The Distributional Effects of Inflation on the Labor Market

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Evolving...

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- How does all this work in a micro-founded model? Are low-wage workers actually made better off from inflationary periods?

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- Model shows that the effect of inflation on inequality has multiple effects, some of which go in opposite directions.
- Quantitatively, we show that the recent inflation episode had little effect on U.S. wage inequality; show all worker types are *worse off* by roughly the same amount from temporary "inflation" shock.

Literature

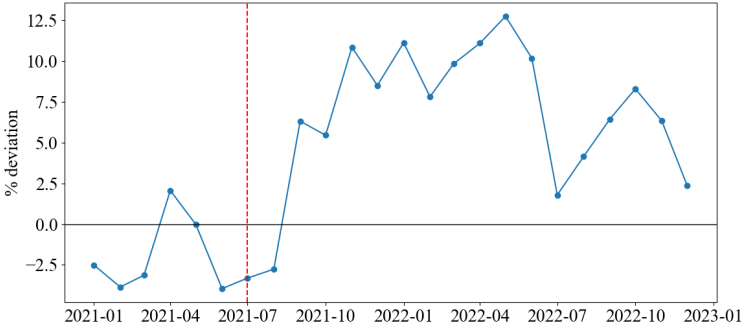
- Evidence on the effects of inflation on the labor market
  Blanco, Drenik, Zaratiegui (2024), Autor, Dube and McGrew (2023), Pilossoph and Ryngaert (2023)

- Yet, households dislike inflation, especially for its effect on their labor income
  Shiller (1997), Stancheva (2024), Afrouzi, Dietrich, Myrseth, Priftis, and Schoenle (2024)

- Matching models of labor market with inflation and/or search heterogeneity
  Barro (1977); Erceg, Henderson and Levin (2000); Christiano, Eichenbaum and Evans (2005); Hall (2005); Shimer (2005); Gertler and Trigari (2009); Menzio and Shi (2009); Rogerson and Shimer (2011); Schmitt-Grohé and Uribe (2016, 2023), Hurst, Kehoe, Pastorino, and Winberry (2023), *Blanco and Drenik (2023), Blanco, Drenik, Moser, and Zaratiegui (2024)*

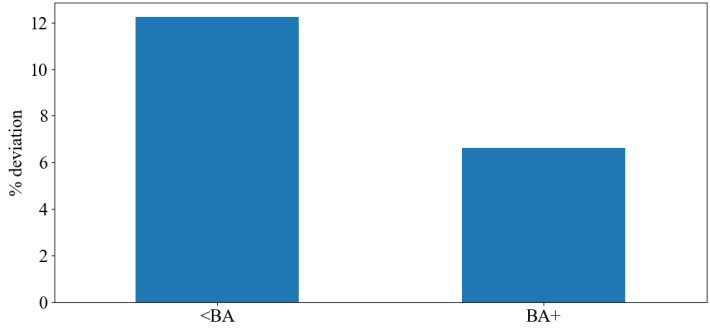
Motivating Facts Part 1:
Inflation and Labor Market Churn

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

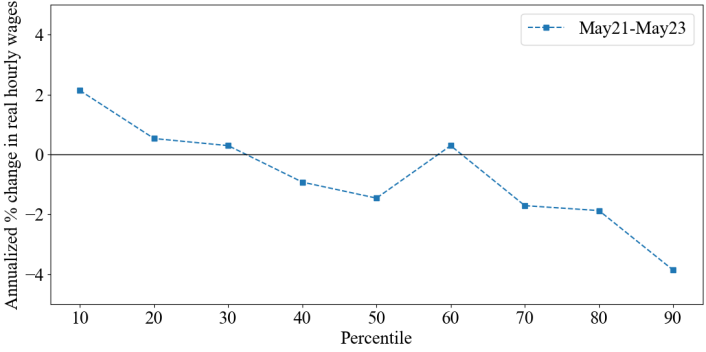
… And More So at the Bottom



- *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))

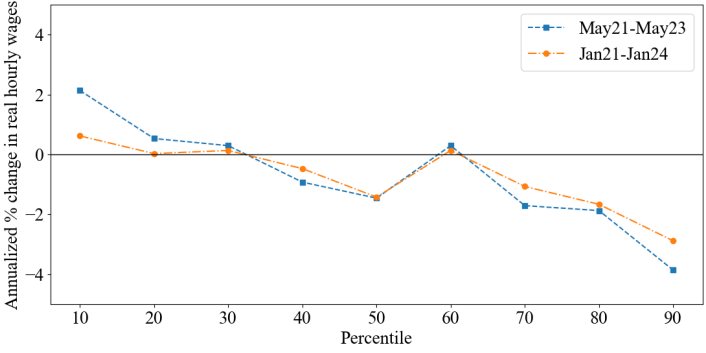
Motivating Facts Part 2:
Inflation and Wage Inequality

Recent Inflation: Higher Wage Growth at Bottom of Distribution



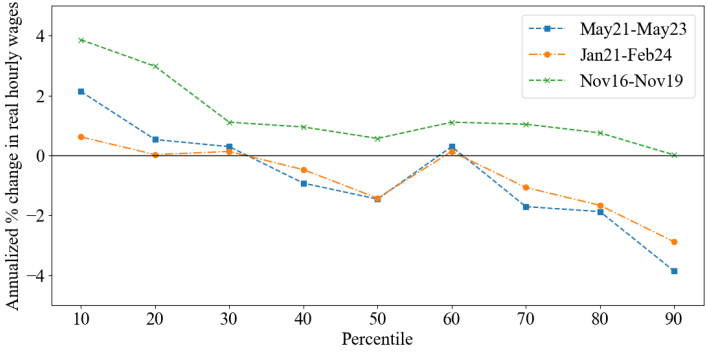
- *Wage growth between 5/21 and 5/23 higher for low wage workers (CPS data, Ages 25-54)*
- Replicates Autor, Dube, and McGrew (2023)

