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TESTING FOR CONTRACTING EFFECTS ON EMPLOYMENT

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ABSTRACT

I test the importance of wage rigidities from long-term contracts by observing how employment behaves when firms and workers recontract. If rigidities are important then we should observe employment adjusting after recontracting to undo movements in employment during the past contract that were excessive due to rigid wages.

The data are for twelve manufacturing industries that display a strong bargaining pattern.

I find that contract rigidities are important, causing considerably larger fluctuations in employment than would occur with flexible wages. By far the most striking case is in motor vehicles where long-term contracts much more than double the size of fluctuations in employment. I also examine the behavior of wage rates when new contracts are introduced. Wage growth does respond to employment growth during the prior contract in several of the industries; but these responses are not related to the pattern of employment responses across industries.

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In many models of macro fluctuations wage rigidities no longer play a central role. The most obvious examples are real business cycle models (e.g., Prescott, 1986), which not only assume employment equates supply and demand, but also typically ignore matching model predictions for real wage movements to actual data. More striking, however, is that those attempting to explain fluctuations with the aid of various market failures have greatly reduced the emphasis on wage rigidities. I note in particular the comments of Rotemberg (1987), Summers (1987), and Lindbeck and Snower (1987).

This deemphasis can be largely traced to the implicit labor contracting literature of the 1970's. This literature typically separated the decisions for employment and compensation, and arrived at efficient cyclical choices for employment independently of the cyclical pattern of wage rates. Barro (1977) pointed out the incompatibility of traditional rigid wage models with the then burgeoning literature on efficient bargaining. Hall (1980) suggested that long-term firm-worker attachments that describe much of the workforce may provide the environment for achieving efficient labor choices while at the same time smoothing wage payments.

Here I propose a simple test for the importance of wage rigidities from long-term contracts, based on observing how employment behaves when firms and workers recontract. If contract rigidities are unimportant, then when a new bargain is signed this should have no impact on the path of employment. If, on the other hand, rigidities are important then we should observe employment adjusting after recontracting to undo movements in employment during the past contract that were excessive due to rigid wages. This exploits the point that wages are not rigid at the time of recontracting. This rebounding should show up as negative moving average terms for employment occurring after

periods of recontracting.

Section 3 examines the behavior of employment for twelve manufacturing industries that are described by pattern bargaining. By using industries as the unit of observation I can observe quarterly data on employment. By using industries where most of the industry bargains within a time span of a month or two it is generally possible to associate bargaining points with particular quarterly observations for employment.

I find evidence that contract rigidities are important, causing considerably larger fluctuations in employment than would occur with flexible wages. The assumption that contracting is irrelevant for employment is rejected in several of the industries. The rejections are economically as well as statistically important. The most striking case is in motor vehicles where long-term contracts much more than double the size of fluctuations in employment. Overall the results suggest that contracting can explain as much as forty percent of the employment variability observed in the twelve industries.

I also examine the behavior of wage rates when new contracts are introduced. The results for employment suggest that wage rates should respond to past employment at the time of new contracts. Wage growth does respond to employment growth during the prior contract in several of the industries; but these wage responses are not very related to the pattern of employment responses across industries. Furthermore, this impact on wage rates is not robust to alternative specifications. This makes it difficult to interpret the employment evidence within the scenario of firms unilaterally choosing employment on the basis of the contract wage. In the final section I discuss alternative interpretations.

2. Setup

I consider a simple bargaining problem between a representative firm and worker or, more realistically, group of workers.

Labor demand and supply

Let the firm's revenue in real terms from employing L_t workers in period t be:

$$(1) \quad \text{Profits}_t = a_t L_t - (b/2)L_t^2 .$$

This yields the downward-sloping labor demand curve:

$$(2) \quad L_t^d = (a_t - w_t)/b$$

where w is an explicit or implicit real wage rate. The stochastic parameter a_t shifts the labor demand schedule.

Suppose the bargaining unit for workers views the opportunity cost of providing employment equal to L_t as:

$$(3) \quad \text{Opportunity cost}_t = c_t L_t + (d/2)L_t^2 .$$

I presume the parameter d to be nonnegative, with labor's bargaining unit viewing the labor it provides as having a rising marginal opportunity cost. This yields the upward-sloping labor supply curve:

$$(4) \quad L_t^S = (w_t - c_t)/d \quad .$$

The stochastic parameter c_t shifts the labor supply schedule (negatively).

Flexible wage solution

The choice for employment that equates supply and demand is:

$$(5) \quad L_t^* = \frac{a_t - c_t}{b + d} \quad .$$

I will refer to this as the flexible-wage solution for employment, although, as discussed in the introduction, we might imagine settings without flexible wages that support this choice. This solution is clearly independent of the relation of time period t to points of bargaining between the firm and workers. The proposition that the flexible-wage level of employment is independent of when bargaining occurs will hold much more generally than for the specific setup here.¹ The proposition that employment should not predictably rebound from realizations during the past contract holds even more generally. For example, the employment-contingent contracts discussed in Hall and Lillien (1979) are not completely indexed, yet preclude any predictable rebounding of employment at the time of recontracting.

Rigid wage solution

As an alternative hypothesis to flexible-wage bargains, now suppose firms and workers bargain in advance to set a path for wage rates, then allow the firm to unilaterally choose employment over the life of the contract. In addition to being determined independently of the realizations for a_t and c_t ,

I also restrict the path for wage rates (not compensation) to be independent of the level of employment.

This is clearly a very restrictive, very strawman-like model of rigid wages; but it is a useful strawman model to consider. For one reason, it shares a similar structure to much analysed models of wage rigidities from Keynes (1936) through Fischer (1977) and Gray (1978). Secondly, I find in the next section that it is helpful in explaining employment behavior. The concluding section considers alternative models in light of the reported joint behavior of wages and employment.

