Evidence of Nominal Wage Stickiness

Outline
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II. Casual Observations
III. Evidence from Union Wage Contracts (U.S.)
IV. Evidence on the Distribution of Individual-Level Wage Changes
V. Evidence on the Frequency of Wage Changes (+ staggering, Calvo v. Taylor, state-dependence, etc.)
VI. Summarizing & Taking Stock
I. A Bit of Motivation

• The opening paragraph of Taylor (1999)

Why does a change in the money supply cause real output and employment to change in the short run, but not in the long run? This is one of the oldest questions in macroeconomics, yet it persists as both the most difficult and the most practical of all. From David Hume in the 18th century to Milton Friedman in the 20th, economists have had a common answer: there are temporary price and wage rigidities in the economy. In other words, in the short run, price and/or wage levels do not change as much as the money supply changes. Thus, if the money supply increases, then real money balances rise, stimulating production and employment. As described by David Hume more than 200 years ago, “by degree the price rises, first of one commodity, then of another”, or as stated more recently by Milton Friedman “prices are sticky” [see Rotwein (1955, p. 38) and Friedman (1982, p. 64)]. Except in unusual circumstances, it takes time for price and wage levels to fully adjust; as prices and wages gradually rise, real money balances return to their original level and in the long run the real economy is unaffected.
Motivation, 2

• Arguments in Hall (2005) and Shimer (2005, 2010) on the amplification role of wage rigidities are also relevant here. The Hall-Shimer arguments are not particularly tied to nominal wage rigidities, but they are consistent with them.

• Taylor’s (1999) line of motivation is the one that animates many empirical studies of nominal wage rigidities.
II. Casual Observations

1. For most workers, especially those employed by larger organizations, wages are adjusted only periodically, say once a year.

2. Wage adjustments are often tied to a periodic performance review.

3. Periodic wage adjustment is a feature of most employment relationships – not just those governed by collective bargaining arrangements or other formal labor contracts.

4. Much or all of a worker’s compensation is stated as a fixed payment of dollars (or other currency) per unit time (e.g., per hour, week, or month)
5. Compensation agreements with intra-year inflation indexation are rare in environments with low and stable inflation rates.

6. Wage setting is not especially synchronized across sectors, firms and workers in the U.S. economy or most other economies. There are exceptions: Japan’s “Shunto” (spring wage offensive) and some countries with highly centralized wage-setting institutions.

7. Most countries have minimum wage mandates (usually stated in nominal terms) that affect a nontrivial share of employees.
8. In some countries (e.g., France), the legal wage minimum is a high percentage (say 40% of more) of the average wage.

9. Minimum wage mandates take many forms, some less visible, e.g., “prevailing wage” requirements for construction projects funded by the 2009 ARRA (fiscal stimulus act)

10. Wage determination and negotiations are strongly influenced by internal and external comparisons. (Is this a source of nominal or real stickiness?)
   - Salary surveys
   - Pattern wage bargaining
III. Union Wage Contracts (U.S.)

- 12.3% of U.S. wage and salary workers belonged to a union as of 2009, down from 20.1% in 1983

- Also as of 2009:
  - 7.4 million union members in the private sector and 7.9 million in the public sector.
  - 7.2% union membership rate in the private sector, and 37.4% in the public sector.

- As of 2011:
  - 7.2 million (6.9%) union members in the private sector and 7.6 million (37.0%) in the public sector

- Source: [www.bls.gov/news.release/union2.t03.htm](http://www.bls.gov/news.release/union2.t03.htm)
Taylor (1983) and Cecchetti (1984) study U.S. data on major union wage contracts. Some findings:

- More than half of the wage contracts last for more than one year.

- Slightly more than half of the multi-year contracts are explicitly indexed to inflation. This result is influenced by outcomes in the high-inflation 1970s.

- Wage setting is not synchronized across sectors. About 15% of union workers get a new contract each quarter and about 40% get one each year.

- The average period between wage changes was about 7 quarters in the 1950s and 1960s when inflation was low, but it fell to about four quarters during the high-inflation 1970s.
IV. Evidence on the Distribution of Individual-Level Wage Changes

• Card and Hyslop (1997) consider individual-level wage changes in the CPS and PSID

• They look for evidence of nominal wage rigidities, and they seek to test whether downward real wage changes and relative wage adjustments occur more readily in higher-inflation environments.

