are non-stationary in level and stationary in first-difference. Given these results, the empirical models are specified in first-difference form as follows:

$$Dw_{jt} - Dp_t = a_0 + a_1E_{t-1}Dq_t + a_2Dqs_t + a_3E_{t-1}Dn_t + a_{4p}pos_t + a_{4n}neg_t + a_5ss_{jt} + a_{jt} \quad (12)$$

$$Dp_{jt} - Dp_t = b_0 + b_1E_{t-1}Dq_t + b_2Dqs_t + b_3E_{t-1}Dn_t + b_{4p}pos_t + b_{4n}neg_t + b_5ss_{jt} + b_{jt} \quad (13)$$

$$Dp_{jt} - Dw_{jt} = c_0 + c_1E_{t-1}Dq_t + c_2Dqs_t + c_3E_{t-1}Dn_t + c_{4p}pos_t + c_{4n}neg_t + c_5ss_{jt} + c_{jt} \quad (14)$$

$$Dy_{jt} = d_0 + d_1E_{t-1}Dq_t + d_2Dqs_t + d_3E_{t-1}Dn_t + d_{4p}pos_t + d_{4n}neg_t + d_5ss_{jt} + d_{jt} \quad (15)$$

$$Dds_{jt} = e_0 + e_{1p}pos_t + e_{1n}neg_t + ss_{jt} \quad (16)$$

$D(.)$ is the first-difference operator. The logarithm of the aggregate price level is denoted by p_t in (12) and (13). The logarithm of the nominal wage, price, and output in industry j are denoted by w_{jt}, p_{jt}, and y_{jt} in (12) through (15). The logarithm of the energy price is denoted by q_t where E_{t-1} denotes expectation given information at time t - 1. Unanticipated change in the energy price is measured by the difference between Dq_t and its forecast and denoted by

[19]The empirical models are based on the reduced-form solution for industrial nominal wage, price, and output in theory.

[20]Anticipated supply-side shifts enter the production function, determining both real and nominal variables. In contrast, anticipated demand shifts are fully absorbed in nominal variables. In addition, cyclical fluctuations in nominal and real variables are attributed to unanticipated changes in both demand and supply shifts. For a theoretical illustration that incorporates supply-side shifts in a related model, see Kandil and Woods (1997).

Dqs_t.[21] The nominal value of Gross Domestic Product (GDP) approximates aggregate demand.[22] The logarithm of GDP is denoted by n_t. Anticipated growth in aggregate demand given information at time t -1 is denoted by E_{t-1}. Unanticipated growth in aggregate demand is decomposed into positive and negative components, pos_t and neg_t.[23] The nominal value of industrial output approximates demand for the specific industry. Unanticipated growth in industrial demand given information at time $(t - 1)$ is denoted by Dds_{jt} in (16). Unanticipated growth in industrial demand varies in response to positive and negative aggregate demand

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[21]The focus of the empirical investigation concerns cyclical fluctuations in response to aggregate demand shocks. It is important, however, to account for major sources of supply-side disturbances that may be correlated with the empirical proxy for demand shocks. Accordingly, the empirical models account for energy price shifts to increase the accuracy of measuring the effects of aggregate demand shocks. To ensure the exogeneity of aggregate demand shocks at the industry level, the forecast equation (see Appendix B) accounts for aggregate and industrial variables that are likely to determine the demand and supply sides for the specific industry.

[22]Narrow measures of aggregate demand induce, by their nature, huge fluctuations in a few sectors of the economy. Further, policy shocks may aim at countering specific exogenous demand shocks in the economy. Accordingly, shocks to nominal GDP approximate expansionary and contractionary shifts around a steady-state (equilibrium) level of aggregate demand, which combines policy and other demand variables in the economy. The results of estimating the paper's empirical models using specific measures of aggregate demand shocks are available upon request. The cross-sectional implications and the paper's conclusions are robust with respect to variation in the time-series estimates for various measures of aggregate demand shocks.

[23]To the extent that productivity disturbances are affecting nominal GDP, their impact will contaminate the usefulness of nominal GDP surprises as a proxy for aggregate demand shocks. To avoid this bias, aggregate labor productivity is included among variables determining agents' forecast of nominal GDP (see Appendix B for details). Further, the paper's implications are robust with respect to two modifications. In the first experiment, I regress aggregate demand shocks on aggregate productivity shocks. The residual measures aggregate demand shocks purged of any correlation with productivity shocks. The time-series correlation between the original and new measures of aggregate demand shocks is 0.93. Accordingly, the qualitative evidence remains robust upon estimating the empirical models with the proxy for aggregate demand shocks purged of any correlation with productivity shocks. Second, I account for shifts in industrial labor productivity in the empirical models (see Kandil and Woods (1997) for details). Labor productivity is approximated by the ratio of the output produced to the full-time equivalent employees in the industry. While the evidence remains robust, this proxy is highly correlated with the output produced, which is controversial especially in the empirical model explaining industrial output. Accordingly, labor productivity is not included in the empirical models for the reported results.

shocks where the residual ss_{jt} measures industry-specific demand disturbances.[24] Finally, the terms a_{jt}, b_{jt}, c_{jt}, d_{jt} are stochastic errors in industry j at time t with a zero mean and a constant variance.

An increase in the energy price increases the cost of the output produced. Consequently, both industrial and aggregate prices are expected to adjust upward in response to anticipated and unanticipated energy price shifts. Nominal wages increase as a result. This positive impact is likely to depend, however, on the energy input ratio and the relation between labor and capital in the production process. If labor and energy are complements, the reduction in labor demand moderates the positive effect of a rise in the energy price on the nominal wage. In contrast, the positive effect of a change in the energy price on the nominal wage is likely to become larger if labor and energy are substitutes. The relative effects of energy price shifts on industrial nominal wage, industrial price and the aggregate price level determine the signs of the parameters in the empirical models (12) through (14). Further, the higher cost of the output produced decreases output growth in response to energy price shifts.

The sticky-wage explanation advocates the flexibility of the nominal wage and price in response to anticipated demand shifts. This assumption is dependent, however, on the span t under investigation. It is possible that the nominal wage may not adjust fully to anticipated demand shifts for contracts that are longer than the t observation (1 year). Accordingly, in equation (15), anticipated demand shifts at time t - 1 may determine real output growth.[25]

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[24]To ensure the exogeneity of industrial demand shocks, the forecast equation (see Appendix B) accounts for aggregate as well as industrial variables that are likely to determine the demand and supply sides for the specific industry. Further, the forecast equation accounts for the nominal value of output in industries that qualify as good instruments for demand from a given industry. Following the suggestions of Shea (1993), these industries are selected based on the 1977 detailed input-output study. The condition to include data for industry k in the forecast equation for industry j is as follows: k demands a large share of j's output and k and other industries closely related to k comprise a small share of j's cost. This procedure aims at isolating shifts in sectoral supply functions from sectoral demand functions as much as possible. Given variables in the forecast equations, aggregate and industrial demand shocks are orthogonal to aggregate and industrial variables in the forecast equations. Accordingly, the e_{1p} and e_{np} parameters in (16) measure the correlation between the random components of aggregate and industrial demand.

[25]Anticipated demand shifts are orthogonal, by construction, to unanticipated shifts. Accordingly, the qualitative results of the paper's analysis remain robust with respect to a modification that omits $E_{t-1}Dn_t$ from the empirical model of real output.

The parameters a_{4p}, b_{4p}, c_{4p}, d_{4p} approximate industrial cyclical fluctuations in response to expansionary aggregate demand shocks.[26] The parameters a_{4n}, b_{4n}, c_{4n}, d_{4n} approximate industrial cyclical fluctuations in response to contractionary aggregate demand shocks. Variation in the response of industrial variables to expansionary and contractionary aggregate demand shocks is the primary focus of this investigation.

- Controlling for variation in the size of industrial demand shifts in the face of expansionary aggregate demand shocks, e_{1p} in (16),[27] and assuming the nominal wage is more rigid in industry *j* compared to industry *k*,[28] the sticky-wage model predicts the following:[29]

$$\{a_{4pj} < a_{4pk},\ b_{4pj} < b_{4pk},\ c_{4pj} > c_{4pk}\} \rightarrow d_{4pj} > d_{4pk} \tag{17}$$

The more upwardly rigid the industrial nominal wage during expansions, the worse off agents are in terms of real standard of living, a_{4p}. The reduction in the real wage is likely to be correlated with a reduction in industrial relative price, b_{4p}, and an increase in industrial profit markup, c_{4p}. Output expansion, d_{4p}, is larger in industry *j* compared to industry *k* as a result.

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[26]Quarterly data are not available to estimate the models in a distributed-lag form. Cyclical fluctuations in response to aggregate demand shocks measure variables' adjustments within a year, a reasonable span to measure the effectiveness of cost of living adjustments in response to unanticipated demand shocks. Using annual observations, the maximum effectiveness of cost of living adjustments is realized if labor contracts are negotiated annually or full indexation is in effect for longer contracts.

[27]The size of industrial demand shifts determines fluctuations in industrial variables in response to aggregate demand shocks. For example, the response of industrial output to expansionary demand shocks, $d_{4pj} = \left\{\frac{\partial Dy_{jt}}{\partial Dds_{jt}} \frac{\partial Dds_{jt}}{\partial pos_t}\right\}$. The first bracket measures the output response to a given shock in industrial demand, which varies with conditions in the labor and/or product markets for the specific industry. The second bracket measures the elasticity of industrial demand with respect to expansionary aggregate demand shocks, e_{1p}.

