A Theory of How Workers Keep Up with Inflation

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Evolving...

Motivation

- Recent inflation has reignited interest among academics and policymakers about its aggregate and distributional effects on the labor market.

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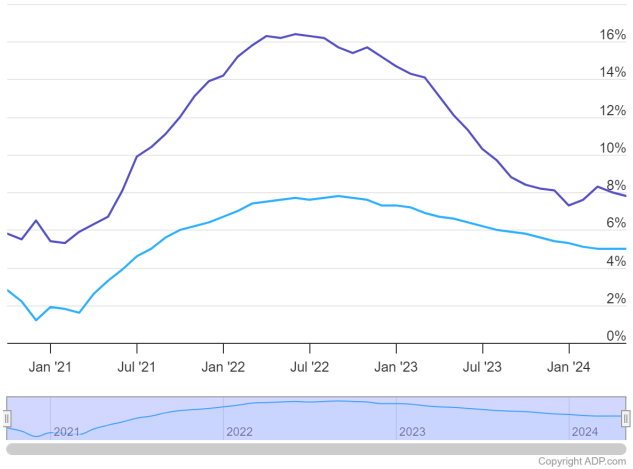
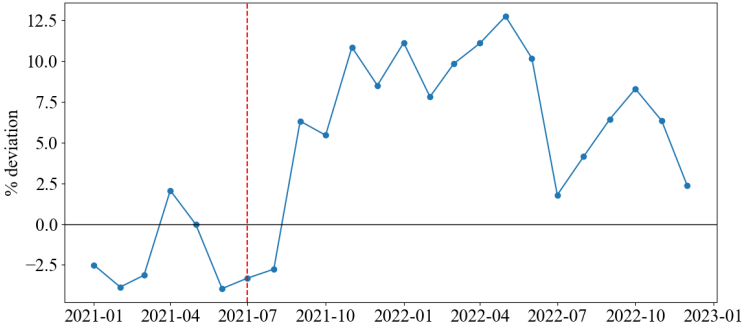
- Some evidence on the effects of inflation on the labor market:
  - Workers search more when they expect higher inflation (Pilossoph and Ryngaert, 2023)
  - Wage adjustment frictions potentially lead to inefficient separations (Davis and Krolikowski, 2024; Lian, Guerreiro, Hazell, and Patterson, 2024)
  - Workers dislike inflation due to its impact on their wages (Stancheva, 2024; Afrouzi et al. 2024)
  - Effects of inflation are potentially different across the wage distribution (Autor, Dube, and McGrew, 2024)

Recent Inflation Period: Nominal Wage Growth By Job Changers and Job Stayers



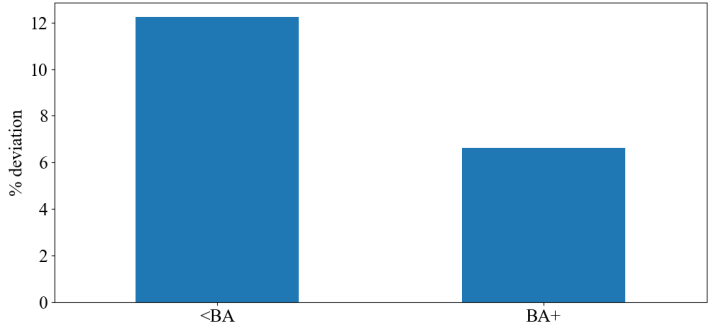
- *Data: ADP Research Institute, Median Annual Nominal Wage Growth Increased During Inflation Period - Most for Job Changers*

Recent U.S. Inflation Coincides with Higher Job-to-Job (EE) Flows



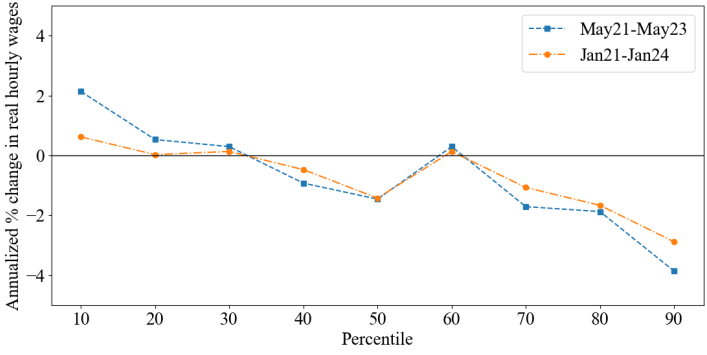
- *EE flows jumped in US right after inflationary period started*
- Data from CPS, individuals aged 25-54; y-axis is percentage change in EE-flows relative to same month during pooled 2016-2019 period

