# Wage Setting in Times of High and Low Inflation

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# Research Question and Contribution

- Recent inflation surge is an opportunity to study price and wage setting during high inflation
- Does wage setting change when inflation is high, and does this affect monetary transmission?

Our contribution:

- Establish facts about state-dependent wage setting for Germany
  - Firm-level survey data from HR managers
  - Union-level data on collective bargaining outcomes
- Study implications for transmission monetary policy
  - Menu cost model of wage setting to rationalize empirical facts
  - Embed state-dep. wage setting in NK model to revisit inflation costs + Phillips curve

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# Preview of Findings

- Firms alter wage setting during times of high inflation along *extensive* and *intensive* margin
  - → Duration shortens by $\sim$ 1.3 months (semi-elasticity of -0.26 months)
  - → Adjustment rises by $\sim$ 2 p.p. per pay round (elasticity of 0.2)
- Highest adjustment among firms that view inflation as a key factor
- Bargaining room for new hires at 28% of firms, with an average of 8.3%
- Evidence from union-level bargaining outcomes confirms survey findings
- Policy implications:
  - → Phillips curve steepens, real effects of monetary policy diminish
  - → Welfare costs of inflation diminish with state-dependent wage setting

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# Related Literature

- Provide empirical evidence on state-dependent wage setting, similar to price-setting side
  Kashyap (1995), Nakamura and Steinsson (2008), Gagnon (2009), Alvarez et al. (2019)
- Add to empirical literature on wage setting
  Druant et al. (2012), Barattieri et al. (2014), Sigurdsson and Sigurdardottir (2016), Grigsby et al. (2021)
- Present more evidence on low pass-through of inflation (expectations) to wage (expectations)
  Abberger et al. (2024), Buchheim et al. (2024), Baumann et al. (2024)
- Develop menu cost models for wage setting, building on price-setting research
  Danziger (1999), Golosov and Lucas (2007), Gagnon (2009)
- Propose simple NK model with state-dependent wage setting
  Erceg et al. (2000), Ascari & Sbordone (2014), Costain et al. (2020)

# Data and Empirical Findings

# The ifo HR Survey

- ifo HR survey: quarterly survey of 600 HR managers in German firms
  - Representative sample across industries and size distribution descriptive statistics
- Supplemented **Q4 2022 survey round** with questions on wage-setting practices over time
- Ask HR managers about two periods with different underlying inflation rates: time series
  - 2017-19: average inflation 1.6%
  - 2022-24: average (expected) inflation 6.5%
- Repeat questions in **Q2 2025 survey round**

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# Supplementary Questions

1. *On average, how often (in months) did your firm adjust wages during 2017-2019? (excluding promotions, extraordinary wage changes, etc.)*

   Every _____ months.

2. *On average, by how much (in percent) did you adjust wages per pay round during 2017-2019?*

   $\square < 0\%$ $\square 0-2\%$ $\square 2-4\%$ $\square 4-6\%$ $\square 6-8\%$ $\square 8-10\%$ $\square > 10\%$

survey instrument

# Supplementary Questions

3. *On average, how often (in months) does your firm plan to adjust wages during 2022-2024? (excluding promotions, extraordinary wage changes, etc.)*

   Every _____ months.

4. *On average, by how much (in percent) do you plan to adjust wages per pay round during 2022-2024?*

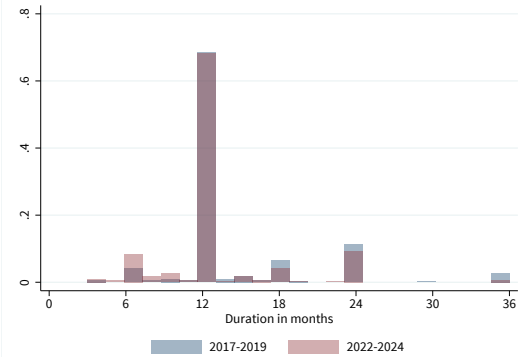
   $\square < 0\%$ $\square 0-2\%$ $\square 2-4\%$ $\square 4-6\%$ $\square 6-8\%$ $\square 8-10\%$ $\square > 10\%$

survey instrument

# Fact 1: Duration of Wage Adjustments Shortens During High Inflation

- Bunching at 6, 12, 18, and 24 months
- Monthly duration drops from 14.2 to 12.9
- 20% of firms plan to shorten duration
- Variation within-industry > across-industry

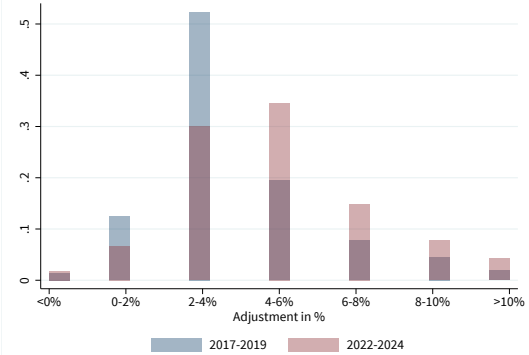
details




scatter plot firm-level differences

# Fact 2: Size of Wage Adjustments Rises During High Inflation

- Rightward shift in the entire distribution
- 20% plan to increase wage adjustment from 2-4% to 4-6% per pay round
- 28% plan to adjust wages by at least 6% during 2022-24, implying non-decreasing real wages

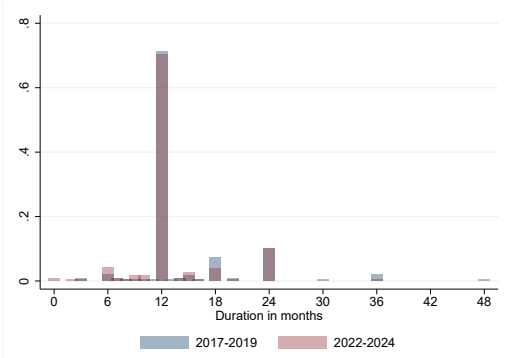



scatter plot | firm-level differences

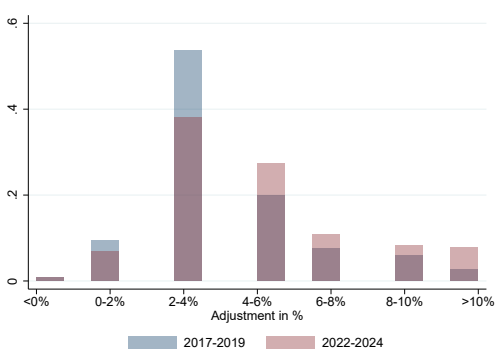
# Duration and Size of Wage Adjustments in Repeat Survey (2025)

**Figure:** Wage-setting behavior in times of high and low inflation (realized)

**(a)** Extensive margin




**(b)** Intensive margin



# Bargaining Room for New Hires

*How much room is there for salary adjustments in the coming year for newly hired employees compared to the salary of existing employees (on average)?*

