Impact of Inflation on Time Use of Individuals

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Introduction

Motivation

- The impact of inflation is far beyond the higher price levels, wages, purchasing power, etc.
- Inflation affects the value of time
- Rising prices change the relative value of market goods, home production, and leisure
- Understanding time allocation is key for interpreting how households experience inflation
- Home production has a major contribution to welfare but it is invisible in national accounts

Research Question

What is the impact of inflation on time allocation of individuals?

- The effect on market work hours
- The effect on home production hours
- The effect on leisure hours

Methodology

Research Question:
What is the impact of inflation on time allocation of individuals?

1) Empirical Method:

- A two-stage IV-Local Projection model
- A variation of the Phillips Curve as instrument

2) Theoretical Method:

- A DSGE model with home sector
- Inflationary shocks:
  - Demand-side: Government expenditure, Household preferences
  - Supply-side: TFP, Markup

Finding

1) **Empirical:**
   - Market work $\uparrow$
   - Home production $\downarrow$
   - Leisure $\downarrow$

2) **Theoretical:**
   - Different source of inflation generate different time-use responses
   - Demand-driven inflation: Market work $\uparrow$, Home production $\downarrow$, Leisure $\downarrow$
   - Supply-driven inflation: Market work $\downarrow$, Home production $\uparrow$, Leisure $\uparrow$

Related Literature and Contributions

Inflation and Labor Market

- Christiano et al. (2005, JPE): DSGE model with sticky wage/price: inflationary shocks $\rightarrow$ labor hours $\uparrow$
- Blanchard and Galí (2007, JMCB): NK model with wage rigidity: inflation $\rightarrow$ real wage $\downarrow$ $\rightarrow$ labor hours $\uparrow$
- Christiano et al. (2016, Econometrica): Monetary-driven inflation $\rightarrow$ labor hours $\uparrow$
- Pilossoph and Ryngaert (2024, NBER), Stantcheva (2024, BPEA), Afrouzi et al. (2024, NBER): post-covid inflation and time allocated to job search

Contribution: Economic effects of inflation on time allocation with home production

Related Literature and Contributions

Time Use in Macroeconomics

- Benhabib et al.(1991, JPE): Homework in RBC model
- Gnocchi et al.(2016, JME): Housework and fiscal expansions
- Cacciatore et al.(2024, RESTAT): The effect of economic uncertainty on time use

Contribution:

- (1) Extend a DSGE model with home sector
- (2) Develop a mechanism to rationalize the empirical findings

Empirical Analysis

Data: American Time Use Survey (ATUS)

- Conducted by BLS
- Asking how, where, and with whom they spend their time in the previous day from 4 AM to 4 AM of the interview day
- Interviewing approximately 252,000 individuals drawn from the existing CPS sample pool from 2003 to 2024
- Continuous data collection
- Downloaded directly from the BLS website and cleaned following Aguiar et al. (2013, AER)
- Mutually exclusive variables for market hours, home production hours, and leisure hours

Data: American Time Use Survey (ATUS)

Market work activities:

- Working
- Other income-generating activities
- Socializing, relaxing, and leisure as part of job
- Eating and drinking as part of job
- Travel related to work
- Travel related to work-related activities

Data: American Time Use Survey (ATUS)

Home production activities:

- Food and drink preparation
- Core housework tasks
- Home ownership activities
- Child care
- Lawn, garden, and houseplants
- Animals and pets care
- Car maintenance at home
- Travel related to home production

Data: American Time Use Survey (ATUS)

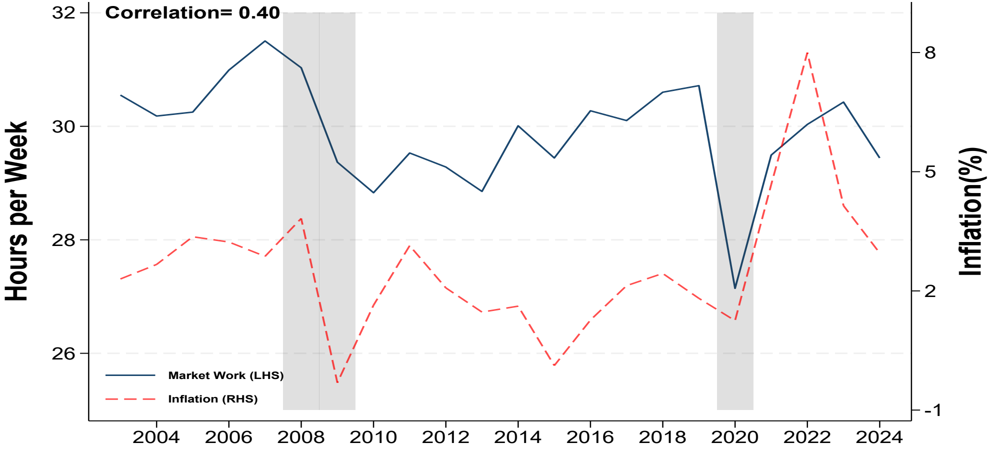
1 **Leisure activities**:

- Watching TV
- Socializing
- Sleeping
- Eating
- Personal care
- Sports, exercise, and recreation
- Reading
- Other leisure activities
- Travel related to leisure activities