… And More So at the Bottom



- *EE flows jumped more during 2021M7-2022M12 period (relative to 2016-2019 period) for those with lower education*
- Similar patterns documented in Autor, Dube, McGrew (2023) (and similar to patterns in Argentina after 2002 found in Blanco, Drenik, Zaratiegui (2024))

Recent Inflation: Real Wage Growth By Income Decile



- *CPS Data, Nominal Wage Growth Kept Up With Inflation for Low Wage Workers - Modest Real Wage Deciles for High Wage Workers*

This Paper

- **Question:** How do workers keep up with inflation when there are frictions in adjustment of nominal wages?
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  - Develop a model with heterogeneous workers, frictional labor markets with many types of endogenous worker flows, wage rigidity, and endogenous wage markdowns to explore the effects of inflation on worker wages and utility.
  - Quantitatively, we show that the recent inflation episode had a modest effect on U.S. wage inequality; all worker types are *worse off* by roughly the same amount from temporary "inflation" shock. But permanent inflation has opposing effects on worker welfare that can dominate in either direction.

Model

Model Objectives

To investigate the distributional effects of inflation on job flows and wage growth, we formulate a search and matching framework with:

- Nominal wage rigidities:
  - Introduces a role for inflation to erode wages
  - Workers can increase their wages through EUE, EE, or infrequent renegotiations
- Heterogeneous outside options & hiring costs to study inflation's impact on:
  - incentives across the distribution
  - flows across the distribution
  - the distribution of wages and markdowns

Model Overview and Ingredients

- Time is continuous and is indexed by $t \geq 0$
- A unit measure of heterogeneous workers engage in directed search
- Employed workers produces with productivity Z
- Unemployed workers with prod. Z produce $B \times Z^{\phi_B}$
  - ϕ_B captures how home production scales with productivity
- Endogenous measure of homogeneous firms post vacancies at cost $K \times Z^{\phi_K}$
  - ϕ_K captures how hiring costs scales with productivity

- **Worker's State:** E_{it}: employed (h_{it}) or unemployed (u_{it})
- **Worker's Preferences:** $\mathbb{E}_0\left[\int_0^\infty e^{-\rho t}(C_{i,t} - \mathcal{C}(S_{i,t}, Z_{i,t}))dt\right]$ where

$$\mathcal{C}(S, Z) = \mu_E \frac{S^{1+\phi_S^{-1}}}{1+\phi_S^{-1}} Z$$

S_{it} = search activity of employed worker i in t

- **Worker's Productivity:** $Z_{i,t} = \exp(a_i + \hat{z}_{i,t})$
  - a_i is a permanent productivity drawn at birth
  - $\hat{z}_{i,t}$ captures idiosyncratic productivity shocks:

$$d\hat{z}_{i,t} = \begin{cases} \gamma_E dt + \sigma_E d\mathcal{W}_{i,t} \\ \gamma_U dt + \sigma_U d\mathcal{W}_{i,t} \end{cases}$$

Environment: Within Job Wage Adjustments

- **Employed worker's nominal income**: $W_{i,t}$
- **Inflation rate**: $d\ln(P_t) = \pi dt$ determined by the central bank
- **Employed worker's (log) real income**: $w_{i,t} = \ln(W_{i,t}/P_t)$
- **Fixed nominal wages**: $\implies$ real wages depreciate with inflation: $dw_{i,t} = -\pi dt$
- Renegotiation opportunities arrive at Calvo rates $\beta^{\pm}$ where $(\beta^{+} \neq \beta^{-})$
  - New wage is determined with Nash bargaining with weight ω for worker

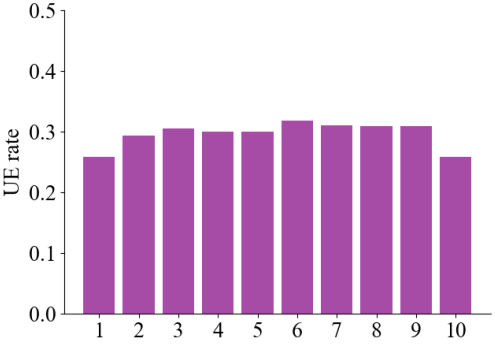
- **Firms post vacancies $\mathcal{V}$** at cost $K \times Z^{\phi_K}$
  - **Free entry:** $K \times Z^{\phi_K}$ = firm's expected value of finding a worker
- **Markets:** Indexed by $(z; w)$, where w is real wage and $z \equiv \ln(Z)$ is log-productivity.
- **Matching function:** $m(\mathcal{V}, \mathcal{S}) = \mathcal{S}^{\alpha}\mathcal{V}^{1-\alpha}$, $\alpha \in (0, 1)$
  - Average search intensity: $\mathcal{S} = \int_0^1 S_i(z; w)di$
  - Market tightness: $\theta(z; w) = \mathcal{V}(w, z)/\mathcal{S}(w, z)$
  - Worker's matching rate: $S_i f(\theta(z; w)) = S_i \theta(z; w)^{1-\alpha}$
  - Firm's matching rate: $q(\theta(z; w)) = \theta(z; w)^{-\alpha}$

