

Monetary Policy During Technological Transformation

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Motivation

1. The plausible emergence of a new general-purpose technology (GPT)
2. So far, little evidence of a significant acceleration in TFP growth...
3. ...yet a substantial investment boom, potentially fueling economic overheating

What, if anything, should monetary policy do?

Productivity J-curve upon a new general purpose technology (GPT)

- Solow paradox: “You can see the computer age everywhere but in the productivity statistics”
- Large literature on measured productivity J-curve from 1990s IT revolution.

Brynjolfsson *et al.* (2021), Hornstein and Krusell (1996), Greenwood and Yorukoglu (1997), Yorukoglu (1998), etc

- learning-by-doing the new technology,
- intangible capital investment to reorganize management and workforce.
- this ties up production inputs $\Rightarrow$ temporary decline in TFP measures
- GenAI generated optimism for TFP growth; no TFP surge yet...

Average growth	Historical	Last 10 years	Since 2023Q1
Labor productivity	2.31%	2.15%	2.85%
TFP	1.21%	1.09%	1.58%
Utilization adjusted TFP	1.24%	1.11%	1.16%

The role of monetary policy during technological transformation.

- Should monetary policy accommodate investment boom during technological transformation?
 - Chairman Warsh: “...should not make the big mistake by tightening into a productivity boom...”
 - AI/automation slump from decline in labor share (Fornaro and Wolf, 2026).
- Or, react against aggregate demand effects of positive news about productivity?
- Develop and estimate New Keynesian model with endogenous TFP and productivity J-curve.
 - A new GPT arrives: higher potential TFP or capital elasticity.
 - New intangible capital investment is required to unlock its potential.
- **Results:** Monetary policy changes short-run demand and inflation dynamics,
 - but **does little to technology adoption** along the productivity J-curve.
 - Intangible complementarity triggers investment boom $\Rightarrow$ undoes Fornaro-Wolf slump

NK Model with Endogenous TFP

Environment

Based on the St. Louis Fed DSGE model

- Time is discrete and infinite, $t = 0, 1, 2, \dots$
- Agents: three types of firms, two types of households, fiscal and monetary authority

Production structure:



Monopolistically competitive basic good producers employ CRS technology:

$$a_t K_{Pt}^\alpha (A_t N_{Pt})^{1-\alpha}$$

- K_{Pt} , and N_{Pt} are capital and labor services employed in physical production.
- a_t is the stationary component of TFP
- A_t is the labor-augmenting endogenous component of TFP

$$A_t = A_{t-1}^\rho \cdot \left[\lambda F_t^\omega + (1 - \lambda) (H_{t-1} / \bar{H})^\omega \right]^{(1-\rho)/\omega}$$

- F_t is the exogenous technological frontier
- H_{t-1} is the stock of intangible capital
- ω governs the elasticity of substitution between the two

Technological frontier, adoption, and intangible capital

- Endogenous TFP evolves as

$$A_t = A_{t-1}^\rho \cdot \left[\lambda F_t^\omega + (1 - \lambda) (H_{t-1} / \bar{H})^\omega \right]^{(1-\rho)/\omega}$$

- F_t is the exogenous technological frontier

$$\log F_t = \log F_{t-1} + \bar{g} + \varepsilon_t^{GPT}$$

- H_{t-1} is the stock of intangible capital, with law of motion:

$$H_t = (1 - \delta_H) H_{t-1} + I_{Ht} \left[1 - \varphi \left(\frac{I_{Ht}}{I_{Ht-1}} \right) \right]$$

- Intangible investment requires capital and labor:

$$I_{Ht} = a_t K_{Ht}^\alpha (A_t N_{Ht})^{1-\alpha}$$

- ω is the elasticity of substitution between frontier and intangible capital
 - Need strong complementarity for J-curve pattern, $\omega \ll 0$

Two-agent model (TANK): **Workers**

- Infinitely lived workers with separable preferences over consumption and labor

$$U^w = \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[\log C_t^w - \frac{\psi}{1+\theta} (N_t^w)^{1+\theta} \right]$$

- Workers are hand-to-mouth:

$$C_t^w = w_t N_t$$

- Worker consumption and labor are fully determined by movements in the real wage
 - consistent with the GE channel emphasized by the HANK literature.
- **Sticky wages:** workers supply differentiated varieties of labor to unions, who set nominal wages subject to menu costs.