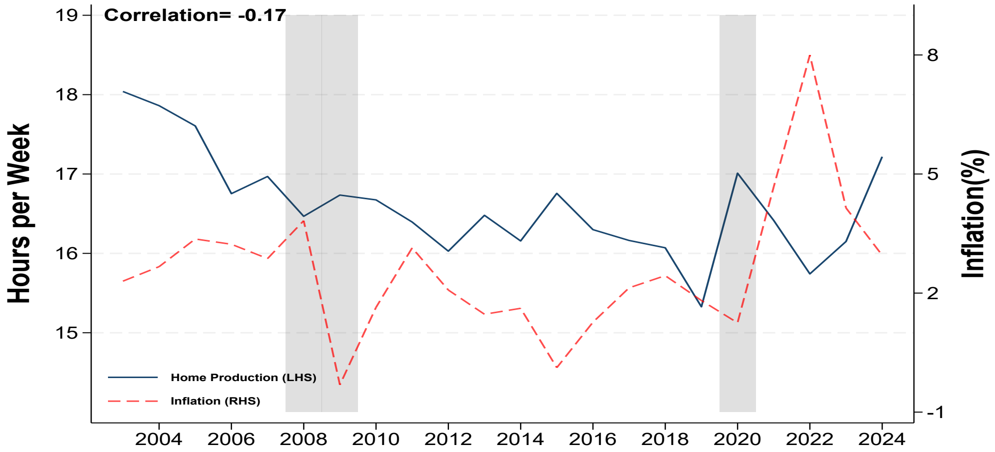
Data: Aggregated-level

- Survey of Professional Forecasters (SPF)
  - Federal Reserve Bank of Philadelphia collecting data since 1981(Q3)
  - Forecasters provide quarterly estimates for the next five quarters
  - Mean, median, 25 percentiles, and 75 percentiles level of CPI
- FRED, Federal Reserve Bank of St. Louis
  - Quarterly inflation calculated from the CPI
  - Real GDP
  - Potential GDP

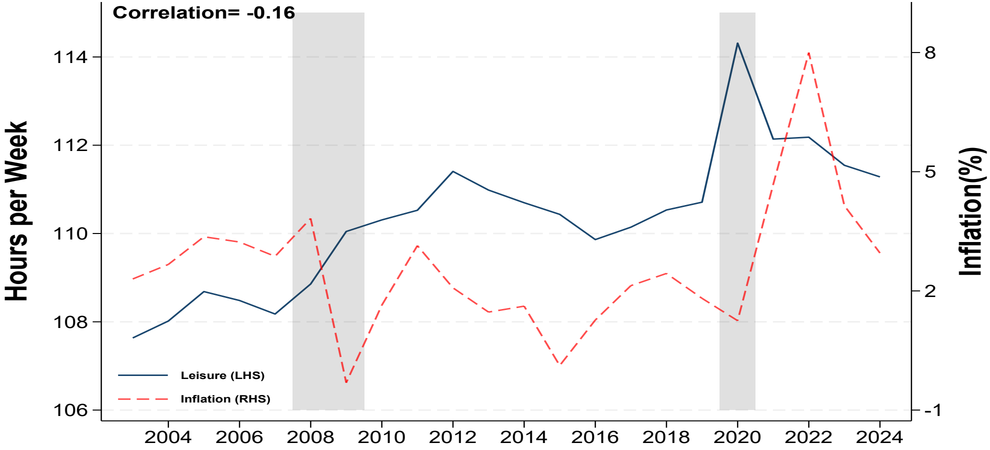
Market Work and Inflation



Home Production and Inflation



Leisure and Inflation



IV-Local Projection

2nd-Stage

$$H^j_{t+\kappa} - H^j_{t-1} = \delta_\kappa + \gamma_\kappa \widetilde{\pi}_t + \sum_{i=1}^{p} \phi_\pi \widetilde{\pi}_{t-i} + \sum_{i=1}^{p} \phi_{h^j} \Delta H^j_{t-i} + \varepsilon^j_t \tag{1}$$

- H^j_t: market hours (j=1), home production hours (j=2), and leisure hours (j=3)
- $\widetilde{\pi}_t$: estimated inflation from instrument
- $\widetilde{\pi}_{t-i}$: i-th lag of estimated inflation
- ΔH^j_t: first difference of allocated hours
- $\kappa = 0, 1, 2, ..., 12$: time horizon
- $p = 3$: number of lags
- Example: market = 40 hours, hp=20, leisure=108

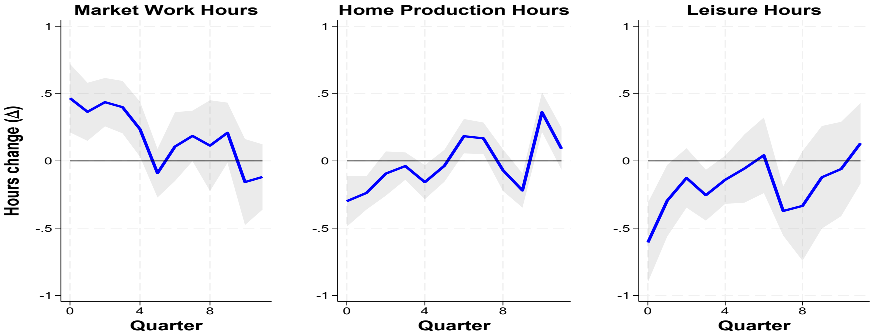
IV-LP

1st-Stage

$$\pi_t = \alpha + \sum_{i=1}^{p} \phi_i^{\pi} E_{t-i}\pi_{t+1} + \sum_{i=1}^{p} \phi_i^{Y} \Delta Y_{t-i} + \mu_t^{\pi} \tag{2}$$

- π_t: instrumented inflation
- $E_t\pi_{t+1}$: next period's inflation expectation
- ΔY_t: percentage deviation of real GDP from potential GDP
- μ_t^{π}: the residual term
- $p = 3$: number of lags