Environment: Job-Separations

- Matches are **exogenously dissolved** at Poisson rates
  - $\delta(z)$: exogenous separations rate by z
  - χ: death rate
- Matches are **endogenously dissolved** either by firm (layoff) or worker (quit)
- **Match duration**: Time until first occurrence of any of these events

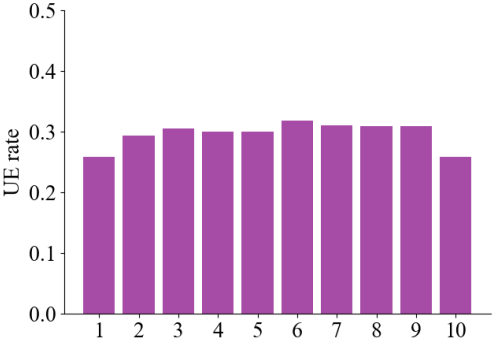
How the Model Works: Role of Heterogeneity

Job Finding Rate of Unemployed Across Models



(a) CPS Data 2016-2019

Job Finding Rate of Unemployed Across Models



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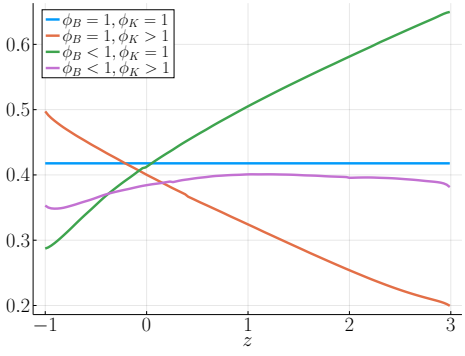
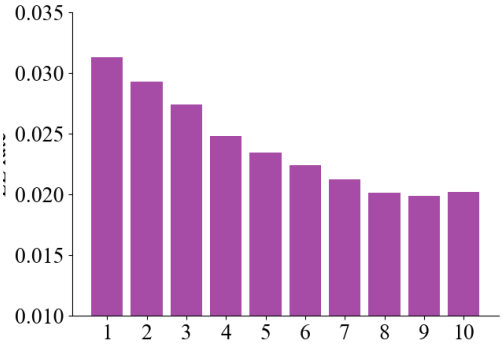


(b) Model Predictions

Data suggests we are either in $\phi_B = \phi_K = 1$ or (more generally) $\phi_B < 1, \phi_K > 1$

Job Finding Rate of Median Employed Worker Across Models



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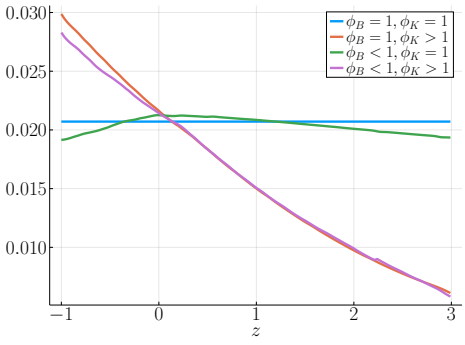
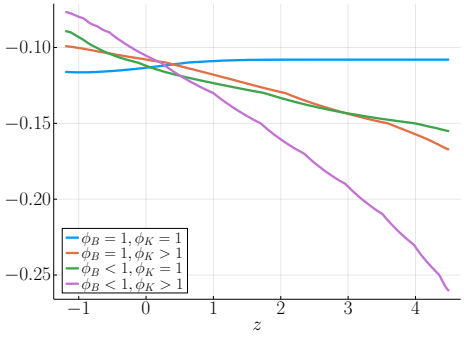