[28]This may be the result of a longer labor contract, T_j, and/or a smaller degree of nominal wage indexation, A_j, in industry *j* compared to industry *k*.

[29]This prediction assumes that other supply-side factors, e.g., relative labor demand elasticities and relative output elasticities with respect to employment, are less important across the two industries. Of course, with real data, these factors are likely to be operative across industries. To control for this variation, the empirical investigation includes experiments that account for these factors across industries, as discussed below.

• Controlling for variation in the size of industrial demand shifts in the face of contractionary aggregate demand shocks, e_{1n} in (16), and assuming the nominal wage is more rigid in industry j compared to industry k, the sticky-wage model predicts the following:

$$\{a_{4nj} < a_{4nk}, b_{4nj} < b_{4nk}, c_{4nj} > c_{4nk}\} \rightarrow d_{4nj} > d_{4nk} \tag{18}$$

The more downwardly rigid the industrial nominal wage during contraction, the smaller the reduction in workers' real standard of living, a_{4n}. The downward rigidity of the real wage is likely to be correlated with a downward rigidity in industrial relative price, b_{4n}, and a decrease in industrial profit markup, c_{4n}. Output contraction is larger in industry j compared to industry k as a result.

IV. The Time-Series Results

Given hypotheses (17) and (18), the time-series analysis will seek to shed some light on the cyclical behavior of agents' real standard of living, industrial relative price, industrial profit markup and output fluctuations over the business cycle. The estimation of the empirical models (12) through (16) follows the methodology described in Appendix B. To account for cross-equation restrictions, the empirical models are estimated jointly.[30] The data are annual for 28 private disaggregated sectors (industries) of the U.S. economy over the sample period 1947-1997.[31] The sample comprises a large subset of industries in the United States.[32] These industries were chosen because they are the only two-digit industries for which <u>hourly</u> nominal wage data are available for the estimation period. A measure of agents' real standard of living is approximated by deflating sectoral hourly wage data by a measure of the aggregate price level, the GDP deflator.[33] Industrial relative price is measured by deflating

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[30]That is, industrial variables are generated jointly in the same stochastic structure. Joint estimation takes into consideration correlation among the residuals of various equations.

[31]The estimation procedure allows for a structural break in the process generating the energy price. Given the joint estimation procedure, it was not possible to divide the sample into subperiods for estimation. Testing for structural break in the reduced-form parameters proved to be insignificant.

[32]Description and sources of data are described in Appendix C. According to the Standard Industrial Classification (S.I.C.) system in Table 1, private sectors of the U.S. economy are grouped by division. Within the divisional aggregates are the component sectors. The sample under investigation comprises 6 divisional aggregates. Two of the divisional aggregates are further disaggregated into 24 component industries. Only annual data are available at the level of disaggregation under consideration.

[33]The GDP deflator is used to measure the real wage and relative industrial price. These measures indicate how industrial nominal wage and price adjust relative to the aggregate

(continued…)

sectoral price data by the aggregate price level, the GDP deflator. The profit markup is measured by deflating industrial output price by industrial nominal wage. To conserve space, the discussion below will be limited to the effects of aggregate demand shocks.

A. During Expansions

Table 1 summarizes the responses of industrial real wage growth, relative price inflation, markup inflation, and output growth to the positive and negative components of aggregate demand shocks.[34] The response of the real wage to expansionary aggregate demand shocks signals reduction in workers' real standard of living, as evident by the negative coefficient in the majority of industries (18 out of 32). Nonetheless, this reduction is statistically significant in one industry only (Misc. Manufacturing). For the remaining industries, the positive response of the real wage to expansionary demand shocks is also statistically insignificant except for Primary Metal Industries. Overall, the predominant statistically insignificant response indicates that nominal wage inflation follows aggregate price inflation closely, insulating workers' real standard of living in the face of expansionary aggregate demand shocks in various industries.

Given the stability of the real wage, it becomes interesting to observe fluctuations in industrial relative price inflation during expansions. The reduction in industrial relative price inflation is evident by the negative response to expansionary aggregate demand shocks for the majority of industries (20 out of 32). Generally, this response is, however, statistically insignificant, except for Food and Kindred Products, and Finance, Insurance, and Real Estate. For these industries, price inflation appears more moderate compared to aggregate price inflation during expansions. It is interesting to note that the reduction in relative price inflation is correlated with a reduction, although statistically insignificant, in real wage growth in these industries. For the remaining industries, the positive response of relative price inflation to expansionary demand shocks is also statistically insignificant, except for Metal Mining, Lumber and Wood Products, and Stone, Clay and Glass Products. For these industries, inflation exceeds aggregate price inflation significantly during expansions. It is interesting to note that nominal wage inflation for these industries also exceeds aggregate price inflation, as evident by the positive, although statistically insignificant, response of real wage growth to expansionary aggregate demand shocks. Overall, the deviation between aggregate and industrial inflation during expansions appears minor for various industries under investigation.

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price level. Deflating the nominal wage by the CPI produces similar results for the cyclical behavior of the real wage.

[34]Detailed estimates are available upon request. Statistical significance is established at the five or ten percent levels of a two-sided test.

The evidence concerning fluctuations in industrial profit markup during expansions suggests the following. Profit markup inflation is evident by the positive response to expansionary aggregate demand shocks in fifteen industries. This response is generally insignificant, however, except for Metal Mining, and Lumber and Wood Products. Contrary to the theoretical implications, profit markup inflation is not consistent with nominal wage rigidity, as evident by the positive responses of the real wage and industrial relative price to expansionary aggregate demand shocks. For the remaining industries, the negative coefficient indicates reduction in profit markup inflation, which is statistically significant for Fabricated Metal Products, Food and Kindred Products, and Finance, Insurance, and Real Estate where nominal wage inflation exceeds price inflation during expansions. Overall, the statistically insignificant response indicates close correlation between industrial nominal wage inflation and price inflation, maintaining the stability of industrial profit markup during expansions.

Industrial output fluctuations appear generally insignificant during expansions. The increase in output is evident by the positive response to expansionary demand shocks in twenty three industries. This response is generally insignificant, however, except in Construction, Paper and Allied Products, Chemicals and Allied Products, Leather and Leather Products, Retail Trade, and Finance, Insurance, and Real Estate. For the remaining industries, the negative response to expansionary aggregate demand shocks is generally insignificant.

Overall, the evidence in the face of expansionary demand shocks supports the implications of nominal wage indexation. Across industries of the economy, nominal wages have followed price inflation, maintaining workers' real standard of living during expansions. Consistently, industries have maintained a relatively stable real price inflation during expansions. The combined effects are consistent with stable profit markup inflation and output growth for many industries during expansions. That is, wage flexibility has moderated the benefits of economic expansions in the form of higher output growth and/or higher profit markup inflation.[35]

B. During Contractions

The evidence appears in sharp contrast during recessions. Workers suffer a reduction in their real standard of living, as evident by the positive response of real wage growth to contractionary demand shocks in the majority of industries (27 out of 32).[36] Further, this

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[35]This evidence is clearly supportive of the implications of nominal wage indexation. It is also worth noting that the evidence is supportive of a framework in which price and wage decisions are predetermined and staggering. In this framework, Blanchard (1986) demonstrates that there be no systematic relation between real wages and output in response to demand shocks, i.e., there is no persistent deviation in the real wage from full-equilibrium.

[36]The sign indicates the direction of the cyclical change "pro- or counter-cyclical." Statistical significance indicates whether the variable increases or decreases significantly with the cycle.

response is statistically significant in Manufacturing, Durable Goods, Machinery Except Electrical, Textile Mill Products, Rubber and Misc. Plastic Products and Retail Trade. In all these industries, aggregate price inflation exceeds nominal wage inflation during recessions. For the remaining five industries, the negative response of the real wage to contractionary demand shocks has protected workers' real standard of living from deterioration during recessions. This is particularly evident by the significant negative response of real wage growth to contractionary demand shocks in Nonmetallic Minerals Except Fuel. Workers of this industry enjoy an increase in real standard of living despite recessionary conditions.

To what extent has the reduction in workers' real standard of living determined changes in industrial relative prices during recessions? The coefficient measuring the response of industrial relative price inflation to contractionary demand shocks is negative in twenty two industries. Further, the negative response is statistically significant in Stone, Clay, and Glass Products where industrial price inflation is increasing relative to aggregate price inflation during recessions. For the remaining industries, the positive response to contractionary demand shocks indicates reduction in industrial relative price inflation. This reduction is statistically significant in Tobacco Manufactures and Finance, Insurance and Real Estate.

Despite the deterioration in workers' real standard of living, industrial relative price inflation appears, in general, downwardly rigid. This indicates faster reduction in nominal wage inflation relative to industrial price inflation during recessions. Consistently, profit markup inflation increases, as evident by the negative response to contractionary aggregate demand shocks in twenty four industries. Further, this increase is statistically significant in Manufacturing, Durable Goods, Motor Vehicles and Equipment, Other Transportation, Rubber and Misc. Plastic Products, and Retail Trade. In the remaining industries, the response of profit markup inflation to conctractionary demand shocks is positive, which is statistically significant in Finance, Insurance, and Real Estate. This significant reduction is consistent with the reduction in relative price inflation in this industry during recessions.

Contraction in output growth is evident by the positive response to negative demand shocks in twenty seven industries.[37] In the remaining industries, the negative response to contractionary demand shocks is statistically insignificant.