Recent Inflation: Higher Wage Growth at Bottom of Distribution



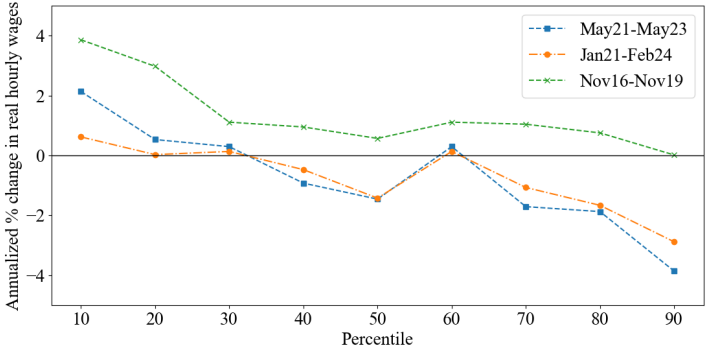
- *Patterns slightly muted when we extend Autor et al (2023) sample from from Jan 21-Jan 24*

Recent Inflation: Higher Wage Growth at Bottom of Distribution



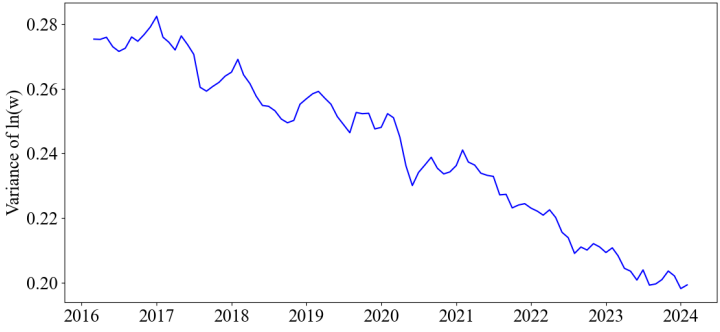
- *But note the pre-trends: Wages were growing faster at the bottom **before** the inflationary period (2017-2019)*

Recent Inflation: Higher Wage Growth at Bottom of Distribution



- *Similar patterns found in Argentina after the 2002 devaluation; see Blanco, Drenik, Zaratiegui (2024)*

Dispersion of Wage Growth Over Time



- *Inequality in US (as measured by variance of log wages) has been declining in the US since mid 2010s*
- *No noticeable break in trend during inflation period*

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

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

- **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
  - δ: exogenous separations rate
  - 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

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

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

Value Functions: Employed Worker

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

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

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

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

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

Value Functions: Unmatched Firms

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

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

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

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

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

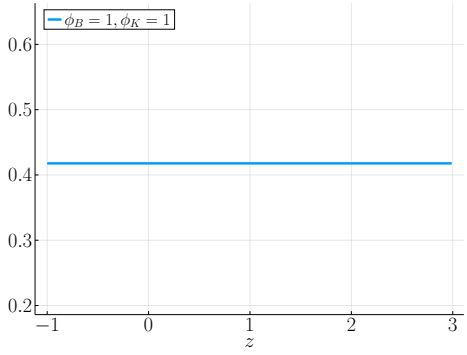
$$\underbrace{+ J_t(w,z,t) + \gamma_e J_z(w,z,t) + \frac{\sigma_e^2}{2} J_{zz}(w,z,t)}_{\text{differential value from wage and prod. changes}} \Big\}$$

where

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

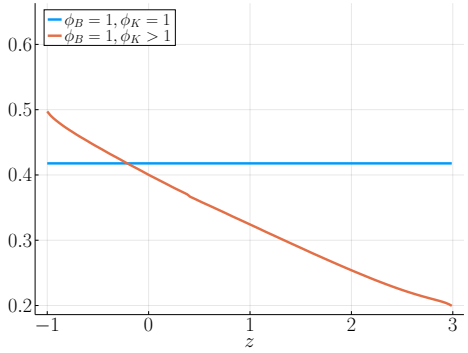
How the Model Works: Role of Heterogeneity

Job Finding Rate of Unemployed Across Models



(a) Model

Job Finding Rate of Unemployed Across Models



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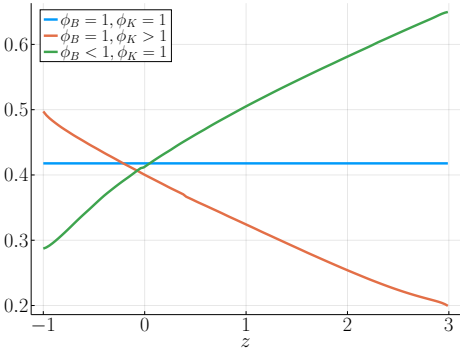

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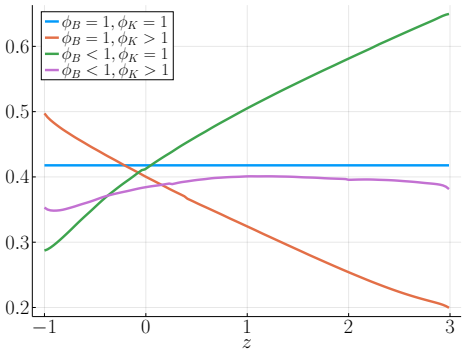

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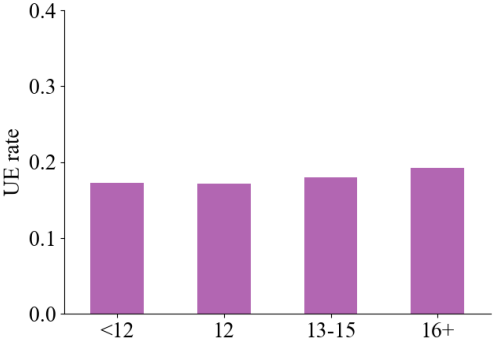
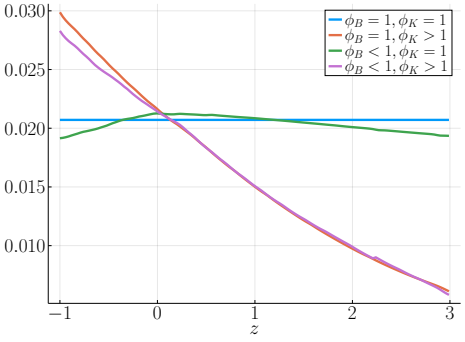