☐ *no room* ☐ *room:* _____% ☐ *no new hires planned*

| | *Extensive Margin* | | *Intensive Margin* | |
|---|---|---|---|---|
| | 2024 | 2025 | 2024 | 2025 |
| Manufacturing | 19.7 | 21.5 | 8.0 | 7.9 |
| Retail | 41.2 | 29.1 | 7.6 | 8.8 |
| Services | 29.6 | 25.0 | 8.8 | 7.1 |
| Total | 28.3 | 24.6 | 8.3 | 7.8 |

# Quantifying the Degree of State Dependence

*Panel A: Wage Duration*

| | | | | |
|---|---|---|---|---|
| Inflation | -0.251*** | -0.231*** | -0.255*** | -0.252*** |
| | (-4.01) | (-5.82) | (-4.11) | (-4.03) |
| N | 1068 | 1014 | 1065 | 1068 |
| $R^2$ | 0.015 | 0.807 | 0.091 | 0.020 |
| FE | | Firm | Sector | Size |

- Semi-elasticity of duration to inflation of -0.25 months
- Significantly higher than previous literature (e.g. Sigurdsson et al. 2016 )

# Quantifying the Inflation Elasticity of Wage Growth

*Panel B: Wage Growth*

| | | | | |
|---|---|---|---|---|
| Inflation | 0.204*** | 0.206*** | 0.204*** | 0.204*** |
| | (7.54) | (9.98) | (7.77) | (7.59) |
| N | 1114 | 1062 | 1111 | 1114 |
| $R^2$ | 0.049 | 0.739 | 0.155 | 0.059 |
| FE | | Firm | Sector | Size |

- Elasticity of nominal wages to inflation of 0.2
- Accounting for extensive margin increases pass-through by 0.1 annualized
- Consistent with the recent literature on the pass-through of wage (expectations) to inflation (expectations) (e.g. Abberger et al. 2023; Buchheim et al. 2024; Baumann et al. 2024)

# Evidence from Union Data

- Cross-check firm-level findings with **union-level data** on collective bargaining outcomes
- Data derived from WSI "Tarifarchiv", supplemented by news reports
  - Main sample period 1990-2024, but going back to 1956 for some industries
  - 317 contracts in 12 industries, regionally differentiated (e.g. federal/state), sector/firm-level.
- Focus again on **duration** and **size** of wage changes per pay round

summary statistics

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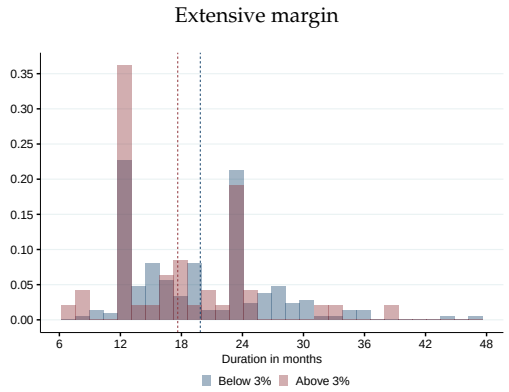
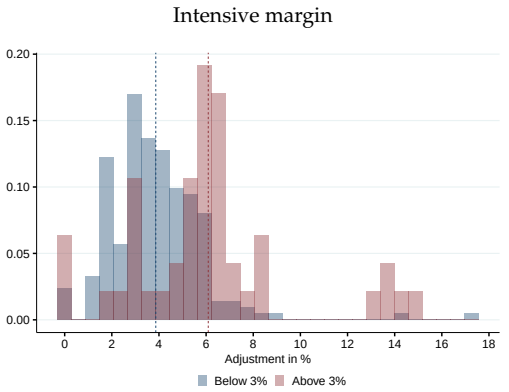
# Collective Bargaining Outcomes in High vs. Low Inflation Periods




'17-'19 v '22-'23

# Collective Bargaining Outcomes and Level of Inflation

| | Duration (in months) | | Wage Increase (in Percent) | | Annualized Wage (in Percent) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Inflation | −0.344 | −0.927** | 0.712*** | 0.588*** | 0.547*** | 0.619*** |
| | (0.327) | (0.425) | (0.071) | (0.100) | (0.067) | (0.084) |
| Union-region FE | | ✓ | | ✓ | | ✓ |
| Other controls | | ✓ | | ✓ | | ✓ |
| Observations | 259 | 259 | 259 | 259 | 259 | 259 |
| Adjusted $R^2$ | 0.0004 | 0.205 | 0.276 | 0.337 | 0.204 | 0.411 |

*Other controls:* GDP growth, unemployment rate, variance of inflation rate, EPU index (EU), and interaction term of inflation and East Germany during 1990-1993. Constant included. * p<0.10, ** p<0.05, * * * p<0.01.

duration and inflation | adjustment and inflation | backward- vs. forward-looking

# Models of State-Dependent Wage Setting

# Model Setup

- Compare two canonical approaches to modeling state-dependent wage setting
- Shared model structure:
  - Firms have **monopsony power** in labor market
  - Firms enter period $t$ with nominal wage $w_{t-1}$, learn productivity $a_t$ and price level $P_t$
- **Menu Costs**: firms may choose to reset wages subject to fixed cost $\gamma$ $(w_{t-1}/P_t)$
- **Calvo**: firms allowed to reset wages with exogenous probability $1 - \theta^w$

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# Nature of the Exercise

- Consider a one-off permanent shock to the price *level* (i.e. a one-off transitory shock to *inflation*):

$$\ln P_t = \mu + \ln P_{t-1} + \epsilon_t, \quad \epsilon_t \sim \mathcal{N}(0, \sigma_\epsilon^2),$$

- Consider different levels of trend inflation $\mu$
  - Low inflation regime: $\mu = 1.6\%$
  - High inflation regime: $\mu' = 6.5\%$
- Alternative: change in inflation volatility $\sigma_\epsilon^2$ yields similar results on the extensive margin

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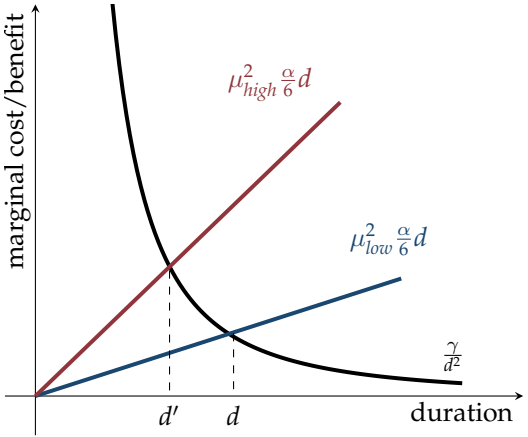
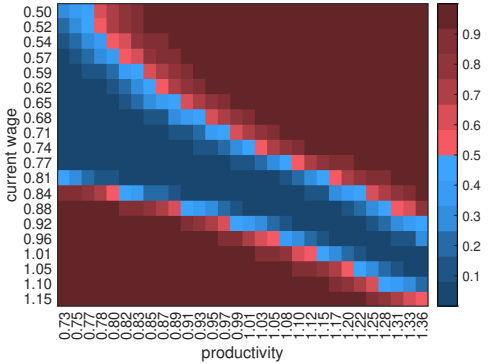
# Intuition

