Endogenous Wage Indexation and Aggregate Shocks

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Motivation

- Price and wage inflation are typically very persistent
- DSGEs assume prices and wages are **indexed to past inflation**

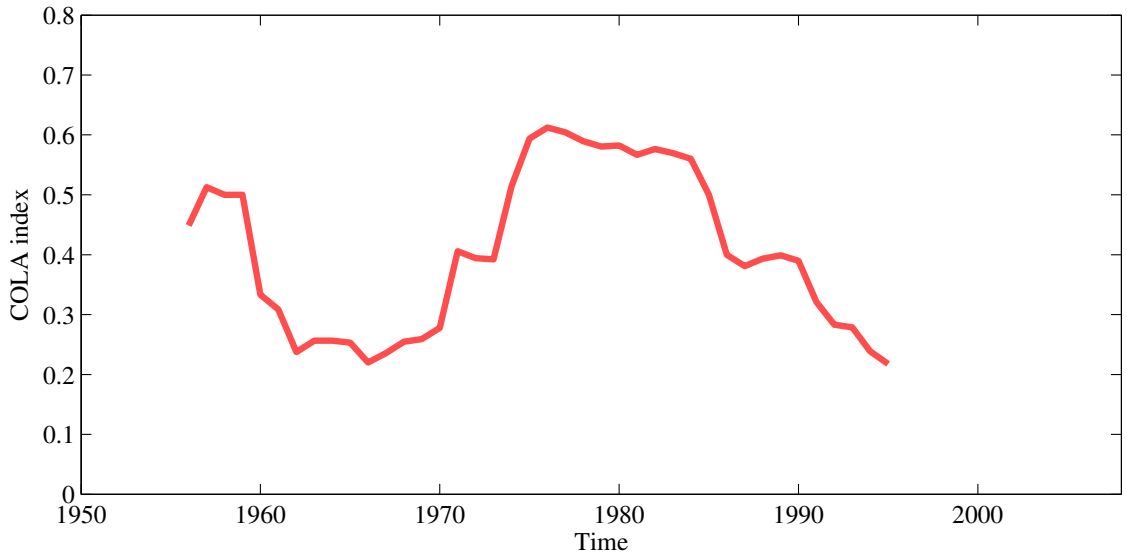
(To fix terms: **Aggregate indexation = past-inflation indexation**)

- Indexation is **hard-wired** as a fixed and policy invariant parameter
- But indexation practices are choices/agreements between agents
- Why should they remain permanently constant? (Lucas critique)
- Evidence suggests wage indexation has varied a lot

Motivation

- **Macro evidence for U.S.:** Hofmann, Peersman, and Straub (2012) find that U.S. wage dynamics are consistent with
  - high indexation for the *Great Inflation* (70s), and
  - low indexation for the *Great Moderation* (2000s)

- **Micro evidence for U.S.:** # contracts with cost-of-living adj. (COLA) clauses



- **Macro evidence for Europe:** Wage negotiations are starting to follow observed inflation rather then the ECB's inflation target.

Motivation

- High wage indexation renders inflation more persistence, making it more difficult to bring it back to target.
- Gray (1976) and Fischer (1977) offer a rationale for *socially optimal* changes in wage indexation
- To reduce output fluctuations, wage indexation should
  - decrease with supply-side shocks, and
  - increase with demand-side shocks.
- However, the Gray-Fischer hypothesis is problematic for two reasons:
  - Did demand shocks drive the 70s and supply shocks the 2000s?
  - The U.S. is driven by a decentralized wage setting (Calmfors and Driffil, 1988).

Aim

- Within a microfounded environment, we ask

Which macro factors influence workers' wage indexation choices?

- We proceed as follows:
  - In a stylised NK-DSGE model,
  - Utility-maximizing workers select a wage indexation rule:

past inflation or **inflation target**.

  - Workers respond to prevailing shocks, policy, and market structures.
  - We use the model's predictions to ask: **What caused wage indexation changes in the U.S.?**

Results

1. Workers index wages to
   - **past inflation** in face of perm. productivity and inflation-target shocks
   - **target inflation** in face of aggregate-demand shocks
2. The decentralized wage indexation equilibrium carries an externality
   - Social planner choices are different than decentralised equilibrium
   - A worker does not internalise the effect of his choice on the aggregate
3. Model correctly predicts
   - high aggregate indexation for the *Great Inflation* and
   - low aggregate indexation for the *Great Moderation*
   - Changes in the volatility of **productivity shocks** drive results

Model building blocks

- New Keynesian model with sticky prices and wages (Ercerg, Henderson, and Levin, 2000)
  - Linear technology on labor with no capital
  - Monetary policy: CB follows Taylor-type rule and sets inflation target
  - Shocks: Technology (perm.), Gov't spending (temp.), Target inflation

- Households have a unique labor type
  - Re-optimize labor contract infrequently
    - Step 1, HH choose *indexation rule given economic structure*
    - Step 2, HH choose *optimal wage given indexation rule*
    - In both steps, HH maximise expected utility

It is illustrative to analyse step 2 first, and then step 1

Households, step 2: wage-setting

- Household i's objective is

$$\max_{c_{i,T}, b_{i,T}, W_{i,t}^k} \mathrm{E}_t \left\{ \sum_{T=t}^{\infty} \beta^{T-t} \left(\log \left(c_{i,t} - \gamma^h c_{i,t-1} \right) - \psi \frac{(\ell_{i,t,T})^{1+\omega}}{1+\omega} \right) \right\}, \tag{1}$$

subject to

$$c_{i,T} + \frac{b_{i,T}}{R_T} \leq \frac{W_{i,t}^k}{P_T} \ell_{i,T} + \frac{b_{i,T-1}}{1+\pi_T} + \frac{\Upsilon_{i,T}}{P_T}, \tag{2}$$

$$\ell_{i,t,T}^k = \left(\frac{\delta_{t,T}^k W_{i,t}^k}{W_T} \right)^{-\theta_w} \ell_T \tag{3}$$

- HH sets new contract with probability $1 - \alpha_w$
- Available indexation rules are

$$\delta_{t-1,t}^{trend} = 1 + \pi_t^\star \quad \text{and} \quad \delta_{t-1,t}^{past} = 1 + \pi_{t-1}$$

$\pi_t^\star$ is the central bank inflation target $=$ trend inflation.