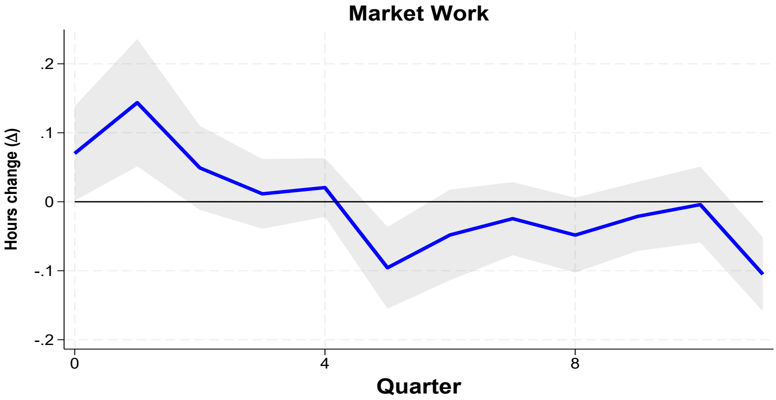
Baseline IRF Result



IRF to 1-standard-deviation shock in the inflation rate using the median of next-quarter inflation expectations (68% confidence interval) Theoretical results

Robustness Check

BLS data: The total number of hours worked over all jobs in the last week



IRF of market work to 1% increase in the inflation rate, using the median level of next-quarter inflation expectations. Data from 1989:Q1–2024:Q4. (68% confidence interval)

Theoretical Analysis

Households

0.8

$$Max \ E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[(C_t)^b (l_t)^{1-b}\right]^{1-\sigma} - 1}{1-\sigma}, \quad b \in (0,1), \quad \sigma \geq 1 \tag{3}$$

subject to:

$$E_t \left\{Q_{t,t+1} B_{t+1}\right\} + P_t \left(C_t^m + I_t\right) \leq B_t + W_t P_t h_t^m + r_t^k P_t k_t^m + T_t \tag{4}$$

$$C_t = \left[\alpha_1 (C_t^m)^{b_1} + (1-\alpha_1)(C_t^h)^{b_1}\right]^{\frac{1}{b_1}}, \quad \alpha_1 \in [0,1], \quad b_1 < 1 \tag{5}$$

$$C_t^h = (k_t^h)^{\alpha_2} (h_t^h)^{1-\alpha_2} \tag{6}$$

$$h_t = h_t^m + h_t^h, \quad l_t = 1 - h_t \tag{7}$$

$$I_t = k_{t+1} - (1-\delta) k_t + \frac{\xi}{2} \left(\frac{k_{t+1}}{k_t} - 1\right)^2, \quad k_t = k_t^m + k_t^h \tag{8}$$

Firms

$$\underset{\{P(t)_i\}}{Max} \ \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \theta^j Q_{t,t+j} \left[\underbrace{P_t(i) Y_{t+j}(i)}_{\text{revenue}} - \underbrace{P_{t+j} \Xi_{t+j} Y_{t+j}(i)}_{\text{cost}} \right] \right\} \tag{9}$$

subject to:

$$Y_t(i) = \left(k_t^m(i)\right)^{\alpha_3} \left(h_t^m(i)\right)^{1-\alpha_3}, \quad \alpha_3 \in [0, 1] \tag{10}$$

$$Y_t(i) = \left[\frac{P_t(i)}{P_t} \right]^{-\varepsilon_t} Y_t^d \tag{11}$$

Aggregation and Market Clearing

1

$$Y_t = \left[\int_0^1 \left(Y_t(i)\right)^{\frac{\varepsilon_t-1}{\varepsilon_t}} di\right]^{\frac{\varepsilon_t}{\varepsilon_t-1}}, \quad G_t = \left[\int_0^1 \left(G_t(i)\right)^{\frac{\varepsilon_t-1}{\varepsilon_t}} di\right]^{\frac{\varepsilon_t}{\varepsilon_t-1}} \tag{12}$$

$$c_t^m = \left[\int_0^1 \left(c_t^m(i)\right)^{\frac{\varepsilon_t-1}{\varepsilon_t}} di\right]^{\frac{\varepsilon_t}{\varepsilon_t-1}}, \quad I_t = \left[\int_0^1 \left(I_t(i)\right)^{\frac{\varepsilon_t-1}{\varepsilon_t}} di\right]^{\frac{\varepsilon_t}{\varepsilon_t-1}} \tag{13}$$

$$h_t^m = \int_0^1 h_t^m(i)di, \quad k_t^m = \int_0^1 k_t^m(i)di \tag{14}$$

$$Y_t = Y_t^d = c_t^m + I_t + G_t \tag{15}$$

$$(1+R_t) = (1+R_{t-1})^{\rho_m} \left(\beta^{-1}\Pi_t^{\Phi_\pi}\left(\frac{Y_t}{Y_t^n}\right)^{\Phi_y}\right)^{1-\rho_m} \tag{16}$$

Exogenous Shocks

$$\textit{Fiscal Multiplier}: \ \ln g_t = (1-\rho_g)\ln \bar{g} + \rho_g \ln g_{t-1} + \eta_t^g \tag{17}$$

$$\textit{Household Preference}: \ \ln \beta_t = (1-\rho_b)\ln \bar{\beta} + \rho_b \ln \beta_{t-1} + \eta_t^\beta \tag{18}$$

$$\textit{TFP}: \ \ln a_t = (1-\rho_a)\ln \bar{a} + \rho_a \ln a_{t-1} + \eta_t^a \tag{19}$$

$$\textit{Markup}: \ \ln \varepsilon_t = (1-\rho_\epsilon)\ln \bar{\varepsilon} + \rho_\epsilon \ln \varepsilon_{t-1} + \eta_t^\varepsilon \tag{20}$$

