

Transfer Payments, Sacrifice Ratios, and Inflation in an Active-Fiscal HANK

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If the government

1. Send transfers to households
2. Issues debt
3. Does not raise future taxes to pay down debt

Trade-off between output and inflation?

- Does it matter who receives transfers?

A model for answering these questions

This paper:

- Canonical heterogeneous agent New Keynesian model (HANK)
 - | Uninsurable income risk, incomplete markets
 - | Endogenous savings, consumption
 - | Nominal rigidities (sticky wages)
 - | Long-term nominal gov. bonds
- “Active”/“passive” fiscal and monetary policy
 - | Depends on choice of policy parameters
- Shocks come from policy
 - | Fiscal Transfers:
 - To all households
 - To only below-median income
 - To only above-median income
- Linearized sequence space solutions
 - | Auclert, Bardoczy, et al. (2021)

In this paper...

- Does it matter for this trade-off who receives the checks?
 - | **NO** for inflation, **YES** for output
 - | High MPC agents receive transfers / output boom is larger
 - But price level rises by similar amount regardless of targeting
 - | **Lower** sacrifice ratios when net transfers to the rich are cut, relative to the poor
- If monetary policy is passive, doesn't quantitatively matter if fiscal policy is
 - | active
 - | passive via very slow automatic adjustments

Using Leeper (1991) terminology

- Consider government debt equation:

$$\frac{d(\tilde{B}_t = p_t)}{dt} = T_t + r_t \frac{\tilde{B}_t}{p_t} \quad (1)$$

- | $B_t = \tilde{B}_t = p_t$: Real value of government debt
 - B_t : Value of nominal government liabilities
 - p_t : The price level
- | $r_t = i_t - \pi_t$: Real interest rate
 - i_t : Nominal interest rate
 - π_t : Rate of inflation
- | T_t : Taxes net of transfers, where

$$T_t = \text{Exog. Taxes}_t + (B_t - B_{NSS})$$

- B_{NSS} : Real debt in the the non-stochastic steady state (NSS)
- $\pi > r_{NSS}$) **Passive Fiscal**
- $\pi = 0$) **Active Fiscal**

A Heterogeneous Agent New Keynesian Model

HANK Model overview:

- Households: incomplete markets, heterogeneous agents
 - | hold gov bonds as assets ($r = 0.005$ quarterly)
 - | income risk calibrated as in McKay, Nakamura, and Steinsson (2016)
 - | borrowing constraint (assets ≥ 0)
- Federal government
 - | collects income taxes proportional to household labor income
 - | Issues nominal long-term bonds
 - can be inflated away
 - | Transfers shocks direct 1% of annual steady-state GDP to households (targeted or not)
 - | Passive Fiscal: $\tau = 0.01$, Active Fiscal: $\tau = 0$
- Central Bank: $i_t = r + \dots_t$
 - | Passive $\tau = 0$, Active $\tau = 1.05$
- Decentralized unions and nominal wage rigidities as in Auclert, Rognlie, and Straub (2023b)
 - | Competitive final goods sector: wage = price
- All production through labor, $Y_t = L_t$

- When is does the HANK model have a determinate equilibrium?

	Active Fiscal	Passive Fiscal
Active Monetary	No Eqm.	Standard NK
Passive Monetary	Determinate	Determinate

- Model is determinate in all scenarios *except when both policies are active*
 - | See Hagedorn (2023) for details
 - | **Can separate implications of active monetary vs passive fiscal**
- Test the model's determinacy 3 different ways
 - | Onatski (2006) criterion methods
 - Hagedorn (2023)
 - Auclert, Rognlie, and Straub (2023a)
 - | State-space version
 - Bayer and Luetticke (2020)