The combined evidence appears contradictory to the implications of nominal wage indexation during recessions. Aggregate price inflation exceeds nominal wage inflation,

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[37]This response is statistically significant in Mining, Construction, Manufacturing, Durable Goods, Furniture and Fixtures, Stone, Clay, and Glass Products, Primary Metal Industries, Fabricated Metal Products, Machinery Except Electrical, Electric and Electronic Equipment, Motor Vehicles and Equipment, Instruments and Related Products, Misc. Manufacturing Industries, Nondurable Goods, Textile Mill Products, Apparel and Other Textile Products, Printing and Publishing, Chemicals and Allied Products, Rubber and Misc. Plastic Products, and Retail Trade.

decreasing workers' real standard of living in many industries. Concurrently, producers resisted deflating the product price, increasing profit markup inflation and exacerbating output contraction.[38]

C. Asymmetry: Evidence and Implications

While the implications of nominal wage indexation appear to be supported by the data in the face of expansionary demand shocks, the empirical evidence does not support these implications in the face of contractionary shocks. To illustrate aspects of this asymmetry, consider the difference in variables' adjustments to expansionary and contractionary aggregate demand shocks.

In general, workers' real standard of living appears to be stable in the face of expansionary demand shocks. More significantly, there is evidence of a reduction in real standard of living for workers of several industries during recessions. Consistently, the difference between the real wage response to expansionary and contractionary demand shocks is negative in twenty-five industries.[39] In all these industries, the reduction in real standard of living for workers during contractions is not offset by a comparable increase during expansions. The difference

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[38]During recessions, the larger reduction of nominal wage inflation compared to price inflation is not consistent with the implications of sticky-wage models. This evidence may be explained in the context of sticky-price models where price decisions are predetermined assuming continuous wage setting. Producers may resist to adjust prices downward during recessions while conditions in the labor market necessitate continuous adjustment of the nominal wage to contractionary demand (see, e.g., Ball and Mankiw (1994)). One could also attempt to reconcile the empirical evidence with a framework in which both price and wage decisions are predetermined. According to Blanchard (1986), conditions in labor and product markets differentiate the relative price and wage responses to demand shocks (see Figure I, p. 548). The higher the degree of competition in the product market, firms do not use their monopoly power, so that the markup is lower at any level of output. The higher the degree of competition in the labor market, unions do not exert their monopoly power so that the real wage is lower at any level of employment. Given that real wage growth is decreasing while industrial relative price and profit markup inflation are rising, industrial product markets appear to be less competitive. Firms exert stronger monopoly power compared to that of unions in industrial labor markets.

[39]For this test, the difference between the coefficient for positive and negative shocks is divided by the standard deviation of the coefficient for the positive shocks. The result measures the t-ratio of the difference. This difference is statistically significant in Metal Mining, Construction, Manufacturing, Durable Goods, Furniture and Fixtures, Machinery Except Electrical, Instruments & Related Products, Misc. Manufacturing Industries, Textile Mill Products, Printing and Publishing, Petroleum and Coal Products, Rubber & Misc. Plastic Products, Wholesale Trade, and Retail Trade.

between the real wage response to expansionary and contractionary demand shocks is positive and statistically significant in Primary Metal Industries, and Tobacco Manufactures. For these workers, the rise in real standard of living during expansions dominates the reduction during recessions. On average, demand variability (higher probability of realizing positive and negative demand shocks) decreases workers' real standard of living in the majority of industries in the United States. Clearly, cost of living adjustments fail to guarantee workers symmetric protection of their real standard of living over the business cycle. More specifically, recessionary conditions are evident to have larger consequences in deteriorating workers' real standard of living, indicating failure to index nominal wages based on aggregate price inflation during recessions.[40]

Asymmetry in the adjustment of industrial relative price to demand shocks is generally insignificant for many industries. For these industries, price adjustment appears to be stable relative to the aggregate price level over the business cycle. The coefficient of asymmetry is positive and statistically significant for Mining, Metal Mining, Stone, Clay and Glass Products, Machinery Except Electrical, and Chemicals and Allied Products. For these industries, demand variability increases relative price inflation, on average, over time. For other industries, Fabricated Metal Products, Food & Kindred Products, Tobacco Manufactures, Wholesale Trade and Finance, Insurance, and Real Estate, the reduction in relative price inflation during recessions exceeds its increase during expansions and the difference is statistically significant. Hence, demand variability decreases relative price inflation in these industries, on average, over time.

Producers attempt to maintain the stability of the profit markup by closely correlating nominal wage inflation to output price inflation during expansions. In contrast, producers attempt to protect their profit markup during recessions, as evident by the larger output price inflation relative to nominal wage inflation. Asymmetry is captured by the difference in the response of the profit markup to expansionary and contractionary demand shocks. This coefficient is positive in twenty two industries and statistically significant in Metal Mining, Manufacturing, Durable Goods, Stone, Clay and Glass Products, Motor Vehicles and

[40]Theoretical models of the variety of Gray (1978) demonstrate that higher demand uncertainty increases the optimal degree of nominal wage indexation. High variability of industrial demand and/or high trend inflation of industrial output price increase the probability of fluctuations in demand and, in turn, incentives for nominal wage flexibility. During expansions, cross-industry regressions indicate that the rise in agents' real standard of living is more pronounced the higher the variability of industrial demand. During contractions, the deterioration in agents' real standard of living is less pronounced the higher the trend inflation of industrial output price. These results indicate asymmetry in nominal wage adjustments with respect to industrial demand variability and trend inflation. Industrial demand variability increases upward nominal wage adjustments during expansions. In contrast, wages are more downwardly rigid the higher the trend inflation of industrial output price. Detailed results are available upon request.

Equipment, Other Transportation, Chemicals and Allied Products, Rubber and Misc. Plastic Products, and Retail Trade. In all these cases, demand variability has a net positive effect on profit markup inflation on average over time. For the remaining industries, demand variability has a net negative effect on profit markup inflation, which is statistically significant in Primary Metal Industries, Food and Kindred Products, and Finance, Insurance and Real Estate.

Wage indexation has moderated fluctuations in real standard of living, industrial relative price and the profit markup during expansions. Consistently, expansionary demand shocks are generally neutral on output growth. In contrast, output contraction remains pronounced despite the apparent reduction in workers' real standard of living. Asymmetry is measured by the difference in the output response to expansionary and contractionary demand shocks. The asymmetry coefficient is negative in twenty-four industries.[41] For all these industries, demand variability decreases real output growth on average over time. There is no evidence of a significant increase in output expansion relative to contraction in any of the industries under investigation.

V. Theoretical Hypotheses and Cross-Section Evidence

To shed additional light on the validity of the theoretical implications, the evidence of this section illustrates patterns of variation across industries over the business cycle.[42] The data are based on the time-series parameter estimates. To draw further implications, the cross-section analysis will utilize measures of industrial nominal wage and price flexibility in the face of expansionary and contractionary demand shocks. These estimates are obtained from the time-series estimation of empirical models for industrial price and nominal wage inflation that follow the model specifications in (12) through (15).[43]

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[41]This coefficient is statistically significant in Mining, Manufacturing, Durable Goods, Stone, Clay, and Glass, Primary Metal Industries, Fabricated Metal Products, Machinery Except Electrical, Motor Vehicles Equipment, Misc. Manufacturing, Textile Mill Products, Rubber & Misc. Plastic, and Retail Trade.

[42]To avoid duplication, the cross-industry analysis includes only the components for 28 industries, excluding Mining, Manufacturing, Durable Manufacturing, and Nondurable Manufacturing. The observation for Metal Mining represents a clear outlier that biases the cross-industry results, particularly during expansions. To establish the robustness of general implications, the observation for Metal Mining is also excluded from the cross-industry analysis.

[43]These parameters are reported in Table A1 of Appendix A. A descriptive summary of these parameters is provided in Appendix A.

A. Cross-Industry Correlations

The correlation between the time-series parameter estimates across industries determines the direction and strength of co-movements in the variables' adjustments to demand shocks. This correlation indicates whether the effects of demand shocks are positively or negatively correlated and the strength of this correlation across industries.[44] Cross-industry correlations are presented in Table 2. During expansions, theory predicts that the upward flexibility of the nominal wage moderates the reduction in workers' real standard of living and industrial relative price. The rise in industrial profit markup is likely to become less pronounced as the nominal wage becomes more upwardly flexible. Consistent with theory's predictions, industrial price inflation adjusts upwardly with nominal wage inflation in the face of expansionary demand shocks with a correlation coefficient, 0.25. The correlation between adjustments in workers' real standard of living and industrial relative price, while positive, is small in magnitude, 0.019. The correlation between workers' real standard of living and producers' profit markup is negative, although small in absolute magnitude, -0.12.

During contractions, theory predicts that the downward flexibility of the nominal wage accelerates the reduction in workers' real standard of living and industrial relative price. The reduction in industrial profit markup is likely to become less pronounced as the nominal wage becomes more downwardly flexible. In contrast to theory's predictions, the correlation between the responses of the nominal wage and price to contractionary demand shocks is negative, -0.39. Consistently, while workers accept a reduction in their real standard of living, industrial relative price inflation is rising, as evident by the negative correlation, -0.57. Similarly, the reduction in workers' real standard of living is correlated with an increase in profit markup inflation, as evident by the negative correlation, -0.44.