Rest of the model: capitalists & government

- Infinitely lived agents with consumption habits

$$U^k = \mathbb{E} \sum_{t=0}^{\infty} \beta^t \log \left(C_t^k - h C_{t-1}^k \right)$$

- They do not work but own firms, capital, and bonds.

$$C_t^k + I_{Kt} + B_t = r_t^k u_t K_{t-1} + \frac{R_{t-1}}{\Pi_t} B_{t-1} + D_t - T_t$$

- Law of motion for capital: $K_t = I_{Kt} [1 - \varphi (I_{Kt}/I_{Kt-1})] + [1 - \delta (u_t)] K_{t-1}$

Government

- Fiscal authority funds exogenous spending using lump-sum taxes: $G_t = T_t$
- Central bank follows standard Taylor rule: $R_t = R_{t-1}^{\rho_r} \left[\bar{R} \left(\frac{\Pi_t}{\bar{\Pi}} \right)^{\phi_{\Pi}} \left(\frac{Y_t}{\bar{Y}} \right)^{\phi_Y} \right]^{1-\rho_r}$

Measured vs. Physical TFP and the J-curve

- Physical TFP is given by $a_t \times A_t^{1-\alpha}$
- Measured TFP* is computed as

$$MTFP_t = \frac{Y_t}{(u_t K_{t-1})^\alpha N_t^{1-\alpha}} = a_t \times A_t^{1-\alpha} \times f_t$$

intangible investment does not show up in output

- f_t is the share of inputs allocated to goods production

$$f_t = \frac{N_{Pt}}{N_t} = \frac{N_{Pt}}{N_{Pt} + N_{Ht}}$$

- J-curve arises when $f_t \downarrow$, even if $A_t \uparrow$
 - Technology *adoption* can generate a J-curve

Model parametrization

1. Externally calibrate “standard” parameters
2. Internally calibrate remaining “structural” parameters
3. Estimate “dynamic” parameters using standard Bayesian methods

Most data series are standard, except for measures of intangible investment/capital

- Measure H and I_H as in Corrado *et al.* (2009, 2022)
- Identify it as organizational capital and employer-provided training
- Data for intangible investment and capital series taken from the 2024 EUKLEMS/INTANProd database

Parametrizing the model I: external calibration

Parameter	Description	Value	Reason/target
σ	Risk aversion	1	Standard log utility
θ	Inverse Frisch elasticity	1	Unit Frisch elasticity
ψ	Labor-disutility scale	1	Normalization
χ	Share of workers	0.70	Faria-e-Castro (2024)
μ_p	Gross price markup	1.20	20% markup; elasticity of substitution of 6
μ_w	Gross wage markup	1.20	20% markup; elasticity of substitution of 6
$\bar{\Pi}$	Gross inflation target	$1.02^{1/4}$	2% annual inflation target
μ_b	Gross basic input markup	$1/0.9 \approx 1.111$	Elasticity of substitution of 10; $\kappa_b = 0.9$
ω	Frontier–intangible capital CES curvature	−1000	Near-Leontief complementarity
ρ	Adoption persistence	0.95	Fixed in estimation