(b) CPS Data 2016-2019

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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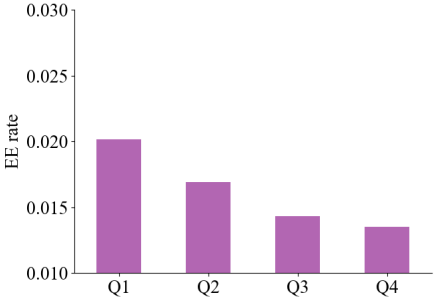
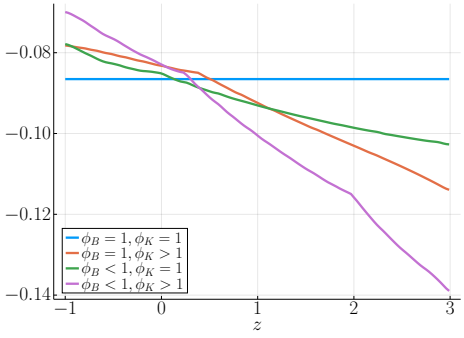
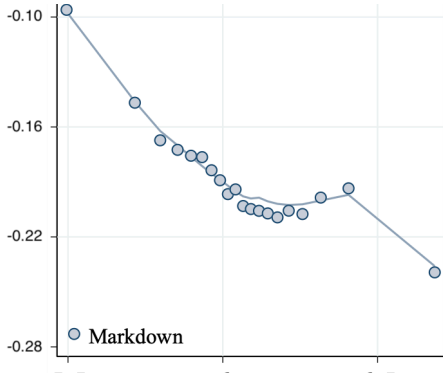


(b) CPS Data, 2016-2019

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



(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 $\phi_B < 1$

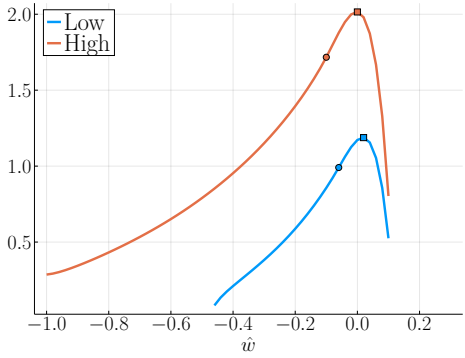
"Calibration"; Key Parameters

Parameter	Description	Value
$\bar{\Pi}$	Trend inflation	0.02/year
γ_e	Drift id. prod. — employed	0.024/year
γ_u	Drift id. prod. — unemployed	-0.036/year
δ	Ex. separation rate	0.024/month
β^+	Probability of positive Δw	0.2/month
β^-	Probability of negative Δw	0.01/month
ϕ_K	Scaling factor vacancy cost wrt z	1.3
ϕ_B	Scaling factor income during unemployment wrt z	0.93

Markdown Definition

- Define $\hat{w} = z - w$ (markdown)
- Explore how values evolve for workers with differing markdowns and levels of productivity

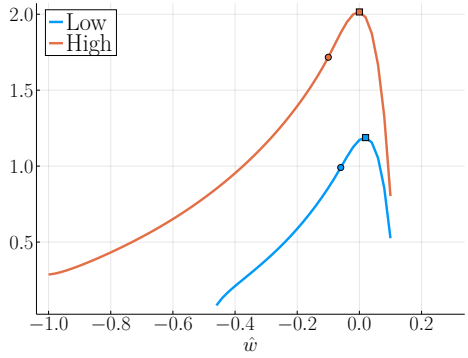
Values of Employed Worker and Firm: Low vs. High Productivity



Worker Values vs. Markdowns

1. *Worker value is higher with higher productivity but non-monotonic in markdown because of layoff risk*

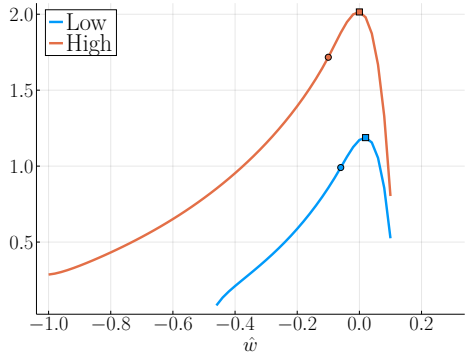
Values of Employed Worker and Firm: Low vs. High Productivity



Worker Values vs. Markdowns

2. *Workers enter at the circle and climb to the square; markdowns are roughly the same and zero at the top of the job ladder*

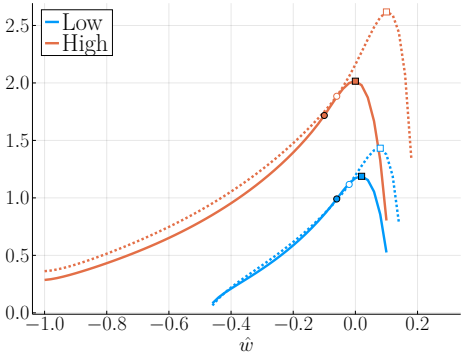
Values of Employed Worker and Firm: Low vs. High Productivity



Worker Values vs. Markdowns

3. *But more productive workers start from wages with **larger** markdowns because they dislike unemployment more and are harder to hire*

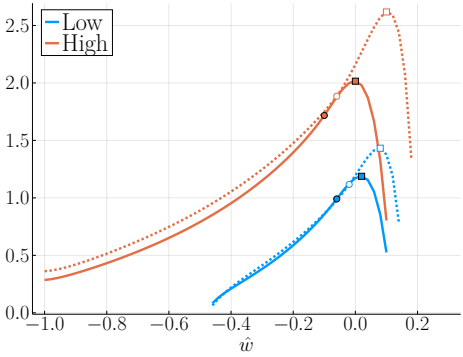
Values of Employed Worker and Firm: Low vs. High Productivity



Firm Values (Dashed = High Inflation)

4. *With higher inflation all workers' asking wages shift to the right; higher inflation erodes wages faster, so workers opt for higher starting wages*

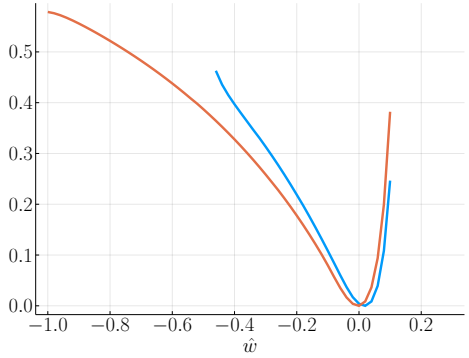
Values of Employed Worker and Firm: Low vs. High Productivity