B. Cross-Industry Regressions

Given asymmetry in variables' adjustments and their correlations, how do these adjustments differentiate output fluctuations across industries?[45] Cross-industry regressions evaluate the

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[44]Correlation measures the closeness of a linear relationship between variables. A correlation of 0 between two variables means that each variable has no linear predictive ability for the other. The sample correlation approximates the Pearson product-moment correlation. It is computed: $r_{xy} = \sum (x-\bar{x})(y-\bar{y}) / \sqrt{\left[\sum (x-\bar{x})^2 \sum (y-\bar{y})^2\right]}$ where $\bar{x}$ and $\bar{y}$ are the sample means of x and y. The significance probability approximates the significance level for the null hypothesis of a zero correlation.

[45]The cross-section analysis employs estimates from the time-series regressions. Point estimates from the time-series regressions approximate the average response of industrial variables to demand shocks over time. The statistical significance of these estimates varies depending on the standard error of the regression. To account for the two-step procedure, the cross-industry regressions follow the generalized least squares estimation method suggested (continued...)

effects of changes in workers' real standard of living, industrial relative price, and the profit markup on output fluctuations during expansions and contractions. Estimates from the empirical models (12) through (16) will be used to approximate variables' fluctuations within industries over time. To shed additional light on the results of these regressions, cross-industry regressions will also evaluate the relative effects of nominal wage and price adjustments on output fluctuations. To control for other important determinants of cyclical fluctuations, cross-industry regressions account for other variables as follows: (i) the elasticity of industrial demand with respect to aggregate demand fluctuations, e_{1p} in (16), and (ii) average labor productivity, $\overline{prod}$. Both factors are likely to contribute positively to the difference in cyclical fluctuations across industries. Cross-section regressions are presented in Tables 3 and 4.[46]

Table 3 presents the evidence concerning variations in the face of expansionary demand shocks. The dependent variable, d_{4p}, captures the response of industrial output to expansionary aggregate demand shocks for each of the industries under investigation. The explanatory variables approximate fluctuations in the real wage, a_{4p}, the relative price, b_{4p}, the profit markup, d_{4p}, wage flexibility, f_{4p}, and price flexibility, g_{4p}, during expansions. Industrial output expansion is generally insignificant in the face of demand shocks. Subsequently, output fluctuations do not vary significantly with fluctuations in real standard of living, industrial relative price, or the profit markup. The only factor that appears relevant is the elasticity of industrial demand with respect to aggregate demand shocks. That is, where the demand for output is more cyclical, industries experience larger expansion in output during economic booms (regressions (1) through (6)).

Table 4 presents the evidence concerning variation in the face of contractionary demand shocks. The dependent variable, d_{4n}, captures the response of industrial output to contractionary aggregate demand shocks for each of the industries under investigation. The explanatory variables approximate fluctuations in the real wage, a_{4n}, the relative price, b_{4n},

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by Saxonhouse (1977). That is, estimates with high standard errors are weighted less heavily in the cross-industry regression.

[46]The elasticity of industrial demand with respect to aggregate demand shocks is approximated by the parameters e_{1p}, e_{1n} in the empirical model (16). Labor productivity growth in each industry is approximated by the sample average of the growth in the ratio of output per worker in each industry. Separate experiments include other industry-specific factors that may have affected the responses of industrial variables to aggregate demand shocks. The degree of capital intensity in each industry is approximated by the difference in the average annual rate of change in gross and net value added. The elasticity of output with respect to the labor input is approximated by the coefficient from regressing the log of output on the log of the full-time equivalent employees across industries. In all these experiments, the evidence remains robust concerning the effectiveness of cost of living adjustments and accompanying implications over the business cycle. Details are available upon request.

the profit markup, d_{4n}, wage flexibility, f_{4n}, and price flexibility, g_{4n}, during contractions. Contrary to the implications of wage indexation, the reduction in workers' real standard of living does not moderate output contraction in the face of demand shocks. Nonetheless, the downward rigidity of relative industrial price inflation exacerbates output contraction, as evident by the negative and statistically significant coefficients in regression (2). Similarly, output contraction is more pronounced the larger the profit markup inflation during recessions, as evident by the negative and statistically significant coefficients in regressions (3) and (3)'. Consistently, there is evidence of an increase in output contraction with the reduction in nominal wage inflation during recessions, as evident by the positive and statistically significant coefficients in regressions (4) and (6). In contrast, output contraction increases the smaller the reduction in industrial price inflation during recessions, as evident by the negative and statistically significant coefficients in regressions (5), (6), (5)', and (6)'. Further, the elasticity of industrial demand with respect to aggregate demand shocks exacerbates output contraction across industries in regressions (1) through (6). It appears, therefore, that attempts to lower the cost of labor during recessions decrease workers' real standard of living without moderating output contraction across industries.

Given the apparent asymmetry in output fluctuations over the business cycle, Table 5 illustrates the effects of movements in the various indicators during expansions and contractions on industrial output variability. The dependent variable in the cross-industry regression measures output variability for each of the industries under investigation, the standard deviation of industrial real output growth, σ_{yj}. Regression (1) measures he effects of industrial real wage fluctuations during expansions, a_{4p}, and contractions, a_{4n}, on industrial output variability. Regression (2) measures the effects of industrial relative price fluctuations during expansions, b_{4p}, and contractions, b_{4n}, on industrial output variability. Regression (3) measures the effects of industrial profit markup fluctuations during expansions, c_{4p}, and contractions, c_{4n}, on industrial output variability. Regression (4) measures the effects of industrial nominal wage flexibility during expansions, f_{4p}, and contractions, f_{4n}, on industrial output variability. Regression (5) measures the effects of industrial price flexibility during expansions, g_{4p}, and contractions, g_{4n}, on industrial output variability. To control for variation in demand fluctuations, the cross-industry regressions include the standard deviation of unanticipated growth in industrial demand, σ_{dsj}. Demand variability differentiates output variability significantly across industries. Further, asymmetry appears particularly pronounced in regressions (3) and (5). Both regressions indicate that the downward rigidity of price inflation relative to nominal wage inflation increases profit markup inflation during recessions, a key factor in exacerbating output variability across industries.

VI. Summary and Conclusion

The analysis of this paper has attempted to evaluate whether cost of living adjustments are operative to protect workers' real standard of living over the business cycle. These adjustments are achieved through shorter labor contracts and/or a higher degree of nominal wage indexation. Cost of living adjustments are likely to determine fluctuations in industrial relative price, the profit markup and real output over the business cycle. The theory under investigation predicts that these fluctuations become more moderate if cost of living adjustments are operative. For example, during expansions, shorter labor contracts and/or a higher degree of nominal wage indexation moderate the reduction in workers' real standard of living and industrial relative price. Consequently, the rise in industrial profit markup and output growth is more moderate during expansions.

To trace the validity of these implications over the business cycle, the empirical investigation employs techniques that separate demand shocks into expansionary and contractionary components. The evidence appears asymmetric concerning the operation of cost of living adjustments over the business cycle. During expansions, nominal wages across sectors of the economy have kept pace with aggregate price inflation. Subsequently, fluctuations in workers' real standard of living, industrial relative output price, the profit markup, and output fluctuations are generally insignificant in the face of expansionary demand shocks.

The evidence appears in sharp contrast in the face of contractionary demand shocks. Cost of living adjustment appears less effective in maintaining workers' real standard of living during recessions. This is because aggregate price inflation exceeds industrial nominal wage inflation in the face of contractionary demand shocks. Concurrently, producers resist reduction in output price inflation during recessions. Accordingly, in general, industrial output price inflation remains stable (or may even increase) relative to aggregate price inflation during recessions. Consistently, industrial profit markup inflation increases, in general, during recessions, exacerbating output contraction despite the reduction in workers' real standard of living.

The analysis of the paper is particularly important in highlighting fluctuations in the real standard of living over the business cycle. Contrary to the common perception, cost of living adjustments appear to be effective in insulating workers' real standard of living in the face of boom inflationary conditions. During contractions, concerns about unemployment often dominate that for real standard of living. As a result, workers are more likely to accept lower wage inflation while producers resist lowering price inflation. Lower wage inflation relative to price inflation exacerbates output contraction and lowers workers' real standard of living during recessions.

Table 1. Fluctuations in Workers' Real Standard of Living and Industrial Relative Price, Profit Markup, and Output Growth