• If nominal wages are downward rigid, moderate levels of inflation may improve labor market efficiency by facilitating real wage cuts.
Distribution of Wage Changes, 2

• For workers who do not change jobs, and using CPS data from 1979 to 1993, Card-Hyslop find:
  – 6-15% experience no change in the nominal wage from one year to the next
  – The frequency of wage adjustment rises with inflation
  – 15-20% of workers experience nominal wage cuts from one year to the next
  – Measurement error in the survey data is a serious concern here
Distribution of Wage Changes, 3

- Histograms of real wage changes tend to be centered around 0, with a prominent “spike” at the point corresponding to a fixed nominal wage. The height of the spike tends to be greater in periods of lower inflation. See the next two slides.

- There appears to be a deficit in the distribution of wage changes to the left of the inflation rate suggesting that the distribution of real wage changes is being “swept up” to the floor imposed by rigid nominal wages.
Distribution of Wage Changes, 4

PSID Wage-Change Data from 1976-79 and 1985-88, Card and Hyslop.

Spike at 0 nominal change accounts for 7.66% of all wage-change observations.

The sample excludes non-heads of households, people who change employers during a year, and people with missing wage or salary data for those years, and people who work only for themselves. The analysis uses data on hourly pay rate workers beginning in 1970 and began collecting pay data for salary workers beginning in 1976. The PSID converts salaries into an hourly pay rate and codes only this number.
Nickell & Qunitini (2003) consider data from the UK New Earnings Survey (NES). The data are reported by employers and, in all likelihood, are subject to much less measurement error than data from household surveys.

They NES is based on a 1% sample of all employees who are “members of pay-as-you-earn income tax schemes” – apparently the NES covers almost all full-time adult workers.

Data are for a reference period in April of each year.
The Measurement of Earnings and Hours

Employers provide information on hours worked in the reference week, separating standard hours and overtime hours. They also separate overtime pay, so we define our measure of hourly pay as weekly pay excluding overtime pay divided by weekly hours excluding overtime hours. The authors exclude part-time employees and those whose pay was affected by holidays, sickness, other absence and short-time working. Finally, they cannot identify those individuals who are paid on an hourly basis, although those who work overtime hours are typically paid by the hour. The authors can, however, identify people whose pay contains some form of incentive pay (e.g. piece rates, bonuses etc.). To summarize, in the rest of the paper we consider the wage changes of full-time employees where the wage change refers to the April to April movements in the hourly rates as described above.
Inflation rate of 18.8%
Distribution of Wage Changes, 10

Inflation rate
= 4.4%

Inflation rate
= 1.3%
Three articles published in the *Economic Journal* in 2007 apply a common approach to the study of real and nominal rigidities in data on individual-level wage changes in Germany, Italy and the U.K.

— See Barwell and Schweitzer, Bauer et al., and Devicienti et al.

The statistical model allows for inferences about the fraction of workers with wage changes constrained by downward real and nominal rigidities by year.
Distribution of Wage Changes, 12

- Histograms of wage-change distributions are suggestive of nominal and real wage rigidities. See the charts on the next three slides.
  - In all countries and all years, the density of wage changes exhibits a spike at zero nominal wage change
  - The density to the left of zero nominal change is smaller than the density to the right
  - There is a second spike located at or near the inflation rate. This second spike is further to the right when inflation is higher.
  - The density also exhibits an asymmetry around this second spike.
Distribution of Wage Changes, 13

[Bar charts showing the distribution of nominal wage growth for Germany, with fractions on the y-axis and wage growth percentages on the x-axis.]
Distribution of Wage Changes, 14
Distribution of Wage Changes, 15
The authors proceed to estimate a statistical model with parameters governing the likelihood that a given individual-level wage change (in a given year for a given country) belongs to one of three possible regimes:

- No wage rigidity
- Downward nominal rigidity
- Downward real rigidity

Estimating by maximum likelihood, the authors recover the fraction of wage changes constrained by downward rigidities by country and year.
Vector of individual characteristics

\[ \Delta w_{it}^* = x_{it} \beta + e_{it}, \]

Normally distributed errors.

Allowing downward nominal rigidity

\[ \Delta w_{it} = \begin{cases} \Delta w_{it}^* & \text{if } \Delta w_{it}^* \geq 0 \\ 0 & \text{if } \Delta w_{it}^* < 0 \end{cases} \]

Allowing downward real rigidity, with a floor that may differ in the C-S

\[ \Delta w_{it} = \begin{cases} \Delta w_{it}^* & \text{if } \Delta w_{it}^* \geq r_{it} \\ 0 & \text{if } \Delta w_{it}^* < r_{it} \end{cases} \]

\( r \) can be interpreted as the expected rate of inflation
• Assume that $r_{it}$ is normally distributed with finite mean and variance.