(b) Model Predictions

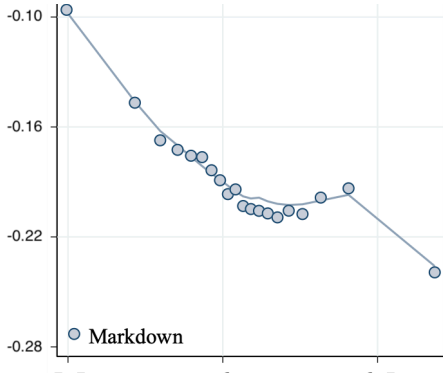
Data again suggests we are in the region where $\phi_K > 1$

Calibration; Key Parameters

Parameter	Description	Value
$\bar{\Pi}$	Trend inflation	0.02/year
γ_e	Drift id. prod. — employed	0.0024/year
γ_u	Drift id. prod. — unemployed	-0.036/year
$\delta(z)$	Ex. separation rate profile	varies with z
β^+	Probability of positive Δw	0.2/month
β^-	Probability of negative Δw	0.01/month
ϕ_K	Scaling factor vacancy cost wrt z	1.4
ϕ_B	Scaling factor income during unemployment wrt z	0.9



(a) Starting Markdown of the Unemployed

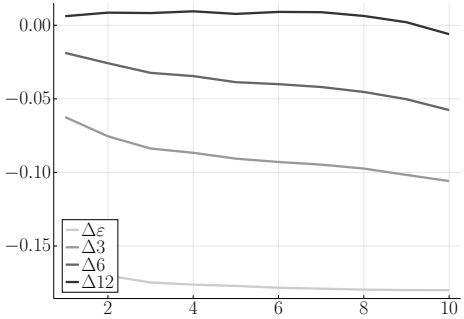


(b) Data, Denmark from Chan et al (2023)

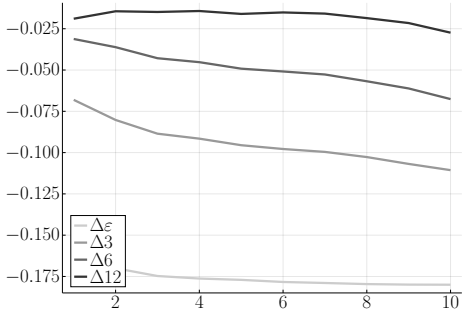
Data again suggests we are in the region where $\phi_K > 1$ and/or $\phi_B < 1$

High and Transitory Inflation:

The experiment is an unexpected one-time increase in the price level of 18% today

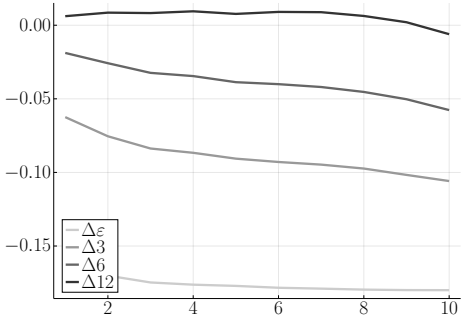


(a) Changes in (Log) Real Income



(b) Changes in Markdowns

1. *On impact, wages of all types fall by about 18% (panel (a).... $\Delta\epsilon$ line)*



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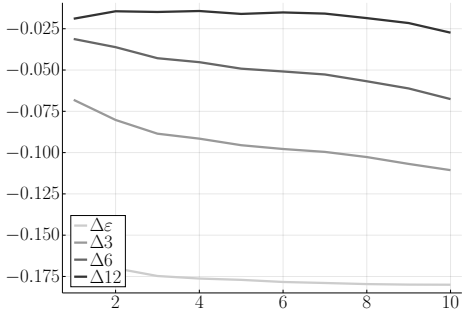
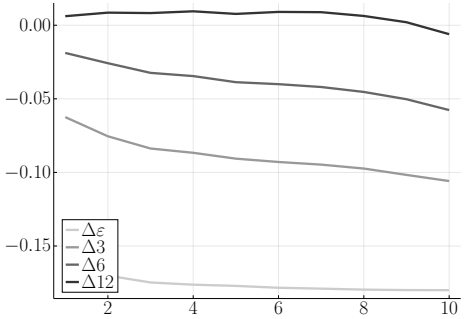


(b) Changes in Markdowns

2. *Over time, wages recover, but do so faster for those at the bottom of the distribution*