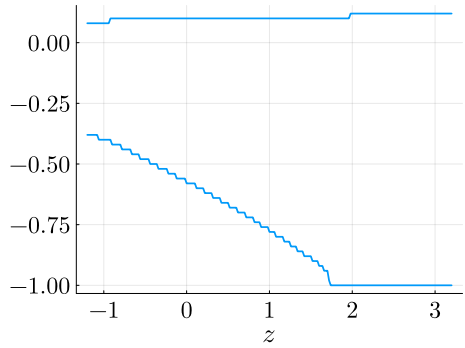
Firm Values (Dashed = High Inflation)

5. *Note that higher **permanent** inflation shifts worker values up and expands the ladder (and the layoff margin)*

Search Effort and Continuation Regions

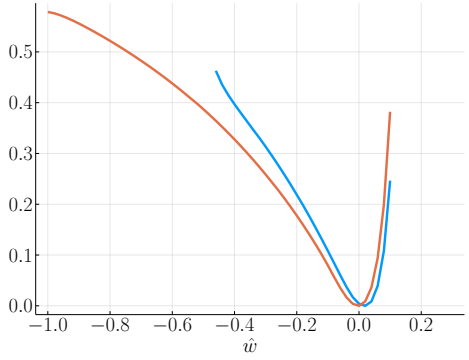


(a) Search Effort



(b) Continuation Regions

Left: *Workers do not search at the top of their job ladder*



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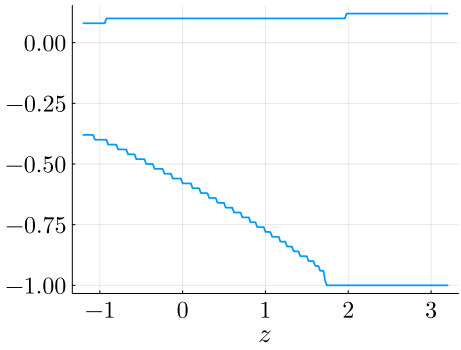
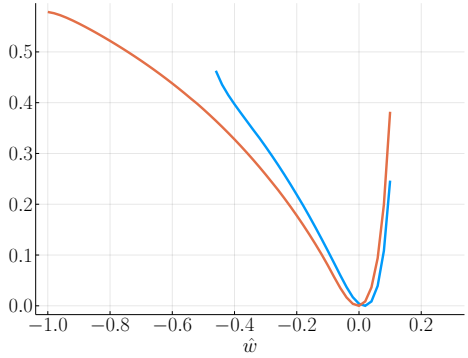


(b) Continuation Regions

Left: *But their search effort increases when their wages deviate from this maximum value*

Search Effort and Continuation Regions



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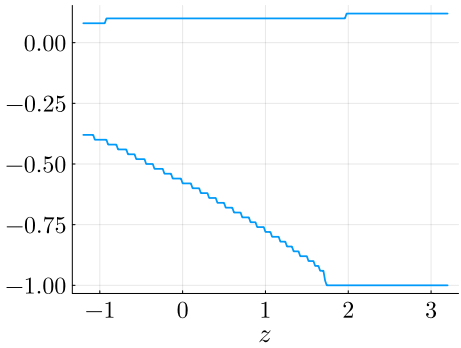
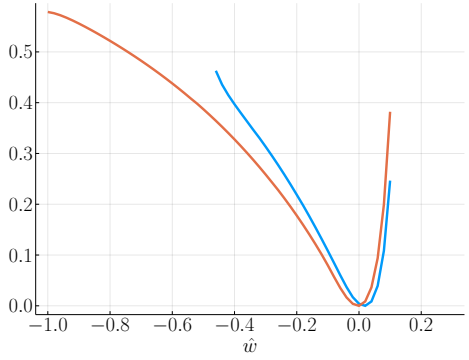
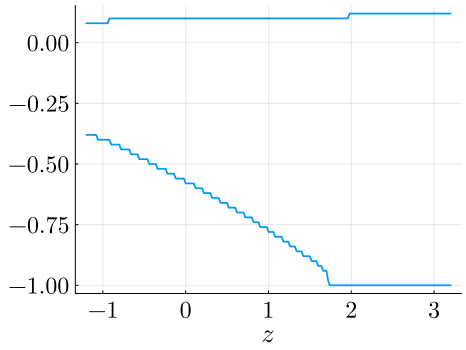


(b) Continuation Regions

Left: *When wages are lower, they seek higher wages*

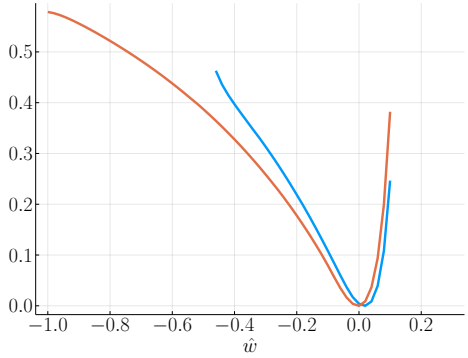


(a) Search Effort

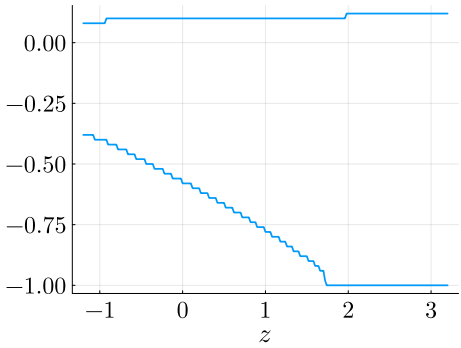


(b) Continuation Regions

Left: *When wages are higher, they seek new jobs because they are likely to be laid off*



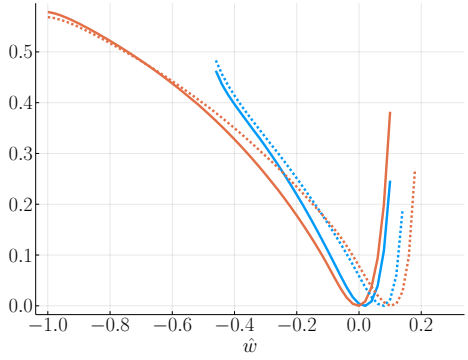
(a) Search Effort



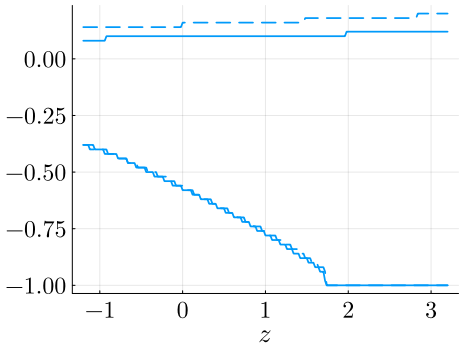
(b) Continuation Regions

Right: *Lower productivity workers have smaller continuation regions because they are closer to their outside option* ***and*** *seek jobs in tighter markets*