- Consider individual firm in deterministic environment setting wages for $d$ periods
- Frictionless optimal wage $w_0^*$ grows at $\mu$
- Optimal reset wage is $w_0 = w_0^* + \frac{\mu}{2}d$
- Optimal duration is $d = \sqrt[3]{\frac{6\gamma}{\alpha\mu^2}}$
- Higher $\mu$ raises marg. cost of waiting $\rightarrow$ lower optimal $d$

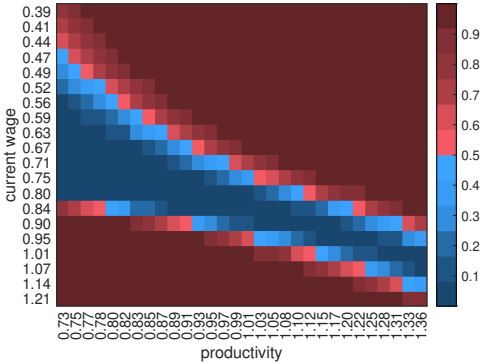


# Probability of Wage Change

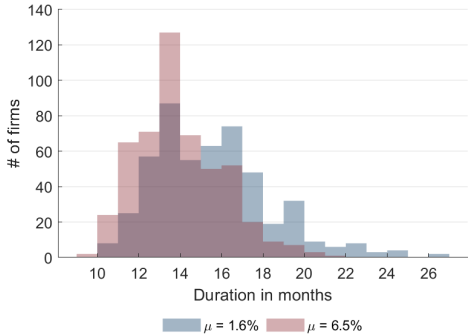
Low inflation (1.6%)




High inflation (6.5%)



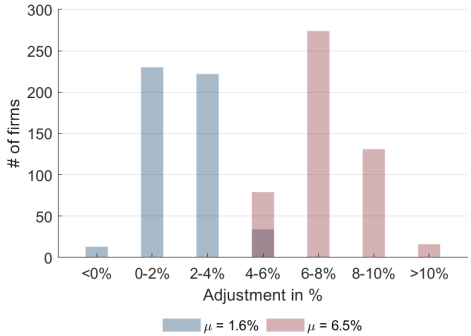
# Menu Cost Model: Duration of Wage Agreements




- Duration shortens from 14.2 to 12.8 months during high vs. low inflation

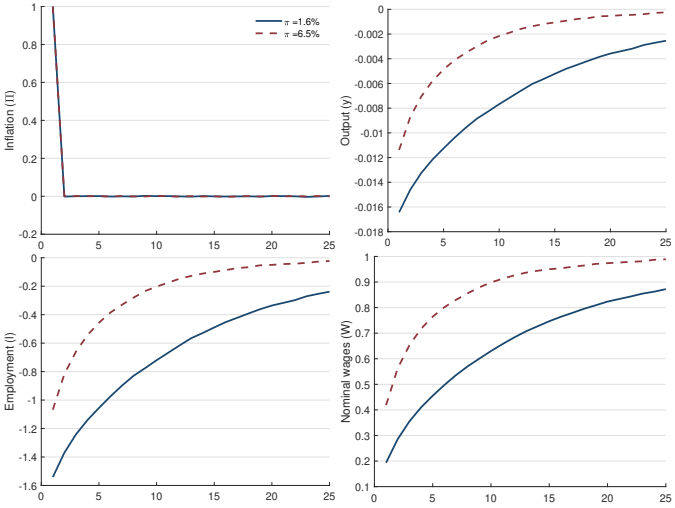
  $\rightarrow$ Duration is *endogenous* and varies with the level of inflation
- Duration lower for larger firms (higher $a_t$), consistent with Fact 4 duration & size

# Menu Cost Model: Size of Wage Agreements




- Size of wage adjustments increases from 2% to 6.8% during times of high inflation compared to low inflation.

# Transmission of Monetary Policy Given High and Low Inflation




- Real effects dampened in high inflation environment due to more frequent wage adjustment

  Wage Phillips Curve

# NK Model with State-Dependent Wage Setting

- Embed state-dependent wage setting into standard NK model with sticky wages (Erceg et al., 2000)
- Key modification: make reset probability function of inflation $\pi_t$:

$$(1-\theta_t^w) = \frac{\gamma e^{\eta \pi_t^2}}{1+\gamma e^{\eta \pi_t^2}},$$

  - Calibrate $\gamma$ and $\eta$ to match observed duration in **firm survey** and **union data** on average
  - Sigmoid function bounded between 0 and 1

- Duration becomes endogenous object:

$$d_t = (1-\theta_t^w) + 2\theta_t^w \mathbb{E}_t d_{t+1} - \theta_t^w \mathbb{E}_t \theta_{t+1}^w d_{t+2}$$

- Firm's optimal reset wage:

$$W_t^{\#} = \frac{\epsilon^w}{(1-\epsilon^w)} \frac{\mathbb{E}_t \sum_{j=0}^{\infty} \theta_{t+j}^w \Lambda_{t,t+j} mrs_{t+j} W_{t+j}^{\epsilon^w} L_{t+j}^d}{\mathbb{E}_t \sum_{j=0}^{\infty} \theta_{t+j}^w \Lambda_{t,t+j} W_{t+j}^{\epsilon^w} P_{t+j}^{-1} L_{t+j}^d}$$

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  - Sigmoid function bounded between 0 and 1

- Duration becomes endogenous object:

$$d_t = (1-\theta_t^w) + 2\theta_t^w \mathbb{E}_t d_{t+1} - \theta_t^w \mathbb{E}_t \theta_{t+1}^w d_{t+2}$$

- Firm's optimal reset wage:

$$W_t^{\#} = \frac{\epsilon^w}{(1-\epsilon^w)} \frac{\mathbb{E}_t \sum_{j=0}^{\infty} \theta_{t+j}^w \Lambda_{t,t+j} mrs_{t+j} W_{t+j}^{\epsilon^w} L_{t+j}^d}{\mathbb{E}_t \sum_{j=0}^{\infty} \theta_{t+j}^w \Lambda_{t,t+j} W_{t+j}^{\epsilon^w} P_{t+j}^{-1} L_{t+j}^d}$$

# NK Model with State-Dependent Wage Setting

- Embed state-dependent wage setting into standard NK model with sticky wages (Erceg et al., 2000)
- Key modification: make reset probability function of inflation $\pi_t$:

$$(1-\theta_t^w) = \frac{\gamma e^{\eta \pi_t^2}}{1+\gamma e^{\eta \pi_t^2}},$$

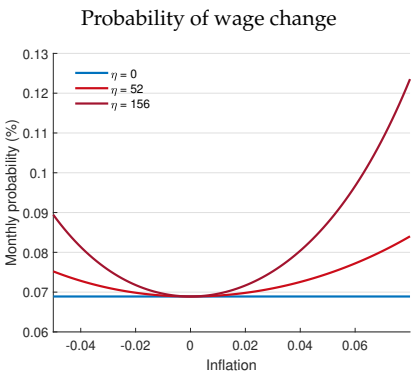
  - Calibrate $\gamma$ and $\eta$ to match observed duration in **firm survey** and **union data** on average
  - Sigmoid function bounded between 0 and 1
- Duration becomes endogenous object:

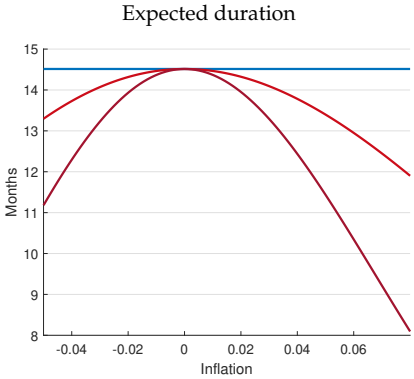
$$d_t = (1-\theta_t^w) + 2\theta_t^w \mathbb{E}_t d_{t+1} - \theta_t^w \mathbb{E}_t \theta_{t+1}^w d_{t+2}$$

- Firm's optimal reset wage:

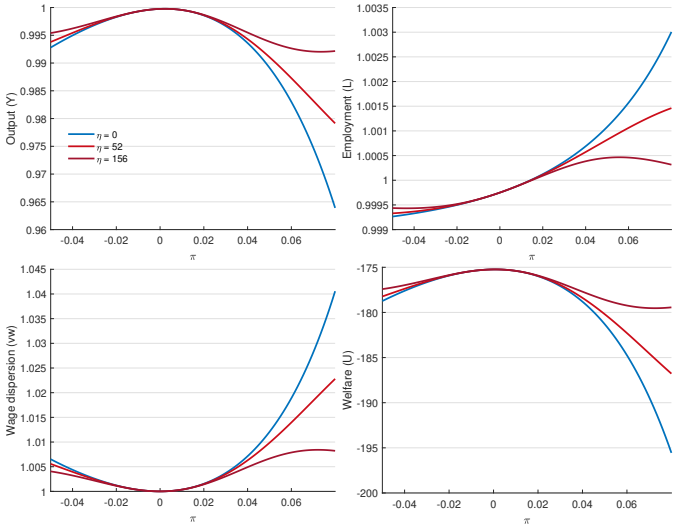
$$W_t^{\#} = \frac{\epsilon^w}{(1-\epsilon^w)} \frac{\mathbb{E}_t \sum_{j=0}^{\infty} \theta_{t+j}^w \Lambda_{t,t+j} mrs_{t+j} W_{t+j}^{\epsilon^w} L_{t+j}^d}{\mathbb{E}_t \sum_{j=0}^{\infty} \theta_{t+j}^w \Lambda_{t,t+j} W_{t+j}^{\epsilon^w} P_{t+j}^{-1} L_{t+j}^d}$$

# Probability of Wage Change and Expected Duration



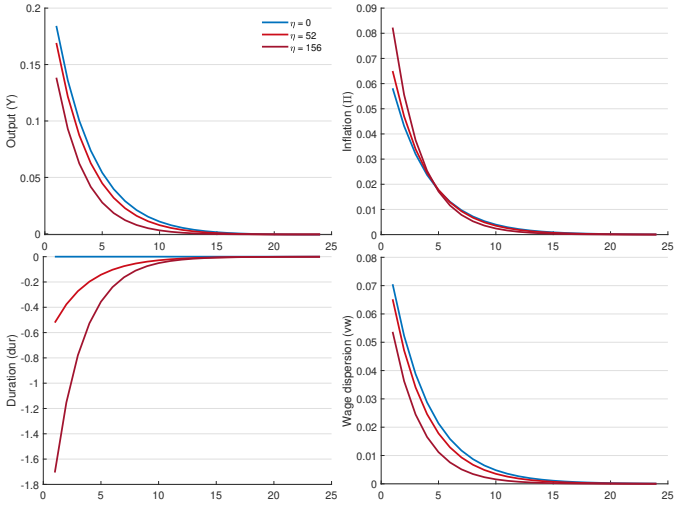



# Trend Inflation With State-Dependent Wage Setting



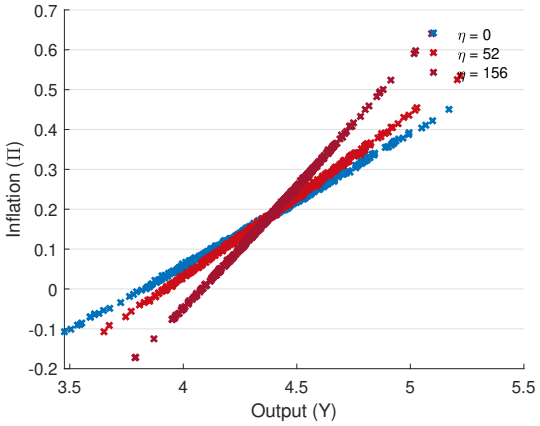

- In general, trend inflation leads to output + welfare losses
- State-dependent wage setting almost neutralizes output and employment effects; wage dispersion lower, and welfare costs diminish

# Monetary Transmission With State-Dependent Wage Setting




- Under state-dependent wage setting, faster pass-through to prices and wages, lower effects on output and wage dispersion
- *Intuition:* state-dependent wage setting pushes economy towards flexible-price equilibrium

# Phillips Curve With State-Dependent Wage Setting




- State-dependent wage setting makes Phillips curve *steeper*

| State dependence | Slope of Phillips curve | Sacrifice ratio |
|---|---|---|
| $\eta = 0.0$ | 0.33 | 3 |
| $\eta = 52$ | 0.4 | 25.5 |
| $\eta = 156$ | 0.62 | 1.6 |

- Note: trend inflation tends to *flatten* slope

# Conclusion

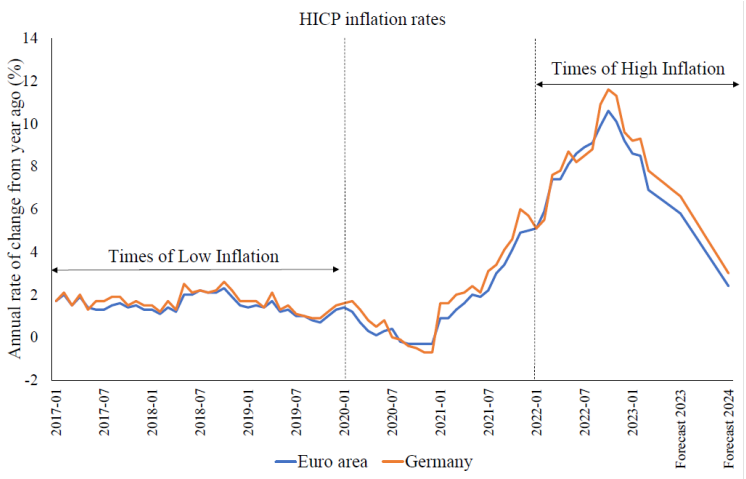
- Evidence for state-dependent wage setting from firm-level survey and union-level data
  - Wages adjust more frequently in times of high inflation
  - Size of wage changes increases at the same time
- Menu cost can match facts about state-dependent wage setting