Calibration

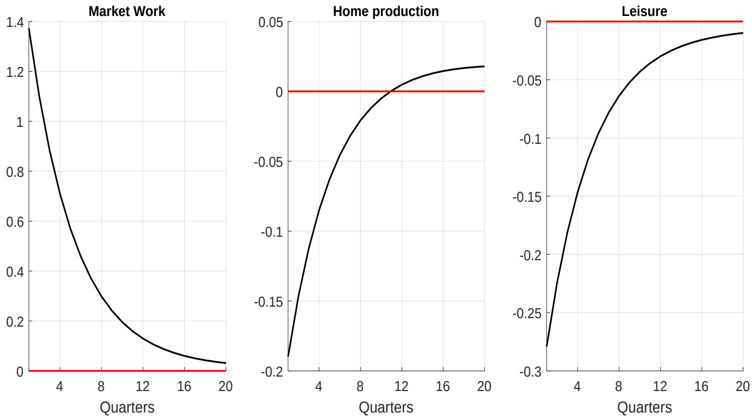
- Investment-to-capital ratio equal to the depreciation rate ($\frac{I}{K} = \delta = 0.025$)
- $\beta = 0.995$
- Annual inflation rate of $\Pi = 2\%$
- b_1: elasticity of substitution between home and market goods, $\frac{1}{1-b_1} = 2$
- $1 - \theta = 0.25$: probability of price resetting
- Steady states for $h^m = 0.19$, $h^h = 0.11$, and $l = 0.7$, consistent with ATUS
- Elasticity of substitution between intermediate goods (ε) is 6 $\rightarrow \mu = \frac{\varepsilon}{\varepsilon - 1} = 1.2$
- ρ_m and Φ_y are assumed zero
- Fiscal multiplier: $\bar{g} = \frac{G}{Y} = 0.18$

Calibration

1.3

Parameter	Value	Description
ρ_β	0.935	Persistence household discount factor shock
ρ_g	0.55	Persistence government expenditures shock
ρ_a	0.987	Persistence TFP shock
ρ_ϵ	0.9	Persistence markup shock
σ_β	0.0026	Household discount factor shock, std. deviation
σ_g	0.027	Government expenditures shock, std. deviation
σ_a	0.00012	TFP shock, std. deviation
σ_ϵ	0.0014	Markup shock, std. deviation

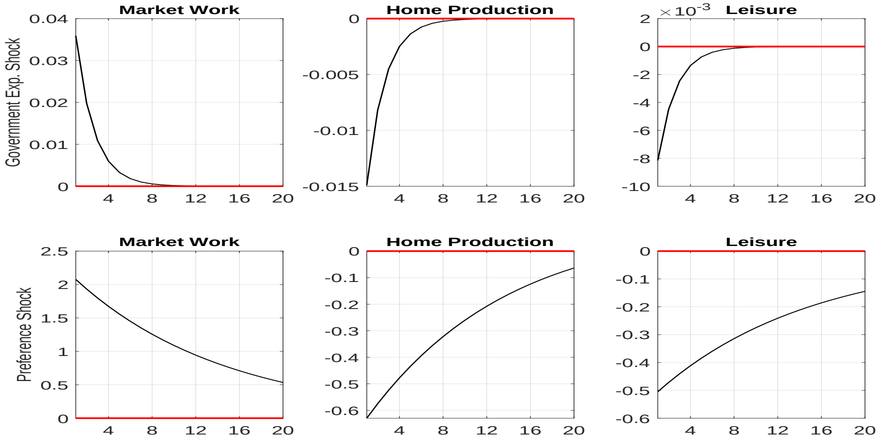
Baseline Results



IRFs are calculated as the linear sum of shocks to the household discount factor, government expenditures, technology level, and price markups. Empirical results

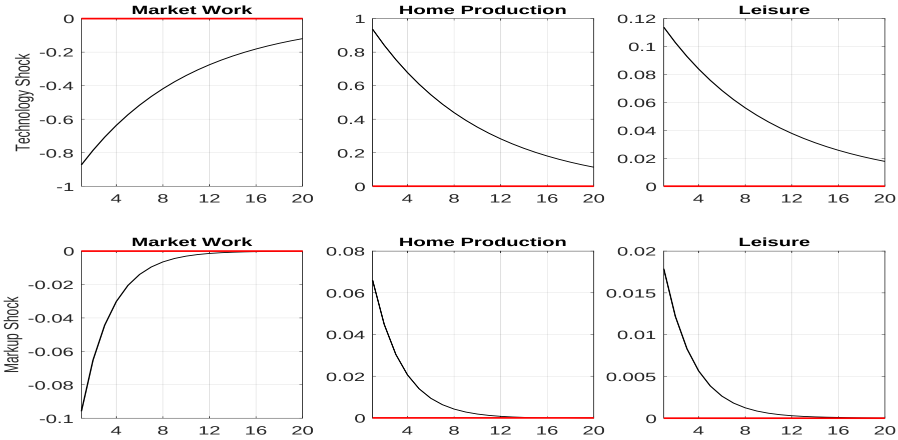
Mechanism Inspection

Demand-driven Inflation



IRFs to one-standard-deviation demand-sided shocks of fiscal multiplier and household preference.

Supply-driven Inflation

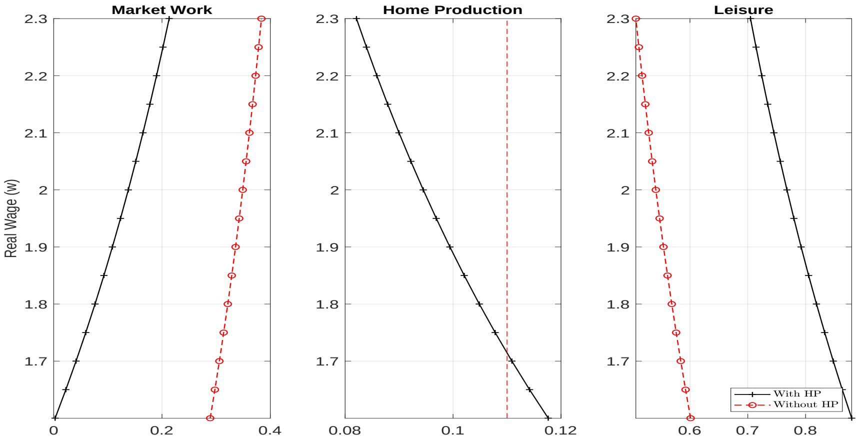


IRFs to one-standard-deviation supply-sided shocks of TFP and markup.