Search Effort and Continuation Regions



(a) Search Effort



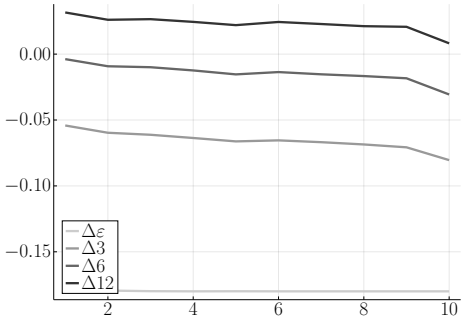
(b) Continuation Regions

Left: *Higher inflation shifts search effort towards higher wages*

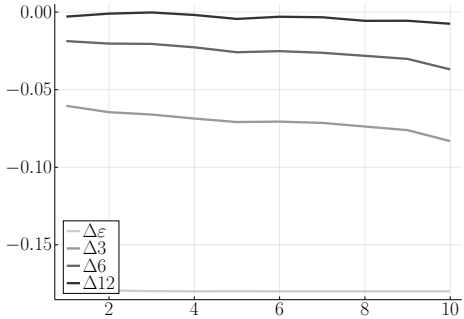
Right: *Higher inflation* ***relaxes*** *the layoff margin*

High and Transitory Inflation:

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

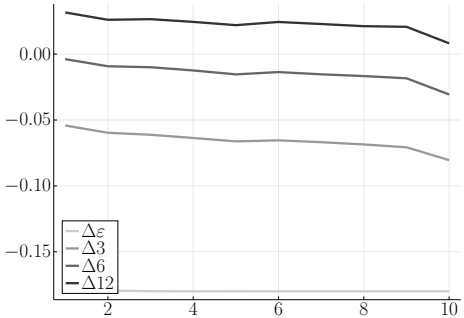


(a) Changes in (Log) Real Income

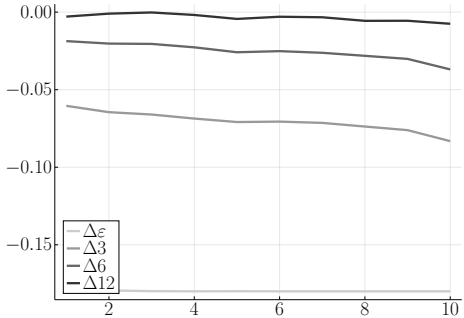


(b) Changes in Markdowns

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

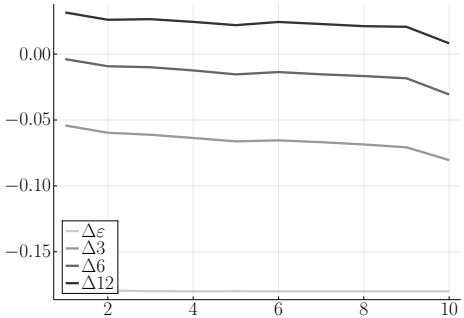


(a) Changes in (Log) Real Income

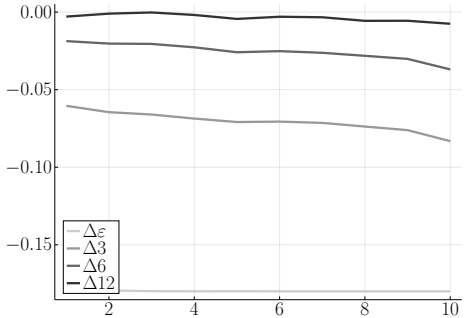


(b) Changes in Markdowns

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



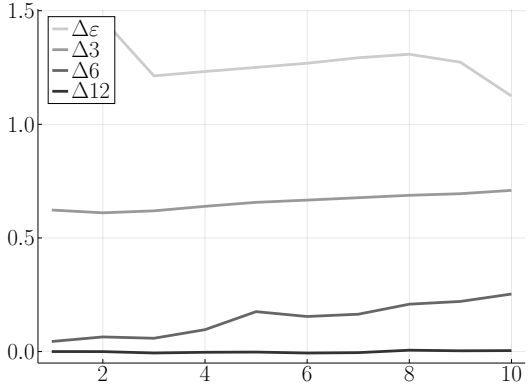
(a) Changes in (Log) Real Income



(b) Changes in Markdowns

3. *Markdowns recover within about a year (panel (b)....Δ12 line)*

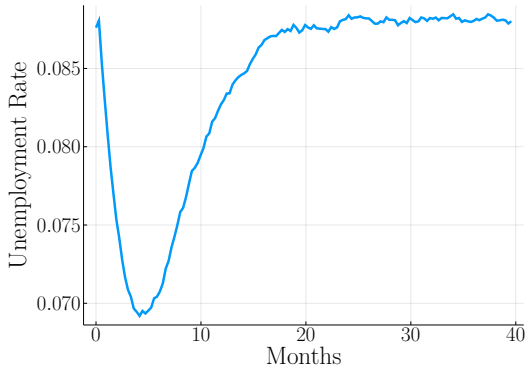
Search Effort



Percetange Changes in Search Effort

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

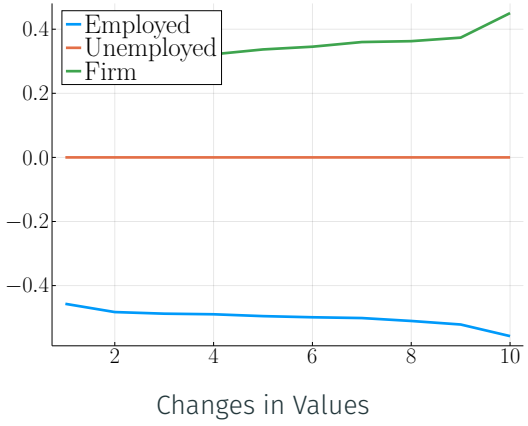
Unemployment Rate



Unemployment Rate

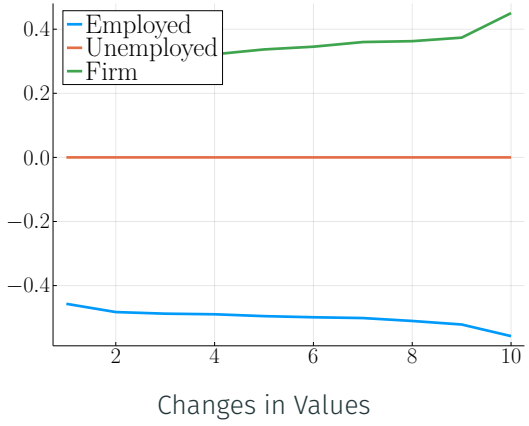
- *Unemployment rate temporarily falls with temporary price increase - churn increases but layoffs decrease*