I assume that the bargainers choose the predetermined wage rates so as to maximize the expected value of the firm/union match. This presumes a fixed, side-payment component of compensation is available for providing necessary expected utility to each side of the bargain. Given L equal to L^d from equation (2), this optimal wage path is:

$$(6) \quad w_t^* = \frac{\tilde{d}a_t + \tilde{b}c_t}{b + d}$$

\tilde{a}_t and \tilde{c}_t are the expected values for a_t and c_t respectively at the time the bargain covering period t is decided. Employment for period t is:²

$$(7) \quad L_t = L_t^d = (1/b)[a_t - \pi a_t - (1-\pi)c_t]$$

where $\pi = d/(b + d)$

Employment with rigid contracts will be affected by introducing a new contract. At new contract periods the estimates for demand and supply, \tilde{a}_t and \tilde{c}_t , will significantly improve because they will now reflect disturbances

that occurred during the life of the expired contract. This point is highlighted by rewriting equation (7) as:

$$(8) \quad L_t = (1/b) [a_t - \pi \tilde{a}_t^{\text{old}} - (1-\pi) \tilde{c}_t^{\text{old}} - \pi (\tilde{a}_t^{\text{new}} - \tilde{a}_t^{\text{old}}) - (1-\pi) (\tilde{c}_t^{\text{new}} - \tilde{c}_t^{\text{old}})]$$

\tilde{a}_t^{old} and \tilde{c}_t^{old} refer to the expected values of a_t and c_t given information available at the time the contract in effect period $t-1$ was determined. \tilde{a}_t^{new} and \tilde{c}_t^{new} refer to their expected values when the contract for period t is made. If there is no new contract prior to period t then no new information is used in setting the wage and the second line in equation (8) disappears. But if period t does begin a new contract there will be adjustment in the wage and the second line of (8) will be nonzero.

Section 3 examines the importance of contracting by testing for the shifts in employment at the beginning of new contracts predicted by equation (8). Under rigid contracts with employment determined by labor demand employment overresponds to labor demand disturbances. If disturbances are primarily to labor demand, employment will change at the beginning of a contract to partially undo its movement during the prior contract. Under rigid contracts employment underresponds to labor supply disturbances. At the time of a new contract there should additionally be a change in employment in response to labor supply disturbances that occurred during the prior contract. (If employment is determined by labor supply rather than demand, then the response at new contract points to past demand and supply disturbances would be simply reversed.) The next section discusses particular examples in more detail.

If there is no persistence in labor demand and supply disturbances ($a_t - c_t$ is white noise) then there will be no useful information to incorporate at the time of a new contract. Therefore the test I propose for examining contract rigidities would have no power. (It would also imply there is no efficiency loss in extending the length of contracts.) Empirically this is not a problem; disturbances to time-series equations for employment exhibit a great deal of persistence.

Of course, if for some reason the wage is not flexible even at contracting times--for instance, because of hysteresis as in Blanchard and Summers (1986)--this test would not detect it. Thus it might be necessary to look at the behavior of both employment and wages. (Wage behavior is examined in Section 3.)

Examples

Here I consider particular time-series forms for labor-demand and labor-supply disturbances and compare the time-series behavior of employment under flexible wages and rigid contracts.

Firstly, suppose the labor demand parameter a_t follows the first-order autoregressive process:

$$(9) \quad a_t = \delta a_{t-1} + \epsilon_t \quad ;$$

and that labor supply, reflected in c_t , is purely deterministic. (I will relax this momentarily.) The flexible-wage level for employment (ignoring deterministic components) then also follows a first-order process:

$$(10) \quad L_t^* = \delta L_{t-1}^* + \epsilon_t / (b+d)$$

For rigid-contract employment, on the other hand, it is necessary to distinguish bargaining points. If no new bargaining occurs between periods $t-1$ and t , then equation (8) reduces to:

$$(11A) \quad L_t = L_t^d = \delta L_{t-1} + \epsilon_t / b$$

By comparison, if period t is the first period of a new contract employment is given by:

$$(11B) \quad L_t = \delta L_{t-1} + \epsilon_t / b - \pi \sum_{i=1}^{k(t)} \delta^i (\epsilon_{t-i} / b)$$

$k(t)$ is the number of periods the previous contract was in effect. That is, bargaining occurred between period $t-k-1$ and period $t-k$. The negative moving-average terms result from the wage rate at time t adjusting to reflect the residual of disturbances that occurred during the prior contract. Therefore a simple test of rigid contract effects is to test for the presence of these negative moving average terms at the beginning of new contracts.

The size of the negative moving average terms indicates the importance of contract rigidities. With rigid contracts employment responds $(b+d)/b$ times too much to a demand disturbance. This is simply equal to $1/(1-\pi)$; where the parameter π is identified from equation (11B). Identifying the parameter π requires knowing the parameter δ ; but this can be estimated from the persistence in employment in periods without new contracts. The importance of long-term contracts also clearly depends on the length of

contracts and whether they can be prematurely ended in the face of a large disturbance. These issues are addressed empirically in Section 3.

For a_t described by richer processes parallel tests for importance of contract rigidities can be similarly calculated.

When labor supply is stochastic it remains true that employment will exhibit extra negative moving average terms in periods of new contracts. This reversion is indicative of how much employment overreacts to demand disturbances because of the rigid contracts. It does not indicate, however, the effect of rigid contracts causing employment to underrespond to supply disturbances.