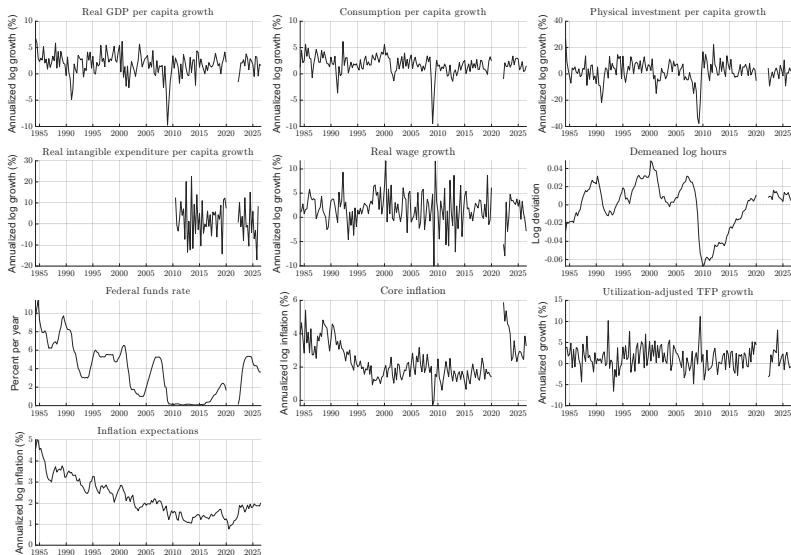
Parametrizing the model II: internal calibration

Parameter	Description	Value	Reason/target
$\bar{g}$	Quarterly trend log growth	0.004371	1.7636% annual GDP growth
β	Discount factor	0.998199	2.5% annual real rate
G/Y	Government-spending share	0.187	Residual share of GDP of 18.7%
δ_K	Physical capital depreciation	0.013728	Physical investment: 16.5% of GDP
δ_H	Intangible capital depreciation	0.106724	Intangible investment: 5.0% of GDP
α	Physical capital share	0.2269	Physical capital: 228.8% of (annual) GDP
λ	Frontier CES weight	0.9150	Intangible capital: 11.3% of (annual) GDP

Parametrizing the model III: Bayesian estimation

- Remaining “dynamic” parameters estimated using standard Bayesian methods
- Estimation sample: 1984Q1-2026Q2
- Ten observables: real GDP growth, real consumption growth, real investment growth, **real intangible investment growth**, real wage growth, hours worked, FFR, core PCE inflation, 10y inflation expectations, utilization-adjusted TFP
- Add ten shocks to the model: cyclical TFP, price markup, wage markup, physical MEI, intangible MEI, government spending, discount factor, risk premium, monetary policy, inflation target
- Exclude COVID-19 period 2020Q1-2021Q4 for most series
- **Importantly:** assume no GPT shocks in the estimation sample