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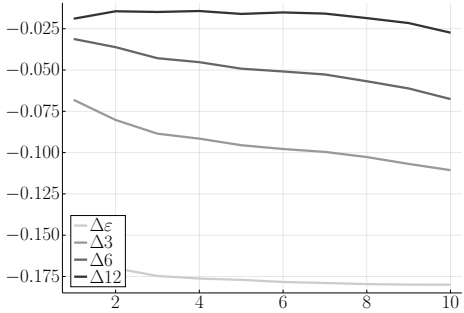
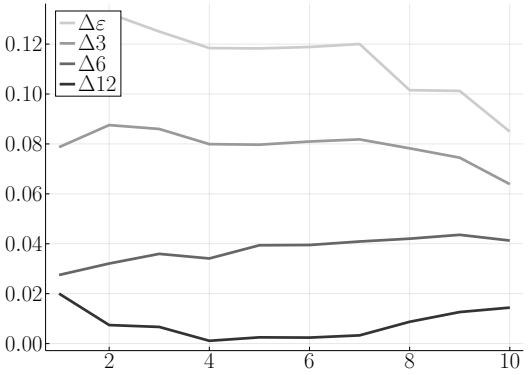


(b) Changes in Markdowns

3. *Markdowns still low about a year later (panel (b)....Δ12 line), recover fully in about 18 months*

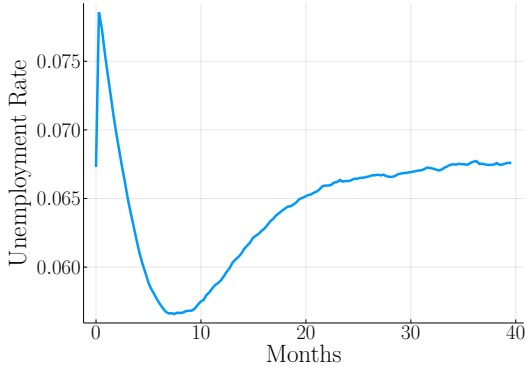
Search Effort



Percetange Changes in Search Effort

- *Search effort increases most (early on) for those with lower productivity*

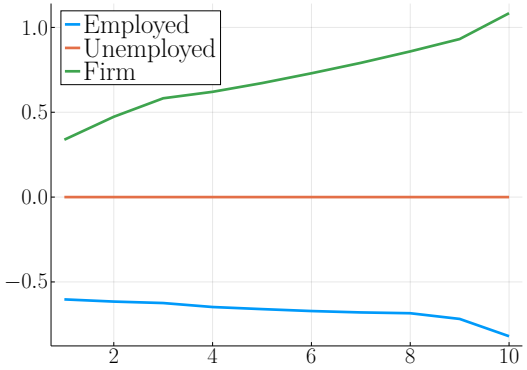
Unemployment Rate



Unemployment Rate

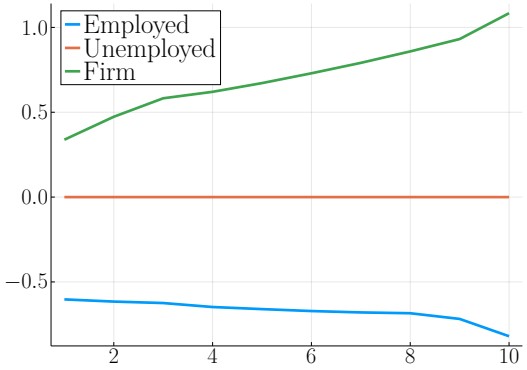
- *Unemployment rate temporarily falls with temporary price increase - churn increases but layoffs decrease*

Changes in Values (Monthly Consumption Equivalent)



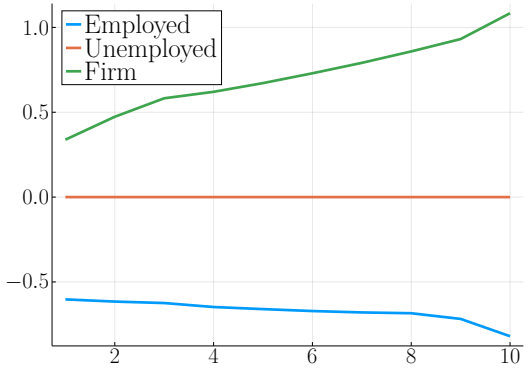
1. ***Key Figure***: *Inflation unambiguously lowers welfare for all workers (blue line) - workers hate temporary bursts of inflation!*

Changes in Values (Monthly Consumption Equivalent)



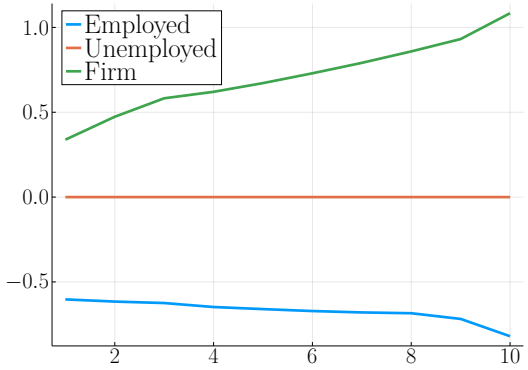
2. *Increased search is costly to workers (needed to get real wages to catch up with inflation)*