Changes in Values (Monthly Consumption Equivalent)



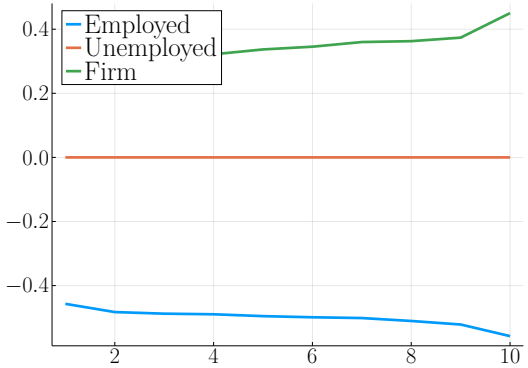
1. ***Key Figure**: Inflation unambiguously lowers welfare for all workers (blue line) - workers hate temporary bursts of inflation!*

Changes in Values (Monthly Consumption Equivalent)



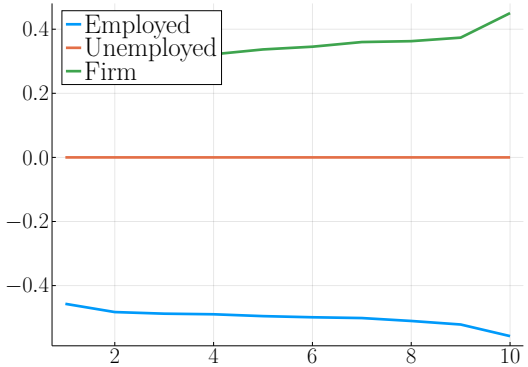
2. *Increased search is costly to workers (needed to get real wages to catch up with inflation*

Changes in Values (Monthly Consumption Equivalent)



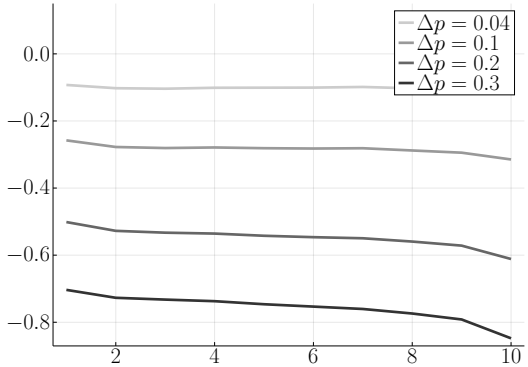
3. *Welfare losses slighltly less for low productivity workers*

Changes in Values (Monthly Consumption Equivalent)



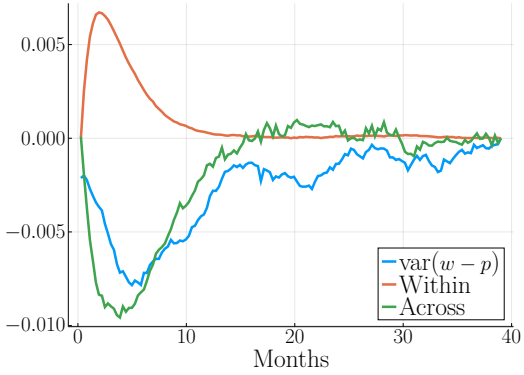
4. *All else equal, temporary inflation makes firms better off (green line)*

Changes in Values of Employed Workers, Different Size Price Increases



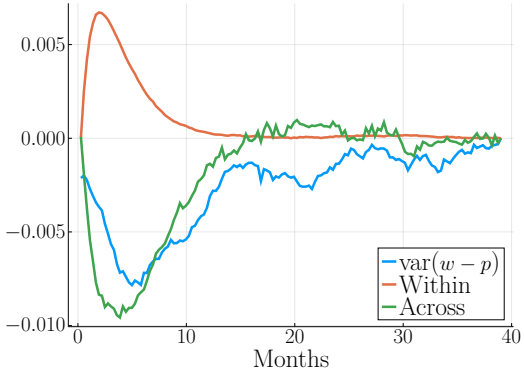
Changes in Values for Different Inflation Rates

- *Higher bursts of temporary inflation makes all workers worse off - workers hate inflation more when the temporary burst of inflation is larger*



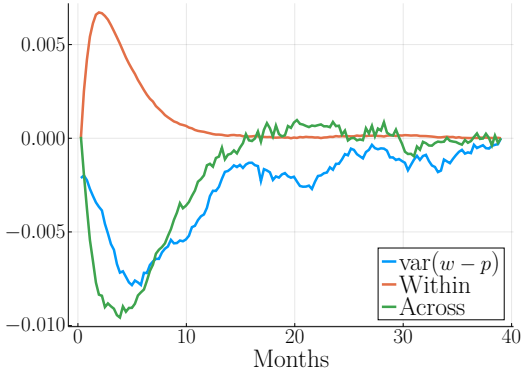
Wage Inequality

1. *Large temporary increase in price level (18%) has only a very small temporary effect on inequality*



Wage Inequality

2. *Increase in within group inequality partially offsets temporary decline in cross-group inequality*



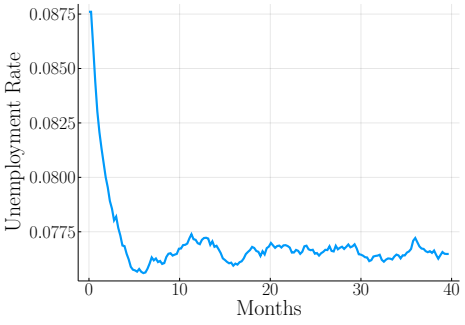
Wage Inequality

3. ***Take-Away***: *Large temporary inflation is not something that meaningful effects inequality; makes all workers worse off by roughly the same amount*

