Testing for Contracting Effects on Employment

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by

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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 occuring after

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:

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

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:

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

I presume the parameter d to be nonegative, 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:

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:

$$(6) \qquad w_t^* = \frac{d\tilde{a}_t + b\tilde{c}_t}{b + d} .$$

$\tilde{a}_t$ 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]

$$(7) \qquad L_t = L_t^d = (1/b)[\, a_t - \pi\tilde{a}_t - (1-\pi)\tilde{c}_t \,] ,$$

$$\text{where} \quad \pi = d/(b + d) .$$

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

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:

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

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:

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:

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

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

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 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 noticably 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

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.

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,

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

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

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

Estimation again takes place in two steps. In the first step, which excludes time periods with new contracts, I now estimate the first-order coefficient δ as well as trends (both linear and quadratic) and seasonal dummies. The estimates for δ by industry are given in the first column of Table 4. The estimates average .874 across industries, ranging from a low of .777 in cigarettes to a high of .935 in farm machinery.

Given the estimate for δ and residuals as estimates for the innovations to employment, ϵ/b, it then straightforward to construct the distributed lag of disturbances during the prior contract that appears as a regressor in equation (19). The second step is then to estimate the equation given this generated regressor. (To obtain consistent estimates of the standard errors for equation (19) requires a correction because δ and the innovations are estimated rather than known. The t-statistics presented below do not reflect this correction; however, they do represent consistent t-tests against the null hypothesis of no contract effect on employment.)

I first present results pooling the 12 industries. (But trends, seasonals, and δ estimates are industry specific.)

$$(19') \quad L_t - \hat{\delta} L_{t-1} = \underset{(-1.97)}{-\ .0085}\, Z_t \ - \underset{(6.56)}{.344}\, Z_t \sum_{i=1}^{k-1} \hat{\delta}^i (\hat{\epsilon}_{t-i}/b) \ + \underset{(1.31)}{.021} \sum_{i=1}^{9} \hat{\delta}^i (\hat{\epsilon}_{t-i}/b)$$

$$\{\ R^2 = .035 \qquad SEE = .045 \qquad D.W. = 2.08\ \}$$

The major change is that the size of the rebound effect, Φ, increases to .34. Thus the data suggests that employment rebounds to undo fully one third of 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:

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

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

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.

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

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

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.

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

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 belive 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:

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

$$(A2) \quad W_t^* = [\delta - \frac{b(1-q)(\delta-\beta)}{b+d}]W_{t-1}^* + \frac{b(d+qb)(\delta-\beta)L_{t-1}^*}{b+d} + \frac{(d+qb)\epsilon_t + b\mu_t}{b+d}$$

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

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

$$+ \ (1-q)[\frac{\epsilon_t - \beta\epsilon_{t-1}}{b+d}] - [\frac{\mu_t - \delta\mu_{t-1}}{b+d}] \quad .$$

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

4. For the twelve industries I corrected for 31 strike occurances 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 occured 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 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 4 -- Results by Industry for Employment Equation (19)

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

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

	δ	α	bΦ	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

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