Changes in Values (Monthly Consumption Equivalent)



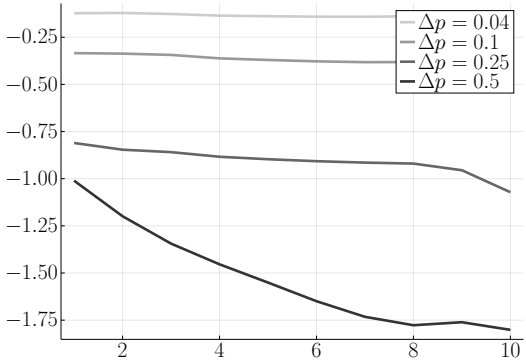
3. *Welfare losses largest for high productivity workers*

Changes in Values (Monthly Consumption Equivalent)



4. *All else equal, temporary inflation makes firms better off (green line), particularly those higher high productivity workers*

Changes in Values of Employed Workers, Different Size Price Increases



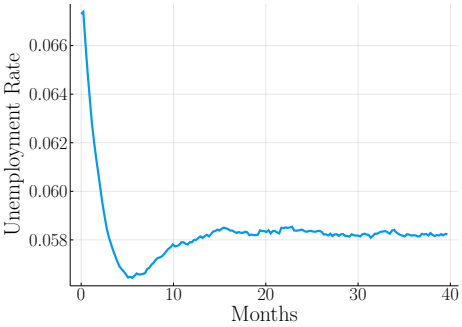
Changes in Values for Different Inflation Rates

- *Higher bursts of temporary inflation makes all workers monotonically worse off (particularly at the top)*

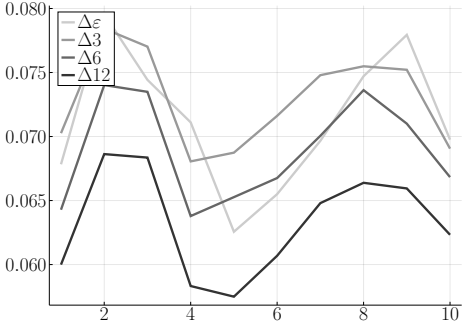
High and Permanent Inflation:

The experiment is an unexpected permanent increase in the inflation rate to 18% going forward

Unemployment Rate and Search Effort



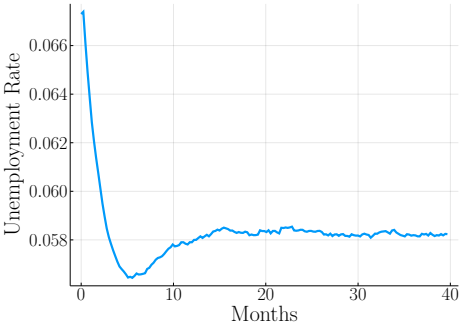
(a) Unemployment Rate, Over Time



(b) Changes in Search Effort, By Productivity

1. ***Key Take-Away***: *Permanent increase in inflation leads to a permanent decline in unemployment; money is not neutral in long-run (panel (a))*

Unemployment Rate and Search Effort



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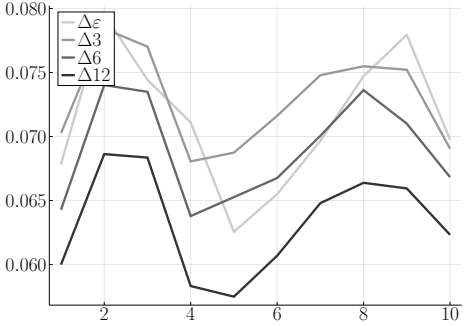
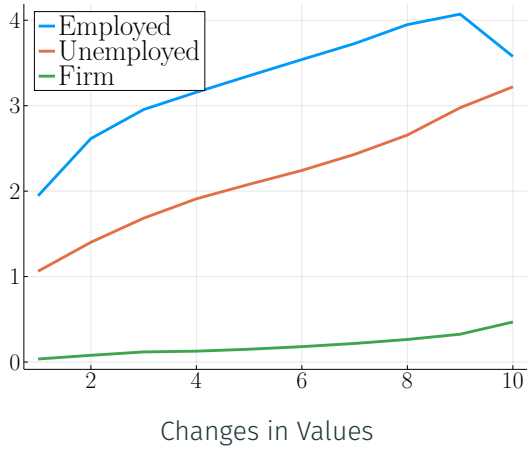