Parametrizing the model III: observable series

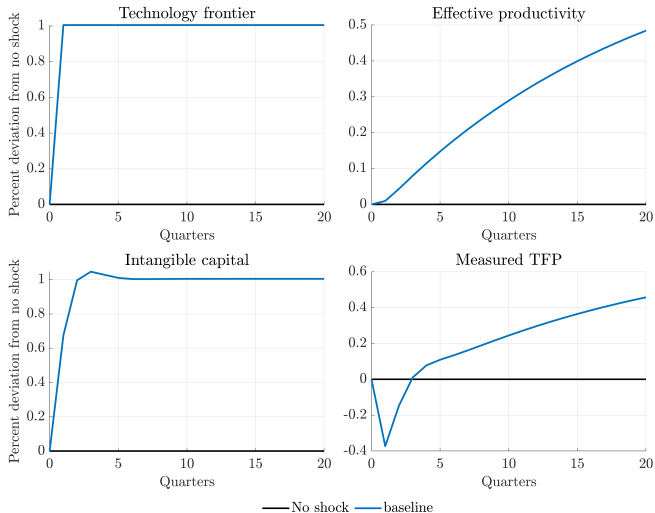


Parametrizing the model III: estimation results

Parameter	Description	Prior distr.	Prior mean	Prior SD	Post. mean	Post. 5%	Post. 95%
<i>A. Structural parameters</i>							
h	Consumption habit	B	0.500	0.200	0.0671	0.0196	0.1303
ϕ_K	Physical inv. adj. costs	IG	5.000	1.000	3.1630	2.6091	3.9127
ϕ_U	Utilization cost curvature	IG	0.500	0.250	0.2297	0.1716	0.3071
ϕ_H	Intangible inv. adj. costs	IG	5.000	1.000	4.3974	3.3452	5.7399
ϕ_π	Taylor rule: inflation	G	2.000	0.250	3.2253	2.8054	3.6758
ϕ_y	Taylor rule: output	G	0.125	0.100	0.0796	0.0076	0.3261
ρ_R	Interest-rate smoothing	B	0.800	0.100	0.7857	0.7150	0.8519
η_p	Price adjustment costs	G	80.000	20.000	102.9773	73.5155	139.5658
η_w	Wage adjustment costs	G	80.000	20.000	131.8446	88.3894	184.1421

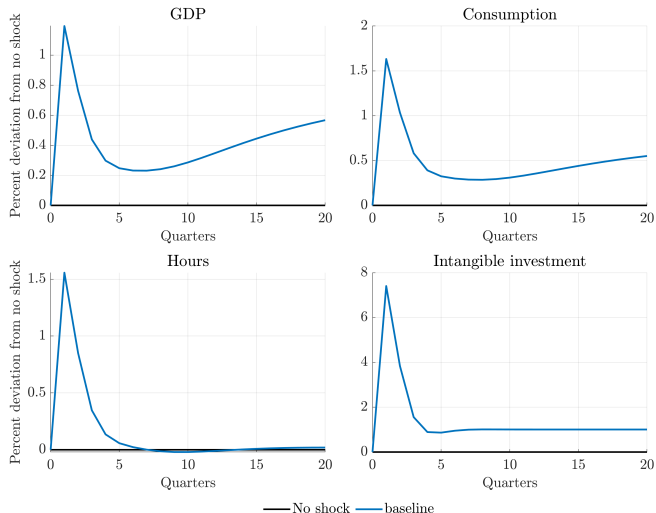
TFP–intangible complementarity

J-curve after GPT shock, $A_t = A_{t-1}^\rho \cdot [\lambda F_t^\omega + (1 - \lambda)(H_{t-1}/\bar{H})^\omega]^{(1-\rho)/\omega}$



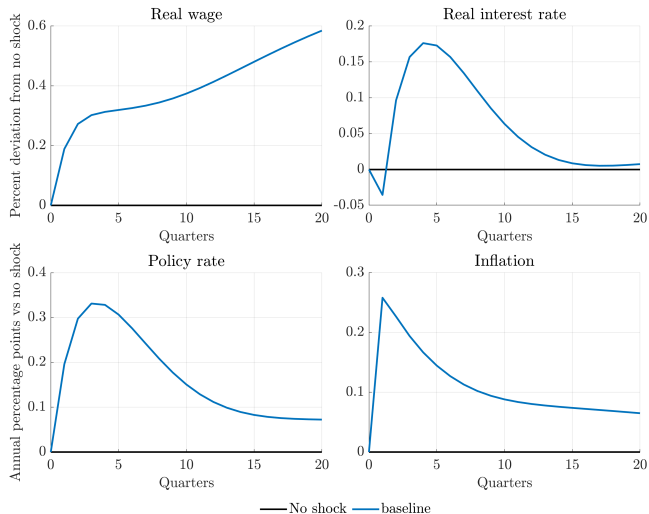
- GPT shocks, F_t jumps at $t = 0$
- Need intangible investment to unleash its potential.
- Endogenous TFP, A increases gradually
- J-curve pattern for measured TFP as $N_{Pt}/N_t \downarrow$

