The Amplification of Monetary Shocks in HANK

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In preparation for JMCB 50th birthday issue
A recent trend

- Monetary macro meets heterogeneous-agent macro
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- Fraction of speeches at Central Banks and Feds mentioning at least once the words: heterogeneous, heterogeneity, inequality

Source: BIS database of central bankers’ speeches
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Alves, Kaplan, Moll and Violante (2019)
Emerging new framework

- HA + NK: Aiyagari meets Gali-Woodford
Emerging new framework

• HA + NK: Aiyagari meets Gali-Woodford

• Attractive for at least three reasons:

  1. **Conceptually**, unified framework to study:
     • Short-run fluctuations and long-run dynamics of distribution
     • Stabilization and redistributive policies
     • Aggregate demand channel ⇒ importance of MPC

  2. **Empirically**, unified approach to micro and macro data

  3. **Technically**, now easier and faster to solve these models

Alves, Kaplan, Moll and Violante (2019)
Transmission mechanism of monetary shock

- **RA+NK**: direct intertemporal substitution effect

Qualitatively, many forces matter for amplification:

- **Income incidence**: heterogeneous exposure of $y$ to $Y$
- **Fiscal response**: timing and distribution of government budget constraint
- **Profit distribution**: distribution and liquidity of profit income
- **$K$ adjustment cost**: response of investment amplifies indirect GE effects

This paper: a quantitative assessment
Transmission mechanism of monetary shock

- **RA+NK**: direct intertemporal substitution effect

- **HA+NK**: indirect general equilibrium effects due to high MPC

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Alves, Kaplan, Moll and Violante (2019)
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  • **Fiscal response**: timing and distribution government budget constraint
  
  • **Profit distribution**: distribution and liquidity of profit income
  
  • **$K$ adjustment cost**: response of investment amplifies indirect GE effects

• **This paper**: a quantitative assessment
Outline

1. Model

2. Stationary Equilibrium
   Parameterization
   Distributions
   Monetary Transmission

3. What Matters for Amplification?
   Income Incidence
   Fiscal Policy
   Profit Distribution

4. Conclusion
Households: Simplified Version

- Continuum of households each solving the problem:

$$\max_{\{c_{it}, d_{it}\}} \mathbb{E}_0 \int_0^\infty e^{-(\rho+\zeta)t} \log(c_{it}) \, dt$$

subject to

$$\dot{b}_{it} = w_t z_{it} \eta_{it} + r_t^b b_{it} - c_{it} - d_{it} - \chi(d_{it}, a_{it})$$

$$\dot{a}_{it} = r_t^a a_{it} + d_{it}$$

$$b_{it} \geq 0, \quad a_{it} \geq 0$$
Continuum of households each solving the problem:

\[
\max_{\{c_{it}, d_{it}\}} \mathbb{E}_0 \int_0^\infty e^{-(\rho+\zeta)t} \log(c_{it}) \, dt
\]

subject to

\[
\dot{b}_{it} = (1 - \tau_t) w_t \Gamma_N(z_{it}, \eta_{it}, N_t) + r^b_t b_{it} + (1 - \alpha) z_{it} \eta_{it} \prod_{t}^m
\]
\[
+ \Gamma_T(z_{it}, T_t) - c_{it} - d_{it} - \chi(d_{it}, a_{it})
\]
\[
\dot{a}_{it} = r^a_t a_{it} + d_{it}
\]
\[
b_{it} \geq 0, \quad a_{it} \geq 0
\]
Incidence functions

- Exogenous rules that allocate $(N, T)$ across households

- Functional form for labor income incidence

\[
\Gamma_N(z, \eta, N) = \frac{z \eta(N/\bar{N}) \gamma_n(z)}{\int z' \eta'(N/\bar{N}) \gamma_n(z') d\mu} N \quad \text{with} \quad \int z \eta \gamma_n(z) d\bar{\mu} = 1
\]

- This satisfies

\[
\Gamma_N(z, \eta, \bar{N}) = z \eta \bar{N}, \quad \frac{\partial \log \Gamma_N(z, \eta, \bar{N})}{\partial \log N} = \gamma_n(z)
\]

- Similar functional form for $T$ incidence function
Asset markets

Liquid asset $b$

- Real government bonds $\rightarrow \int b_t d\mu_t + B_t^g = 0$

Illiquid asset $a$

- Equity of an investment fund:
  $$A_0 = \max_{\nu_t} \int_0^\infty e^{-\int_0^t r_s^a ds} \left\{ \left[ r_t^k - \nu_t - \Phi(\nu_t) \right] K_t + \alpha \Pi_t^m \right\} dt$$

  s.t.
  $$\dot{K}_t = (\nu_t - \delta) K_t$$

- Tobin’s $q$: $q_t^k = 1 + \Phi'(\nu_t)$

- Market clearing: $A_t = q_t^k K_t + q_t^m = \int a_t d\mu_t$

Alves, Kaplan, Moll and Violante (2019)
Monopoly profits

- Monopolistic producers of intermediate goods
  - Rent capital from fund and labor services from households
  - Produce with Cobb-Douglas production function, capital share = $\alpha$
  - Quadratic price adjustment costs à la Rotemberg (1982) $\Rightarrow$ Phillips curve