Metrics for Assessing Output and Inflation

- Cumulative quarterly output gaps (as percent of steady-state) as of time t :

$$CY_t = \frac{1}{Y_{NSS}} \int_0^t (Y - Y_{NSS}) dt$$

| As a percent of annual GDP: $CY_{t=4}$

- Cumulative inflation (change in the price level) up until time t :

$$1 + C_t = \exp \int_0^t d$$

- Sacrifice Ratio: $(CY_{t=4}) = C_t$

Numerical Simulations: Active Fiscal/Passive Monetary

	Transfers to All		Transfers to Low-Income		Transfers to High-Income	
	1 yr	50 qtrs	1 yr	50 qtrs	1 yr	50 qtrs
$CY_{t=4}$	0.66%	0.59%	0.90%	0.73%	0.43%	0.46%
C_t	1.58%	1.47%	1.85%	1.40%	1.34%	1.54%
Sac. Ratio	0.42	0.40	0.49	0.52	0.32	0.30

Table: Cumulative Output, Inflation, and Sacrifice Ratios for Active Fiscal Transfers

- $CY_{t=4}$ essentially fiscal transfer multiplier
- Transfers to high-MPC low income vs low-MPC high income:
 - ▮ Substantially more output (59%), slightly *less* inflation (9%)
- Sacrifice ratios much smaller for high-income transfers

Cumulative Impulse Response Functions

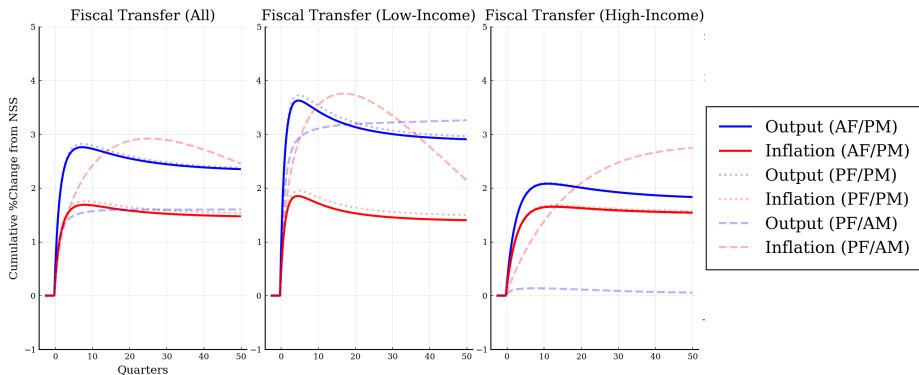
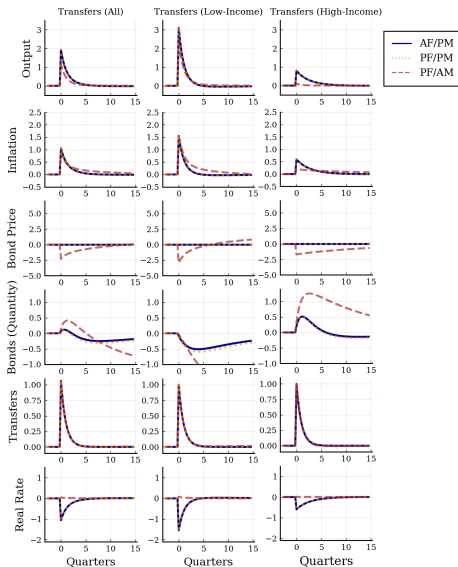


Figure: Cumulative Impulse Response Functions (CY_t, C_t)

- Passive fiscal/passive monetary IRFs very similar to active fiscal/passive monetary ones