Industry	a_{4p}	a_{4n}	$a_{4p}-a_{4n}$	b_{4p}	b_{4n}	$b_{4p}-b_{4n}$	c_{4p}	c_{4n}	$c_{4p}-c_{4n}$	d_{4p}	d_{4n}	$d_{4p}-d_{4n}$
Mining	0.07	-0.086	0.16	0.84	-1.86	2.7*	-0.32	-1.72	1.40	-0.50	3.78*	-4.28*
	(0.27)	(-0.35)	(0.60)	(0.83)	(-1.53)	(2.67)	(-0.33)	(-1.46)	(1.44)	(-0.63)	(3.94)	(-5.39)
Metal Mining	0.091	0.62	-0.53**	12.64*	-2.72	15.36*	12.56*	-4.84	17.4*	-1.83	1.17	-3.00
	(0.30)	(1.31)	(-1.74)	(4.16)	(-0.72)	(5.05)	(4.01)	(-1.25)	(5.55)	(-0.56)	(0.31)	(-0.92)
Coal Mining	0.099	0.77	-0.67	0.60	-2.56	3.16	-1.98	-1.07	-0.91	-0.29	-1.28	0.99
	(0.18)	(1.16)	(-1.22)	(0.24)	(1.04)	(1.26)	(-0.80)	(-0.39)	(-0.37)	(-0.27)	(-1.10)	(0.92)
Nonmetallic Minerals	0.29	-0.03*	0.32	-1.32	-0.15	-1.17	-2.04	-0.88	-1.16	0.31	2.89	-2.58
except fuel	(1.26)	(-2.17)	(1.39)	(-1.05)	(-0.12)	(-0.93)	(-1.39)	(-0.48)	(-0.79)	(0.18)	(1.31)	(-1.50)
Construction	-0.36	0.47	-0.83*	-0.16	-0.53	0.37	-0.10	-0.62	0.52	1.56*	1.72*	-0.16
	(-1.38)	(-1.40)	(-3.18)	(-0.25)	(-0.83)	(0.58)	(-0.15)	(-0.92)	(0.18)	(2.96)	(3.44)	(-0.30)
Manufacturing	-0.013	0.47*	-0.48*	-0.39	-0.20	-0.19	-0.19	-0.87*	0.68*	0.93	3.16*	-2.23*
	(-0.07)	(2.03)	(-2.60)	(-1.62)	(-0.67)	(-0.79)	(-0.58)	(-2.24)	(2.07)	(1.18)	(3.70)	(-2.83)
Durable Goods	-0.059	0.55*	-0.61*	0.19	-0.26	0.45	0.02	-0.86**	0.88*	0.99	4.38*	-3.39*
	(-0.29)	(2.29)	(-2.99)	(0.33)	(-0.46)	(0.78)	(0.05)	(-1.71)	(2.20)	(0.95)	(3.87)	(-3.25)
Lumber and Wood Products	0.40	0.33	0.07	2.66*	2.30	0.36	2.40**	1.88	0.52	1.71	-0.49	2.20
	(1.13)	(0.96)	(0.20)	(1.94)	(1.57)	(0.26)	(1.72)	(1.12)	(0.37)	(0.91)	(-0.21)	(1.17)
Furniture and Fixtures	0.018	0.25	-0.23**	-0.67	-0.74	0.07	-0.60	-0.98	0.38	1.68	3.30*	-1.62
	(0.14)	(1.43)	(-1.80)	(-1.14)	(-1.11)	(0.12)	(-0.97)	(-1.35)	(0.61)	(1.12)	(2.00)	(-1.08)
Stone, Clay, and Glass	0.015	0.14	-0.13	0.91**	-0.94	1.85*	0.48	-0.79	1.27*	0.90	4.20*	-3.30*
Products	(0.07)	(0.67)	(-0.58)	(1.65)	(-1.65)	(3.35)	(0.76)	(-1.11)	(2.01)	(1.06)	(4.77)	(-3.89)
Primary Metal Industries	0.72**	-0.056	0.78**	-0.17	-0.32	0.15	-1.058	0.66	-1.72**	2.15	6.33*	-4.18*
	(1.75)	(-0.12)	(1.89)	(-0.17)	(-0.33)	(0.15)	(-1.05)	(0.54)	(-1.71)	(1.17)	(2.77)	(-2.27)
Fabricated Metal Products	0.02	0.13	-0.11	-0.41	0.48	-0.89*	-1.07**	-0.39	-0.68	1.64	4.10*	-2.46*
	(0.11)	(0.73)	(-0.61)	(-0.93)	(1.00)	(-2.02)	(-1.65)	(-0.54)	(-1.04)	(1.58)	(3.60)	(-2.37)
Machinery Except Electrical	-0.14	0.64*	-0.78*	2.23	-2.55	4.87*	0.82	-1.32	2.14	-0.23	5.58*	-5.81*
	(-0.76)	(2.78)	(-4.23)	(1.39)	(-1.61)	(2.92)	(0.46)	(-0.63)	(1.20)	(-0.14)	(3.06)	(-3.54)
Electric and Electronic	-0.26	0.17	-0.43	-0.65	0.18	-0.83	-0.49	-0.34	-0.15	1.57	2.79**	-1.22
Equipment	(-0.93)	(0.65)	(-1.54)	(-1.08)	(0.33)	(-1.38)	(-0.81)	(-0.46)	(-0.25)	(1.16)	(1.84)	(-0.90)
Motor Vehicles and	0.38	0.32	0.06	-0.32	0.02	-0.34	0.14	-2.23**	2.37*	1.77	9.95*	-8.18*
Equipment	(0.99)	(0.79)	(0.16)	(-0.32)	(0.02)	(-0.34)	(0.12)	(-1.73)	(2.03)	(0.59)	(2.92)	(-2.73)
Other Transportation	0.086	0.24	-0.15	0.0058	0.032	-0.026	0.16	-0.97**	1.13**	0.11	-0.94	1.05
	(0.31)	(0.80)	(-0.56)	(0.03)	(0.17)	(-0.14)	(0.27)	(-1.65)	(1.91)	(0.07)	(-0.55)	(0.67)
Instruments and Related	-0.29	0.13	-0.42*	0.44	-0.41	0.85	0.017	0.16	-0.14	0.70	2.66**	-1.96
Products	(-1.38)	(0.65)	(-2.00)	(0.59)	(-0.48)	(1.14)	(0.03)	(0.23)	(-0.25)	(0.55)	(1.65)	(-1.54)
Misc. Manufacturing	-0.38**	0.27	-0.65*	-0.16	-1.31	1.15	0.20	-1.62	1.82	-0.069	3.79**	-3.86*
Industries	(-2.28)	(1.59)	(-3.90)	(-0.12)	(-1.00)	(0.86)	(0.17)	(-1.16)	(1.55)	(-0.04)	(1.65)	(-2.24)
Nondurable Goods	-0.16	0.069	-0.23	-0.35	-0.21	-0.14	-0.12	-0.16	0.04	0.80	1.46*	-0.66
	(-0.95)	(0.41)	(-1.36)	(-0.90)	(-0.52)	(-0.36)	(-0.32)	(-0.41)	(0.11)	(1.42)	(2.43)	(-1.17)

Table 1. Fluctuations in Workers' Real Standard of Living and Industrial Relative Price, Profit Markup, and Output Growth (Cont.)

Industry	a_{4p}	a_{4n}	$a_{4p}-a_{4n}$	b_{4p}	b_{4n}	$b_{4p}-b_{4n}$	c_{4p}	c_{4n}	$c_{4p}-c_{4n}$	d_{4p}	d_{4n}	$d_{4p}-d_{4n}$
Food and Kindred Products	-0.073	0.091	-0.16	-2.52*	0.76	-0.28*	-2.95*	1.37	-4.32*	1.013	0.63	0.38
	(-0.50)	(0.52)	(-1.12)	(-2.59)	(0.71)	(-3.37)	(-2.84)	(1.30)	(-4.16)	(1.55)	(0.78)	(0.59)
Tobacco Manufactures	0.15	-0.65	0.80*	-2.21	3.36**	-5.57*	-1.32	1.42	-2.74	-1.21	-0.52	-0.69
	(0.39)	(-1.56)	(2.08)	(-1.06)	(1.69)	(-2.67)	(0.70)	(0.78)	(-1.45)	(-0.71)	(-0.30)	(-0.40)
Textile Mill Products	0.05	0.43**	-0.38	1.65	-0.53	2.18	0.58	-0.71	1.29	-0.94	3.09	-4.03*
	(0.22)	(1.72)	(-1.67)	(1.12)	(-0.40)	(1.48)	(0.38)	(-0.41)	(0.85)	(-0.48)	(1.58)	(-2.06)
Apparel and Other Textile	0.098	0.46	-0.36	-0.75	-0.031	-0.72	-0.47	-0.40	-0.07	0.16	1.86	-1.10
Products	(0.29)	(1.26)	(-1.07)	(-1.47)	(-0.05)	(-1.41)	(-0.78)	(-0.67)	(-0.12)	(0.14)	(1.54)	(-1.49)
Paper and Allied Products	-0.12	0.10	-0.22	0.30	-1.23	1.53	-0.33	-1.10	0.77	2.72*	1.21	1.51
	(-0.59)	(0.57)	(-1.08)	(0.31)	(-1.36)	(1.58)	(-0.28)	(-0.87)	(0.65)	(2.19)	(0.90)	(1.22)
Printing and Publishing	-0.32	0.23	-0.55*	-0.23	-0.51	0.28	-0.27	-0.61	0.34	0.40	1.44**	-1.04
	(-1.45)	(0.96)	(-2.49)	(-0.45)	(-0.89)	(0.55)	(-0.47)	(-1.05)	(0.59)	(0.60)	(1.93)	(-1.56)
Chemicals and Allied	-0.066	0.078	-0.14	0.63	-0.84	1.47**	1.03	-0.93	1.96*	2.29*	1.21	1.08
Products	(-0.35)	(0.44)	(-0.76)	(0.76)	(-1.06)	(1.77)	(1.14)	(-1.07)	(2.17)	(2.10)	(1.01)	(0.99)
Petroleum and Coal	-0.24	0.50	-0.74*	1.51	1.28	0.23	1.55	0.94	0.61	0.84	-0.12	0.96
Products	(-0.67)	(1.44)	(-2.06)	(0.71)	(0.52)	(0.11)	(0.78)	(0.42)	(0.31)	(0.43)	(-0.06)	(0.49)
Rubber and Misc. Plastic	-0.34	0.72**	-0.71*	-0.33	-0.38	0.05	0.092	-1.64*	1.73*	-0.45	5.43*	-5.88*
Products	(-1.53)	(1.72)	(-3.20)	(-0.59)	(-0.70)	(0.09)	(0.15)	(-2.81)	(2.82)	(-0.35)	(3.63)	(-4.57)
Leather and Leather	-0.035	0.091	-0.13	-1.22	-0.067	-1.15	0.75	-0.35	1.10	3.42*	1.82	1.60
Products	(-0.13)	(0.30)	(-0.47)	(-1.17)	(-0.07)	(-1.11)	(0.72)	(-0.27)	(1.06)	(2.16)	(1.10)	(1.01)
Wholesale Trade	-0.091	0.28	-0.37**	-1.20	0.97	-2.17*	-0.25	1.00	-1.25	-0.73	1.29	-2.02
	(-0.47)	(1.32)	(-1.92)	(-1.36)	(1.09)	(-2.45)	(-0.21)	(0.85)	(-1.05)	(-0.59)	(1.06)	(-1.63)
Retail Trade	-0.049	0.62*	-0.67*	-0.21	-0.53	0.32	0.10	-1.41*	1.51*	0.65**	1.80*	-1.15*
	(-0.23)	(2.06)	(-3.14)	(-0.54)	(-1.14)	(0.82)	(0.25)	(-2.98)	(3.78)	(1.75)	(4.48)	(-3.10)
Finance, Insurance, and	-0.13	-0.20	0.07	-0.85**	0.71**	-1.56*	-1.19*	1.03*	-2.22*	0.53**	0.63**	-0.10
Real Estate	(-0.70)	(-0.85)	(0.38)	(-1.88)	(1.65)	(-3.45)	(2.40)	(2.18)	(-4.48)	(1.80)	(1.73)	(-0.34)