Policy implications:

- State-dependent wage setting alters monetary policy transmission
- Phillips curve steepens + costs of inflation diminish once accounting for state-dependency

# Appendix

# Inflation Dynamics Since 2017




back - motivation back - ifo

# The Survey Instrument

**Personalleiterbefragung**

**Sonderfragen: Lohnsetzung**

1) **In welchem zeitlichen Abstand (in Monaten) wurden in Ihrem Unternehmen in den Jahren 2017-2019 die Mitarbeiterlöhne durchschnittlich angepasst? (exklusive Beförderungen, außerordentliche Gehaltsänderungen, etc.)**

   Alle _____ Monate

2) **Um wie viel Prozent wurden die Mitarbeiterlöhne bei einer Lohnanpassung in den Jahren 2017-2019 im Durchschnitt verändert?**

   ☐ < 0%  ☐ 0-2%  ☐ 2-4%  ☐ 4-6%  ☐ 6-8%  ☐ 8-10%  ☐ >10%

3) **Wie wichtig waren die folgenden Faktoren für die vergangenen Lohnentscheidungen in Ihrem Unternehmen Bitte tragen Sie einen Wert von 0 (= gar keine Bedeutung) bis 10 (= sehr hohe Bedeutung) ein.**

   ___ Lohnwettbewerb von Konkurrenten
   ___ Erwartetes Arbeitskräfteangebot/Angebot von Fachkräften
   ___ Orientierung an der Inflationsrate
   ___ Anpassung durch Tarifvertrag
   ___ Veränderung der Verkaufspreise
   ___Veränderung der Nachfrage nach Arbeitskräften

   ___ Sonstiges: _____

back

# The Survey Instrument

**4) Auswirkungen einer hohen Inflation auf Lohnverhandlungen**

**a) In welchem zeitlichen Abstand (in Monaten) wurden bzw. werden in Ihrem Unternehmen in den Jahren 2022-2024 die Mitarbeiterlöhne durchschnittlich angepasst? (exklusive Beförderungen, außerordentliche Gehaltänderungen, etc.)**

Alle _____ Monate

**b) Um wie viel Prozent wurden bzw. werden die Mitarbeiterlöhne bei einer Lohnanpassung in den Jahren 2022-2024 im Durchschnitt verändert?**

☐ < 0% ☐ 0-2% ☐ 2-4% ☐ 4-6% ☐ 6-8% ☐ 8-10% ☐ >10%

**5) Welche Faktoren schränken Ihr Unternehmen in der Lohnsetzung ein? (Mehrfachnennung möglich)**

☐ administrativer Aufwand
☐ Regulierung
☐ Lohnsetzung liegt nicht beim Unternehmen
☐ wirtschaftliche Faktoren/Existenzbedrohung

back

# The Survey Instrument

**6) Inwieweit variiert die Lohnanpassung in Ihrem Unternehmen nach Beschäftigungsgruppen im Vergleich zum Durchschnitt der drei Beschäftigungsgruppen?**

- → **Zeitlicher Abstand der Anpassung (häufiger, gleich, weniger häufig)**
- → **Höhe der Anpassung der Mitarbeiterlöhne in % (höher, gleich, niedriger)**

| | **Zeitlicher Abstand der Anpassung** | | | **Höhe der Anpassung in %** | | |
|---|---|---|---|---|---|---|
| | häufiger | gleich | weniger häufig | höher | gleich | niedriger |
| Ungelernte Beschäftigte | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fachkräfte ohne Leitungsposition | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Führungskräfte | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

PL 79.406.079.579

**Rücksendung bitte bis Montag, 21. November 2022**
**Fax: (089) 9224-1463, E-Mail: PL-Umfrage@ifo.de**

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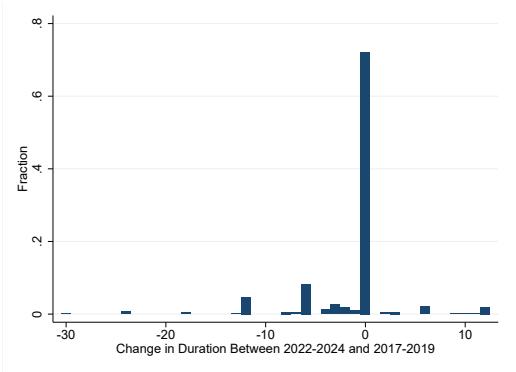
# Descriptive Statistics of ifo HR Survey

| | N | Mean | Std. dev. | p10 | p25 | p50 | p75 | p90 |
|---|---|---|---|---|---|---|---|---|
| Duration (2017-2019) | 529 | 14.18 | 5.71 | 12 | 12 | 12 | 12 | 24 |
| Duration (2022-2024) | 504 | 12.93 | 4.86 | 8 | 12 | 12 | 12 | 24 |
| Adjustment (2017-2019) | 529 | 3.44 | 1.07 | 2 | 3 | 3 | 4 | 5 |
| Adjustment (2022-2024) | 506 | 3.98 | 1.20 | 3 | 3 | 4 | 5 | 6 |
| Relevance of wage competition | 499 | 0.17 | 0.15 | 0 | 0 | 0.19 | 0.25 | 0.33 |
| Relevance of labor supply | 499 | 0.19 | 0.14 | 0 | 0.09 | 0.2 | 0.26 | 0.33 |
| Relevance of inflation | 499 | 0.15 | 0.17 | 0 | 0 | 0.13 | 0.21 | 0.32 |
| Relevance of coll. bargaining | 499 | 0.20 | 0.29 | 0 | 0 | 0.11 | 0.29 | 0.56 |
| Relevance of sales prices | 499 | 0.08 | 0.10 | 0 | 0 | 0.05 | 0.14 | 0.21 |
| Relevance of labor demand | 499 | 0.18 | 0.12 | 0 | 0.08 | 0.19 | 0.25 | 0.31 |
| % of part-time workers | 428 | 0.16 | 0.15 | 0.02 | 0.05 | 0.10 | 0.22 | 0.36 |
| % of temporary workers | 428 | 0.01 | 0.05 | 0 | 0 | 0 | 0 | 0.04 |
| % of trainees | 428 | 0.05 | 0.05 | 0 | 0 | 0.03 | 0.07 | 0.12 |
| Family business | 461 | 0.64 | 0.48 | 0 | 0 | 1 | 1 | 1 |
| Number of employees | 433 | 253 | 855 | 17 | 33 | 74 | 195 | 411 |
| % of minimum wage workers | 352 | 11.46 | 22.48 | 0 | 0 | 0 | 10 | 45 |
| Payout % of one-time bonus | 233 | 70.76 | 29.65 | 30 | 50 | 75 | 100 | 100 |