Households, step 2: costs from sticky wages

- If wages were flexible, usual *welfare maximizing* condition holds

  Mg. rate of substitution between $c_{i,t}$ and $\ell_{i,t}$ $\propto$ real wage

$$\frac{\psi \ell_t^{\omega}}{\lambda_t} = \frac{w_t}{\mu_w}.$$

- Since wages are sticky, this condition may not be satisfied
- Sticky wages imply welfare losses,
- but an indexation rule may close the gap between the desired and actual labor supply

Households, step 1: indexation-rule setting

- Workers select an indexation rule to maximise expected utility

$$\max_{\delta_i \in \{\delta^{trend}, \delta^{past}\}} \mathrm{E}_t \left\{ \sum_{T=t}^{\infty} (\beta \alpha_w)^{T-t} \mathcal{U} \left(c_T \left(\xi_T, \Sigma_T \right), \ell_{i,T} \left(\delta_i, \xi_T, \Sigma_T \right) \right) \right\},$$

subject to the economy's structure, Σ_t

  - $\Rightarrow$ c_t does not depend on $\delta_i^\star$ (perfect risk sharing)
  - $\Rightarrow$ Only expected labor disutility matters

- A worker chooses $\delta_i^\star$ to minimize

$$\Omega_{i,t} \left(\delta_i, \xi_t \right) = \mathrm{E}_t \left\{ \sum_{T=t}^{\infty} (\beta \alpha_w)^{T-t} \frac{\psi}{1+\omega} \ell_{i,T}^{1+\omega} \right\}$$

$\xi_t = \#$ workers indexing to past inflation, taken as given by an individual worker

Shocks & Policy

- Productivity shock:

$$y_{j,t} = A \exp(z_t)\, n_{j,t}, \text{ with } z_t = z_{t-1} + \varepsilon_{z,t},$$

- Government-spending shock (aggregate-demand shock):

$$g_t = g \exp(\varepsilon_{g,t})\, y_t \text{ with } \varepsilon_{g,t} = \rho_g \varepsilon_{g,t} + \eta_{g,t},$$

- Monetary policy:
  - Interest-rate rule:

$$R_t = [R_{t-1}]^{\rho_R} [R_t^*]^{1-\rho_R} \left[\frac{1+\pi_t}{1+\pi_t^*}\right]^{a_\pi(1-\rho_R)} [y_t]^{a_y(1-\rho_R)} \left[\frac{y_t}{y_{t-1}}\right]^{a_{\Delta y}},$$

    where R_t^* is the long-term gross nominal rate

  - Trend-inflation rule:

$$\pi_{t+1}^* = \rho_{\pi^\star} \pi_t^* + \varepsilon_{\pi,t+1} \text{ with } \rho_{\pi^\star} \in [0,1].$$

Benchmark calibration

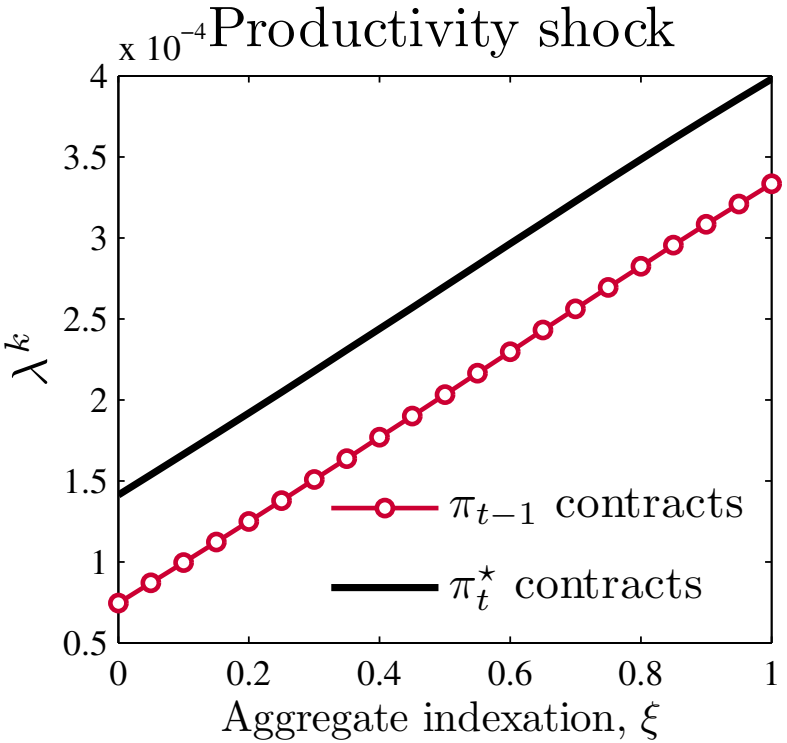
Table 1. Calibration based on HPS (2012)'s estimation

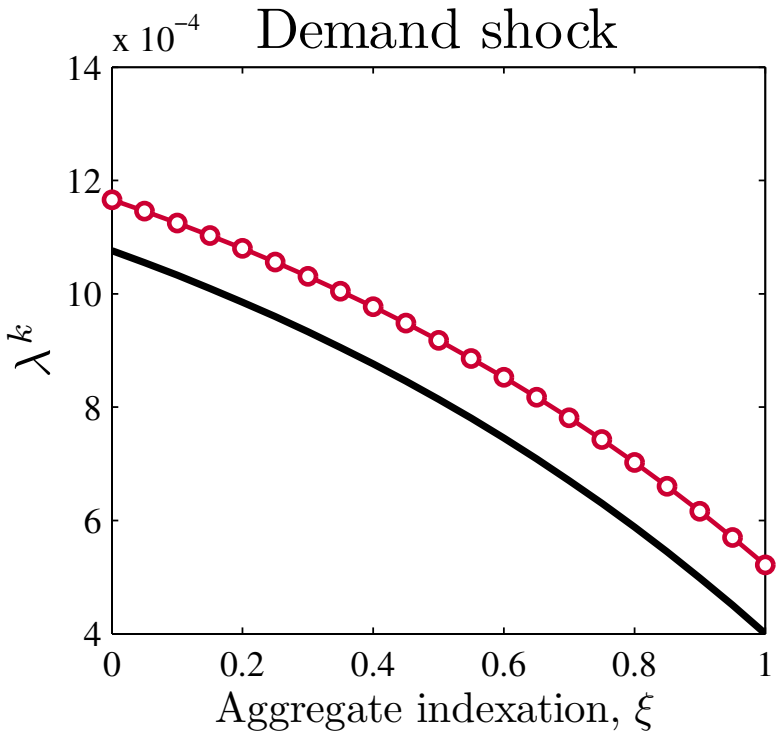
		Great Moderation year 2000
γ^h	Habit formation	.37
γ^p	Inflation inertia	.17
α_p	Calvo-price rigidity	.78
α_w	Calvo-wage rigidity	.54
a_π	Taylor Rule: inflation	1.35
a_y	Taylor Rule: output gap	.1
$a_{\Delta y}$	Taylor Rule: output gap growth	.39
ρ_R	Taylor Rule: smoothing	.78