Again suppose that a_t is described by the AR(1) process in equation (9), but now suppose the labor supply parameter c_t is stochastic and given by:

$$(12) \quad c_t = qa_t + v_t ,$$

$$\text{where: } v_t = \beta v_{t-1} + \mu_t .$$

A nonzero parameter q allows demand and supply to be correlated. For example, an increase in labor demand might be correlated with increased demand at other firms, which raises the opportunity cost of labor. This would correspond to q greater than zero. There is an additional supply disturbance, v , which I assume is uncorrelated with demand and has an autocorrelation parameter of β . For simplicity I treat here the case where supply and demand disturbances exhibit equal persistence (β equal to δ). This conveys the intuition of the more general case. The more general case is presented in a footnote.³

With β equal to δ , employment under flexible wages would also follow an

AR(1) with parameter δ .

$$(13) \quad L_t^* = \delta L_{t-1}^* + \frac{(1-q)\epsilon_t - \mu_t}{b+d}$$

Turning to rigid contracts, with no new bargain between periods $t-1$ and t employment is given by:

$$(14A) \quad L_t = \delta L_{t-1} + \epsilon_t/b$$

It has the same autocorrelation as L^* , but responds more dramatically to demand disturbances and not at all to supply disturbances. The response to ϵ_t is $\frac{b+d}{b(1-q)}$ times as large as with flexible wages; this equals $\frac{1}{(1-q)(1-\pi)}$. If q is positive the labor supply curve is effectively steeper because when labor demand is high labor supply is low. This amplifies the cost of rigid wages.

In the first period of a new contract employment makes up for past overreactions to ϵ and underreactions to μ . Employment in these periods is described by:

$$(14B) \quad L_t = \delta L_{t-1} + \epsilon_t/b - \frac{k(t)}{\Phi} \sum_{i=1}^{k(t)} \delta^i (\epsilon_{t-i}/b) - (1-\pi) \sum_{i=1}^{k(t)} \delta^i (\mu_{t-i}/b)$$

$$\text{where } \Phi = \pi + q - \pi q$$

Estimating the negative moving average terms yields an estimate of Φ , which correctly measures how much rigid contracts cause employment to overrespond to demand. Making up for past disturbances to v will show up as extra

variance in time periods of new contracts. One could theoretically measure the importance of this effect by measuring heteroscedasticity in employment equations caused by time periods with new contracts. This is discussed in the following empirical section.

3. Results

I test for the importance of wage rigidities in twelve manufacturing industries that are not only heavily unionized but that also either bargain as an industry or else usually follow a general industry bargaining pattern. The twelve industries are listed in Table 1. The industries are very uneven in size; together they have made up about fifteen percent of employment in manufacturing since World War II.

Even for these twelve selected industries the matching of employment data to contracting points is often much less than perfect. In several of the industries noticeably less than 100 percent of the industry, as measured by the employment figures, are covered in the pattern bargains. This is particularly true for Sawmills, Glass Containers, Metal Cans, Cigarettes, and Petroleum. Another problem is that the pattern settlements do not always fit nicely into a period of a couple months, so that a time period can be accurately depicted as the first period of a new contract. This bias is particularly important for Farm Machinery, Meat Packing, and Petroleum where strikes often dragged out the pattern of settlements. Each of these problems

bias estimation toward finding no effect of contracting on employment.

Proceeding, consider the example discussed directly above with a_t described by an AR(1) process, but with no independent labor supply disturbances (v_t nonzero, but μ_t identically equal to zero). This gives the following equation for employment:

$$(15) \quad L_t = \delta L_{t-1} + (\epsilon_t/b) - \Phi Z_t \left\{ \sum_{i=1}^{k(t)} \delta^i (\epsilon_{t-i}/b) \right\} .$$

Z_t is a dummy variable which equals one for first period of a new contract and zero otherwise.

Examining Growth Rates

As a first step in examining the data, I simply test whether the rate of growth in employment at the beginning of new contracts responds significantly to the rate of growth in employment that occurred during the prior contract. I examine this case because it is a parsimonious manner to present the data to the reader. This coincides exactly with equation (15) for the particular case of a_t equal to a random walk (δ equal to one). Immediately below I estimate δ as a prelude to testing for contracting effects; the estimate for δ in most of twelve industries is considerably less than one.

The equation estimated is:

$$(16) \quad L_t - L_{t-1} = (\epsilon_t/b) + \Gamma Z_t - \Phi Z_t \sum_{i=1}^{k(t)-1} (L_{t-i} - L_{t-1-i}) - \theta \sum_{i=1}^9 (L_{t-i} - L_{t-1-i}) .$$

There are three alterations going from equation (15) to (16). I have added the dummy variable Z_t into the equation directly; this allows a predictable effect of recontracting on the average growth of employment, as opposed to the rebounding effect I have focused on. Secondly, the summation over the prior contract examines the last $k-1$ periods of the k period contract. The first period of the prior contract would reflect the rebound effect for which I am testing. Therefore its inclusion would require iterative estimation. Ignoring the innovation in the first period of the prior contract does not bias the estimates because by definition the innovations over the contract are not correlated. Because the contracts in my sample average about 10 periods (quarters), there is also relatively little loss in information. Finally, the equation allows the growth in employment to be related to employment growth over the nine previous periods. I include this term to allow for the possibility that employment growth responds to past employment growth in all periods, not just the first period of contracts. This provides a more meaningful estimate for the parameter ϕ . I choose a lag length of 9 periods (quarters) because in my sample $k-1$ averages 9 periods.

For employment I use the natural log of production worker employment for the months of January, April, July, and October for the years 1958 to 1986 (for Aluminum data were only available for 1964 to 1986). This data is from the BLS establishment surveys. The bargaining periods were determined from reports in the Current Wage Developments either directly or from the data set derived from the Current Wage Developments by Wayne Vroman and expanded by Beverly Hirtle. The industries average about 11 bargains each over the sample period. I call a period the first period of a contract if agreement on a new contract was reached during one of the preceding three months.