Notes:

- Empirical Models:

$$Dw_{jt} - Dp_t = a_0 + a_1E_{t-1}Dq_t + a_2Dqs_t + a_3E_{t-1}Dn_t + a_{4p}pos_t + a_{4n}neg_t + a_5ss_{jt} + a_{jt}$$

$$Dp_{jt} - Dp_t = b_0 + b_1E_{t-1}Dq_t + b_2Dqs_t + b_3E_{t-1}Dn_t + b_{4p}pos_t + b_{4n}neg_t + b_5ss_{jt} + b_{jt}$$

$$Dp_{jt} - Dw_{jt} = c_0 + c_1E_{t-1}Dq_t + c_2Dqs_t + c_3E_{t-1}Dn_t + c_{4p}pos_t + c_{4n}neg_t + c_5ss_{jt} + c_{jt}$$

$$Dy_{jt} = d_0 + d_1E_{t-1}Dq_t + d_2Dqs_t + d_3E_{t-1}Dn_t + d_{4p}pos_t + d_{4n}neg_t + d_5ss_{jt} + d_{jt}$$

- t-ratios are in parentheses. * and ** indicate significance at the five and ten percent levels.

Table 2. Cross-Industry Correlations

During	**(1)**	**(2)**	**(3)**
Expansions	Corr(f_{4p}, g_{4p})	Corr(a_{4p}, b_{4p})	Corr(a_{4p}, c_{4p})
	0.25	0.019	-0.12
	(0.20)	(0.92)	(0.55)
Contractions	Corr(f_{4n}, g_{4n})	Corr(a_{4n}, b_{4n})	Corr(a_{4n}, c_{4n})
	-0.39	-0.57	-0.44
	(0.041)	(0.0018)	(0.02)

Notes:

- Empirical Models:

$$Dw_{jt} - Dp_t = a_0 + a_1 E_{t-1}Dq_t + a_2 Dqs_t + a_3 E_{t-1}Dn_t + a_{4p}pos_t + a_{4n}neg_t + a_5 ss_{jt} + a_{jt}$$

$$Dp_{jt} - Dp_t = b_0 + b_1 E_{t-1}Dq_t + b_2 Dqs_t + b_3 E_{t-1}Dn_t + b_{4p}pos_t + b_{4n}neg_t + b_5 ss_{jt} + b_{jt}$$

$$Dp_{jt} - Dw_{jt} = c_0 + c_1 E_{t-1}Dq_t + c_2 Dqs_t + c_3 E_{t-1}Dn_t + c_{4p}pos_t + c_{4n}neg_t + c_5 ss_{jt} + c_{jt}$$

$$Dw_{jt} = f_0 + f_1 E_{t-1}Dq_t + f_2 Dqs_t + f_3 E_{t-1}Dn_t + f_{4p}pos_t + f_{4n}neg_t + f_5 ss_{jt} + f_{jt}$$

$$Dp_{jt} = g_0 + g_1 E_{t-1}Dq_t + g_2 Dqs_t + g_3 E_{t-1}Dn_t + g_{4p}pos_t + g_{4n}neg_t + g_5 ss_{jt} + g_{jt}$$

- Corr(.,.) denotes statistical correlations between parameters across industries.

- Bracketed magnitudes indicate probability of zero correlation.

Table 3. Variations in Output Fluctuations in Response to Expansionary Aggregate Demand Shocks Across Industries

Dep. Var. $d_{4n} = \frac{\partial Dy_{jt}}{\partial pos_t}$				**Exp.**	**Var.**	**and**			R^2
	Constant	a_{4p}	b_{4p}	c_{4p}	f_{4p}	g_{4p}	e_{1p}	$\overline{prod}$	
(1)	0.84*	0.75							0.028
	(3.77)	(0.85)							
(2)	0.82*		0.017						0.0003
	(3.66)		(0.089)						
(3)	0.86*			0.19					0.033
	(3.83)			(0.93)					
(4)	0.81*				0.032				0.0001
	(2.41)				(0.041)				
(5)	0.79*					0.13			0.018
	(3.42)					(0.67)			
(6)	0.82*				-0.10	0.14			0.018
	(2.40)				(-0.13)	(0.67)			
(1)'	0.21	0.076					0.64*	-0.76	0.37
	(0.45)	(0.099)					(3.52)	(-0.053)	
(2)'	-0.20		-0.27				0.76*	9.77	0.42
	(-0.39)		(-1.46)				(4.09)	(0.63)	
(3)'	-0.13			-0.24			0.79*	4.43	0.40
	(-0.24)			(-1.17)			(3.76)	(0.30)	
(4)'	0.22				-0.09		0.65*	-0.31	0.37
	(0.46)				(-0.14)		(3.66)	(-0.02)	
(5)'	-0.11					-0.32	0.84*	7.61	0.43
	(-0.24)					(-1.62)	(4.08)	(0.52)	
(6)'	-0.15				0.14	-0.33	0.84*	7.30	0.43
	(-0.30)				(0.21)	(-1.59)	(4.00)	(0.49)	

Notes:

- a_{4p}, b_{4p}, c_{4p}, d_{4p}, and e_{1p} approximate the expansionary effects of aggregate demand shocks on workers' real standard of living, industrial relative output price, the profit markup, real output, and industrial demand shocks (see Table 1).
- f_{4p}, g_{4p}, approximate the upward flexibility of industrial nominal wage and price in the face of aggregate demand shocks (see Table A1).
- $\overline{prod}$ approximates the time-series average of industrial labor productivity.
- t-ratios are in parentheses.
- * and ** denote statistical significance at the five and ten percent levels.

Table 4. Variations in Output fluctuations in Response to Contractionary Aggregate Demand Shocks Across Industries

Dep. Var. $d_{4n} = \frac{\partial Dy_{jt}}{\partial pos_t}$				**Exp.**	**Var.**	**and**			$\mathbf{R^2}$
	Constant	a_{4n}	b_{4n}	c_{4n}	f_{4n}	g_{4n}	e_{1n}	$\overline{prod}$	
(1)	2.23*	0.68							0.0059
	(3.53)	(0.39)							
(2)	2.31*		-0.62						0.093
	(4.91)		(-1.60)						
(3)	1.94*			-1.19*					0.26
	(4.36)			(-2.96)					
(4)	2.87*				3.80*				0.22
	(6.078)				(2.62)				
(5)	1.67*					-1.19*			0.20
	(3.16)					(-2.46)			
(6)	2.25*				2.81**	-0.83**			0.29
	(3.77)				(1.84)	(-1.65)			
(1)'	0.17	-0.40					1.48*	0.66	0.69
	(0.25)	(-0.36)					(7.056)	(0.028)	
(2)'	0.54		-0.40**				1.41*	-15.57	0.72
	(0.78)		(-1.65)				(7.074)	(-0.69)	
(3)'	0.51			-0.73*			1.31*	-16.58	0.77
	(0.84)			(-2.88)			(7.02)	(-0.84)	
(4)'	0.61				0.90		1.38*	-9.59	0.69
	(0.69)				(0.77)		(5.82)	(-0.40)	
(5)'	0.13					-0.96*	1.39*	-18.68	0.80
	(0.24)					(-3.68)	(8.32)	(-1.029)	
(6)'	0.023				-0.23	-0.98*	1.41*	-17.26	0.80
	(0.031)				(-0.22)	(-3.49)	(7.24)	(-0.88)	

Notes:

- a_{4n}, b_{4p}, c_{4n}, d_{4n}, and e_{1n} approximate the contractionary effects of aggregate demand shocks on workers' real standard of living, industrial relative output price, the profit markup, real output, and industrial demand shocks (see Table 1).
- f_{4n}, g_{4n}, approximate the downward flexibility of industrial nominal wage and price in the face of aggregate demand shocks (see Table A1).
- $\overline{prod}$ approximates the time-series average of industrial labor productivity.
- t-ratios are in parentheses.
- * and ** denote statistical significance at the five and ten percent levels.