Partial Equilibrium: Substitution Effect

- Market work, home production, and leisure are normal goods
- $w \uparrow \Rightarrow$ price of market goods $\downarrow$, price of home goods $\uparrow$, price of leisure $\uparrow$
- Substitute away from home production and leisure

Partial Equilibrium: Substitution Effect



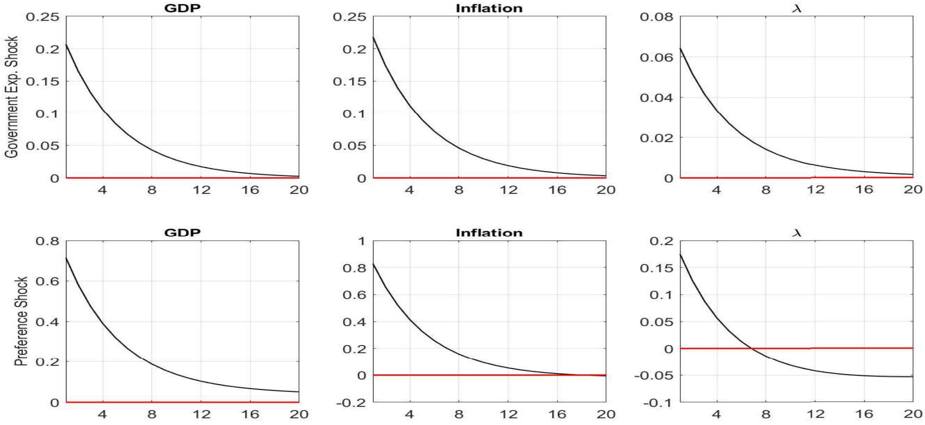
Time allocation responses to real wage in models w/ and w/o home production.

Partial Equilibrium: Wealth Effect

1.7

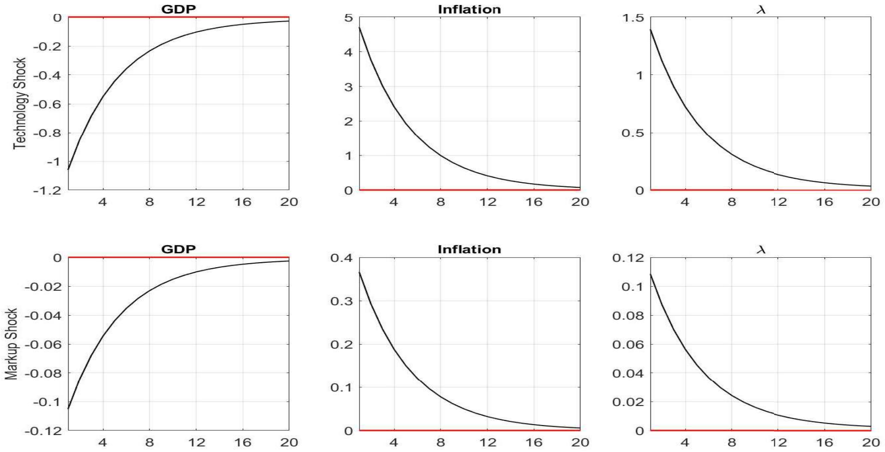
- Lagrange multiplier λ tells us how much the maximum utility increases when the budget constraint is relaxed by one unit
- $\lambda =$ marginal utility of wealth
- FOC: $\lambda = \frac{dU}{dc^m} = U_{c^m}$
- Marginal utility of wealth = Marginal utility of market goods consumption
- $\frac{d\lambda}{d\Pi} > 0$???

Mechanism Inspection: Wealth Effect



IRFs to one-standard-deviation demand-sided shocks of fiscal multiplier and household preference.

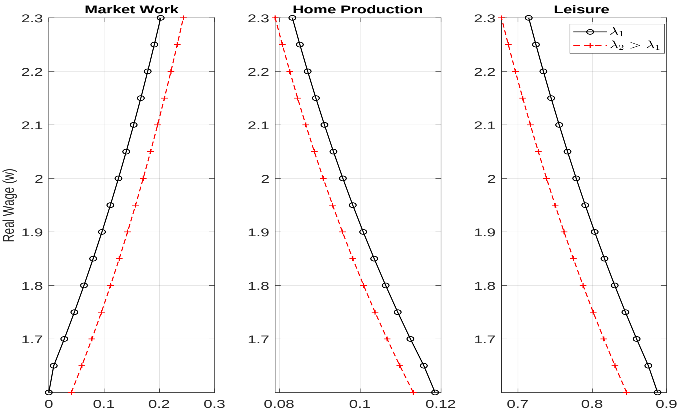
Mechanism Inspection: Wealth Effect



IRFs to one-standard-deviation supply-sided shocks of TFP and markup.