Estimation is in two steps. In the first step I estimate a time trend and four seasonal dummies by industry using only those time periods that are not quarters with new contracts. This is about ninety percent of the observations. Given these consistent estimates, I then remove trend and seasonals for all time periods and estimate equation (16).

For several of the industries there were a number of strikes during the sample period. The relevant periods were determined from the Current Wage Developments.⁴ In estimating the trend and seasonals I remove all observations during which strikes occurred or which follow a strike period. In estimating equation (16) I remove periods with strikes and for periods following strikes I examine employment growth since the previous nonstrike observation. Similarly, the distributed lags of innovations contained in equation (16) do not reflect periods contaminated by strikes.

I first present results for equation (16) pooling the 12 industries. (Trend and seasonals, however, are estimated by industry.) The results are:

$$(16') \quad L_t - L_{t-1} = \begin{matrix} - .0077 & Z_t & - & .198 & Z_t & \sum_{i=1}^{k-1} & (L_{t-i} - L_{t-1-i}) \\ (-1.72) & & & (5.31) & & & \end{matrix} \\ - \begin{matrix} .016 & \sum_{i=1}^9 & (L_{t-i} - L_{t-1-i}) \\ (-1.39) & & \end{matrix}$$

$$\{ R^2 = .027 \quad SEE = .047 \quad D.W. = 2.14 \}$$

The impact of contracts on employment is very significant. The estimate for Φ shows that twenty percent of the innovation in employment during the prior contract is typically undone in the first quarter after recontracting. This impact is statistically as well as economically important. By contrast,

the estimate for θ implies there is only a small amount of regress in growth of employment except at the beginning of new contracts.

Beyond the rebound effect, the beginning of contracts is associated with typically a slight reduction (.77 of one percent) in the level of employment. I show below that this effect varies greatly across industries. Models of rigid wages where employment is determined by the minimum of labor supply and labor demand (e.g., Hall and Lazear, 1984) would predict increases in employment with recontracting. The significant estimate for ϕ together with the slightly negative estimate for Γ constitutes evidence against these models.

Table 2 presents estimates for equation (16) separately for each of the twelve industries. Because there are only about 11 new contracts per industry during the sample period, the standard errors estimating by industry are generally unavoidably large.

The most striking contracting effects are for motor vehicles. With new contracts, employment in motor vehicles undoes almost half of its movement during the preceding contract. There is also a large increase in employment of twelve percent on average associated with new contracts. Because motor vehicles also exhibits the most volatile employment of the twelve industries, it also importantly influences the pooled estimates. In five other industries, however, the estimate for ϕ is near or even greater than the pooled estimate. These are sawmills, aluminum, metal cans, cigarettes, and men's apparel.

The remaining six industries show no rebound effect of new contracts on employment. (The steel and tire industries do show predictable decreases in employment at the beginning of contracts.) In three of these industries,

meatpacking, farm machinery, and petroleum, testing for contracting effects may be clouded by many strike occurrences which upset the bargaining pattern.

According to the rigid wage model presented above, the adjustments in employment at the beginning of contracts reflects adjustments occurring in wage rates. The wage equation that corresponds to equation (15) is:

$$(17) \quad W_t = \delta W_{t-1} + b\phi Z_t \left\{ \sum_{i=1}^{k(t)} \delta^i (\epsilon_{t-i}/b) \right\}$$

I begin by simply examining the behavior of wage growth at the beginning of new contracts. The wage equation that corresponds to estimated employment equation (16) is:

$$(18) \quad W_t - W_{t-1} = \alpha Z_t + b\phi Z_t \sum_{i=1}^{k(t)-1} (L_{t-i} - L_{t-1-i}) \\ + \Omega \sum_{i=1}^9 (L_{t-i} - L_{t-1-i})$$

I measure wages with BLS data on average hourly earnings of production workers, as with employment, for the months of January, April, July, and October for the years 1958 through 1986 (1964 through 1986 for Aluminum). Straight-time wages are not available for before 1972 for the 4-digit industries. I deflated the nominal wage rates by the Consumer Price Index for Urban Workers. The estimated wage-growth equation includes a trend and seasonal dummies. As with the employment equation, these terms were estimated in a first step using only time periods without new contracts.

I first present results pooling the 12 industries. (Trend and seasonals differ by industry.) The results are:

$$(18') \quad W_t - W_{t-1} = \frac{.0146}{(8.51)} Z_t + \frac{.048}{(3.53)} Z_t \sum_{i=1}^{k-1} (L_{t-i} - L_{t-1-i}) - \frac{.012}{(-2.82)} \sum_{i=1}^9 (L_{t-i} - L_{t-1-i})$$

$$\{ R^2 = .062 \quad SEE = .019 \quad D.W. = 2.26 \}$$

There is an effect of employment growth during the past contract on wage growth at the beginning of contracts. The estimate states that if employment grew by 10 percent faster than normal over the prior contract then wages grow an additional half percent with the new contract. Quantitatively this effect appears small. To generate the employment effect estimated above would require an elasticity response in employment to wages of four. Furthermore, I demonstrate momentarily that the pattern of wage responses across industries does not correspond to the pattern in employment responses. In periods without new contracts there is a slight negative response of wage rates to employment growth during the prior 9 quarters.

The most striking result is a predictable increase in wages of 1.5 percent at the beginning of a new contract. It is well known that union contracts are often front loaded; in fact the BLS publishes data on wage changes in major bargaining agreements separately for the first year of contracts.

