MPCs, MPEs and Multipliers:
A Trilemma for New Keynesian Models

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What do micro data tell us about macro models?

- New Keynesian (NK) models can match macro moments very well.
    - comovement of time series, impulse responses to identified shocks…
- We need **more data** to choose from competing models and to make further progress!

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- We need **more data** to choose from competing models and to make further progress!
- **This paper:** use a mix of **micro** and **macro** moments to
  1. reject canonical NK with sticky prices and flexible wages
  2. argue for NK with **sticky wages** & **household heterogeneity**

Three Facts to judge business cycle models

▸ Where do our Facts come from?

- **Micro**: How do individuals respond to a one-time increase in income?
  - consume more: marginal propensity to consume, **MPC**
  - work less: marginal propensity to earn, **MPE**
  - save more: $1 - \text{MPC} - \text{MPE}$
- **Macro**: How does GDP respond to an increase in government spending?
  - **cumulative fiscal multiplier**: $\text{PDV}(dY)/\text{PDV}(dG)$

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Facts

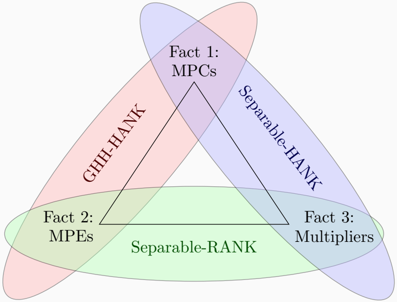
Fact 1: Average MPCs are high, around 0.25 quarterly or 0.5 annually.

Fact 2: Average MPEs are low, between 0 and 0.04 annually.

Fact 3: Fiscal multipliers are moderate, between 0.6 and 2 when monetary policy is accommodative.

The trilemma and its solution

- New Keynesian models with **frictionless labor market fail** to match at least one of the Facts.
  - separable-RANK: Galí (2015)
  - separable-HANK: Kaplan, Moll and Violante (2018)
  - GHH-HANK: Bayer, Lütticke, Pham-Dao and Tjaden (2019)



RANK: representative agent
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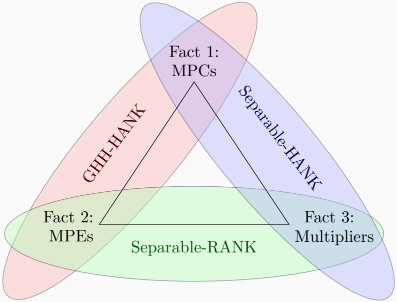
- **One solution**: HANK models with
  - sticky wages and demand-determined labor
  - weak consumption-labor complementarity
  - calibrated to match high MPCs



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Roadmap

1. **Consumer theory**: high MPC + low MPE requires high consumption-labor complementarity (CI).
2. **RANK analytics**: high CI dramatically increases multipliers.
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4. **Solution**: break MPC-MPE relationship with a labor market friction

The MPC-MPE relationship

Standard household model with frictionless labor supply

- Households are indexed by their skill e and assets a.
- Skills evolve according to Markov chain $\Pi(e'|e)$.

$$
\begin{aligned}
V_t(e,a) = \max_{c,n,a'} U(c,n) + \beta \mathbb{E}_t\left[V_{t+1}(e',a')\right] \\
\text{s.t. } c + a' = (1+r_t)a + w_t(e)n + T_t \\
a' \geq \underline{a}
\end{aligned}
$$

- Nests rep agent model for $e \equiv 1$ and $\underline{a} = -\infty$.

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- Formally, Fact 1 and Fact 2 are about the **population averages** of

$$\text{MPC} = \frac{\partial c_t(e,a;T_t)}{\partial T_t} \qquad \text{MPE} = -w\frac{\partial n_t(e,a;T_t)}{\partial T_t}$$

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- Nests rep agent model for $e \equiv 1$ and $\underline{a} = -\infty$.
- $U(c,n)$: strictly concave, twice cont differentiable, satisfies Inada conditions.
- All agents are on their **FOC for labor supply** (even the borrowing constrained):

$$-U_n(c,n) = w \cdot U_c(c,n) \tag{1}$$

Fact 1 vs Fact 2

Frisch and EIS definitions

Proposition 1 (MPC-MPE relationship)

Let's define **consumption-labor complementarity index** as

$$\mathrm{CI} \equiv \frac{\partial c(\lambda, w)}{\partial w} \Big/ w \frac{\partial n(\lambda, w)}{\partial w}.$$

Optimality of labor supply implies that for every individual and every period,

$$\boxed{\frac{\mathrm{MPE}}{\mathrm{MPC}} = \frac{wn}{c} \cdot \frac{\mathrm{Frisch}}{\mathrm{EIS}} \cdot (1 - \mathrm{CI}).}$$

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- CI can be interpreted as a *compensated MPC out of labor income.*

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- CI can be interpreted as a *compensated MPC out of labor income.*
- For typical calibrations, $c \approx wn$ and $\mathrm{Frisch} \approx \mathrm{EIS}$, hence $\mathrm{MPE} \approx (1 - \mathrm{CI})\,\mathrm{MPC}$.

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- For typical calibrations, $c \approx wn$ and $\text{Frisch} \approx \text{EIS}$, hence $\text{MPE} \approx (1 - \text{CI})\,\text{MPC}$.
- **Takeaway**: matching Fact 1 & Fact 2 requires high CI.