(b) Changes in Search Effort, By Productivity

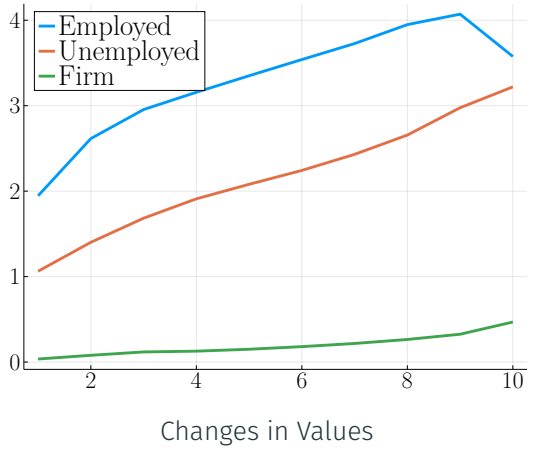
2. *Job-finding rate increases for all workers – due to increased search effort – making the duration of unemployment spells shorter (panel (b))*

Changes in Values (Monthly Consumption Equivalent)



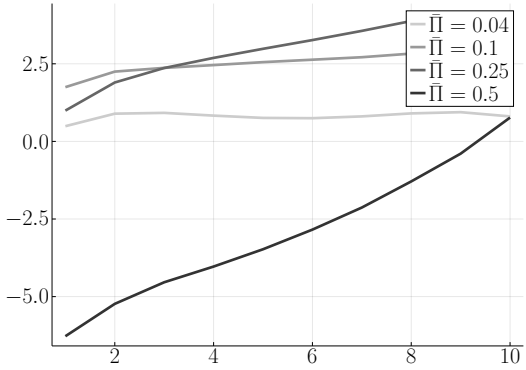
- ***Key Take-Away***: *Higher permanent inflation has positive welfare effects on all workers; increases worker productivity by reducing time in unemployment*

Changes in Values (Monthly Consumption Equivalent)



- *Welfare gains are higher for high productivity workers*

Changes in Values (Monthly Consumption Equivalent)



Changes in Values for Different Inflation Rates

- ***Key Take-Away***: *But these gains are non-monotonic and are overturned by the lower average wages and shortened duration of matches*

Conclusion

- **Main Contribution**: Develop a framework to assess the effects of inflation on worker well-being in a modern macro model of the labor market.
- Inflation does affect labor market flows; additional search behavior makes workers worse off.
- Temporary bursts of inflation make all workers worse off
- Permanent changes in inflation can have long run productivity effects by reducing the time workers spend in unemployment.
- Even in a model with rich worker heterogeneity, both permanent and temporary changes in inflation have essentially no effect on wage inequality.

$$(\rho+\chi)U(z,t) = \underbrace{e^{\phi_B z}B}_{\text{flow benefit}} + \underbrace{\max_{s^*,w^*}\{s^* f(\theta_t(z,w^*))\left(H(w^*,z,t)-U(z,t)\right) - \mu_u \frac{{s^*}^{1+\phi_S^{-1}}}{1+\phi_S^{-1}} e^z\}}_{\text{gains from finding a job}} + \underbrace{U_t(z,t)+\gamma_u U_z(z,t)+\frac{\sigma_u^2}{2}U_{zz}(z,t)}_{\text{differential value from time and productivity changes}}$$

- $w_u^*(z)$ and $s_u^*(z)$ are the optimal wage and search effort for the unemployed worker with productivity z

Value Functions: Employed Worker

$$\rho H(w,z,t) = \max\Big\{ \underbrace{\rho U(z,t)}_{\text{outside option}} \;,\; \underbrace{e^w}_{\text{flow wage}}$$

$$- \underbrace{\delta(H(w,z,t) - U(z,t))}_{\text{losses from exog. separation}} - \underbrace{\chi H(w,z,t)}_{\text{losses from exog. death}} - \underbrace{H_w(w,z,t)\pi_t}_{\text{losses from inflation}}$$

$$+ \underbrace{\beta^+ \Delta^+ H(w,z,t) + \beta^- \Delta^- H(w,z,t)}_{\text{gains or losses from wage increases or decreases}}$$

$$+ \underbrace{\max_{s^*, w^*} \left\{ s^* f(\theta_t(z,w^*)) \left(H(w^*,z,t) - H(w,z,t)\right) - \mu_h \frac{s^{*\,1+\phi_S^{-1}}}{1+\phi_S^{-1}} e^z \right\}}_{\text{gains from on-the-job search}}$$