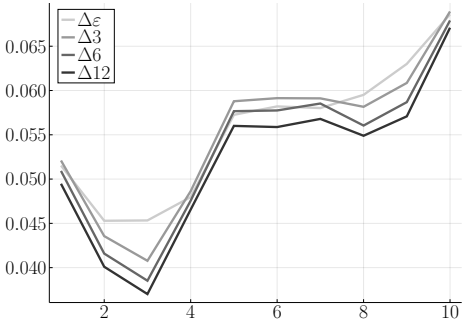
High and Permanent Inflation:

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

Unemployment Rate and Search Effort

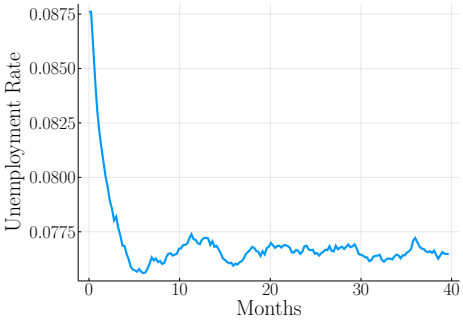


(a) Unemployment Rate, Over Time

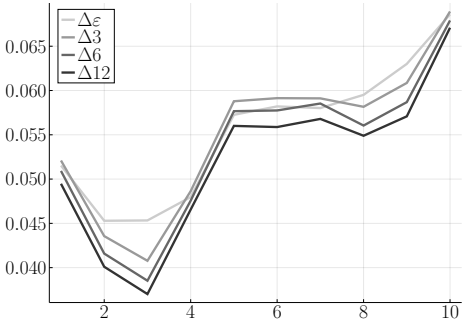


(b) Changes in Search Effort, By Productivity

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

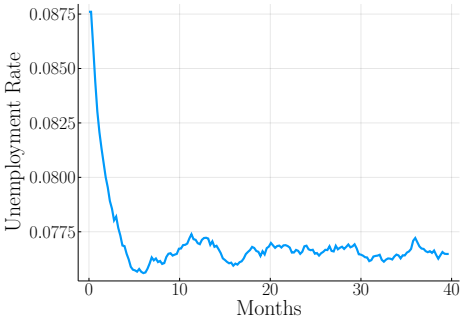


(a) Unemployment Rate, Over Time

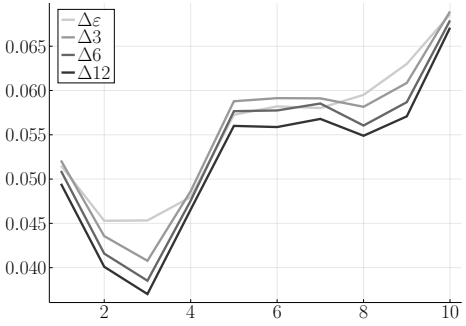


(b) Changes in Search Effort, By Productivity

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

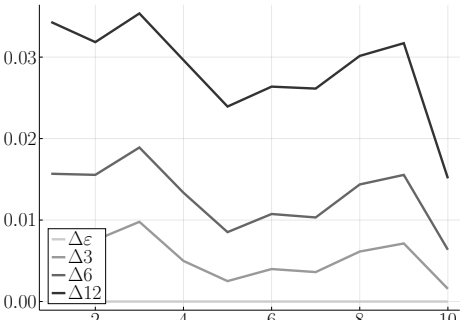


(a) Unemployment Rate, Over Time

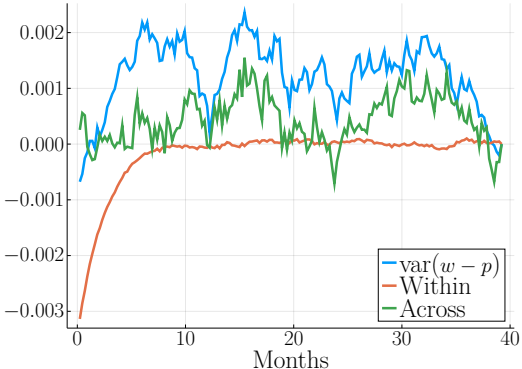


(b) Changes in Search Effort, By Productivity

3. *Search effort increases most for high productivity workers which will reduce their welfare (panel (b))*

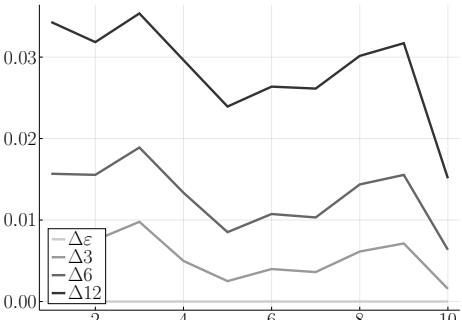


(a) Changes in (Log) Real Income

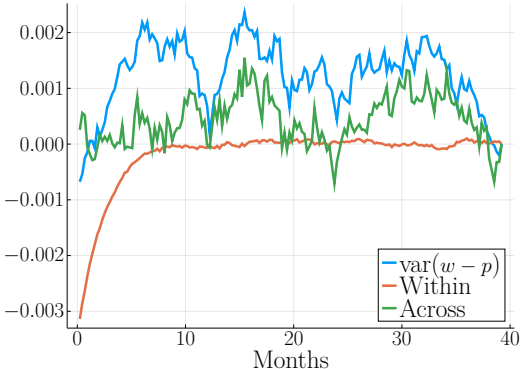


(b) Changes in Inequality Over Time

1. *Permanent increase in inflation has no effect on wages on impact, wage growth increases over time (panel (a), $\Delta\epsilon$ line)*