Counterfactual implications of countercyclical profits:
- If reinvested in the fund, dampen $I_t$ in a boom
- If paid to liquid account, reduce household income in boom

Baseline: fraction paid in the illiquid account neutralize fluctuations of $m_t + k_t = [m_t Y_t + (1 - m_t) Y_t] = Y_t$
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- Baseline: fraction $\alpha$ paid in the illiquid account ⇒ neutralize fluctuations of $mc_t$

$$r_t^k K_t + \alpha \Pi_t^m = \alpha [mc_t Y_t + (1 - mc_t)Y_t] = \alpha Y_t$$

Alves, Kaplan, Moll and Violante (2019)
Labor market

- Aggregate labor demand schedule (from optimization):
  \[ mc_t F_N(K_t, N_t) = w_t \]

- Real wage setting (ad-hoc)
  \[ w_t = \bar{w} \left( \frac{N_t}{\bar{N}} \right)^\varepsilon \]

- Aggregate labor input \( N_t \) is demand determined:
  \[ mc_t F_N(K_t, N_t) = \bar{w} \left( \frac{N_t}{\bar{N}} \right)^\varepsilon \]

- Incidence function \( \Gamma_N \) allocates \( N_t \) across households
Government

Fiscal Authority

- Issues liquid debt \((B^g)\), spends \((G)\), taxes \((\tau)\) and transfers \((T)\)

\[
B^g_t + G_t + T_t = \tau w_t N_t + r_t^b B^g_t
\]

Monetary Authority

- Sets nominal rate on liquid assets based on the Taylor rule:

\[
i_t = \bar{r}_t^b + \phi \pi_t + \epsilon_t
\]

Alves, Kaplan, Moll and Violante (2019)
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Parameters → moments

- Earnings dynamics → panel data evidence

- Discount factor → $A/Y$ ratio (3)

- Transaction cost function (3 parameters) →
  - $B/Y$ ratio (0.2)
  - Share of total hand to mouth households (0.31)
  - Share of wealthy hand to mouth households (0.25)

- $I_{\text{adj. cost}}$ → relative elast. of $I$ to $Y$ after monetary shock (2)

- Elasticity of $w$ to $N$ after monetary shock (0.10)

Alves, Kaplan, Moll and Violante (2019)
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Model liquid and illiquid wealth distributions

- **Top**: very skewed wealth distribution (Gini \(\approx 0.84\))
- **Bottom**: share of hand-to-mouth households as in the data
MPC heterogeneity (windfall of $500)

• Aggregate quarterly MPC out of $500 rebate: 15%
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Monetary shock (25 BP)

Without capital adj. cost  With capital adj. cost

- Relative volatility of $C, I$ in line with the data
Transmission mechanism of a monetary shock

Without capital adj. cost  With capital adj. cost

• Indirect GE effects important, more so when \( l \) moves by more
• Without capital adjustment costs, dividend movements account have negative effect
Transmission mechanism across the $b$ distribution

- Indirect and direct effect have different relative importance for households at different parts of the liquid wealth distribution
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Understanding role of incidence for amplification

- Recent papers emphasize potential importance of unequal incidence of aggregate income dynamics on individual income (Patterson (2019), Auclert (2018))

- Logic: Larger GE effects when high MPC households are more exposed to \( Y \) movements

- Aggregate consumption response to a change in aggregate income \( dY = \mathbb{E}_i[dy_i] \):

\[
dC = \mathbb{E}_i[MPC_i \cdot dy_i] \\
= E_i[MPC_i] dY + Cov_i \left( MPC_i, \gamma_i \frac{Y_i}{Y} \right) dY
\]
Understanding role of incidence for amplification

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• Aggregate consumption response to a change in aggregate income $dY = \mathbb{E}_i [dy_i]$: 

$$dC = \mathbb{E}_i [MPC_i \cdot dy_i]$$

$$= E_i [MPC_i] dY + Cov_i \left( MPC_i, \gamma_{yi} \frac{Y_i}{Y} \right) dY$$

• Two ingredients:
  1. Incidence functions: elasticities $\gamma_{yi}$
  2. Covariance of elasticities with with MPCs
Estimating incidence functions

• CPS 1967-2017: all individuals aged 26-55

• Construct persistent component of each type of income:
  • Project earnings on age, gender, race, marital status, education, occupation with interactions, by year \( (R^2 \approx 0.4) \) \( \Rightarrow \) divide sample of fitted values \((z_i)\) into 50 quantiles
Estimating incidence functions