Other parameters: $\beta = .99,\ \sigma = 1,\ \phi = 1,\ \omega = 2,\ \theta_w = \theta_p = 10.$

Aggregate indexation: welfare costs I

- Welfare costs are approx to the second order (leisure-equivalent λ_k)

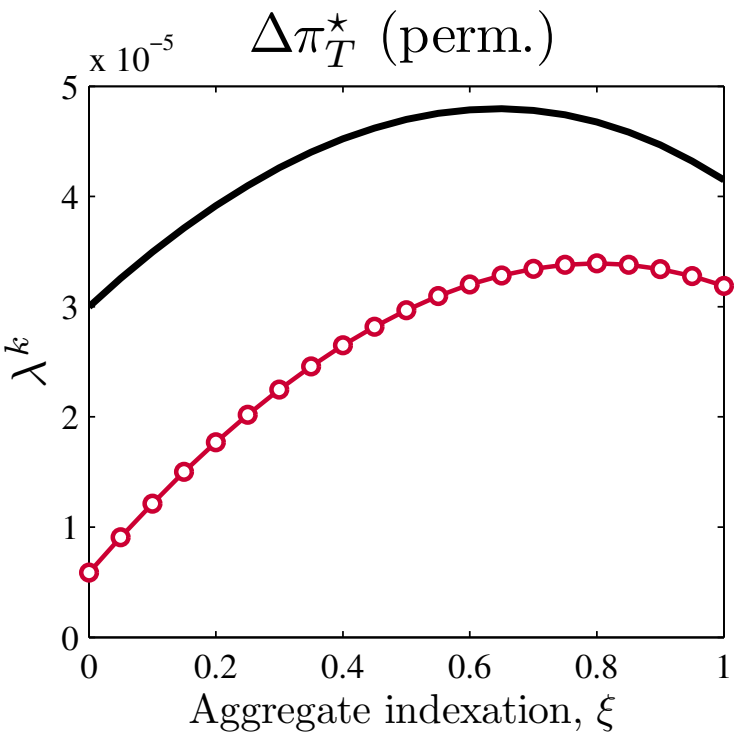


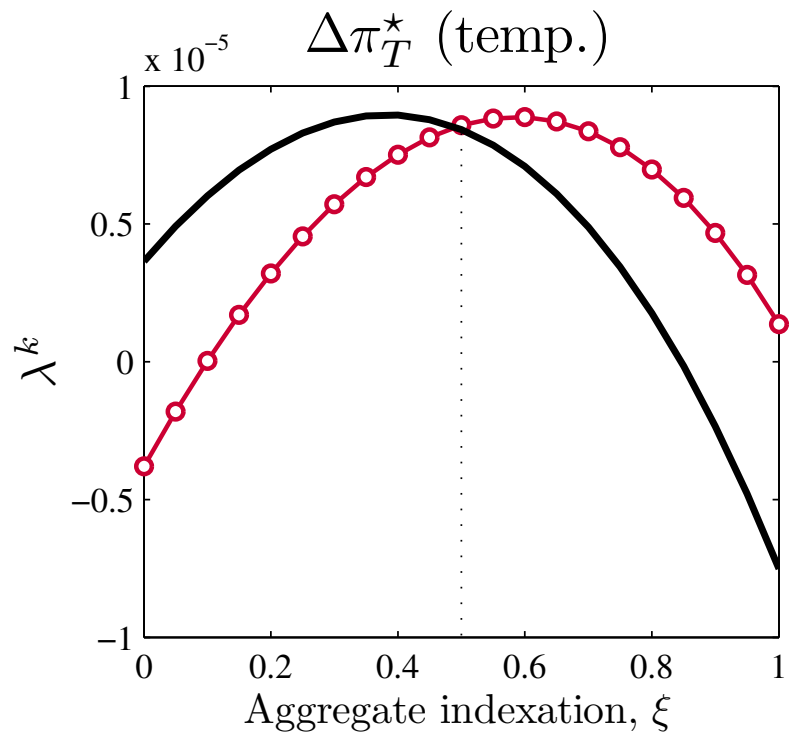


- Workers pick *past* index. in the productivity shock regime
- Workers pick *trend* index. in the gov't spending regime
- The equilibria are globally stable

Aggregate indexation: welfare costs II

(black is trend and red is past)





- If the $\pi^{\star}$-shocks are permanent, then workers pick *past* index.
- If the $\pi^{\star}$-shocks are temporal, there's an interior solution
- Again, the equilibria are globally stable

Labor disutility at the steady state

- At the steady state, labor disutility is given by (let $\omega = 1$)

$$\Omega_{ss}^{k} \approx \frac{\psi}{1-\beta\alpha_w}\left(R_{ss}^{k} + V_{ss}^{k}\right),$$

where

$$R_{ss}^{k} = \frac{1}{2}\left[\frac{\int_{i\in I_k}\left(\frac{W_i}{W}\right)^{-\theta_w} \mathrm{d}i}{\xi^{k}} \times \ell_{ss}\right]^{2}, \text{ and } V_{ss}^{k} = \frac{1}{2}\mathrm{var}\left(\ell_t^{k}\right)$$

where $\xi^{k} = \xi$ if $k = \textit{past}$ and $1-\xi$ if $k = \textit{trend}$

  - R_{ss}^{k} depends on wage dispersion within a sector
  - V_{ss}^{k} is a total measure of variance in hours worked
  - We show that differences in R_{ss}^{k} are the main drivers of wage indexation decisions