Table 5. Industrial Output Variability and Cyclical Fluctuations in Various Indicators During Expansions and Contractions

Dep. Var. σ_{yj}		**Exp.**	**Var.**	**And**	$\mathbf{R^2}$
(1)	constant	a_{4p}	a_{4n}	σ_{dsj}	
	0.036*	0.019	-0.016	0.85*	0.67
	(3.70)	(0.93)	(-1.00)	(5.047)	
(2)	constant	b_{4p}	b_{4n}	σ_{dsj}	
	0.027*	-0.0024	0.00019	0.93*	0.63
	(2.86)	(-0.59)	(0.052)	(6.06)	
(3)	constant	c_{4p}	c_{4n}	σ_{dsj}	0.67
	0.29*	0.0005	-0.0071**	0.85*	
	(3.32)	(0.13)	(-1.81)	(6.13)	
(4)	constant	f_{4p}	f_{4n}	σ_{dsj}	0.65
	0.028*	-0.048	-0.052	0.95*	
	(3.10)	(-1.056)	(-1.12)	(6.38)	
(5)	constant	g_{4p}	g_{4n}	σ_{dsj}	0.79
	0.028*	-0.01	-0.031*	1.014*	
	(4.12)	(-1.48)	(-3.90)	(9.065)	

Notes:

- a_{4p}, b_{4p}, and c_{4p} approximate the expansionary effects of aggregate demand shocks on workers' real standard of living, industrial relative output price, and the profit markup (see Table 1).

- f_{4p}, g_{4p} approximate the upward flexibility of industrial nominal wage and price in the face of aggregate demand shocks (see Table A1).

- a_{4p}, b_{4n}, and c_{4n} approximate the contractionary effects of aggregate demand shocks on workers' real standard of living, industrial relative output price, and the profit markup (see Table 1).

- f_{4n}, g_{4n} approximate the downward flexibility of industrial nominal wage and price in the face of aggregate demand shocks (see Table A1).

- σ_{yj} is the standard deviation of industrial real output growth.

- σ_{dsj} is the standard deviation of unanticipated growth in the industrial demand.

- t-ratios are in parenthesis.

- * and ** denote statistical significance at the five and ten percents levels.

Industrial Nominal Wage and Price Flexibility: A descriptive Summary

To establish evidence on the cyclical flexibility of industrial nominal wage and price, the empirical model in (14) is re-estimated replacing the dependent variable with each of nominal wage and price inflation sequentially. Detailed results are summarized in Table A1. A summary of these results is as follows.

Aggregate price inflation increases during expansions with a coefficient that is statistically significant. During recessions, in contrast, downward rigidity is evident by the negative response of aggregate price inflation to contractionary demand shocks. That is, aggregate price inflation does not decrease (or may even increase) during periods of a slow down in aggregate spending.

Prices are generally flexible to adjust upward, as evident by the positive response of price inflation to expansionary demand shocks in nineteen Industries. This response is positive and statistically significant in Metal Mining, Lumber and Wood Products, Stone, Clay and Glass Products. In the remaining industries, the negative coefficients indicate rigidity of price inflation to adjust upward, which is statistically significant in Food & Kindred Products and Finance, Insurance, and Real Estate. In these industries, price inflation is decreasing despite expansionary aggregate demand shocks. Downward price rigidity is more prevalent across industries. This is evident by the negative response of price inflation to contractionary demand shocks in twenty-five industries. This response is statistically significant in Manufacturing, Durable Goods, Stone, Clay, and Glass Products, and Rubber and Misc. Plastic Products. That is, price inflation is increasing despite contractionary demand shocks. In the remaining industries, price deflation is evident by the positive coefficient, which is statistically significant in Finance, Insurance, and Real Estate.

Asymmetry is measured by the difference in the response of price inflation to expansionary and contractionary demand shocks. This difference is positive in twenty-five industries. Further, this difference is statistically significant in Mining, Metal Mining, Manufacturing, Durable Goods, Stone, Clay and Glass Products, Machinery Except Electrical, Motor Vehicles, Other Transportation, Instruments and Related Products, Miscellaneous Manufacturing, Chemicals and Allied Products, Rubber and Misc. Plastic Products, and Wholesale Trade. In all these cases, price inflation increases, on average, in the face of aggregate demand variability over time. In the remaining industries, demand variability decreases price inflation, on average, over time, which is statistically significant in Food and Kindred Products, and Finance, Insurance, and Real Estate.

Nominal wage inflation is evident by the positive response to expansionary demand shocks in twenty-nine industries. This response is statistically significant in Metal Mining, Nonmetallic Minerals, Manufacturing, Durable Goods, Lumber and Wood Products, Primary Metal Industries, Fabricated Metal Products, Machinery, Electric and Electronic Equipment, Textile Mill Products, Apparel and Other Textile Products, and Leather and Leather Products. In the remaining industries, the upward rigidity of the nominal wage is evident by the negative response to expansionary demand shocks, which is not statistically significant in any industry.

The downward rigidity of the nominal wage is evident by the negative response to contractionary demand shocks in twenty industries. This response is statistically significant in Instruments and Related Products, Food and Kindred Products, Tobacco Manufactures, and Chemicals and Allied Products. In these industries, nominal wage inflation is increasing despite contractionary demand shocks. In the remaining industries, the positive response to contractionary demand shocks is statistically insignificant in all industries.

Asymmetry is measured by the difference in the response of nominal wage inflation to expansionary and contractionary demand shocks. This difference is positive in twenty-nine industries. Further, this difference is statistically significant in Metal Mining, Nonmetallic Minerals, Construction, Lumber and Wood Products, Stone, Clay and Glass Products, Primary Metal Industries, Fabricated Metal Products, Instruments and Related Products, Nondurable Goods, Food and Kindred Products, Tobacco Manufactures, Textile Mill Products, Apparel and Other Textile Products, Paper and Allied Products, Chemicals and Allied Products, Petroleum and Coal Products, Leather and Leather Products, and Wholesale Trade. In all these cases, demand variability increases nominal wage inflation, on average, over time. In the remaining industries, nominal wage inflation decreases, on average, in the face of demand variability with a negative coefficient that is statistically insignificant.

Table A1. Estimates of Aggregate Price Flexibility and Industrial Nominal Wage and Price Flexibility

Industry	Nominal f_{4p}	Wage f_{4n}	Inflation $(f_{4p} - f_{4n})$	Nominal g_{4p}	Price g_{4n}	Inflation $(g_{4p} - g_{4n})$
GDP				0.30**	-0.25	0.55*
				(1.70)	(-1.45)	(3.12)
Mining	0.29	-0.23	0.52	0.20	-1.82**	2.02*
	(0.76)	(-0.61)	(1.36)	(0.22)	(-1.65)	(2.22)
Metal Mining	0.99*	-0.34	1.33*	13.22*	-3.29	16.51*
	(2.46)	(-0.86)	(3.30)	(4.27)	(-0.86)	(5.33)
Coal Mining	0.76	0.20	0.56	-1.06	-0.97	-0.09
	(1.25)	(0.29)	(0.92)	(-0.41)	(-0.34)	(-0.035)
Nonmetallic Minerals except fuel	0.34**	-0.15	0.49*	-1.66	-1.07	-0.59
	(1.75)	(-0.80)	(2.52)	(-1.29)	(-0.65)	(-0.035)
Construction	0.21	-0.36	0.57*	-0.018	-0.97	0.95
	(0.90)	(-1.60)	(2.44)	(-0.03)	(-1.53)	(1.59)
Manufacturing	0.28**	0.077	0.20	0.40	-0.93*	1.33*
	(1.76))	(0.51)	(1.28)	(1.12)	(-2.39)	(3.72)
Durable Goods	0.29**	0.13	0.16	0.73	-1.16*	1.89*
	(1.91)	(0.85)	(1.05)	(1.40)	(-2.11)	(3.62)
Lumber and Wood Products	0.69*	-0.073	0.76*	3.30*	2.14	1.16
	(2.63)	(-0.29)	(2.91)	(2.26)	(1.30)	(0.79)
Furniture and Fixtures	-0.21	0.0079	-0.22	-0.024	-1.30**	1.28
	(-1.14)	(0.04)	(-1.18)	(-0.03)	(-1.65)	(1.60)
Stone, Clay, and Glass Products	0.31**	-0.052	0.36**	1.29**	-1.37**	2.66*
	(1.65)	(-0.28)	(1.90)	(1.87)	(-1.86)	(3.86)
Primary Metal Industries	0.98*	-0.32	1.30*	0.083	0.39	-0.31
	(2.66)	(-0.89)	(3.53)	(0.08)	(0.32)	(-0.30)
Fabricated Metal Products	0.28**	-0.056	0.34*	-0.63	-0.56	-0.07
	(1.65)	(-0.34)	(1.98)	(-1.03)	(-0.80)	(-0.11)
Machinery Except Electrical	0.29**	0.12	0.17	1.16	-1.95	3.11**
	(1.82)	(0.74)	(1.066)	(0.63)	(-0.91)	(1.69)
Electric and Electronic Equipment	0.29**	0.12	0.17	-0.13	-0.72	0.59
	(1.82)	(0.74)	(1.067)	(-0.20)	(-1.01)	(0.91)
Motor Vehicles and Equipment	0.61	0.55	0.06	0.76	-1.27	2.03**
	(1.41)	(1.23)	(0.14)	(0.67)	(-1.04)	(1.79)
Other Transportation	0.44	0.11	0.33	0.52	-0.79	1.31*
	(1.49)	(0.37)	(1.12)	(0.84)	(-1.31)	(2.12)
Instruments and Related Products	0.29	-0.61*	0.9*	0.81	-0.63	1.44*
	(1.00)	(-2.15)	(3.10)	(1.25)	(-0.78)	(2.22)
Misc. Manufacturing Industries	-0.15	0.02	-0.17	0.57	-1.89	2.46*
	(-0.82)	(0.12)	(-0.93)	(0.47)	(-1.31)	(2.028)
Nondurable Goods	0.055	-0.22	0.28**	-0.029	-0.44	0.41
	(0.34)	(-1.40)	(1.70)	(-0.08)	(-1.30)	(1.13)
Food and Kindred Products	0.13	-0.37*	0.50*	-2.14*	0.17	-2.31*
	(0.85)	(-2.52)	(3.27)	(-2.09)	(0.16)	(-2.26)

Table A1. Estimates of Aggregate Price Flexibility and Industrial Nominal Wage and Price Flexibility (Cont.)