Results for equation (18) by industry are given in Table 3. There are strong reactions in wages at the beginning of contracts to employment growth during the prior contract in glass containers, steel, metal cans, petroleum, and to a lesser extent in aluminum and meat packing. The industries which

exhibit reactions in wages do not correspond to those that show responses in employment. Of these six industries, only three, glass containers, metal cans, and aluminum, demonstrate rebounds in employment at new contract times. The response in wages, without response in employment, in steel, petroleum, and meat packing could be interpreted as evidence of contract wage rigidities that do not have allocative importance for employment. What is difficult to interpret are the industries, particularly motor vehicles, that display marked rebounding of employment with new contracts, but show no reaction in hourly wages in Table 3.

The industry pattern of wage increases at the beginning of contracts is also hard to reconcile with the behavior in employment within a model where firms unilaterally determine employment. The two industries which show the most front loading are glass containers and motor vehicles; but these industries on average show higher than usual employment growth at the beginning of contracts.

Parameter Estimates of Rebounding

I now want to estimate the time-series process for employment together with the impact of recontracting. I continue to consider the employment equation (15); but estimate the first-order coefficient δ for a_t . The estimated equation is:

$$(19) \quad L_t - \delta L_{t-1} = (\epsilon_t/b) + \Gamma Z_t - \Phi Z_t \sum_{i=1}^{k(t)-1} \delta^i (\epsilon_{t-i}/b) \\ - \theta \sum_{i=1}^9 \delta^i (\epsilon_{t-i}/b)$$

the residual of disturbances that occurred during the prior contract. This effect is economically large. Calculations below translate this estimate into a result that rigid contracts can explain much of the variability in employment in these twelve industries.

Replacing the value for δ of one with an estimated value of less than one increases the estimate of Φ because the regressor, the accumulated innovations in employment during the prior contract, becomes smaller. Consider an innovation in employment that occurs during the early periods of a contract. If, for instance, δ equals .9 and the disturbance occurred 10 quarters before the end of the contract, then when the contract expires only 35 percent (equals $.9^{10}$) of the original disturbance remains to which new contracts need respond.

Table 4 presents estimates for equation (19) separately by industry. The relative pattern across the twelve industries appears much as before. Motor vehicles remains by far the most striking case. For motor vehicles I estimate that with recontracting employment undoes three fourths of the remainder of disturbances from the prior contract.

The size of the negative moving average terms at the beginning of contracts suggests to what extent employment overresponds to demand during a contract. Alone, however, they do not give the importance of contract rigidities in explaining the variability of employment. For a given value of Φ , contracts will be less important if contracts are short in duration or if the parties choose to end contracts prior to their scheduled ending in response to large disturbances. From estimating equation (19), however, I obtain estimates of the disturbances to the employment equation, an estimate of δ , and an estimate of Φ . From these I can construct an estimate of the

hypothetical path that employment would follow under perfectly flexible wages. By comparing this constructed employment series to the actual it is possible to gauge the importance of contracts.

If a_t follows an AR(1) and pure supply disturbances are relatively unimportant, then the estimated path employment would follow under perfectly flexible wages is given by:

$$(20) \quad \hat{L}_t^* = \hat{\delta} \hat{L}_{t-1}^* + (1 - \hat{\Phi})(\hat{\epsilon}_t/b)$$

Table 5 gives the sample standard deviation of flexible-wage employment in equation (20) compared to the standard deviation for actual employment as described by equation (19).

The results suggest that as much as forty percent of employment variability in the 12 industries can be attributed to contract rigidities. This is primarily because for motor vehicles, a very large and very variable industry, the estimates suggest three quarters of variability is created by contracts. In four other industries, sawmills, glass containers, aluminum, and cigarettes, a considerable fraction of variability is attributed to rigid contracts. Across the twelve industries the average estimate of variability is 16 percent lower under flexible wages than under actual contracts. Weighting industries by their sizes, however, the estimates suggest 40 percent of employment variability in the twelve industries come from rigid contracts.

If pure supply disturbances are important the variabilities given in Table 5 will misrepresent the impact of rigid contracts on employment variability. As discussed above, if employment is demand determined in the

short run, rigid contracts can reduce employment variability by keeping employment from responding to supply disturbances. The estimates in Table 4 will remain suggestive of how much contracts cause employment to overrespond to demand disturbances.

The prior section suggested the importance of supply disturbances might be inferred from the size of absolute errors in periods of new contracts. Correction for supply disturbances during the past contract should create extra variability at the beginning of a contract. There is some evidence of greater variability. Average squared errors are larger for the first period of new contracts in ten of the twelve industries. In the five industries steel, metal cans, motor vehicles, petroleum, and tires the squared errors are much larger--two or three times larger--in the first period of contracts. It is difficult, however, to infer the importance of supply disturbances from this heteroscedasticity. For one thing, the equation estimated for first periods of contracts differs from other periods; thus the squared errors are not strictly comparable. Secondly, the correction made for strikes is likely to create larger squared errors at the beginning of contracts. Thirdly, it is necessary to have an estimate of the persistence of supply disturbances; this is difficult under an assumption that employment is demand determined in the short run.

Lastly, I estimate the behavior of wages dictated by equation (17). The estimated equation takes the form:

$$(21) \quad W_t - \delta W_{t-1} = \alpha Z_t + b \sum_{i=1}^{k(t)-1} \delta^i (\epsilon_{t-i}/b) + \Omega \sum_{i=1}^9 \delta^i (\epsilon_{t-i}/b)$$

This generalizes the examination above of growth rates in wages.

For the constructed right-hand regressors I use the estimates of δ by industry and residuals from the estimated employment equation (19). As before, in a first step I excluded periods with new contracts and estimated the autocorrelation parameter in wages as well as trends (linear and quadratic) and seasonal dummies. The wage-equation estimates for δ by industry appear in the first column of Table 6. The average estimate across industries is .893. This is a bit higher than the average estimate in the employment equations of .874. Furthermore, comparing the first columns of Tables 4 and 6, one sees little relation between the industry pattern of autocorrelations in the employment and wage equations.