$$+ \underbrace{H_t(w,z,t) + \gamma_e H_z(w,z,t) + \frac{\sigma_e^2}{2} H_{zz}(w,z,t)}_{\text{differential value from time and productivity changes}} \Big\}$$

$$\rho V(w,z,t) = \underbrace{-e^{\phi_K z}K}_{\text{vacancy cost}} + \underbrace{q(\theta_t(w_{jj}^*(w,z),z))(J(w_{jj}^*(w,z),z,t) - V(w,z,t))}_{\text{expected gains from being matched}}, \forall(w,z)$$

- Free entry condition: $V(w,z) = 0, \quad \forall(w,z) \implies$ Unmatched firms are indifferent across markets

$$\rho J(w,z,t) = \max\Big\{ \underbrace{\rho V(w,z,t)}_{\text{outside option (=0)}} , \underbrace{e^z - e^w}_{\text{flow profit}} \underbrace{- J_w(w,z,t)\pi_t}_{\text{gains from wage erosion}}$$

$$\underbrace{- \Big(\delta + \chi + s_e(w^*(w,z),z) f(\theta_t(w^*_{jj}(w,z)),z)\Big)\big(J(w,z,t) - V(w,z,t)\big)}_{\text{losses from separation}}$$

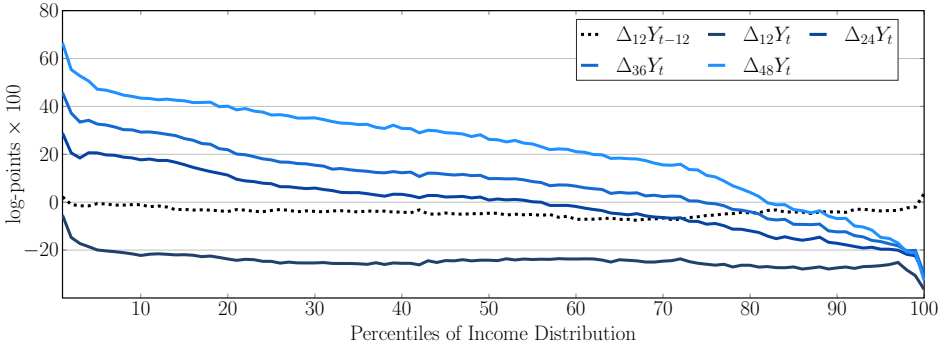
$$+ \underbrace{\beta^+ \Delta^+ J(w,z,t) + \beta^- \Delta^- J(w,z,t)}_{\text{change in value from wages increases or decreases}}$$

$$\underbrace{+ J_t(w,z,t) + \gamma_e J_z(w,z,t) + \frac{\sigma_e^2}{2} J_{zz}(w,z,t)}_{\text{differential value from wage and prod. changes}} \Big\}$$

where

$$\Delta^+ J(w,z,t) = J(\max\{w^*_b(w,z), w\}, z, t) - J(w,z,t)$$
$$\Delta^- J(w,z,t) = J(\min\{w^*_b(w,z), w\}, z, t) - J(w,z,t)$$

2002 Argentina Inflation Coincided with Higher Wage Growth at the Bottom



- *Wage growth after Argentina's 2002 devaluation, per income percentile.*
- Source: Blanco, Drenik, Zaratiegui (2024)

"Calibration"

Parameter	Description	Value
ρ	Discount factor	0.06/12.0
α	Elasticity matching function	0.5
$\bar{\Pi}$	Trend inflation	0.02/12.0
ω	Worker's bargaining power	0.5
χ	Death rate	1.0/(30.0*12.0)
$\tilde{K}$	Vacancy cost	1.6
$\tilde{B}$	Income during unemployment	1.5
μ_{z_0}	Mean initial productivity	0.0
σ_{z_0}	Std. initial productivity	0.17
γ_e	Drift id. prod. — employed	0.024/12
σ_e	Std. id. prod. — employed	0.037
γ_u	Drift id. prod. — unemployed	-0.036/12
σ_u	Std. id. prod. — unemployed	0.037
δ	Ex. separation rate	0.024
μ_e	Search cost scale — employed	1.2
μ_u	Search cost scale — unemployed	1.0
ϕ_K	Scaling factor vacancy cost wrt z	1.3
ϕ_B	Scaling factor income during unemployment wrt z	0.93
β^+	Probability of positive Δw	0.2
β^-	Probability of negative Δw	0.01

Appendix