Industry	Nominal f_{4p}	Wage f_{4n}	Inflation $(f_{4p} - f_{4n})$	Nominal g_{4p}	Price g_{4n}	Inflation $(g_{4p} - g_{4n})$
Tobacco Manufactures	0.68	-1.05*	1.73*	-0.75	0.54	-1.29
	(1.56)	(-2.23)	(3.97)	(-0.42)	(0.31)	(-0.72)
Textile Mill Products	0.56*	0.027	0.53*	1.25	-0.63	1.88
	(2.42)	(0.11)	(2.30)	(0.79)	(-0.36)	(1.19)
Apparel and Other Textile Products	0.59*	-0.098	0.69*	0.32	-0.48	0.80
	(1.89)	(-0.32)	(2.20)	(0.52)	(-0.79)	(1.30)
Paper and Allied Products	0.11	-0.24	0.35*	0.075	-1.47	1.54
	(0.64)	(-1.52)	(2.036)	(0.07)	(-1.28)	(1.44)
Printing and Publishing	0.074	-0.19	0.26	-0.068	-0.90	0.83
	(0.42)	(-1.10)	(1.50)	(-0.12)	(-1.58)	(1.47)
Chemicals and Allied Products	0.25	-0.35*	0.60*	1.04	-1.24	2.28*
	(1.34)	(-1.95)	(3.22)	(1.23)	(-1.49)	(2.70)
Petroleum and Coal Products	0.69	-0.39	1.08*	2.15	0.40	1.75
	(1.35)	(-0.71)	(2.11)	(1.08)	(0.18)	(0.88)
Rubber and Misc. Plastic Products	-0.25	0.21	-0.46	-0.11	-1.46*	1.35*
	(-0.87)	(0.79)	(-1.60)	(-0.17)	(-2.25)	(2.09)
Leather and Leather Products	0.38**	-0.33	0.71*	0.97	-0.84	1.81
	(1.67)	(-1.48)	(3.12)	(0.85)	(-0.62)	(1.59)
Wholesale Trade	0.23	-0.10	0.33*	1.25	0.38	1.78*
	(1.54)	(-0.72)	(2.21)	(1.38)	(0.36)	(1.96)
Retail Trade	0.21	0.12	0.09	-0.013	-0.72	0.71
	(0.94)	(0.55)	(0.40)	(-0.03)	(-1.40)	(1.63)
Finance, Insurance, and Real Estate	0.072	-0.24	0.31	-1.27*	0.93*	-2.2*
	(0.34)	(-1.14)	(1.47)	(-2.76)	(2.10)	(-4.78)

Notes:

- Empirical Models:

$$Dw_{jt} = f_0 + f_1 E_{t-1} Dq_t + f_2 Dqs_t + f_3 E_{t-1} Dn_t + f_{4p} pos_t + f_{4n} neg_t + f_5 ss_{jt} + f_{jt}$$

$$Dp_{jt} = g_0 + g_1 E_{t-1} Dq_t + g_2 Dqs_t + g_3 E_{t-1} Dn_t + g_{4p} pos_t + g_{4n} neg_t + g_5 ss_{jt} + g_{jt}$$

- t-ratios are in parentheses.

- * and ** indicate significance at the five and ten percent levels.

Econometric Methodology

The surprise terms that enter models (12) through (15) are unobservable, necessitating the construction of empirical proxies before estimation can take place. Thus, the empirical models include equations describing agents' forecast of aggregate demand growth and the change in energy price. The predictive values from this equation are the proxies for agents' expectations of the change in aggregate demand and the energy price.

Obtaining a proxy for agents' forecast of nominal GDP growth is complicated by the fact that the level of nominal GDP is endogenous which is supported by the results of the test suggested by Engle (1982). Anticipated aggregate demand growth is generated by taking the fitted values of a reduced form equation for the change in the log value of nominal GDP in which the explanatory variables include two lags of the first-difference of the short-term interest rate and the log first-difference of industrial real output, industrial price level, industrial nominal wage, aggregate labor productivity, the energy price, and nominal GDP itself. The proxy for nominal GDP shocks is then formed by subtracting this forecast from the actual values of nominal GDP growth. Cross-section results are robust with respect to a modification that varies the lag length or the variables in the forecast equation.

To estimate the empirical models in (16), a proxy for forecasted growth in industrial demand is also needed. The log first-difference of the nominal value of the output produced in the industry approximates industrial demand growth, which is endogenous according to Engle's (1982) test. Further, the forecast equation accounts for the nominal value of output in industries that qualify as good instruments for demand from a given industry. Following the suggestions of Shea (1993), these industries are selected based on the 1977 detailed input-output study. Accordingly, anticipated growth in industrial demand is generated by taking the fitted values of a reduced-form equation in which the explanatory variables include a constant and two lagged values of the log first-difference of industrial real output, industrial price level, industrial nominal wage, industrial labor productivity, the nominal value of the output produced in industries that demand a large share of the relevant industry output and contribute with a small share of its cost, the energy price, and nominal GDP. The proxy for industrial demand shocks is then formed by subtracting this forecast from the actual value of industrial demand growth.

The energy price is exogenous according to the results of the test suggested in Engle (1982). Obtaining a proxy for ex-ante forecasts of the energy price is complicated by the assumption that the generating process experienced a structural change between 1973 and 1974. This assumption is supported by the results of a formal test suggested in Dufour (1982). For both the period 1947-73 and the period 1974-97, the generating process is modeled as a second-order auto-regressive process. The proxy for energy price surprises is then formed by subtracting these forecasts from the actual change in the energy price.

In order to obtain efficient estimates and ensure correct inferences (i.e., to obtain consistent variance estimates), the empirical models are estimated jointly with the equation that determines the proxy variables following the suggestions of Pagan (1984 and 1986). To account for the endogeneity of demand variables, instrumental variables are used in the estimation of the empirical models. The instrument list includes two lags each of the first-difference of the short-term interest rate and the log first-difference of nominal GDP; the energy price; and industrial real output, the output price, the nominal wage and aggregate labor productivity.

To test for the asymmetric effects of positive and negative aggregate demand shocks, the positive and negative components of aggregate demand shocks are defined as follows:

$$neg_t = -\frac{1}{2}\{abs(Dns_t) - Dns_t$$

$$pos_t = \frac{1}{2}\{abs(Dns_t) + Dns_t\}$$

abs(.) is the absolute value operator. Dns_t is the shock to the growth of nominal GDP at time t, and neg_t and pos_t are the negative and positive components of the shocks, respectively. The mathematical definitions of these components follow the suggestions of Cover (1992) to facilitate joint estimation.

Following the suggestions of Engle (1982), the results of the test for serial correlation in simultaneous equation models are consistent with the presence of first-order auto-regressive errors for some industries. To maintain comparability, it is assumed in all models that the error term follows an AR(1) process. The estimated models are transformed, therefore, to eliminate any possibility for serial correlation. The estimated residuals from the transformed models have zero means and are serially independent.

Data Sources

Sample Period: 1947-97.

The following annual data were taken from: The *National Income and Product Accounts of the United States, 1929-82 Statistical Tables*, U.S. Department of Commerce/Bureau of Economic Analysis. Updates for the years 1983-97 are provided in the July issues of *Survey of Current Business*.

1. Nominal GDP by industry, Table 6.1.

2. GDP by industry in constant dollars (1982=100), Table 6.2.

3. Sectoral price level = nominal output by industry/constant dollar output by industry.

4. Full-time equivalent employees by industry, Table 6.6B.

5. Sectoral productivity = the ratio of constant dollar output to the full-time equivalent employees by industry.

6. Capital intensity = Gross domestic product by industry (source above) minus national income without capital consumption adjustment, Table 6.3B.

The average annual hourly nominal wage rate data for sectoral production workers were taken from:

1. Employment, Hours, and Earnings, United States, 1909-84, Volume I and II, Establishment Survey Data, U.S. Department of Labor, Bureau of Labor Statistics, March 1985, Bulletin 1312 (for the years 1947-1982).

2. Supplement to Employment, Hours and Earnings, United States, 1909-84, revised establishment data, U.S. Department of Labor, Bureau of Labor Statistics, August 1989 (for the years 1983-88).

3. Employment and Earnings, revised establishment data on employment, hours, and earnings for the United States, 1989-97 (for the years 1989-97).

Other series are as follows:

1. Producers Price Index (1982=100) for Fuels, Power and Related Products-*Historical Series 1926-1997*, the U.S. Department of Labor, Bureau of Labor Statistics.

2. Short-Term Interest Rate: 3-month Treasury Bill rate, *International Financial Statistics*, available on tapes from the International Monetary Fund.

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