The second step is to estimate equation (21). I first present results pooling the 12 industries.

$$\begin{aligned}
 (21') \quad W_t - \hat{\delta}W_{t-1} &= .0130 Z_t + .0022 Z_t \sum_{i=1}^{k-1} \hat{\delta}^i (\hat{\epsilon}_{t-i}/b) \\
 &\quad (7.81) \quad (.11) \\
 &\quad - .0097 \sum_{i=1}^9 \hat{\delta}^i (\hat{\epsilon}_{t-i}/b) \\
 &\quad (-1.54)
 \end{aligned}$$

{ $R^2 = .045$ $SEE = .018$ $D.W. = 2.19$ }

With this specification, wages continue to display front loading, but now show no response to employment behavior during the preceding contract. This change in results from the wage-growth case is surprising, particularly because the data here are quasi differenced given the average estimate for δ of .849.

Table 6 presents results by industries. Some of the positive impact of past employment on wages at the beginning of new contracts persists in glass containers, steel, aluminum, metal cans, and petroleum; but it is much weaker than in the wage growth equations.

One possible explanation is that labor unions grant concessions in the form of foregoing future pay increases rather than current cuts in pay. Verbal descriptions of bargaining in several of the industries supports this contention. I additionally examined whether employment behavior during the prior contract significantly determines wage growth over the entire present contract. I found little evidence of such behavior.

4. Conclusions

I find evidence that recontracting matters for the behavior of employment. At the beginning of new contracts employment shifts to undo part of the residual of disturbances that occurred during the prior contract. This effect shows up in nearly half of the twelve industries I examine; but by far the most dramatic contracting effects are for motor vehicles.

I interpret this as evidence against efficient contracting. It is also counter to hysteresis models (e.g., Blanchard and Summers) that explain persistence in disturbances beyond the length of contracts from union membership effects.

This employment behavior is consistent with rigid-wage bargaining models

that assume the path of wages is determined at contracting and then firms determine the level of employment over the life of the agreement. The evidence presented for average hourly earnings, however, is not at all consistent with this view. In a number of industries wage growth at the beginning of contracts does respond to employment growth over the prior contract. But these typically are not the same industries that display employment rebounding with recontracting. Furthermore, the response in wages is much smaller when estimated in levels.

One explanation for the contrary behavior of employment and wages is that industry measures for average hourly earnings may be very poor measures of the marginal cost of labor. Consider the auto industry. Above I found that new contracts have a very dramatic impact on employment in motor vehicles; but there was no response of hourly earnings to past disturbances at the beginning of a contract. A recent episode that called for a large adjustment in wages were agreements reached in Spring 1982.⁵ Employment had fallen by about 35 percent since the existing contracts began in 1979; yet the real wage upon entering the new contract period stayed the same or slightly increased. Examining the bargaining agreements directly (BLS Current Wage Developments, March 1982 and April 1982), however, reveals a great deal of action on compensation that average hourly earnings fail to capture. One striking feature is that the new contracts allowed the auto companies to hire new workers at 85 percent of the standard wage rate (previously they could be hired at 95 percent). Nine paid personal holiday days per year were eliminated. Furthermore, there was a significant increase in the guaranteed earnings the automakers agreed to pay laid-off workers. Each of these provisions has an important effect on the price of employment

but is not captured by hourly earnings.

Another possibility is that employment is not determined unilaterally by firms on the basis of the contemporaneous price of labor, but renegotiation nevertheless allows the bargainers to arrive at more efficient choices for labor. Returning to the 1982 auto agreements as an example, in exchange for the above union concessions plus significant reductions in scheduled wage increases (as opposed to reductions in the level of wages), the companies agreed to a number of employment provisions. These included a two-year moratorium on plant closings and limits to future rates of layoffs. Rather than viewing employment as unilaterally determined by firms, it may be more realistic to view many contracts as specifying a path for wages and a path with upper and lower bounds for employment, where the distance between the upper and lower bounds increases with the amount of time into the contract. One can imagine models of imperfect-information optimizing contracting that imply giving the firm increased latitude to choose employment as the contract proceeds. What is less obvious is what reasonable restrictions on contracting would lead to the systematic overreactions to disturbances I find in employment behavior.

NOTES

1. The proposition would fail if labor supply or demand are importantly influenced by wealth effects generated purely from the bargaining process. Even then, however, I believe it would be very difficult to explain the systematic adjustments in employment I find in Section 3.

2. Along this wage and employment path employment will at times exceed labor supply at the marginal wage w . Given the fixed payment, F , however, the average wage can be sufficiently high that quits by workers are not a problem.

3. If β does not equal δ then employment cannot be described by an AR(1). Employment and wages together, however, can be described by first-order vector autoregressions. Under flexible wages these are:

$$(A1) \quad L_t^* = \left[\beta + \frac{b(1-q)(\delta-\beta)}{b+d} \right] L_{t-1}^* + \frac{(1-q)(\delta-\beta)w_{t-1}^*}{b+d} + \frac{(1-q)\xi_t - \mu_t}{b+d}$$

$$(A2) \quad w_t^* = \left[\delta - \frac{b(1-q)(\delta-\beta)}{b+d} \right] w_{t-1}^* + \frac{b(d+qb)(\delta-\beta)L_{t-1}^*}{b+d} + \frac{(d+qb)\xi_t + b\mu_t}{b+d}$$

Substituting for the wage yields the following AR(2) for employment with an error that is the sum of two first-order moving averages.