• Let $P_N$ and $P_R$ denote the fraction of persons potentially subject to downward nominal and real rigidities, respectively (in a country-year).

• Observed wage changes are given by

\[
\Delta y_{it} = \Delta w_{it} + \Delta m_{it},
\]

where $m_{it}$ is a normally distributed measurement error, and $q$ is the probability that the wage is measured without error.
Main Results from Statistical Model:

1. Real wage rigidities are important in all three countries:
   - Germany: 30-70% of individual-level wages are set in the real wage rigidity regime
   - Italy: 45-65% in real wage rigidity regime
   - UK: 41% in real wage rigidity regime

2. A smaller fraction of individual-level wage are set in the nominal wage rigidity regime
Main Findings:

3. In all three countries, real wage rigidities appear to become less important over time.

4. Low inflation decreases real wage rigidity but increases nominal wage rigidity.

5. All three studies find some evidence that rigidities involve unfavorable outcomes in the form of excess labor turnover and higher unemployment.

See Dickens et al. (2007) for another multi-country study that seeks to draw inferences about the extent of real and nominal wage rigidities.
V. Evidence on the Frequency of Wage Changes

• The frequency of individual-level wage changes is a key parameter in New Keynesian models along the lines of Erceg et al. (2000), Smets and Wouter (2003) and Christiano et al. (2005).

• The staggering of wage changes also matters for the quantitative implications of NK models.

• As discussed above, Taylor (1983) and Cecchetti (1984) develop evidence on the frequency of wage changes using data on union wage contracts.

• Barattieri et al. (2010) and Le Bihan et al. (2010) study the frequency and staggering of wage changes in more comprehensive micro data sets.
Le Bihan et al. consider French micro data on wage changes at the level of a representative individual in job category cells – 1 to 12 cells per employer. They investigate whether the wage-change process is time-dependent or state-dependent (or both), and whether it has backward- and forward-looking elements. These aspects of the wage-setting process are also important in the specification of New Keynesian models.
French Institutional Setting

• Legal minimum wage is high, covering 9.7% of nonfarm employees in 1998 and 15% in 2005.

• Collective wage negotiations at industry and firm levels define wage floors by detailed job category

• Individual wages often exceed the wage floors

• By law, employer must specify the “base wage” in a contract with the employee
  – Change in base wage requires a contract revision or a change predetermined in the current contract
Frequency of Wage Changes, 4

Macro Context

• 1998-2005 sample period
  – Stable inflation around 2% per year
  – Real GDP growth ranging from 1.1 to 4.0% per year
  – Unemployment rate of 8-11%

• 35-hour work week (down from 39)
  – Adopted in 2000 for firms with >20 employees
  – Adopted in 2002 for smaller firms
  – Implemented without a cut in monthly pay (partly offset by payroll tax cuts for lower wage workers)
  – Promises of future wage moderation in larger firms
Frequency of Wage Changes, 5

The Data

- Estabs with 10+ employees, 1998Q4 – 2005Q4
- 38,000 establishments, end-of-quarter sampling
- Monthly base wage, inclusive of SS contributions
  - Excludes bonuses, allowances & other comp
- Change in monthly base wage for four occupational categories: manual workers, clerical workers, intermediate occupations, managers
- 1 to 3 representative workers per category per establishment (different levels of skill/experience)
- Base wage, hours, industry, # of employees
Measurement

• Hourly wage = (nominal monthly base wage) / (reported “normal working time”)

• Reported wage for estab-occ-job cell in two consecutive quarters is not always for same worker

• However, ACEMO vintage-t survey includes data on a given worker’s wage at t and t-1.
  – Use these data to compute frequency of wage changes

• See paper for other measurement issues.