Impulse Response Functions

HANK Impulse Response Functions



Decomposition of Output Impulse Responses

Active Fiscal/Passive Monetary Fiscal Shock Decompositions

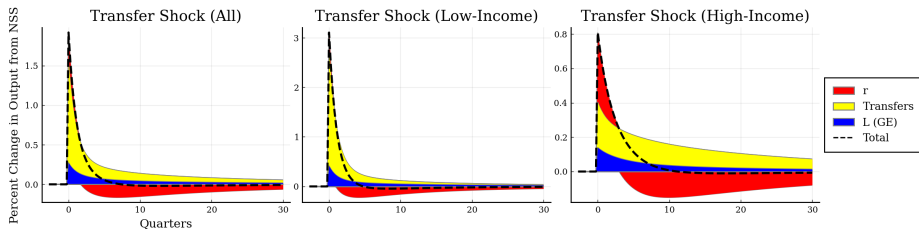


Figure: Decomposition of output IRF to transfers

- Mostly direct effect of the transfers
- Transfers to low-MPC: indirect effects more of smaller response

Intuition

PV of Inflation = PV of Deficits

- Solve forward $\frac{d(\tilde{B}_t = p_t)}{dt} = T_t + r_t \tilde{B}_t$
- Say $\dot{p}_t = 0$ and $i_t = \text{const.}$ (active fiscal, passive monetary)
- Price level, real debt cannot jump on impact
 - | Inflation stabilizes debt, assets
- Shock to $(T_s)_{s=t}$ at time t
- First-order linearization:

$$E_t \int_t^{\infty} e^{-(s-t)r} p_s ds = E_t \frac{T_{NSS}}{B_{NSS}} \int_t^{\infty} e^{-(s-t)r} p_s ds \quad (2)$$

- | Het. only affects timing of inflation
 - If r small, timing barely matters
- | Present value of deficits as pct of debt = overall rise in price level

What about the Phillips Curve?

- Common “Sacrifice Ratio” Intuition
 - | Cumulative % in annual GDP output gap per percentage point of inflation abatement
 - | Constant relationship, static model
 - | Tight link between ratio and inverse slope of the Phillips Curve
 - | See Ball (1994) for survey of estimates
 - Large variance
- **However** the New Keynesian Phillips Curve (NKPC) is more subtle

$$\dot{\pi}_t = \frac{E_t[d \pi_t]}{dt} + \pi_t$$

- | Integrate twice:

$$\int_t^{\infty} \pi_s ds = \int_t^{\infty} (s-t)e^{-(s-t)} \pi_s ds$$

- | Sacrifice ratio is inversely related to the slope of the Phillips curve
- | But also positively related to the speed with which output gaps accumulate!
 - Firms are forward looking and take time to adjust prices
 - Fall behind the curve of fast-moving output expansions

Conclusions

- Fiscal transfers: household heterogeneity matters a lot for output
- But with active fiscal policy, it appears to matter less for inflation
 - | Nominal assets are nominal anchor
 - | Hagedorn (2024): "Sufficient statistic" to describe inflation
- See my paper online for more, including monetary policy experiments!
 - | noahkwicklis.com/research
- Future work: My model assumes iMPCs integrate in NPV to 1
 - | Eventually agents want to spend down assets
 - | But other models make other assumptions
 - Auclert, Rognlie, and Straub (2023b): "Trickling up of excess savings"
 - Some households with MPC of 0
- Future work: Benefits of surprise?
 - | Forward guidance maybe bad idea for fiscal stimulus

Appendix

Sequential household's problem

$$\begin{aligned}
 V_t(a_0; z_0) &= \max_{\{c_t\}_{t \geq 0}} \mathbb{E}_0 \int_0^\infty e^{-\rho t} \left[\frac{c_t^{1-\sigma}}{1-\sigma} - \frac{h_t(a; z)^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}} \right] dt \\
 \text{s.t. } &\frac{q_t}{q_{NSS}} \frac{da_t}{dt} + \frac{dq_t}{dt} \frac{1}{q_{NSS}} a_t = (1 - \delta) w_t z_t h_t(a; z) + r_t \frac{q_t}{q_{NSS}} a_t + M_t(z_t; \rho) - c_t \quad (3) \\
 &d \log(z_t) = \alpha \log(z_t) dt + \sigma_z dW_{t; z} \\
 &a_t \geq 0:
 \end{aligned}$$