$$(A3) \quad L_t^* = \left[\delta + \beta - \frac{b(1-q)(d+qb)(\delta-\beta)^2}{b+d} \right] L_{t-1}^* - \left[\delta\beta + \frac{b(1-q)(d+bq)(\delta-\beta)^2}{b+d} \right] L_{t-2}^* \\ + (1-q) \left[\frac{\xi_t - \beta\xi_{t-1}}{b+d} \right] - \left[\frac{\mu_t - \delta\mu_{t-1}}{b+d} \right]$$

Turning to the rigid wage solution, it is convenient to construct the argument $(L_t - \delta L_{t-1})$. Using equation (7), this equals:

$$(A4) \quad L_t - \delta L_{t-1} = \epsilon_t/b - \bar{\Phi}(a_t - \delta a_{t-1})/b - (1-\pi)(\tilde{\mu}_t - \tilde{\mu}_{t-1})/b \\ + (1-\pi)(\delta - \beta)\tilde{\mu}_{t-1}$$

If period t is not the first period of a contract this reduces to:

$$(A5) \quad L_t - \delta L_{t-1} = \epsilon_t/b + (1-\pi)(\delta - \beta)\tilde{\mu}_{t-1}$$

If period t is neither the first or second period of a contract, equation (A5) can be compared with its expression lagged once to yield a second-order employment equation with a first-order moving average error.

$$(A6) \quad L_t = \delta L_{t-1} + \beta(L_{t-1} - \delta L_{t-2}) + (\epsilon_t - \beta\epsilon_{t-1})/b \\ = (\delta + \beta)L_{t-1} - \delta\beta L_{t-2}$$

Equations for employment for the first and second periods of contracts can be derived in a similar fashion. These are respectively:

$$(A7) \quad L_t = (\delta + \beta)L_{t-1} - \delta\beta L_{t-2} + (\epsilon_t - \beta\epsilon_{t-1})/b \\ - \bar{\Phi} \sum_{i=1}^k \delta^i (\epsilon_{t-i})/b - (1-\pi) \sum_{i=1}^k \beta^i (\mu_{t-i})/b$$

$$(A8) \quad L_t = (\delta + \beta)L_{t-1} - \delta\beta L_{t-2} + (\epsilon_t - \beta\epsilon_{t-1})/b \\ + \beta\bar{\Phi} \sum_{i=1}^k \delta^i (\epsilon_{t-1-i})/b + \delta(1-\pi) \sum_{i=1}^k \beta^i (\mu_{t-1-i})/b$$

As in the text case, the beginning of a contract is associated both with rebounding from demand disturbances that occurred during the past contract as well as adjusting to reflect pure supply disturbances that occurred.

4. For the twelve industries I corrected for 31 strike occurrences covering 42 quarters. The three industries Farm Machinery, Meat Packing, and Petroleum Refining contributed more than 60 percent of the strike activity. In most cases the strike dummies occur in the period prior to the first period of a new contract. In only a couple cases did a strike dummy coincide with the first period of a new contract so that the estimated effect of the new contract was lost.

5. The bargaining in Spring of 1982 occurred prior to the expiration date of contracts signed in 1979. The first contract was signed with Ford in February. Agreements followed at General Motors and American Motors in April. Chrysler had been out of bargaining sync with Ford and General Motors since 1980. American Motors was generally out of sync, but was in line on this occasion.

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Table 1 -- List of Industries

<u>Industry</u>	<u>SIC #</u>	<u>Production worker Employment in 1974 (1,000's)</u>
Sawmills and Planing Mills	2421	168.3
Glass Containers	3211	66.0
Blast Furnaces and Basic Steel	331	456.4
Primary Aluminum	3334	28.9
Metal Cans	3411	60.3
Farm Machinery	352	93.5
Motor Vehicles and Equipment	371	668.6
Meat Packing Plants	2011	140.3
Cigarettes	211	34.7
Men's and Boys' Suits and Coats	231	98.0
Petroleum Refining	291	90.0
Tires and Inner Tubes	301	87.7
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Sum of Twelve		1,993
Total Manufacturing		13,957

TABLE 2 -- Results by Industry for Employment Equation (16)

	Γ	Φ	Θ	R^2	SEE	DW
Sawmills	.0074 (.87)	.244 (2.08)	.014 (.42)	.056	.029	1.38
Glass Containers	.0146 (1.39)	.092 (.56)	.042 (.88)	.027	.032	2.27
Steel	-.0665 (-4.12)	-.181 (-1.34)	.062 (1.61)	.165	.049	1.42
Aluminum	-.0510 (-2.25)	.199 (1.46)	.039 (.88)	.089	.061	1.77
Metal Cans	-.0243 (-2.37)	.201 (1.87)	-.017 (-.43)	.074	.031	2.33
Farm Machinery	-.0135 (-.58)	-.066 (-.51)	.005 (.15)	.006	.059	2.06
Motor Vehicles	.1212 (4.39)	.494 (4.56)	-.008 (-.22)	.269	.082	1.95
Meat Packing	-.0127 (-1.40)	-.382 (-1.95)	.148 (3.06)	.112	.020	2.01
Cigarettes	-.0020 (-.12)	.187 (1.36)	.051 (1.06)	.059	.036	2.48
Men's Apparel	-.0403 (-3.13)	.176 (1.61)	.018 (.51)	.118	.039	2.11
Petroleum	-.0097 (-.67)	-.047 (-.28)	.083 (1.35)	.021	.050	2.57
Tires	-.0266 (-2.13)	-.013 (-.11)	.044 (1.04)	.053	.041	2.06

TABLE 3 -- Results by Industry for Wage Equation (18)