Real variables during J-curve productivity growth



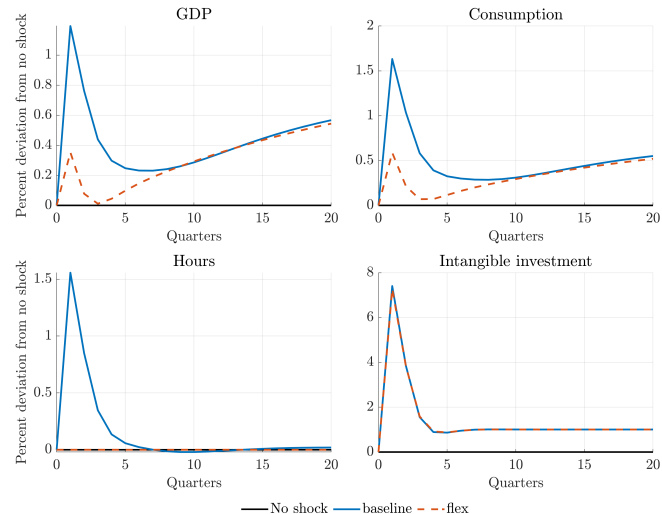
- Higher intangible demand increases labor demand
- Higher labor demand increases real wages
- H-t-M workers increase consumption.
- Wealth effects lead capitalists to increase consumption too.

Prices and inflation during J-curve productivity growth



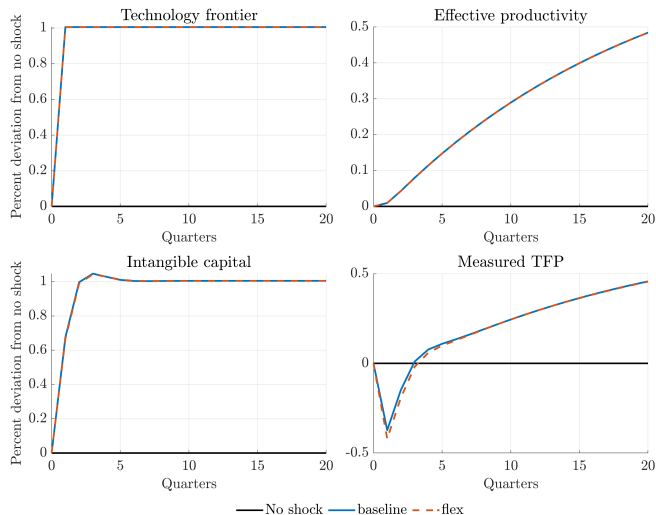
- Wages rise because of higher demand for labor.
- Intangible investment boom generates inflation/overheating.
- Taylor rule raises nominal rates. of the economy.

Output increases gradually under flexible prices



- Aggregate demand effects play important role in amplifying initial expansion.
- Similar intangible investment under flexible prices.
- No need for overheating for intangible investment.

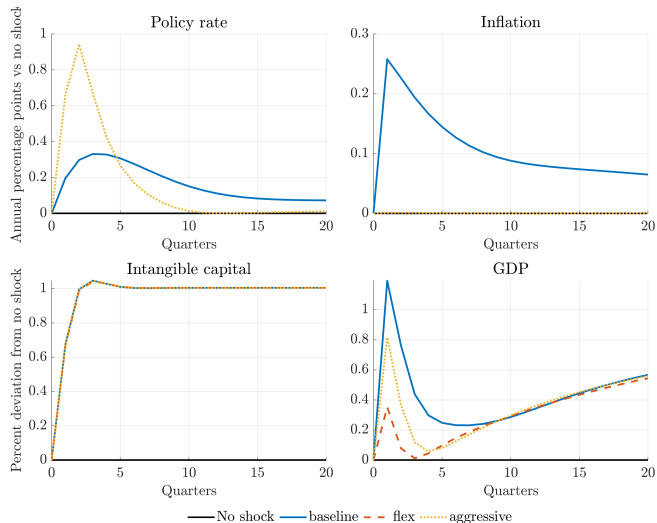
J-curve productivity under flexible prices



- Sticky prices and wages do NOT matter for intangible investment and evolution of TFP.
- Similar J-curve pattern for measured TFP.
- Strong $F - H$ complementarity motive dominates aggregate demand channel of tech adoption (Anzoategui *et al.* (2019)).