• **Bottom line:** Measurement error is an issue, but less serious than in typical HH surveys
# Frequency of Wage Changes, 7

Base hourly wage change frequency is 38% per quarter

<table>
<thead>
<tr>
<th></th>
<th>Mean frequency</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>0.38</td>
<td>3,738,251</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.41</td>
<td>1,566,466</td>
</tr>
<tr>
<td>Construction</td>
<td>0.38</td>
<td>291,544</td>
</tr>
<tr>
<td>Services</td>
<td>0.36</td>
<td>1,880,241</td>
</tr>
<tr>
<td>Manual workers</td>
<td>0.40</td>
<td>917,588</td>
</tr>
<tr>
<td>Clerical workers</td>
<td>0.37</td>
<td>1,000,164</td>
</tr>
<tr>
<td>Intermediate occupations</td>
<td>0.39</td>
<td>895,318</td>
</tr>
<tr>
<td>Managers</td>
<td>0.37</td>
<td>925,181</td>
</tr>
<tr>
<td>10 to 19 employees</td>
<td>0.37</td>
<td>488,333</td>
</tr>
<tr>
<td>20 to 49 employees</td>
<td>0.35</td>
<td>583,915</td>
</tr>
<tr>
<td>50 to 149 employees</td>
<td>0.35</td>
<td>1,274,658</td>
</tr>
<tr>
<td>150 to 499 employees</td>
<td>0.37</td>
<td>1,065,966</td>
</tr>
<tr>
<td>more than 500 employees</td>
<td>0.42</td>
<td>3,253,579</td>
</tr>
</tbody>
</table>

Not much heterogeneity
Big jump in hazard function at 4 quarters. This results point to Taylor-type staggered wage-setting and is at odds with a Calvo-type wage adjustment process.

Smaller spikes at 8 and 12 quarters.
A sharp asymmetry about zero wage change, as we have seen in several other sources of data on the distribution of wage changes. The 38% quarterly wage-change frequency breaks down into 32% increases and 6% decreases.
This chart shows a large degree of staggering in wage changes, especially for wages above the legal minimum and excluding 35-hour work week implementation.
Econometric Approach

• Model the process of nominal wage change as outcome of two joint processes:
  – Wage change decision
  – Size of wage change, given decision to change

• Time-dependent and state-dependent changes
  – Elapsed duration for time dependence
  – Cumulative inflation and unemployment changes for state-dependent changes

• Test for backward-lookingness (indexation, adaptive expectations) and forward-lookingness (NK models)
An Empirical Model of Wage Changes

(1) \( \Delta w_{it} = x_{it} \beta + \eta_i + u_{it} \)

Size of wage change when a wage change is observed.

Job-cell/worker \( i \) at time \( t \)

Random effect

\( x_{it} \) consists of a transformation of \( \log(p_t) \) (national inflation rate), a transformation of \( u_t^r \) (regional unemployment rate), and a vector, \( \tilde{x}_{it} \), of time-varying characteristics for job-cell/worker \( i \).
Frequency of Wage Changes, 13

- Most observations on $\Delta w_{it}$ are zero, so that estimating (1) by LS on non-zero changes is likely to involve a sample selection bias.

- To handle selection, model the inaction band for wage changes as follows:

\[ y_{it}^* = z_{it} \mu + \xi_i + \varepsilon_{it} \quad \text{Latent variable for change} \]

\[ \Delta w_{it}^* = x_{it} \beta + \eta_i + u_{it} \quad \text{Latent wage change} \]

- Wage change that would be observed if no rigidity
- Random effects, possibly correlated
\[ z_{it} \text{ may include covariates also in } x_{it}. \text{ The inaction band such that no wage change occurs is defined by } v_{it} \gamma_1 < y^*_it < v_{it} \gamma_2, \text{ where } v_{it} \text{ includes a constant and possibly some covariates. Thus, we have} \]

\[(4a) \quad \Delta w_{it} = 0 \text{ if } v_{it} \gamma_1 < y^*_it < v_{it} \gamma_2 \]

\[(4b) \quad \Delta w_{it} = x_{it} \beta + \eta_i + \omega_{it} \text{ otherwise} \]
Identifying Assumptions and Covariates

- Error terms are Gaussian and serially uncorrelated
- $corr(\xi_i, \eta_i)$ and $corr(u_{it}, v_{it})$ are unrestricted
- Interpret latter correlation as reflecting degree of state-dependence at micro level – e.g., unobserved productivity shock that increases probability and size of wage change
- $\sigma_{\epsilon}^2 = 1$, a normalization
- $v_{it}$ contains a constant, dummies for elapsed duration since last wage change, and seasonal dummies
Frequency of Wage Changes, 16