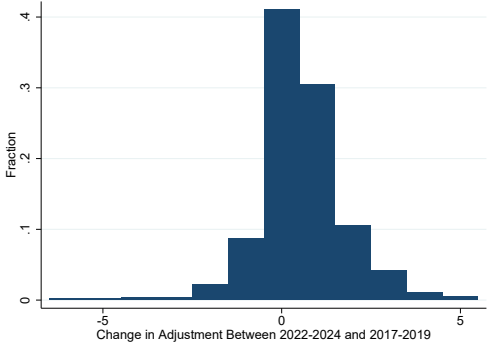
back

# Firm-Level Changes in Wage-Setting Behavior

**(a)** Extensive margin




**(b)** Intensive margin



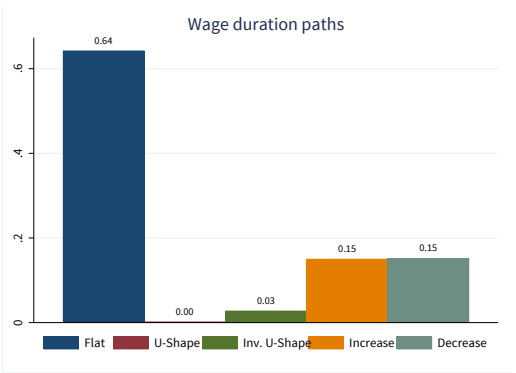

back

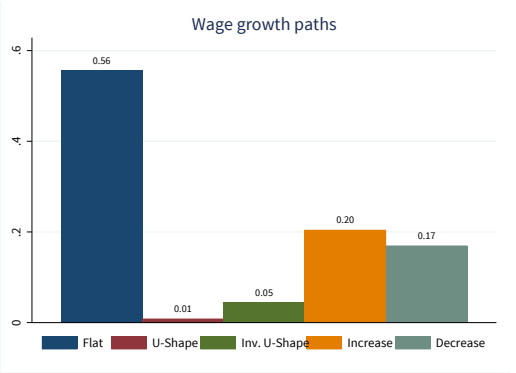
# Duration and Size of Wage Changes Within and Across Industries

| | Standard deviation of Duration (months) | | Adjustment (%) | |
|---|---|---|---|---|
| Inflation regime | *low* | *high* | *low* | *high* |
| Within industries | 5.91 | 5.09 | 0.99 | 1.08 |
| Across industries | 1.38 | 1.42 | 0.32 | 0.37 |

back

# Wage-Setting Behavior Across Workers




→ Roughly 60% of firms follow same wage-setting strategy across workers back

# Firm Size and Wage Setting: Extensive and Intensive Margin

| | $D_{low}$ | $D_{high}$ | $\Delta D$ | $\%_{low}$ | $\%_{high}$ | $\Delta\%$ |
|---|---|---|---|---|---|---|
| log(employees) | -0.70*** | -0.44** | 0.25 | -0.10** | -0.050 | 0.056 |
| | (0.24) | (0.21) | (0.21) | (0.044) | (0.051) | (0.053) |
| Constant | 17.2*** | 14.8*** | -2.17** | 3.82*** | 4.14*** | 0.29 |
| | (0.99) | (0.87) | (0.87) | (0.18) | (0.21) | (0.22) |
| Observations | 405 | 386 | 386 | 408 | 390 | 390 |
| $R^2$ | 0.109 | 0.143 | 0.072 | 0.124 | 0.129 | 0.063 |
| Sector FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

back

# Details on Relevant Decision Factors

| Relevance of ... | N | Mean | Std. dev. | p10 | p25 | p50 | p75 | p90 |
|---|---|---|---|---|---|---|---|---|
| Wage competition | 499 | 0.17 | 0.15 | 0 | 0 | 0.19 | 0.25 | 0.33 |
| Labor supply | 499 | 0.19 | 0.14 | 0 | 0.09 | 0.2 | 0.26 | 0.33 |
| Inflation | 499 | 0.15 | 0.17 | 0 | 0 | 0.13 | 0.21 | 0.32 |
| Coll. bargaining | 499 | 0.20 | 0.29 | 0 | 0 | 0.11 | 0.29 | 0.56 |
| Sales prices | 499 | 0.08 | 0.10 | 0 | 0 | 0.05 | 0.14 | 0.21 |
| Labor demand | 499 | 0.18 | 0.12 | 0 | 0.08 | 0.19 | 0.25 | 0.31 |

back

# Details on Relevant Decision Factors

| | $D_{low}$ | $D_{high}$ | $\Delta D$ | $\%_{low}$ | $\%_{high}$ | $\Delta\%$ |
|---|---|---|---|---|---|---|
| Wage competition | -0.00021 | -0.071 | -0.10 | 0.040** | 0.0074 | -0.031* |
| | (0.088) | (0.078) | (0.071) | (0.017) | (0.019) | (0.019) |
| Labor supply | 0.054 | -0.0073 | -0.048 | -0.0041 | 0.029 | 0.035 |
| | (0.11) | (0.098) | (0.089) | (0.021) | (0.023) | (0.024) |
| Inflation | -0.032 | 0.013 | 0.035 | -0.0039 | 0.042** | 0.048** |
| | (0.090) | (0.080) | (0.073) | (0.017) | (0.019) | (0.019) |
| Sales prices | -0.044 | -0.038 | 0.017 | 0.034* | -0.020 | -0.049** |
| | (0.10) | (0.092) | (0.084) | (0.020) | (0.022) | (0.023) |
| Labor demand | -0.12 | 0.0094 | 0.094 | -0.015 | 0.0063 | 0.021 |
| | (0.11) | (0.098) | (0.089) | (0.021) | (0.024) | (0.024) |
| Constant | 14.7*** | 13.3*** | -0.98** | 3.28*** | 3.66*** | 0.34*** |
| | (0.57) | (0.52) | (0.47) | (0.11) | (0.12) | (0.13) |
| Observations | 483 | 462 | 461 | 485 | 467 | 467 |
| $R^2$ | 0.093 | 0.108 | 0.090 | 0.134 | 0.151 | 0.105 |
| Sector FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

back

# (Semi-)Elasticities by Factor

| | Coll. agreem. | Competition | Labor supply | Inflation | Prices | Labor demand |
|---|---|---|---|---|---|---|
| | | | *Panel A: Wage Duration* | | | |
| Inflation | -0.168* | -0.289*** | -0.258*** | -0.273** | -0.220 | -0.223** |
| | (-2.06) | (-3.51) | (-3.31) | (-2.93) | (-1.90) | (-2.86) |
| N | 519 | 668 | 735 | 542 | 360 | 703 |
| $R^2$ | 0.008 | 0.018 | 0.015 | 0.016 | 0.010 | 0.012 |
| | | | *Panel B: Wage Growth* | | | |
| Inflation | 0.227*** | 0.198*** | 0.216*** | 0.229*** | 0.171*** | 0.219*** |
| | (5.96) | (5.77) | (6.88) | (6.12) | (3.48) | (6.88) |
| N | 547 | 690 | 764 | 565 | 384 | 728 |
| $R^2$ | 0.061 | 0.046 | 0.058 | 0.062 | 0.031 | 0.061 |

back

# ifo HR survey: Other Details

| | N | Mean | Std. dev. | p10 | p25 | p50 | p75 | p90 |
|---|---|---|---|---|---|---|---|---|
| % of part-time workers | 428 | 0.16 | 0.15 | 0.02 | 0.05 | 0.10 | 0.22 | 0.36 |
| % of temporary workers | 428 | 0.01 | 0.05 | 0 | 0 | 0 | 0 | 0.04 |
| % of trainees | 428 | 0.05 | 0.05 | 0 | 0 | 0.03 | 0.07 | 0.12 |
| Family business | 461 | 0.64 | 0.48 | 0 | 0 | 1 | 1 | 1 |
| Number of employees | 433 | 253 | 855 | 17 | 33 | 74 | 195 | 411 |
| % of minimum wage workers | 352 | 11.46 | 22.48 | 0 | 0 | 0 | 10 | 45 |
| Payout % of one-time bonus | 233 | 70.76 | 29.65 | 30 | 50 | 75 | 100 | 100 |