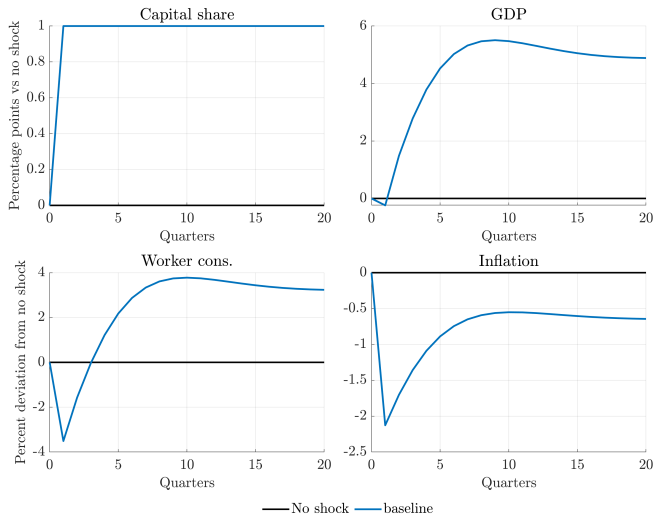
Aggressive monetary policy can achieve price stability without hurting growth

- If the central bank follows an aggressive monetary policy, inflation effects are muted.
- Aggressive MP does not matter for intangible investment, only for aggregate consumption.



Automation shock (no intangible complementarity)

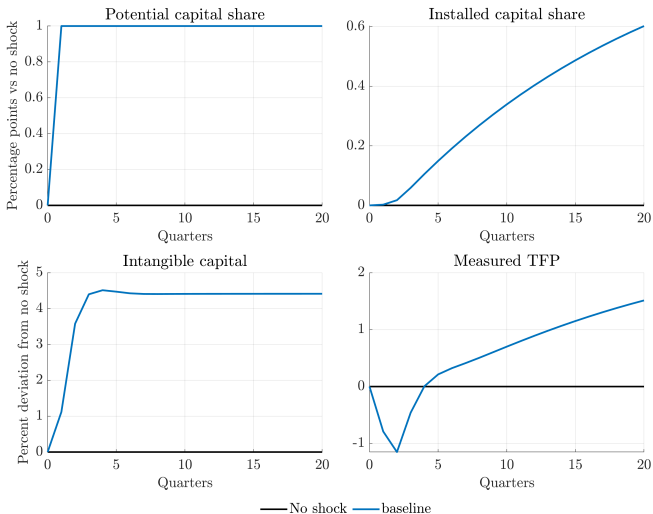
Automation shock without intangible complementarity: $\alpha_t \uparrow$



- Similar to “AI slump” in Fornaro and Wolf (2026).
- Automation reduces labor income share.
- On impact, worker consumption declines, so does GDP/hours, etc.
- As more capital accumulated, output increases above trend.
- No strong J-curve pattern for measured TFP.

Automation–intangible complementarity

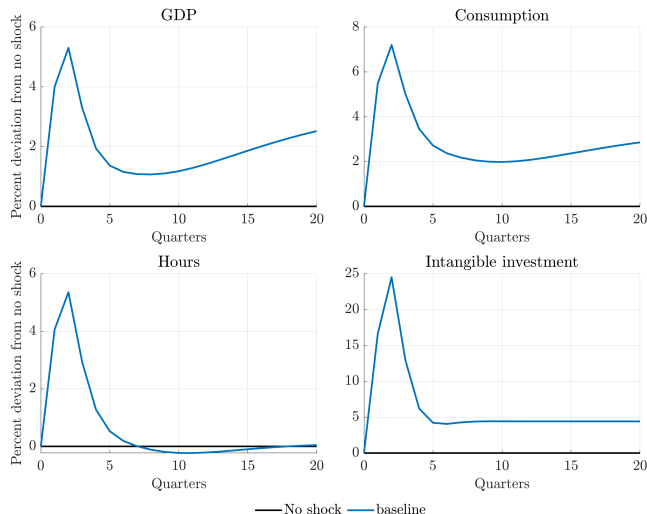
Automation–intangible complementarity, $\alpha_t = \alpha_{t-1}^\rho \cdot [\lambda \tilde{\alpha}_t^\omega + (1 - \lambda)(H_{t-1}/\bar{H})^\omega]^{(1-\rho)/\omega}$