Recursive household's problem

- Hamilton-Jacobi-Bellman equation (HJB):

$$\begin{aligned}
 V_t(a; z) = \max_c & \frac{c^1}{1} - \frac{h_t(a; z)^{1+\frac{1}{3}}}{1+\frac{1}{3}} \\
 & + \frac{\partial V_t}{\partial a}(a; z) \frac{q_{NSS}}{q_t} (1 - \delta) w_t z h_t(a; z) + M_t(z; t) - c + r_t \frac{dq_t}{dt} \frac{1}{q_t} - \frac{q_t}{q_{NSS}} a \\
 & + \frac{\partial V_t}{\partial z}(a; z) z \frac{1}{2} \frac{z}{z} - z \log(z) + \frac{\partial^2 V_t}{\partial z^2}(a; z) \frac{1}{2} \frac{z}{z} z^2 + \frac{\partial V_t}{\partial t}(a; z) :
 \end{aligned} \tag{4}$$

Distribution of households

- Standard Kolmogorov Forward Equation (KFE)

$$\frac{\partial}{\partial t} t(a; z) = \frac{\partial}{\partial a} \frac{da_t}{dt} t(a; z) + \frac{\partial}{\partial z} \frac{E_t[dz_t]}{dt} t(a; z) + \frac{1}{2} \frac{\partial^2}{\partial z^2} \sigma^2 z^2 t(a; z) \quad (5)$$

- “Free” to compute in continuous time

| Maximized HJB in infinitesimal generator (expresses how optimal value function is expected to change over time) is the L^2 adjoint of the KFE operator D , where $\partial_t = D$

Active Fiscal Policy in HANK

- Taxes and transfers free to follow whatever scheme policymakers set
 - | In this model, balance budget in the steady-state

$$T_{nss} + w_{nss}L_{nss} = r_{nss}B_{nss}$$

- | Outside of the steady state, set

$$T_t(a; z; t) = \int_0^1 \int_a T_t(a; z; t) f(a; z) da dz + w_t L_t + (B_t - B_{nss})$$

where

$$T_t(a; z; t) = T_{nss} + 4Y_{nss} \left[T_t^{\text{All}}(a; z; t^{\text{All}}) + T_t^{\text{High}}(a; z; t^{\text{High}}) + T_t^{\text{Low}}(a; z; t^{\text{Low}}) + T_t^{\text{BB}}(a; z; t^{\text{BB}}) \right]$$

- | $\beta < 1$) *active* fiscal policy
 - baseline specification
 - inflation stabilizes real debt, assets
- | $\beta > r_{nss}$) *passive* fiscal policy
 - Model becomes more "traditional" HANK if $\beta > 1$

Three different fiscal policy shocks

- $t < 0$) mean-reverting stimulus checks
- Stimulus checks for everybody

$$\mathcal{T}_t^{\text{All}}(a; z; \frac{\text{All}}{t}) = \frac{\text{All}}{t}$$

- Stimulus checks only for high-earners (cutoff z , $\int_z^{\infty} n_{ss}(z) dz = 0.5$)

$$\mathcal{T}_t^{\text{High}}(a; z; \frac{\text{High}}{t}) = \mathbf{1}_{fz > z_g} \frac{\text{High}}{t}$$

- Stimulus checks only for low-earners

$$\mathcal{T}_t^{\text{Low}}(a; z; \frac{\text{Low}}{t}) = \mathbf{1}_{fz < z_g} \frac{\text{Low}}{t}$$

Interpretation and persistence

- Set mean reversion of fiscal shocks to 1
- After starting at some τ_0^{Tax} , shocks follow

$$\tau_t^{\text{Tax}} = e^{-\lambda t} \tau_0^{\text{Tax}}$$

Integrate to see

$$\int_0^{\infty} e^{-\lambda t} \tau_0^{\text{Tax}} dt = \tau_0^{\text{Tax}} / \lambda$$