# Summary Statistics of Union Data

| | Union | Size | Availability | Contracts | Duration | Adjustment |
|---|---|---|---|---|---|---|
| 1 | Metal industry | 3,726,800 (2024) | 1956 - 2024 | 49 | 17.2 | 5.8 |
| 2 | Civil service, federal and local level | 2,385,200 (2023) | 1990 - 2023 | 20 | 21.0 | 4.3 |
| 3 | Civil service, state level | 1,100,000 (2023) | 1990 - 2023 | 20 | 21.5 | 4.2 |
| 4 | Chemical industry | 586,800 (2024) | 1990 - 2024 | 27 | 15.9 | 3.7 |
| 5 | Retail sector | 573,500 (2024) | 1989 - 2024 | 23 | 19.3 | 4.1 |
| 6 | Main construction industry | 425,100 (2024) | 1988 - 2024 | 24 | 19.5 | 4.8 |
| 7 | Private transport and traffic industry | 175,900 (2024) | 1994 - 2024 | 17 | 23.2 | 5.0 |
| 8 | Insurance sector | 169,600 (2022) | 1990 - 2022 | 21 | 19.7 | 4.0 |
| 9 | Deutsche Post AG | 160,000 (2023) | 1987 - 2023 | 21 | 21.7 | 4.8 |
| 10 | Deutsche Bahn AG | 134,000 (2023) | 1987 - 2023 | 22 | 20.9 | 4.4 |
| 11 | Volkswagen AG | 100,100 (2022) | 1987 - 2022 | 23 | 19.3 | 4.4 |
| 12 | Iron and steel industry | 85,500 (2023) | 1958 - 2023 | 50 | 16.2 | 5.7 |
| ■ / $\tilde{x}$ | | | | 317 | 19 | 4.8 |

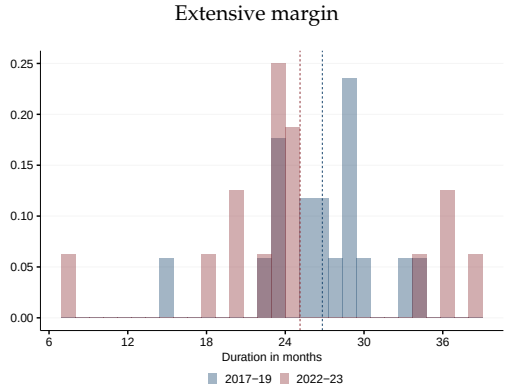
back time series duration time series adjustment

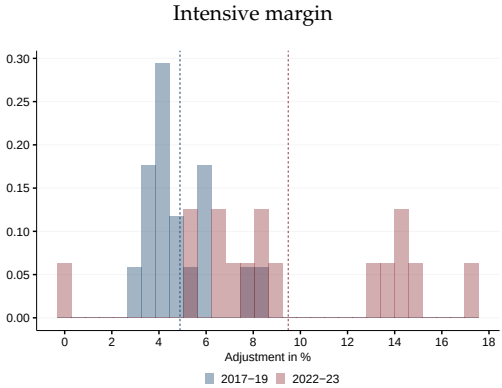
# Elasticity of Annualized Wage Growth

| *Panel C: Annual Wage Growth* | | | | |
|---|---|---|---|---|
| Inflation | 0.291*** | 0.279*** | 0.294*** | 0.291*** |
| | (6.76) | (8.06) | (6.94) | (6.77) |
| N | 1057 | 996 | 1052 | 1057 |
| $R^2$ | 0.042 | 0.677 | 0.130 | 0.047 |
| Fixed Effects | | Firm | Sector | Size |

back

# Collective Bargaining Outcomes ’17-’19 v ’22-’23

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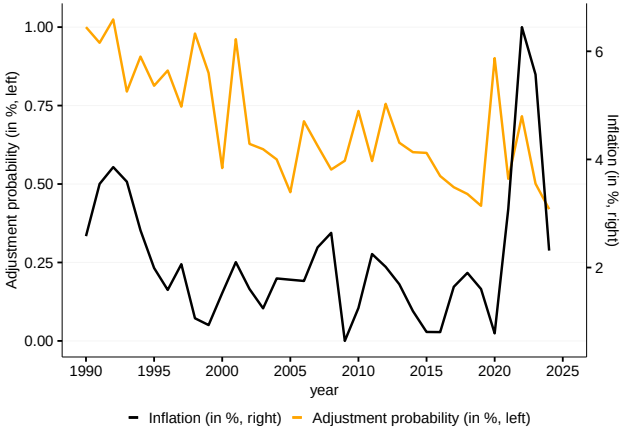
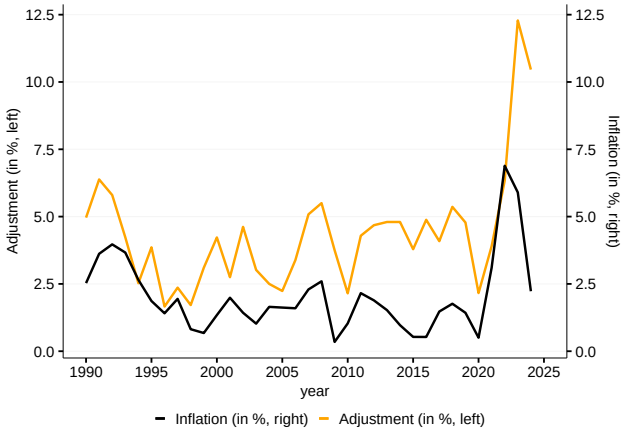
# Time Series of Adjustment Probability and Inflation




back

# Time Series of Wage Growth and Inflation

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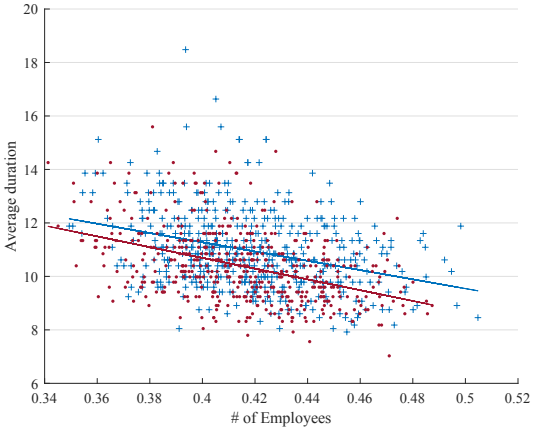
# Backward- vs. Forward-Looking Wage-Setting Behavior

| | Duration (in Months) | | | | Wage Increase (in Percent) | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Inflation | −0.927** | | | 0.758 | 0.627*** | | | 0.112 |
| | (0.425) | | | (0.646) | (0.138) | | | (0.196) |
| Inflation t-1 | | −1.124*** | | −1.528*** | | 0.804*** | | 0.746*** |
| | | (0.330) | | (0.479) | | (0.101) | | (0.145) |
| Inflation t+1 | | | −0.727* | −0.941** | | | −0.343*** | −0.385*** |
| | | | (0.389) | (0.427) | | | (0.130) | (0.130) |
| Observations | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 |
| Adjusted $R^2$ | 0.205 | 0.227 | 0.201 | 0.236 | 0.316 | 0.412 | 0.279 | 0.430 |