- Automation frontier, $\tilde{\alpha}_t$ jumps at $t = 0$
- Need intangible investment to unleash its potential.
- Endogenous α increases gradually
- J-curve pattern for measured TFP

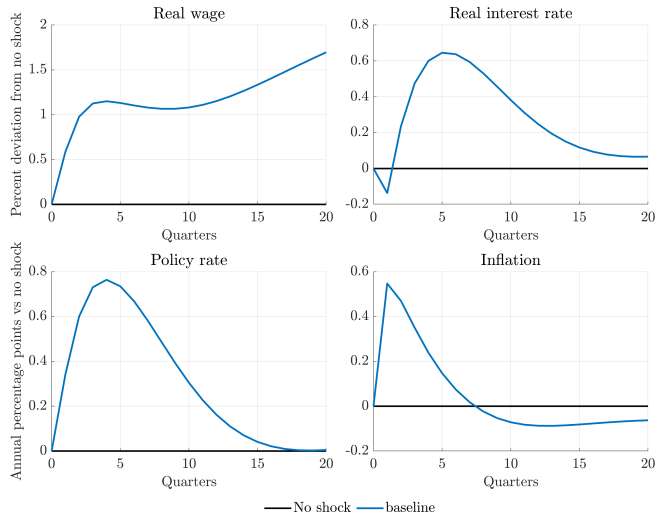
$$(MTFP_t = \frac{A_t^{1-\alpha} K_{Pt}^{\alpha_t} N_{Pt}^{1-\alpha_t}}{(u_t K_{t-1})^{\alpha_t} N_t^{1-\alpha_t}})$$

No AI slump from automation anymore!



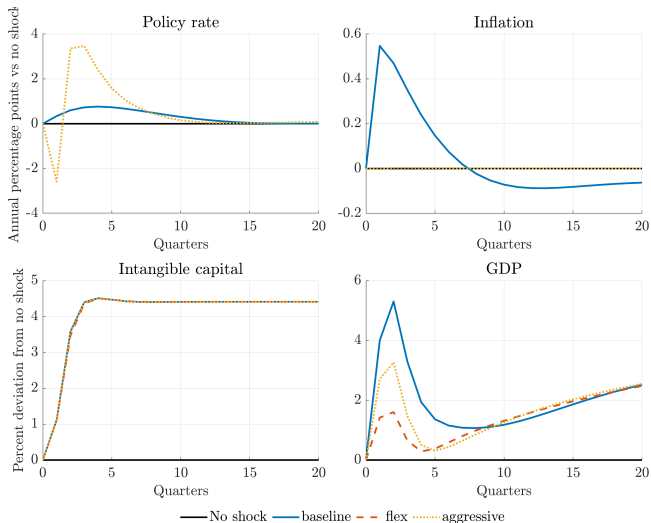
- Higher intangible investment increases labor demand
- H-t-M workers increase consumption.
- Wealth effects lead capitalists to increase consumption too.
- No more AI slump from automation!

Prices and inflation during automation.



- Similar to the previous case: wages and real rates rise due to expanded aggregate demand
- CB responds by raising rates
- Inflation rises and then falls below target

Aggressive monetary policy can achieve price stability without hurting growth



- If the central bank follows an aggressive monetary policy, inflation effects are muted.
- This policy does not reduce intangible investment.
- Strong $\tilde{\alpha} - H$ complementarity is key.

Conclusion

- Strong expectations for productivity gains from generative AI technology.
 - So far, no significant TFP gains yet but substantial inflationary pressure.
- Use NK model with endogenous TFP and intangible capital to study monetary policy.
 - Can capture J-curve pattern of productivity, which is important monetary policy implication.
 - Unlike Fornaro and Wolf (2026), no decline in labor demand or consumption from automation.
 - Monetary policy little or no effect on frontier technology adoption.
- Work-in-progress:
 - Empirical investigation of these mechanisms.
 - Micro data and evidence to discipline (ω, ρ)

Appendix

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