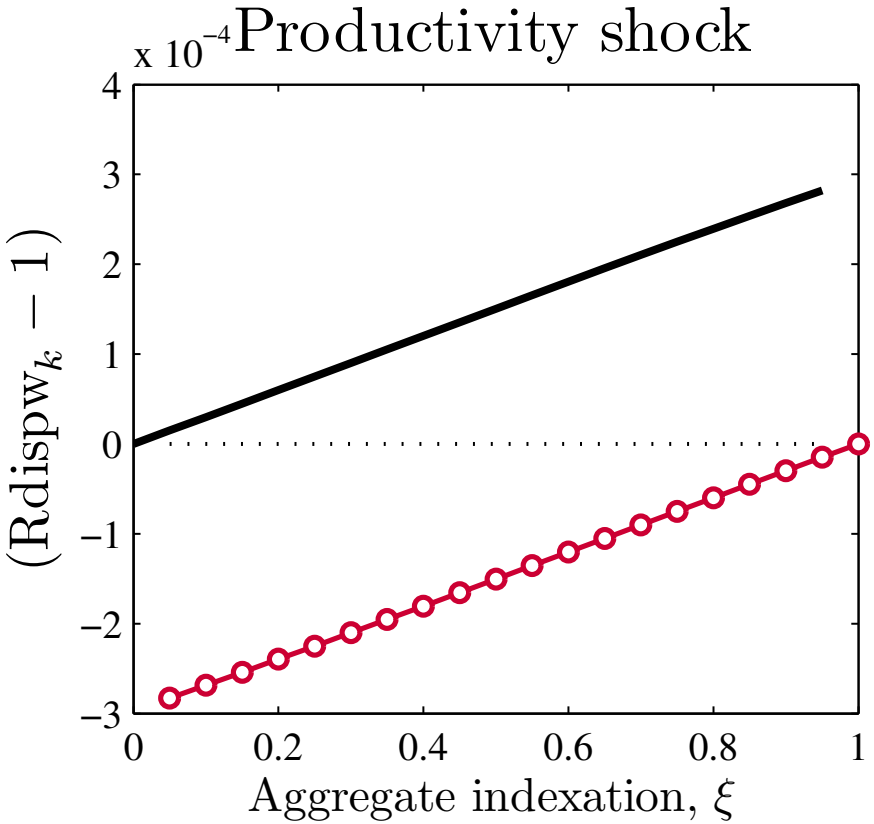
Labor contracts: Intuition

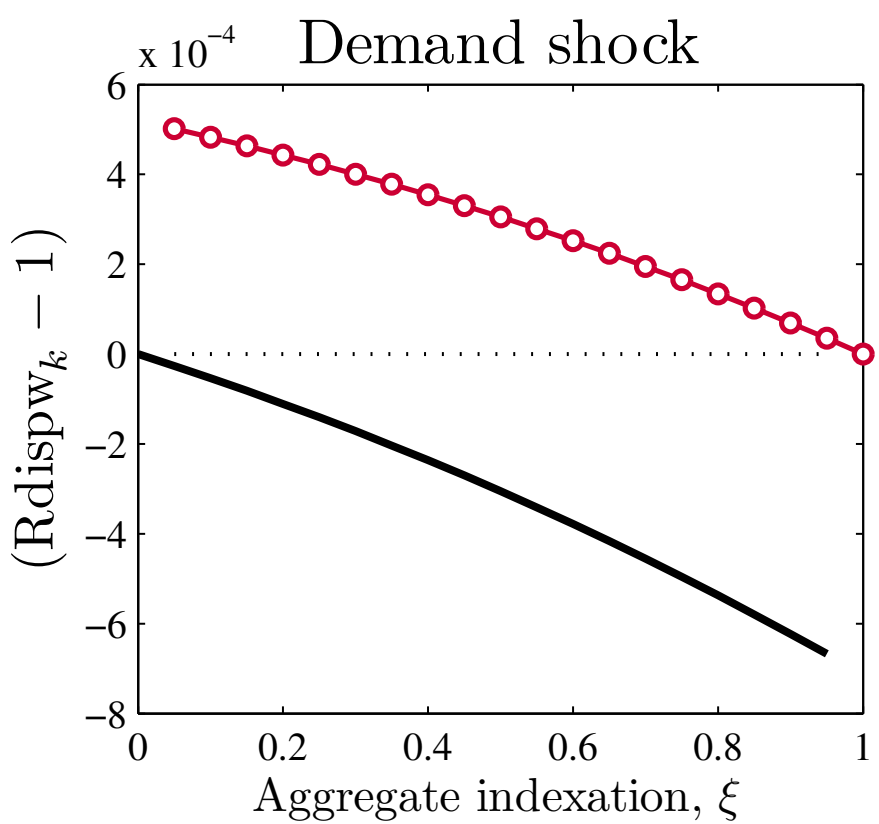
- How workers choose their indexation rule?
- Here's the intuition:
  - A larger wage dispersion means a larger variance in hours worked,
  - Workers dislike uncertainty on their labor and wages $(\omega > 0)$,
  - So they choose a labor contract (δ^k, W^k) that minimizes that uncertainty.