- A 1% jump in τ_0^{Tax} is an announcement of a plan to spend 1% of annual GDP, almost entirely in the current year
 - | Half life of 0.7 quarters
 - | Getting money out of the door *fast*

Government debt

- Similar structure to Cochrane (2018)
- Government issues long-term nominal debt \tilde{B}_t
- Nominal price q_t
- Borrows at nominal rate i_t
 - | (Ex-ante expected real rate $r_t = i_t - \pi_t$, with π_t being inflation)
- Pays geometrically declining nominal coupon payment β^t in each time increment
 - | β determines the maturity of government debt
 - | $\beta = 0$: perpetuity
 - | $\beta = 1$: instantaneously rolled over
- Intuition:
 - | Government debt issued to have an exponential maturity structure
 - | Competitive mutual fund sector purchases debt, maximizes the present discounted value of expected profits
 - | Households own shares of the mutual fund

Government debt equations

- Like households' assets, government debt is also affected by ex-ante revaluations

$$dB_t = (T_t - G_t)dt + B_t [i_t - \dot{q}_{t;t}] dt + d_{q;t} B_t \quad (6)$$

- $B_t \frac{q_t B}{p_t}$ is the real value of government debt
 - G_t are government expenditures ($=0$)
 - T_t are total net taxes and transfers
- Nominal bond prices evolve according to

$$E_t[dq_t] = q_t [i_t + \dot{q}_{t;t}] dt \quad (7)$$

- Unanticipated (time-0) jumps in bond prices are then

$$d_{q;t} = \frac{dq_t - E[dq_t]}{q_t}$$

- Notice: nominal bond prices only affected by the nominal interest rate, and $d_{q;t}$ by its unexpected movements
 - Ex: If $i = 10\%$ and a zero-coupon bond pays off a face value of \$100 next quarter, then $q = \$10$. If i rises to 20%, $dq = 50\%$.

Market clearing (HANK)

- Wage Phillips curve becomes

$$\frac{E_t[d \frac{w}{t}]}{dt} = \frac{w}{t} \frac{1}{w} L_t \int_0^1 \int_a^1 h_t(a; z) \frac{1}{Z} \frac{1}{Z} (1 - \alpha) z w_t c_t(a; z) da dz \quad (8)$$

- Total output

$$Y_t = L_t \quad (9)$$

- Goods market

$$Y_t = C_t + s \int_0^1 \int_a^1 c_t(a; z) da dz$$

- Total assets A_t is equal to the total amount of government debt

$$A_t = \int_0^1 \int_a^1 a c_t(a; z) da dz \quad (10)$$

$$A_t = B_t$$

The Non-Stochastic Steady-State ($\zeta_t = 0$)

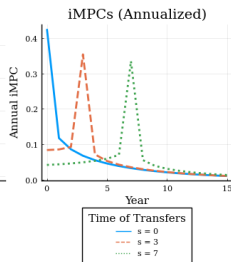
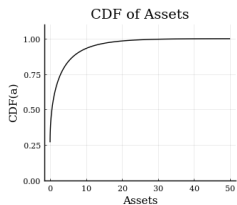
Calibrating the income process

- Kept largely as in McKay, Nakamura, and Steinsson (2016)
- Simulated method of moments:
 - | Select mean-reversion and variance parameters ($\rho; \sigma^2$)
 - | Draw a set of Brownian innovations to get panel of log-Ornstein-Uhlenbeck idiosyncratic productivities
 - | Integrate to the annual frequency to get annual "wages"
 - | Regress
$$\text{wage}_{it}^{\text{Annual}} = \rho + (1 - \rho)\text{wage}_{it-1}^{\text{Annual}} + \sigma \epsilon_{it}$$
 - | Fit empirical Floden and Linde (2001) estimates of residualized wage autocorrelation and dispersion $\rho = 0.9136$ and $\text{var}(\epsilon_{it}) = 0.0426$
- Probably understates kurtosis of actual earnings, employment/unemployment transitions
 - | Very important for the counter-cyclicality of income risk (re: Acharya and Dogra (2020))
 - | But I leave this out for now