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  - Project earnings on age, gender, race, marital status, education, occupation with interactions, by year \( R^2 \approx 0.4 \) ⇒ divide sample of fitted values \( z_i \) into 50 quantiles

- **Labor income**: wage compensation + 2/3 self. employment

- **Capital income**: interests + dividends + rents + 1/3 self. employment

- **Govt income**: all transfers (UI, TANF, SNAPs, SSI, etc.)
Estimating incidence functions

- CPS 1967-2017: all individuals aged 26-55
- Construct **persistent component** of each type of income:
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- **Labor income**: wage compensation + 2/3 self. employment
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- **Govt income**: all transfers (UI, TANF, SNAPS, SSI, etc.)
- For each quantile of \( z \), regress:
  \[
  \log y_{it} = \beta_0(z) + \gamma_y(z) \cdot \log Y_t + \beta_1(z) \cdot t + \epsilon_t
  \]

Alves, Kaplan, Moll and Violante (2019)
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- Zeros are 100 times more frequent at P1 than at P100 ⇒ regress:

  $$\text{asinh}(y_{it}) = \beta_0(z) + \gamma_y(z) \cdot \log Y_t + \beta_1(z) \cdot t + \epsilon_t$$

Alves, Kaplan, Moll and Violante (2019)
Elasticities: labor income

- Guvenen, Schulhofer-Wohl, Yogo (2017): U-shape at high end in SSA data w/o top coding

Alves, Kaplan, Moll and Violante (2019)
Approximation of labor incidence function for model
Elasticities: government income

- Similar, except at bottom 10% (to whom 20% of $T$ are allocated)

Alves, Kaplan, Moll and Violante (2019)
Approximation of government incidence function for model
How incidence covaries with MPCs

- Share of HtM household by permanent income in model and data
- MPC highly correlated with HtM

Alves, Kaplan, Moll and Violante (2019)
Monetary shock with unequal labor incidence

Without capital adj. cost  With capital adj. cost

• Smaller differences with capital adjustment costs
Relation to Patterson (2019)

- Patterson (2019): unequal incidence amplifies GE multiplier by 40%

- Q: How to square with our findings? A: What one means by ‘amplify’

- Patterson: multiplier with (without) unequal incidence is $1.42 (1.3) \Rightarrow 0.42/0.3 - 1 = 40$

- Our findings consistent: blowing up our equal incidence IRF by $1.42/1.3$ yields approximately our estimated incidence IRF
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Fiscal adjustment after monetary expansion

\[ \dot{B}_t^g + G_t + T_t = \tau w_t N_t + r_t^b B_t^g \]

- Failure of Ricardian equivalence: timing of tax or transfer adjustment matters
- Short-run adjustment in the government budget constraint:
  - Debt \((B_t^g)\) falls
  - Transfers \((T_t)\) rise
  - Expenditures \((G_t)\) rise

Alves, Kaplan, Moll and Violante (2019)
Fiscal adjustment after monetary expansion

Without capital adj. cost  With capital adj. cost
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Profit distribution out of steady-state

- Generalized function for profit distributions into liquid account:

\[ z_{it} \eta_{it} \left[ (1 - \alpha) \bar{\Pi}^m + (1 - \omega)(\Pi_t^m - \bar{\Pi}^m) \right] \]

- Compare four alternative versions profit deviations from steady state \( \Pi_t^m - \bar{\Pi}^m \):
  1. Same as in steady-state (baseline): \( \omega = \alpha \Rightarrow z_{it} \eta_{it} (1 - \alpha) \Pi_t^m \)
  2. All into liquid: \( \omega = 0 \)
  3. All into illiquid: \( \omega = 1 \)
  4. All into liquid, but equally distributed

- Trade-off between cyclicality of household income and cyclicality of investment
Profit distribution out of steady-state

Without capital adj. cost  With capital adj. cost

- Without capital adjustment costs, profit distribution matters because it affects / which in turn affects size of indirect GE effects
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Taking stock, so far

- Quantitative assessment of various sources of shock amplification in HANK
  - Income incidence
  - Fiscal policy
  - Profit distribution

Main takeways: all three matter for C. Relative importance: Alves, Kaplan, Moll and Violante (2019)
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- **Main takeways:** all three matter for $C$.
  - Income incidence
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Alves, Kaplan, Moll and Violante (2019)
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  1. Fiscal policy
  2. Profit distribution
  3. Income incidence

Alves, Kaplan, Moll and Violante (2019)
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• Main takeways: all three matter for $C$. Relative importance:
  1. Fiscal policy
  2. Profit distribution
  3. Income incidence

• All of these: in RANK, either unimportant or cannot even think about

• HANK opens up door to doing so