Relative wage dispersion I

- In single-shock regimes, workers prefer contracts with lower relative wage dispersion

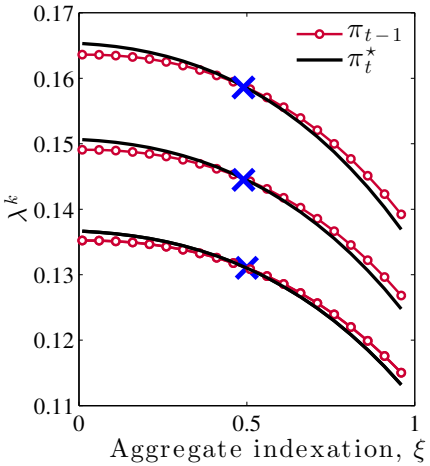
(black is trend and red is past)

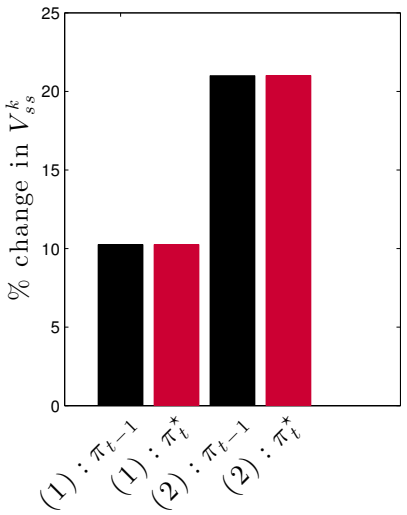


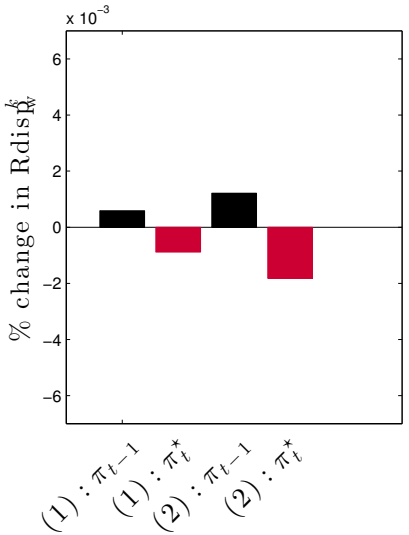


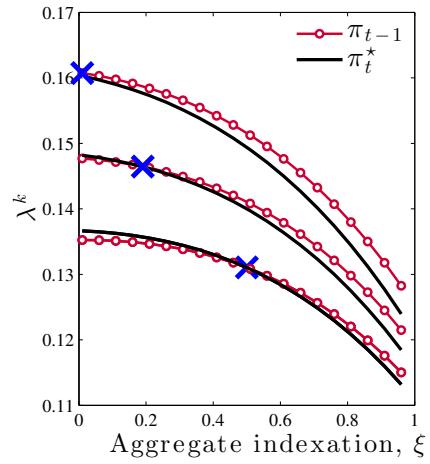
Relative wage dispersion II

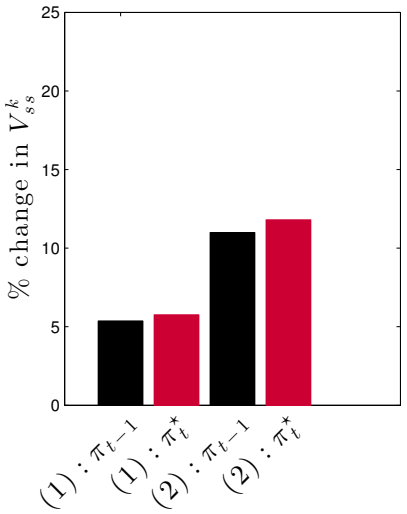
- In multiple-shocks regimes, changes in relative wage dispersion drive changes in aggregate indexation