*Other controls:* GDP growth, unemployment rate, variance of inflation rate, EPU index (EU), and interaction term of inflation and East Germany during 1990-1993. Constant included. * p<0.10, ** p<0.05, * * * p<0.01.

back

# Menu Cost Model: Duration and Firm Size




- Duration is shorter for larger firms both during periods of low and high inflation

back

# Calibration of Model Parameters

| Parameter | Description | Value |
|---|---|---|
| $\beta$ | Discount factor of household | $0.96^{1/12}$ |
| $\epsilon$ | Elasticity of labor supply | 7 |
| $\gamma$ | Menu cost of resetting wage | 0.056 |
| $\rho_a$ | Persistence of productivity shock | 0.8 |
| $\sigma_a$ | Standard deviation of productivity shock | 0.0325 |
| $\sigma_\mu$ | Standard deviation of monetary shock | 0.0032 |

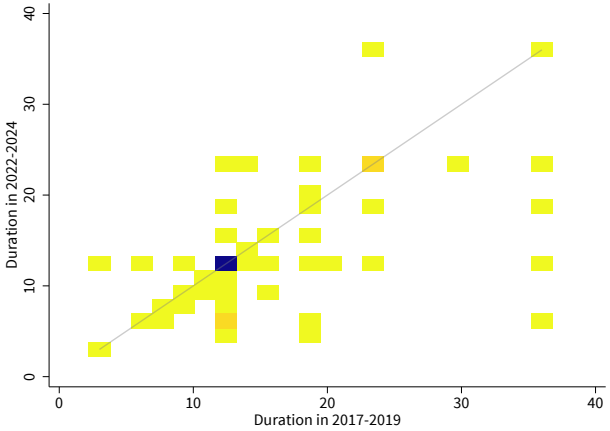
back

# Summary Statistics of Wage Changes

| | Menu cost model | Calvo model | Data |
|---|---|---|---|
| **Low inflation regime:** | | | |
| Annual inflation rate | 0.020 | 0.020 | 0.020 |
| Frequency of wage change (per month) | 0.069 | 0.070 | 0.070 |
| Duration of wage agreements (in months) | 14.469 | 14.183 | 14.180 |
| Size of wage change (percent) | 2.45 | 2.43 | 3.000 |
| **High inflation regime:** | | | |
| Annual inflation rate | 0.068 | 0.069 | 0.070 |
| Frequency of wage change (per month) | 0.085 | 0.079 | 0.080 |
| Duration of wage agreements (in months) | 11.722 | 12.690 | 12.930 |
| Size of wage change (percent) | 6.73 | 7.92 | 5.000 |

back

# Duration of Wage Changes: Times of High vs. low Inflation

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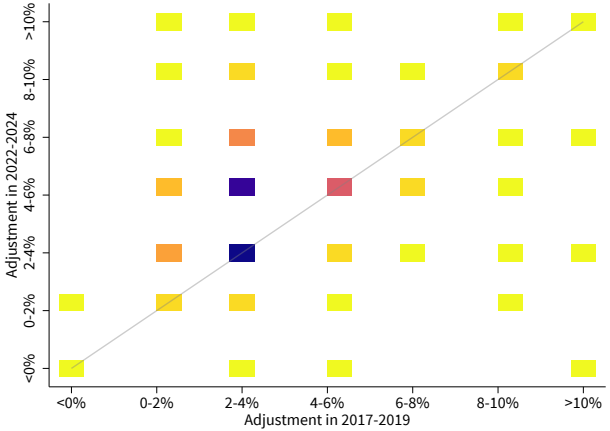
# Size of Wage Changes: Times of High vs. low Inflation

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# Menu Cost Model: Firm's Wage-Setting Problem

- Firm's value function:

$$
\begin{aligned}
V(a_t, w_{t-1}/P_t) &= \max[V_c(a_t, w_{t-1}/P_t), V_{nc}(a_t, w_t/P_t)]. \\
V_{nc}(a_t, w_{t-1}/P_t) &= \left(a_t - \frac{w_{t-1}}{P_t}\right)\left(\frac{w_{t-1}}{P_t}\right)^{\epsilon} + \beta \mathbb{E}_t \left[\left(\frac{P_{t+1}}{P_t}\right) V(a_{t+1}, w_t/P_{t+1})\right] \\
V_c(a_t, w_{t-1}/P_t) &= \max_{W_t} \left[V_{nc}(a_t, w_{t-1}/P_t) - \gamma\left(\frac{w_{t-1}}{P_t}\right)\right].
\end{aligned}
$$

- Firm changes wage iff:

$$
\underbrace{V_c(a_t, w_{t-1}/P_t) - V_{nc}(a_t, w_{t-1}/P_t)}_{\text{Gain of adjusting}} \geq \underbrace{\gamma\left(\frac{w_{t-1}}{P_t}\right)}_{\text{Cost of adjusting}}
$$

calibration back

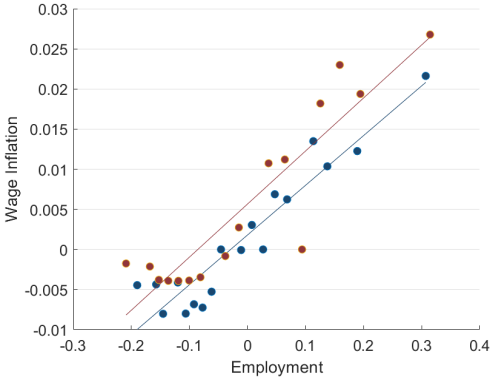
# Calvo Model: Firm's Value Function

- In Calvo model, value function is simply average of $V_c$ and $V_{nc}$ weighted by reset probability $1 - \theta_w$:

$$V(a_t, w_{t-1}/P_t) = \theta^w V_{nc}(a_t, w_{t-1}/P_t) + (1 - \theta^w) V_c(a_t, w_{t-1}/P_t).$$

- Key is to make $\theta^w$ time-varying.

# Wage Phillips Curve under High and Low Inflation




→ Wage Phillips curves under high and low inflation environments back