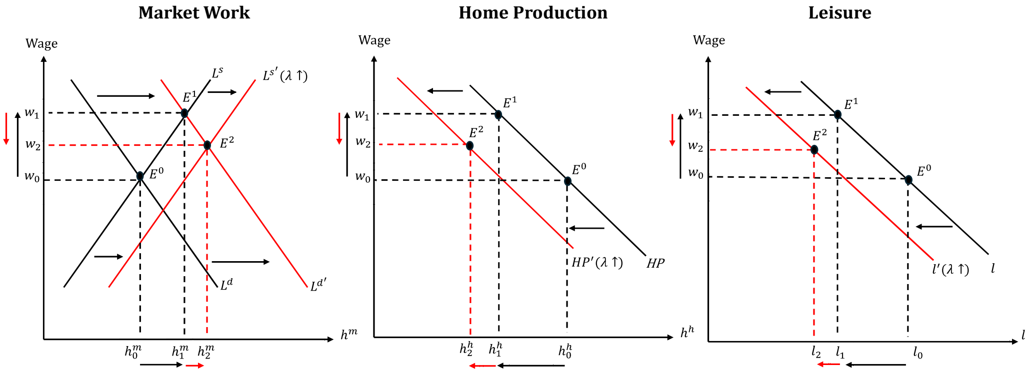
Partial Equilibrium: Wealth Effect

Inflation $\rightarrow \lambda \uparrow$

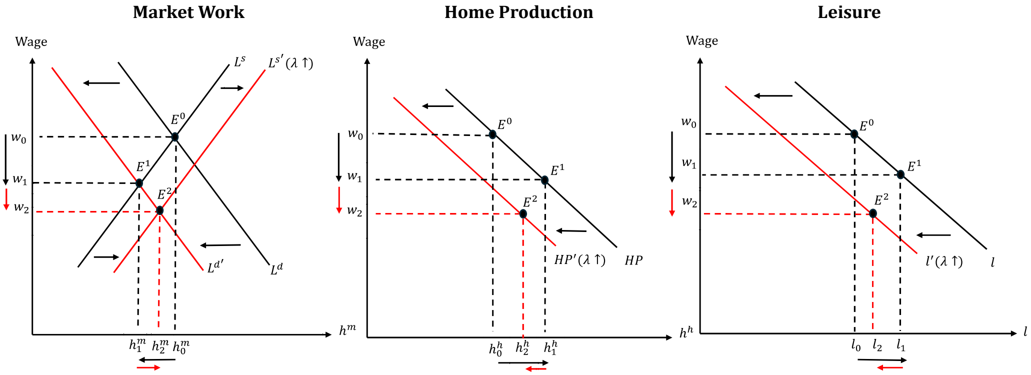


Time use responses to real wage and marginal utility of market goods consumption (λ) – w/ hp.

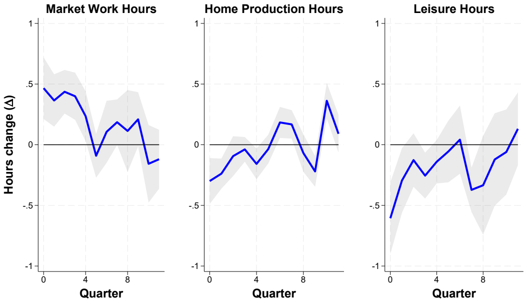
Demand-driven Inflation Mechanism



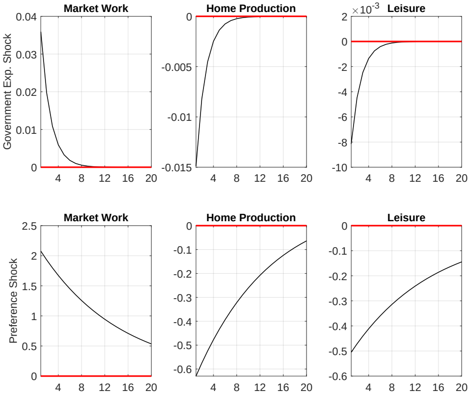
Supply-driven Inflation Mechanism



The Main Source of Inflation



Empirical Result



Theoretical Result: Demand-sided IRFs

Conclusion

Conclusion and Future Studies

Conclusion

- Estimating causal effect of inflation on time allocation using LP-IV
- Discussing how empirical model address endogeneity
- Presenting a theoretical model with home production sector
- Presenting a mechanism to analyze demand- and supply- driven inflationary responses

Future studies

- Extending the empirical model to state-dependent environments, such as high- v.s. low-unemployment or high- v.s. low-inflation
- Exploring heterogeneous responses
- Exploring other time use categories, such as shopping or job search
- Estimating parameters using Bayesian approach

Thank you!

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Empirical Analysis: LP-IV

0.9

1-Stage Regression Result

	$\widetilde{\pi}$
L1.$E_t\pi_{t+1}$	2.056***
	(0.416)
L2.$E_t\pi_{t+1}$	0.415
	(0.4)
L3.$E_t\pi_{t+1}$	-0.551*
	(0.301)
L1.ΔY_t	0.09
	(0.119)
L2.ΔY_t	-0.007
	(0.08)
L3.ΔY_t	-0.066
	(0.089)
Constant	-1.714***
	(0.641)
Observations	85
R^2	0.594
F-statistics	16.13
Prob $>$ F	0.0000

Appendix: Households

1.5

- Maximize the lifetime utility function over C_t and l_t
- Utility function is CRRA (Constant Relative Risk Aversion)
- Rent capital k_t^m to firms at price r_t^k or use for home production as k_t^h
- Allocate their time to market(h_t^m) to produce intermediate goods in exchange of real income of w_t, working at home (h_t^h) to produce non-tradable home goods, and leisure (l_t)
- Market goods can be consumed, $c_t^m(i)$, or stored as investment, $I_t(i)$
- Own one-period riskless portfolio B_t at time t and carry B_{t+1} to the next period of time
- Combine market goods (c^m) and home goods (c^h)through CES function
- Households are price takers

Appendix: Firms

1.5

- Infinite firms indexed by $i \in [0, 1]$ produce intermediate goods
- Market is monopolistically competitive
- They rent labor and capital stock from household in a perfect competition market to produce market good $Y_t(i)$
- Constant-returns-to-scale (CRS) Cobb-Douglas production function
- Constant real marginal cost for all firms
- Calvo price setting: change their nominal price $P_t(i)$ with a constant probability of $(1 - \theta)$

Appendix: Calibration

0.9

Parameter	Value	Description
β	0.995	Discount factor
σ	2.0	Risk aversion
δ	0.025	Capital depreciation rate
ξ	252.5	Capital adjustment costs
α_1	0.55	Expenditure share on market goods
α_2	0.35	Capital share home goods production function
α_3	0.2	Capital share market goods production function
Φ_π	1.50	Monetary policy inflation coefficient
ρ_m	0.0	Interest rate smoother
$\frac{1}{1-b_1}$	2	Elasticity of substitution between market and home consumption
b	0.3	Elasticity of substitution between total consumption and leisure