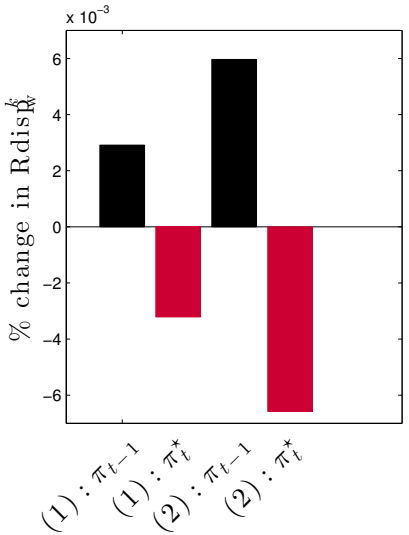






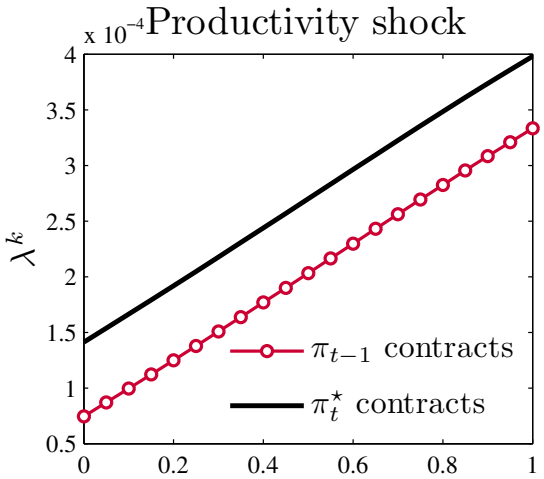


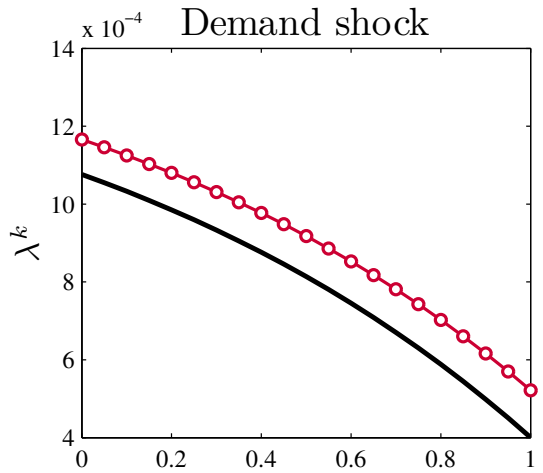


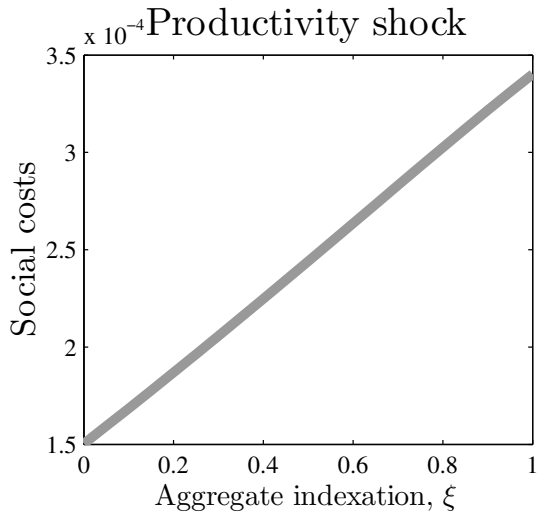


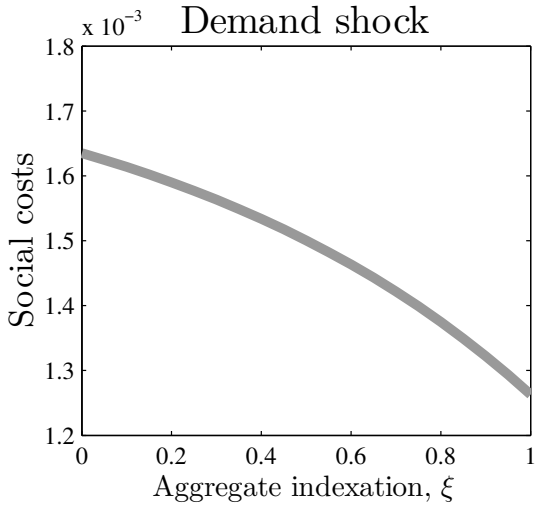
Social planner vs. Decentralized eq

- A worker disregards his own impact on the aggregate
- Coordination failure leads to a suboptimal equilibrium









Great Inflation calibration

Table 2. Calibration based on HPS (2012)'s estimation

		Great Moderation 2000 (benchmark)	Great Inflation 1974
γ^h	Habit formation	.37	.71
γ^p	Inflation inertia	.17	.8
α_p	Calvo-price rigidity	.78	.84
α_w	Calvo-wage rigidity	.54	.64
a_π	Taylor Rule: inflation	1.35	1.11
a_y	Taylor Rule: output gap	.10	.11
$a_{\Delta y}$	Taylor Rule: output gap growth	.39	.5
ρ_R	Taylor Rule: smoothing	.78	.69

Common parameters: $\beta = .99,\ \sigma = 1,\ \phi = 1,\ \omega = 2,\ \theta_w = \theta_p = 10.$

Predictions for U.S.

Table 3. Calibration of shocks

		Great Moderation 2000 (benchmark)	Great Inflation 1974
σ_z	Std. dev. Tech. shock (HPS)	.31	1.02
σ_g	Std. dev. Dem. shock (HPS)	3.25	4.73
σ_{π^*}	Std. dev. inflation target (HPS)	NaN	NaN
$\hat{\chi}$	Estimated indexation (HPS)	.17	.91
Case 1: $\sigma_{\pi^\star} = 0$			
$\chi^\star$	Implied equilibrium indexation	0	.89
χ^S	Implied social optimum	1	0
Case 2: $\sigma_{\pi^\star} > 0$			
σ_{π^*}	Std. dev. inflation target (CPS, 2010)	.049	.081
$\chi^\star$	Implied equilibrium indexation	.05	.89
χ^S	Implied social optimum	1	0

Counterfactuals

Table 4. Counterfactual exercises

		2000: $\xi^\star = 0$, put 1974 value to: $\xi^{counterfactual}$	1974: $\xi^\star = .89$, put 2000 value to: $\xi^{counterfactual}$
I - Shocks			
σ_z	Std. dev. Tech. shock	1	0
σ_g	Std. dev. Dem. shock	0	1
σ_{π^*}	Std. dev. inflation target	.6	.89
II - Policy parameters			
a_π	Taylor Rule: inflation	0	1
a_y	Taylor Rule: output gap	.05	.89
$a_{\Delta y}$	Taylor Rule: output gap growth	0	1
ρ_R	Taylor Rule: smoothing	0	.94

Remarks: Main driver is change in the volatility of the productivity shock, not monetary policy!

Extra: What can we say for SOEs?

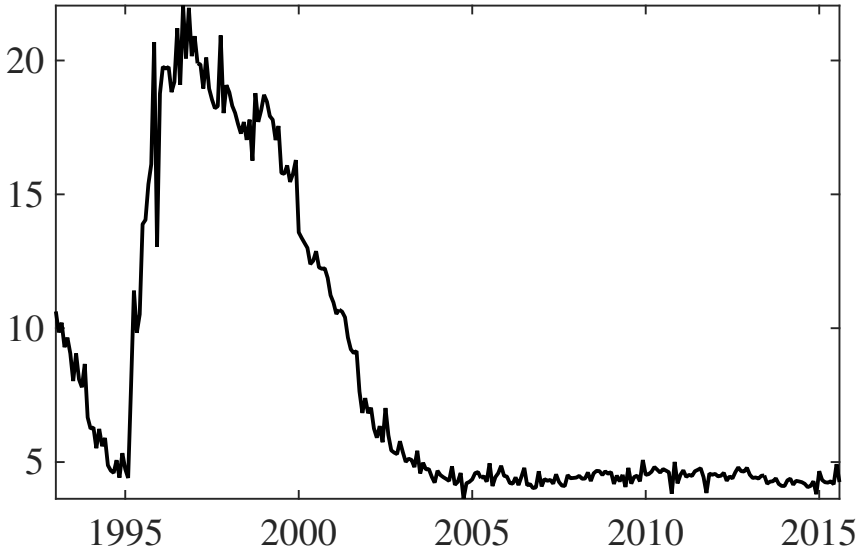
- Evidence suggest that wage indexation has also changed in Mexico
- Consider the following regression for Mexican employees' **contractual wage revisions**, Δw_t

$$\Delta w_t = c_t + \rho_t \Delta w_{t-1} + \beta_{lag,t} \sum_{i=0}^{12} \pi_{t-i} + \beta_{trend,t} \bar{\pi}_t + \gamma_t \Delta s_t + \varepsilon_t$$