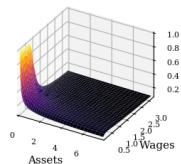
Table: General HANK Model Parameters

Parameter	Symbol	Value	Source or Target
<i>Households</i>			
Internally Calibrated:			
Quarterly Time Discounting		0.021	$r = 2\%$ Annually
Idiosyncratic Income Shock Variance	$\frac{2}{z}$	0.017	Floden and Lindé (2001)
Idiosyncratic Shock Mean Reversion	z	0.034	Floden and Lindé (2001)
Assumed from Literature:			
Relative Risk Aversion		2.0	McKay et al (2016)
Frisch Elasticity of Labor		0.5	Chetty (2012)
<i>Labor Market</i>			
Labor Elasticity of Substitution	σ_L	10	Philips Curve slope of 0.07
Rotemberg wage adjustment cost	w	100	Philips Curve slope of 0.07
<i>Government</i>			
Steady-state government debt	B_{NSS}	2.63	HANK $imPC_0$ 0:40
Geometric maturity structure of debt	β	0.043	Avg. maturity of 70 months
Income Tax Rate		0.25	
<i>Shocks</i>			
Mean reversion of fiscal shocks	τ_{Tax}	1.0	
Mean reversion of fiscal shocks	MP	0.175	Half life of 4 quarters

Distribution of Assets, Income, iMPCs and MPCs



Annual MPCs in the Cross-Section



Steady-state moments

Table: HANK Non-Stochastic Steady-State Statistics

Description	Symbol	Value
Contemporaneous iMPC (Annual)		0.43
Debt to Annual Income	$B_{NSS}=(4Y_{NSS})$	0.67
Correlation btw. Income and Assets	$R \text{ Corr}(a; z)$	0.56
Share of households with $a = 0$	$N_{SS}(0; z) dz$	0.27
Asset Gini Coefficient		0.75
Income Gini Coefficient		0.31

- 27.6% of agents with zero wealth
- Half of the assets of my previous calibration
 - | Auclert, Rognlie, and Straub (2018) shock-contemporaneous MPC of 0.5
 - | Empirical MPC estimated by Fagereng, Holm, and Natvik (2021)

Robustness Exercises

Varying the Slope of the Phillips Curve (AF/PM)

Figure: Cumulative IRFs by Strength of Nominal Rigidities

Varying the Slope of the Phillips Curve (AF/PM)

AF/PM, Sacrifice Ratios by Nominal Rigidity

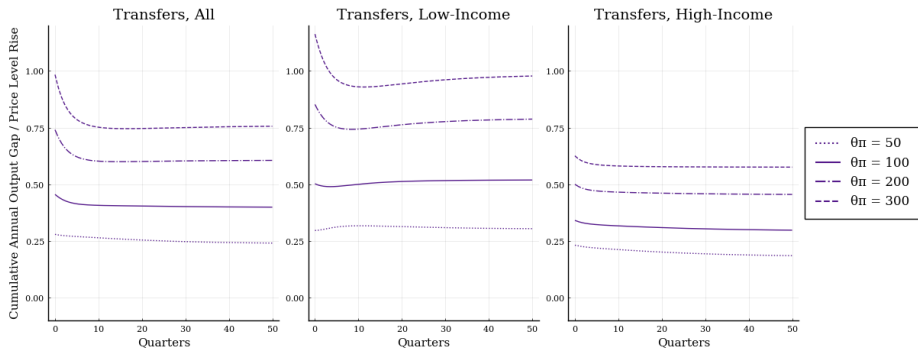


Figure: Sacrifice Ratios by Strength of Nominal Rigidities

Varying the Slope of the Phillips Curve (PF/AM)

Figure: Cumulative IRFs by Strength of Nominal Rigidities