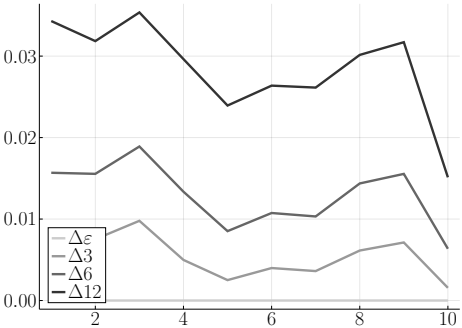


(a) Changes in (Log) Real Income

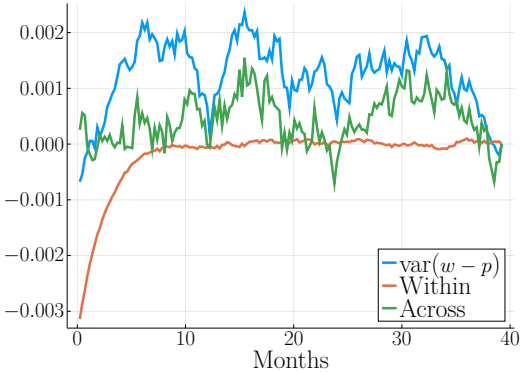


(b) Changes in Inequality Over Time

2. *Overtime, wages increase because productivity increases due to less time in unemployment (panel (a), Δ12 line)*

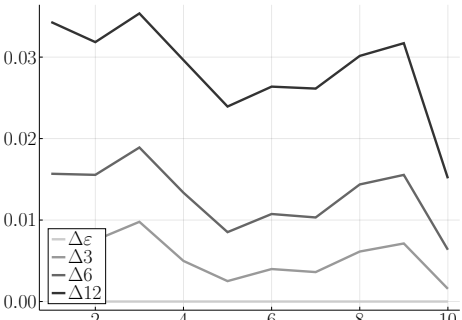


(a) Changes in (Log) Real Income

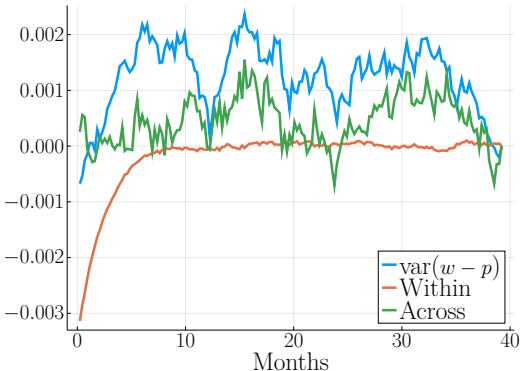


(b) Changes in Inequality Over Time

3. *After about a year, no substantive change in wage mark-downs for any type of worker (not shown on figure)*



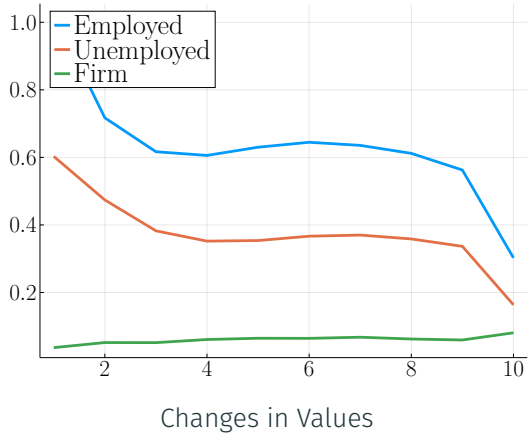
(a) Changes in (Log) Real Income



(b) Changes in Inequality Over Time

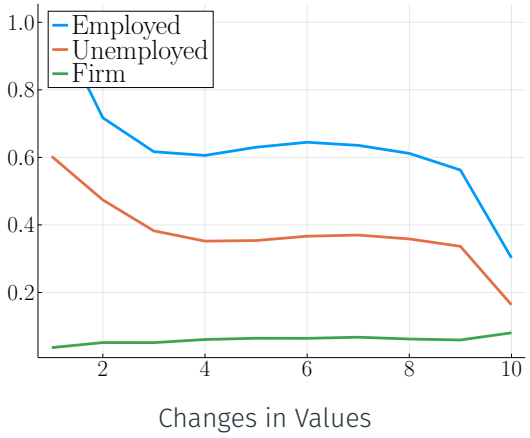
4. *Wage effects similar for all types of workers; therefore no substantive effect on income inequality (panel (b))*

Changes in Values (Monthly Consumption Equivalent)



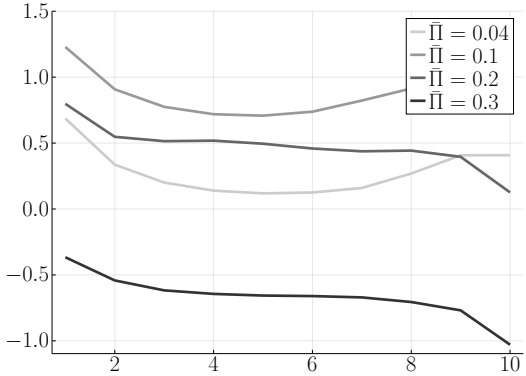
- ***Key Take-Away***: *Higher permanent inflation has positive welfare effects on all workers; increases worker productivity by reducing time in unemployment*

Changes in Values (Monthly Consumption Equivalent)



- *Welfare gains are higher for low productivity workers (more disutility from increased search 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*

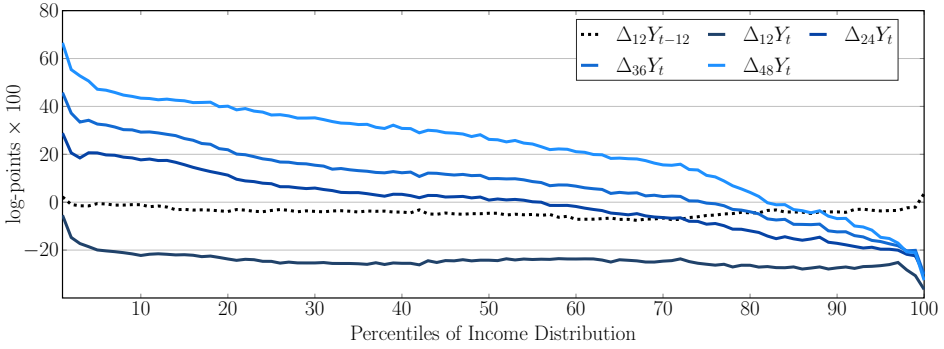
Future Work

- Precise calibration
- State-dependent renegotiation
  - But note that this would mitigate inflationary effects even more
- Monetary disturbances do not happen in vacuum
  - Think about joint effects of distributional shocks with a monetary response
  - e.g., supply shocks (both aggregate and distributional)
- Thinking about congestion externalities of one group on the other

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.

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