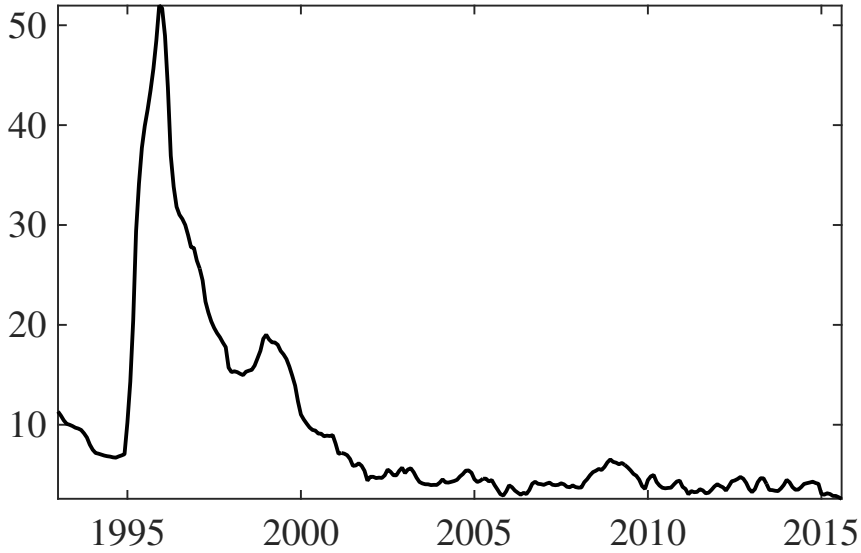
- where Δs_t is the percent change in the peso/dollar exchange rate, and c_t, ρ_t, $\beta_{lag,t}$, $\beta_{trend,t}$, and γ_t are time-varying coefficients

Extra: Mexico 1993-2015, monthly data

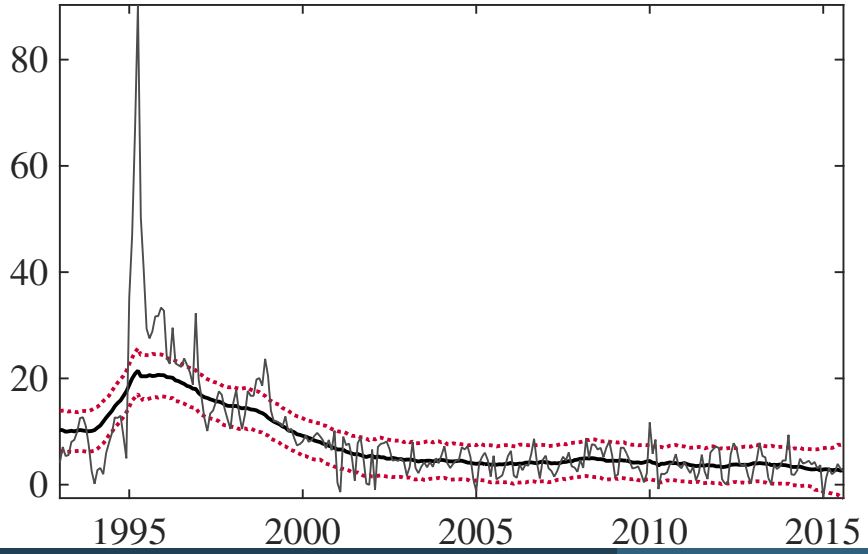
Nominal wage revisions



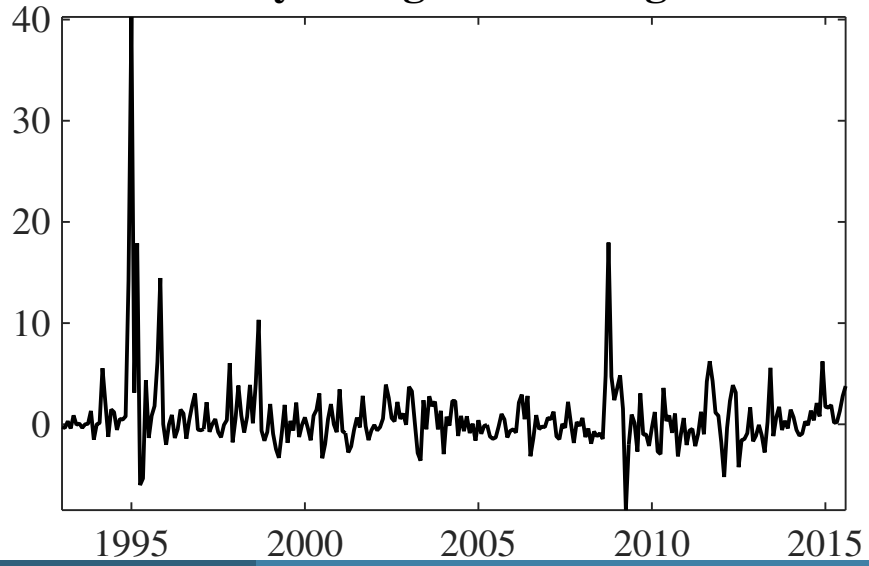
Cumulated annual inflation (lagged)