	α	$b\bar{\phi}$	Ω	R^2	SEE	DW
Sawmills	-.0003 (-.05)	.016 (.21)	-.042 (-1.97)	.035	.019	2.30
Glass Containers	.0248 (6.41)	.336 (5.57)	-.010 (-.60)	.394	.012	2.38
Steel	.0020 (.34)	.217 (4.14)	-.027 (-1.80)	.137	.019	2.18
Aluminum	.0152 (1.93)	.092 (1.96)	-.011 (-.74)	.085	.021	2.24
Metal Cans	.0160 (3.52)	.169 (3.54)	-.035 (-1.96)	.180	.014	2.25
Farm Machinery	.0253 (3.01)	.004 (.11)	.004 (.30)	.076	.024	2.03
Motor Vehicles	.0318 (4.22)	.004 (.14)	-.014 (-1.42)	.167	.022	2.47
Meat Packing	.0036 (.82)	.162 (1.63)	.063 (2.20)	.083	.012	2.17
Cigarettes	.0112 (1.84)	.020 (.22)	.002 (.08)	.031	.018	2.53
Men's Apparel	.0178 (3.35)	-.013 (-.21)	.012 (.67)	.095	.016	2.13
Petroleum	.0221 (5.76)	.125 (2.71)	-.004 (-.24)	.265	.014	2.02
Tires	.0099 (1.45)	.008 (.11)	-.052 (-2.26)	.063	.023	2.25

TABLE 4 -- Results by Industry for Employment Equation (19)

	δ	Γ	Φ	Θ	R^2	SEE	DW
Sawmills	.921 (20.17)	.0077 (.91)	.298 (1.84)	-.018 (-.42)	.038	.029	1.34
Glass Containers	.883 (17.12)	.0151 (1.52)	.280 (1.47)	.023 (.34)	.042	.030	2.18
Steel	.853 (18.39)	-.0669 (-4.19)	-.092 (-.50)	-.009 (-.15)	.140	.048	1.40
Aluminum	.872 (15.86)	-.0545 (-2.39)	.158 (.64)	-.014 (-.20)	.065	.061	1.62
Metal Cans	.882 (19.67)	-.0204 (-2.00)	.044 (.21)	-.008 (-.12)	.037	.030	2.25
Farm Machinery	.935 (20.89)	-.0111 (-.49)	-.060 (-.35)	-.006 (-.12)	.006	.056	2.01
Motor Vehicles	.909 (13.16)	.0861 (3.24)	.747 (4.94)	-.064 (-1.26)	.269	.079	2.00
Meat Packing	.804 (14.05)	-.0037 (-.48)	-.251 (-4.2)	.050 (.60)	.006	.018	2.04
Cigarettes	.777 (11.25)	-.0262 (-2.35)	.273 (1.04)	.010 (.11)	.070	.033	2.33
Men's Apparel	.911 (20.20)	-.0086 (-.99)	.199 (1.34)	-.012 (-.29)	.025	.026	1.57
Petroleum	.894 (19.16)	-.0200 (-1.57)	.058 (.26)	.086 (1.11)	.038	.044	2.51
Tires	.847 (21.67)	-.0147 (-1.26)	-.275 (-1.14)	-.002 (-.04)	.024	.039	2.05

Table 5 -- Estimated Employment Variability, Flexible Wages (L*)
Versus Actual Contracts (L)

	<u>Std. Dev.</u> <u>L*</u>	<u>Std. Dev.</u> <u>L</u>
Sawmills	.052	.0600
Glass Containers	.0431	.0553
Steel	.0966	.0899
Aluminum	.0785	.0932
Metal Cans	.0494	.0511
Farm Machinery	.1261	.1227
Motor Vehicles	.0422	.1605
Meat Packing	.0371	.0300
Cigarettes	.0363	.0481
Men's Suits	.0445	.0492
Petroleum	.0881	.0918
Tires	.0943	.0773
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Average across twelve industries	.0651	.0774
Average weighting by 1974 employment	.0636	.1029

TABLE 6 -- Results by Industry for Wage Equation (21)

	δ	α	$b\phi$	β	R^2	SEE	DW
Sawmills	.882 (18.64)	.0005 (.08)	.051 (.48)	-.037 (-1.34)	.016	.019	2.13
Glass Containers	.869 (17.88)	.0222 (5.44)	.186 (2.39)	.010 (.37)	.260	.012	2.33
Steel	.975 (33.64)	.0027 (.41)	.093 (1.21)	-.049 (-1.98)	.038	.020	2.13
Aluminum	.937 (18.04)	.0158 (2.06)	.095 (1.13)	-.018 (-.73)	.059	.021	2.32
Metal Cans	.902 (17.96)	.0134 (2.88)	.144 (1.55)	-.040 (-1.39)	.100	.014	2.13
Farm Machinery	.817 (12.08)	.0202 (2.50)	.010 (.20)	.014 (.78)	.058	.023	1.93
Motor Vehicles	.854 (12.72)	.0278 (3.86)	-.039 (-.96)	-.007 (-.54)	.146	.021	2.38
Meat Packing	.961 (35.59)	.0057 (1.38)	.053 (.25)	.089 (1.64)	.041	.012	2.12
Cigarettes	.798 (12.03)	.0107 (1.87)	-.135 (-1.00)	-.046 (-1.01)	.047	.017	2.35
Men's Apparel	.866 (17.62)	.0148 (2.89)	-.022 (-.25)	.045 (1.83)	.097	.015	2.02
Petroleum	.933 (19.26)	.0214 (5.52)	.092 (1.34)	-.007 (-.29)	.218	.014	1.98
Tires	.932 (19.53)	.0102 (1.53)	-.242 (-1.76)	-.060 (-1.69)	.078	.022	2.17