Appendix: Calibration

1

Parameter	Value	Description
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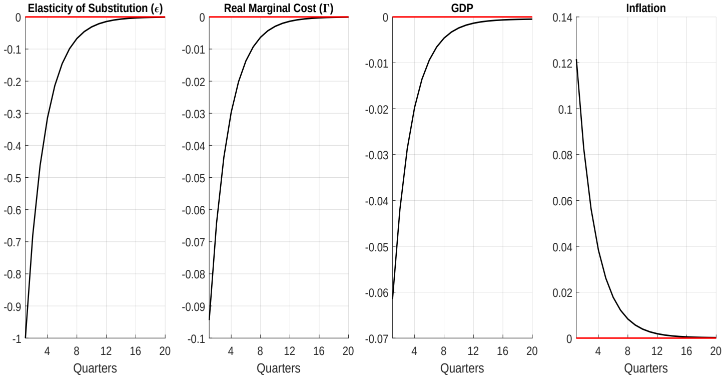
σ_a	0.00012	TFP shock, std. deviation
σ_ϵ	0.0014	Markup shock, std. deviation

Exogenous Shock: Markup

- A negative shock to ε is contractionary inflationary disturbance
- $\mu = \frac{P}{MC} = \frac{1}{RMC} = \frac{\varepsilon}{\varepsilon - 1}$



Partial Equilibrium: Value Functions

0.8

$$C = \left[\alpha_1 (c^m)^{b_1} + (1-\alpha_1)(c^h)^{b_1}\right]^{\frac{1}{b_1}} \tag{21}$$

$$c^h = (k^h)^{\alpha_2} (h^h)^{1-\alpha_2} \tag{22}$$

$$k_{ss} = k^m + k^h, \qquad l = 1 - h^m - h^h \tag{23}$$

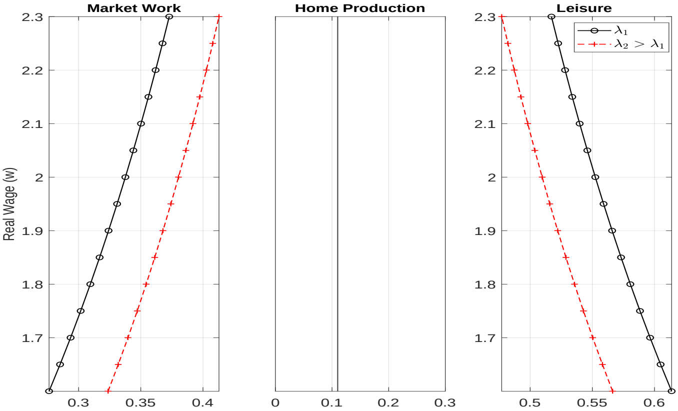
$$\left(\frac{\alpha_1}{1-\alpha_1}\right)\left(\frac{c^m}{c^h}\right)^{b_1 - 1} = \frac{1-\alpha_2}{w(.)}\left(\frac{c^h}{h^h}\right) \tag{24}$$

$$\left(\frac{\alpha_1}{1-\alpha_1}\right)\left(\frac{c^m}{c^h}\right)^{b_1 - 1} = \left(\frac{\alpha_2}{r^k}\right)\left(\frac{c^h}{k^h}\right) \tag{25}$$

$$\lambda_{ss} = b\alpha_1 (l)^{(1-b)(1-\sigma)} (c^m)^{b_1 - 1} c^{(b_1 - \sigma) - b_1} \tag{26}$$

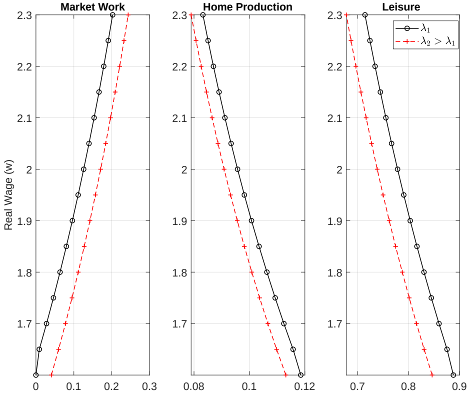
$$w(.)l = \left(\frac{1-b}{\quad}\right) (c^m)^{1-b} C^{b_1} \tag{27}$$

Partial Equilibrium: Wealth Effect

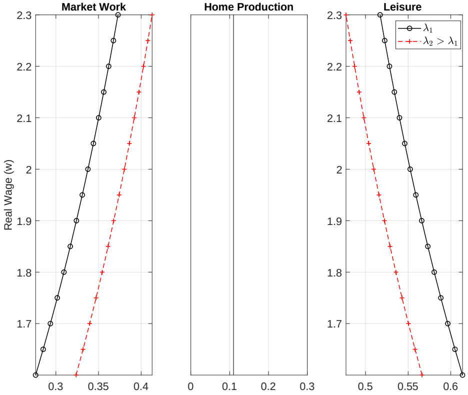


Time use responses to real wage and marginal utility of market goods consumption (λ) – w/o hp.