Monthly inflation (annualized) and trend

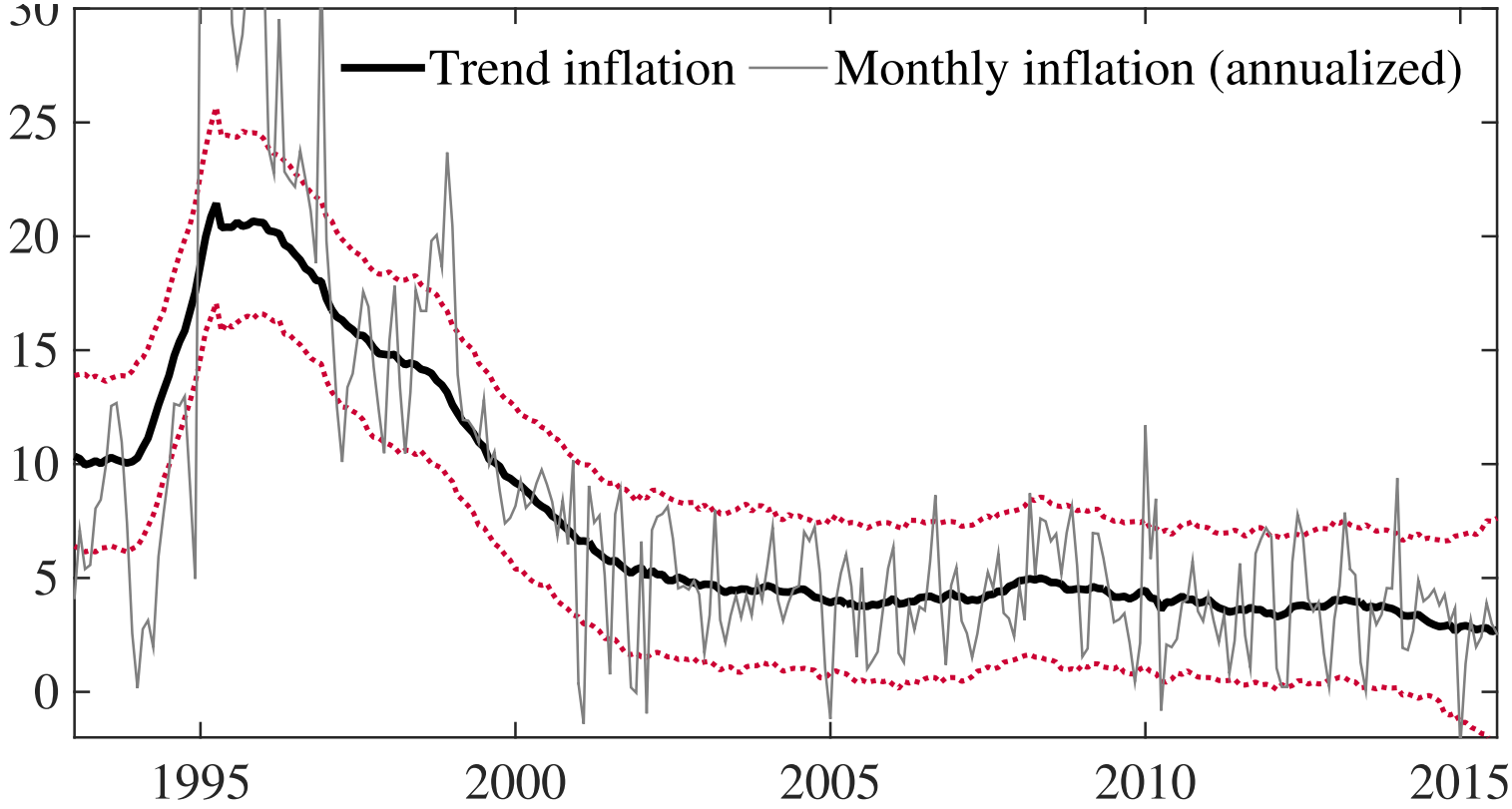


Monthly change in exchange rate



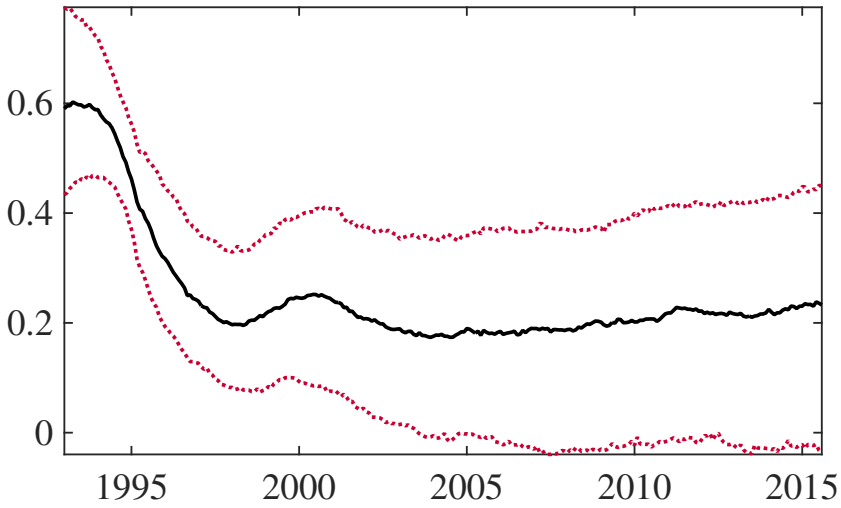
Extra: Predictions for Mexico

- According to the theory, wage indexation to past inflation should have been high in the 90s, and low in the 2000s

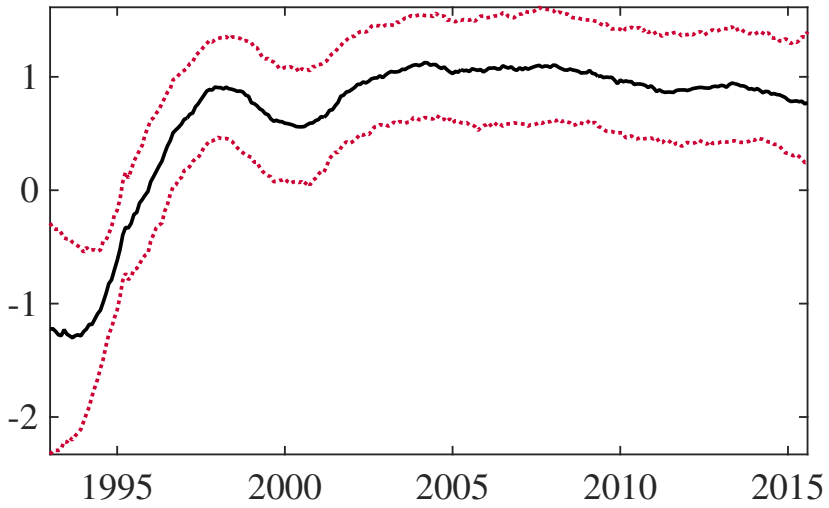


Extra: Predictions for Mexico

Long-run lagged-inflation coef. $((1-\rho_t)^{-1}\beta_{lag,t})$



Long-run trend-inflation coef. $((1-\rho_t)^{-1}\beta_{trend,t})$



- As expected, wage revisions followed more past inflation in the 90s, when trend inflation was drifting
- When trend inflation settled, wage revisions followed this variable

Conclusions

- We propose a microfounded approach to endogenize wage indexation in DSGE models
- We let workers select their own indexation rule
  - Expected changes in hour worked (aka, relative wage dispersion) is the most important driver in a worker's decision
  - However, this decentralized equilibrium suffers from an externality and is suboptimal
- The decentralized equilibrium offers a rationale to changes in U.S. wage indexation from the Great Inflation to the Great Moderation
- And it may offer predictions to SOEs too