- $z_{it}$ and $v_{it}$ must be distinct for identification. $z_{it}$ includes sectoral, occupational category and firm-size dummies.
- $x_{it}$ contains variables in $v_{it}$ and $z_{it}$ except for elapsed duration. Excluding one variable ensures identification.
- “Our motivation for excluding elapsed duration is that wage setting models outlined in Section 2 do not predict that, other things equal, elapsed duration matters for the size of wage changes (duration matters indirectly through the value of the cumulative variables described below).”
- $x_{it}$ also includes transformations of $p_t$ and $u_t^r$, which vary according to specification.
(5) $\Delta w_{it} = \alpha(p_{t-1} - p_{t-\tau-1}) + \kappa(u_{t-1} - u_{t-\tau-1}) + \tilde{\pi}_{it}/\beta + \eta_i + u_{it}$

where $\tau_{-1}$ is the duration of spell that ended at $t - 1$, and the cell index $i$ and date index $t$ are suppressed for convenience. Region indicator is also omitted.

The inflation and unemployment measures in (5) are cumulative changes along the ongoing wage spell. They serve as proxies for deviations from the optimal wage. Because the duration of wage spells differs across cells and time, these variables provide a useful source of variation in the data.
Estimation

1. Estimate (2) and (4a) using a probit model with random individual (i.e., cell) effects.

2. Estimate (4b) by LS, including supplementary variables, akin to Mills ratios, computed from the first-stage probit to correct for selection bias.

3. Variants of (5) involve expectations of inflation and unemployment. Forecasts using ARIMA models. Assume known length of wage spell, consistent with Taylor-like adjustment process but not Calvo or state-dependent ones.
Empirical Results

See class handout with marked-up versions of Tables 4 and 5.
Summary of Main Results in Le Bihan et al. (2010)

1. High frequency of nominal wage changes
2. Downward nominal wage rigidity
3. Some synchronization of wage changes induced by minimum wage changes and the introduction of 35-hour workweek, but otherwise the timing of wage changes shows a lot of staggering
4. Calvo-type models fail to account for timing of wage changes. The data are much friendlier to Taylor-type time-dependent wage changes
Summary (Continued)

5. Little evidence of state-dependent wage changes when controlling for time dependence

6. Evidence points to backward-looking wage-change behavior, contrary to the forward-looking behavior assumed in New Keynesian models

7. Some evidence of pre-determinedness in wage-change behavior, suggesting that wage changes are more frequent than wage-change decisions and imparting additional stickiness to wages

Recall: French setting, low and stable inflation during sample period. Results might differ significantly across time and countries.
VI. Summarizing & Taking Stock

1. Frequency of nominal wage changes for job stayers: 6-38% per quarter (moderate inflation)
   – Underlying inflation, institutional setting, data, and treatment of measurement error matter a lot

2. Abundant evidence of downward nominal wage stickiness among job stayers

3. Much evidence of downward real wage rigidity as well in low-inflation environments.

4. Little evidence of state dependent timing or size of wage changes, but much room for more work.
5. The timing of wage changes (hazard function results) strongly favors Taylor-type over Calvo-type time dependence.

6. Some synchronization, but the timing of wage changes is fairly staggered in most countries.

7. One (interesting) study finds evidence of backward-looking but not forward-looking behavior in the size of wage changes. Some evidence of pre-determinedness in wage-change behavior as well.

   — These findings are at odds with most NK models.
8. How much do these results 1-7 matter for economic outcomes?
   – It depends on whether shorter-term aspects of wage paths determine employment, hours, effort, etc. Perhaps they have little impact on allocations in long-term employment relationships (Barro, 1977)

9. If wages affect allocations, then moderate positive inflation rates can improve labor market outcomes by facilitating real wage cuts.
10. Most macro analyses assume that wages affect allocations; typically, $W=\text{value marginal product}$.

- Under this interpretation, results 1-7 are important for the calibration and specification of macro models, and they matter for how the economy responds to monetary, fiscal, technology and other shocks.

- This type of evidence is especially relevant for New Keynesian models, which play a leading role in many analyses of monetary policy.
What does the evidence of nominal stickiness mean for equilibrium search models of unemployment and fluctuations?

– It depends on whether wage stickiness for job stayers means wage stickiness for potential new hires.

– Little direct evidence on this point, but Bewley (1999) and others suggest that concerns related to perceived fairness, morale, internal compensation structures, etc. links the wages of new hires to wages of incumbents.

– Under this view, if incumbent wages are sticky, then so are wages for new hires. We know from our earlier analyses, that wage stickiness for new hires matters a great deal in equilibrium search models.
References 1