Partial Equilibrium: Wealth Effect



W/ HP



W/O HP

Motivation

$$H_{it}^{j} = \beta_0 + \beta_1^{j}\pi_t + \beta_2^{j} t + \varepsilon_{it}^{j} \tag{28}$$

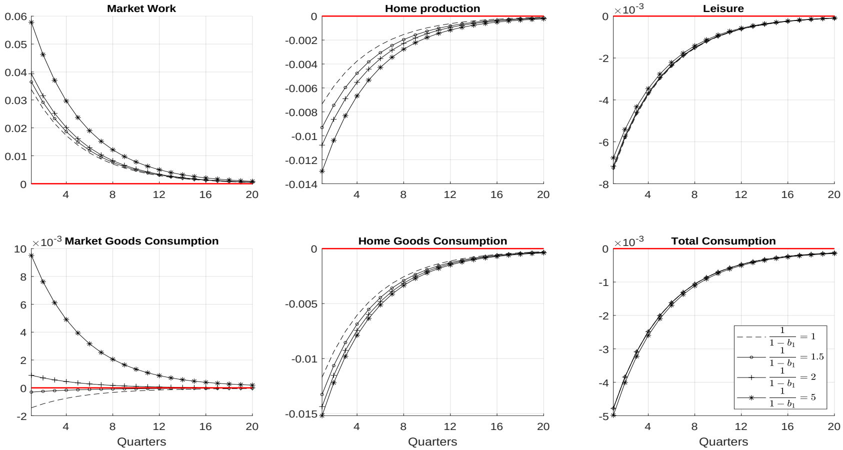
	Market Work (Hour)		Home Production (Hour)		Leisure (Hour)	
	(1)	(2)	(1)	(2)	(1)	(2)
Inflation (%)	0.147***	0.205***	0.018	-0.006	-0.070	-0.110**
	(0.054)	(0.062)	(0.031)	(0.035)	(0.048)	(0.055)
N	252,808	198,635	252,808	198,635	252,808	198635

Standard errors in parentheses.

$*p < 0.10$, $**\,p < 0.05$, $***p < 0.01$

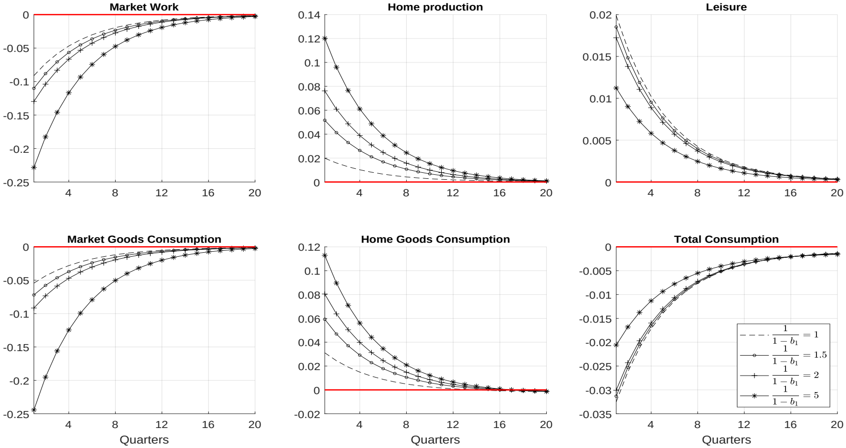
(1): All population, (2): Working age population

Elasticity of Substitution Between Market and Home Goods



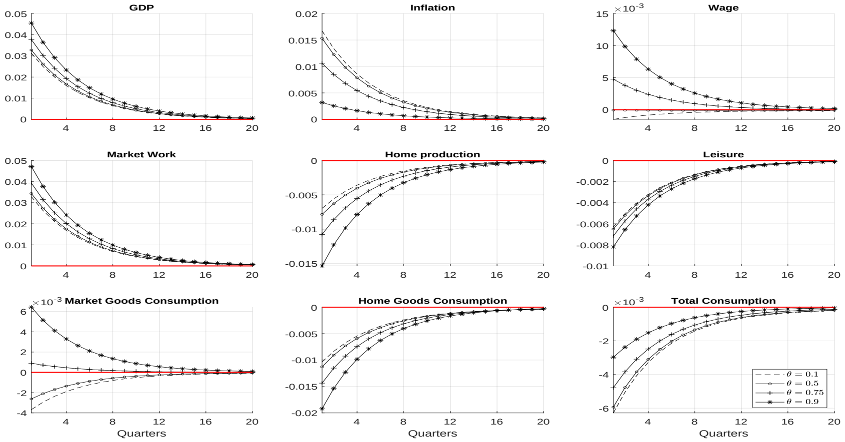
IRFs following a one-standard-deviation government expenditure shock for elasticity of $\frac{1}{1-b_1}$.

Elasticity of Substitution Between Market and Home Goods



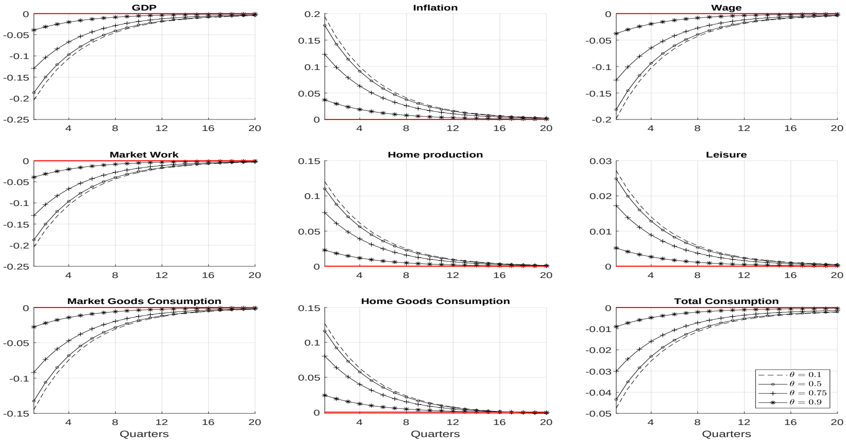
IRFs following a one-standard-deviation markup shock for elasticity of $\frac{1}{1-b_1}$.

Probability of Price Resetting $(1-\theta)$



IRFs following a one-standard-deviation government expenditure shock for different values of θ.

Probability of Price Resetting $(1 - \theta)$



IRFs following a one-standard-deviation markup shock for different values of θ.