Roadmap

1. **Consumer theory**: high MPC + low MPE requires high consumption-labor complementarity (CI).
2. **RANK analytics**: high CI dramatically increases multipliers.
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Complementarity and multipliers

Embed rep-agent household in a New Keynesian model

- Household (Euler eq + labor supply):

$$U_c(C_t, N_t) = \beta(1 + r_t^e)U_c(C_{t+1}, N_{t+1}), \qquad (1 - \tau^w)w_t = -\frac{U_n(C_t, N_t)}{U_c(C_t, N_t)}$$

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- Firms (production fun + Phillips curve):

$$Y_t = f(N_t), \qquad \log(1 + \pi_t) = \kappa\left(\frac{w_t}{f'(N_t)} - \frac{\epsilon - 1}{\epsilon}\right) + \frac{1}{1 + r_t^e}\frac{Y_{t+1}}{Y_t}\log(1 + \pi_{t+1})$$

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- Monetary policy sets r_t, fiscal policy adjusts T_t to balance budget.

Micro meets macro: Fact 1, 2 vs Fact 3

Proposition 2 (Fiscal multipliers in RANK)

Let τ denote the **steady-state labor wedge**:

$$\tau \equiv 1 + \frac{U_n(C_t, N_t)}{U_c(C_t, N_t)} \frac{1}{f'(N_t)} = 1 - (1 - \tau^w) \frac{\epsilon - 1}{\epsilon}$$

The marginal effect of a government spending shock on output in a canonical RANK model with constant real interest rate is

$$\boxed{\frac{dY_t}{dG_s} = \frac{1}{1 - (1 - \tau)\,\mathrm{CI}} \cdot \mathbf{1}_{s=t}}$$

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- **Takeaway**: matching Fact 3 requires low CI.

Proof sketch for intuition

- **Round 1**: aggregate demand increases by $dY = dG$.

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$$dC = \text{CI} \cdot w \cdot dN = \text{CI} \left(-\frac{U_n}{U_c}\right) \cdot \frac{1}{f'(N)} dY = \text{CI}(1-\tau) \cdot dG$$

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- **Round 2:** aggregate demand increases by $dY = \text{CI}(1-\tau)dG$.

- Multiplier process converges to

$$dY = \left[1 + \text{CI}(1-\tau) + \text{CI}^2(1-\tau)^2 + \dots\right] dG = \frac{dG}{1-(1-\tau)\,\text{CI}}$$

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Trilemma in HANK models

The goal of this section

- HANK models are famed for delivering Fact 1 (high MPC).
- Assess trade-off between Fact 2 (low MPE $\sim$ high CI) and Fact 3 (moderate multiplier $\sim$ low CI) conditional on matching Fact 1.
- **Preview**: no CI $\in [0, 1]$ can solve the trilemma.

Embed heterogeneous households in the same New Keynesian model

- Households trade in one-period real gov't bonds and firm equity.
- Certainty equivalence wrt aggregate shocks $\implies$ as if single asset.
- Progressive labor income tax achieves realistically high labor wedge ($\tau = 0.43$).
- Gov't adjusts labor income tax to pay for its spending.

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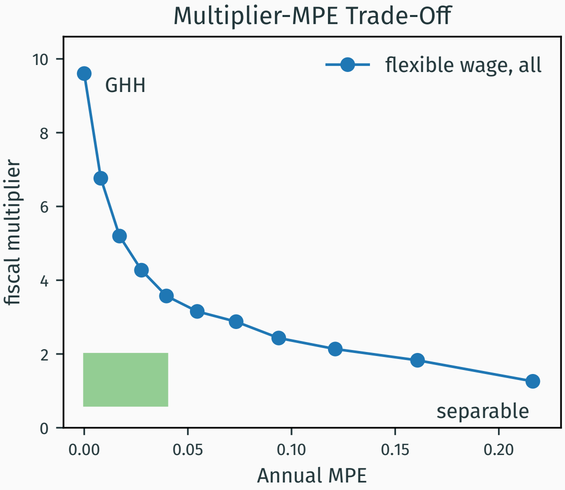
- Certainty equivalence wrt aggregate shocks $\implies$ as if single asset.
- Progressive labor income tax achieves realistically high labor wedge ($\tau = 0.43$).
- Gov't adjusts labor income tax to pay for its spending.
- **GHH-plus preferences** allow for any CI $\in [0, 1]$ as a function of $\alpha \in [0, 1]$:

$$U(c, n) = \frac{1}{1-\sigma}\left(c - \varphi\alpha\frac{n^{1+\nu}}{1+\nu}\right)^{1-\sigma} - \varphi(1-\alpha)\frac{n^{1+\nu}}{1+\nu}$$

$\alpha = 0 =$ CI is separable preferences; $\alpha = 1 =$ CI is GHH preferences.

Fiscal multipliers and MPEs in flexible-wage HANK

Calibration details



■ is the target for Fact 2 and Fact 3.

● are equilibra for full range CI $\in [0, 1]$.
Calibration holds "everything else" constant.

Trilemma: It takes high CI to match Fact 2 and low CI to match Fact 3.

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Sticky-wage HANK

Taking stock

- Frictionless hours choice at the household level $\implies$ tight connection between income effects on consumption and labor supply.
- Data call for high income effect on consumption and low on labor supply.
- Optimal response only if consumption-labor complementarity is high.
- High complementarity leads to large demand multiplier in NK.

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- Data call for high income effect on consumption and low on labor supply.
- Optimal response only if consumption-labor complementarity is high.
- High complementarity leads to large demand multiplier in NK.
- **Break MPC-MPE formula $\implies$ freedom to choose low CI.**

Union wage setting for heterogeneous households

▸ Union problem

- Households supply differentiated labor services n_{ikt} to unions $k \in [0, 1]$.
- Union k sets wage w_{kt} to maximize household welfare subject to
  - quadratic nominal wage adjustment cost
  - labor demand from with elasticity ϵ

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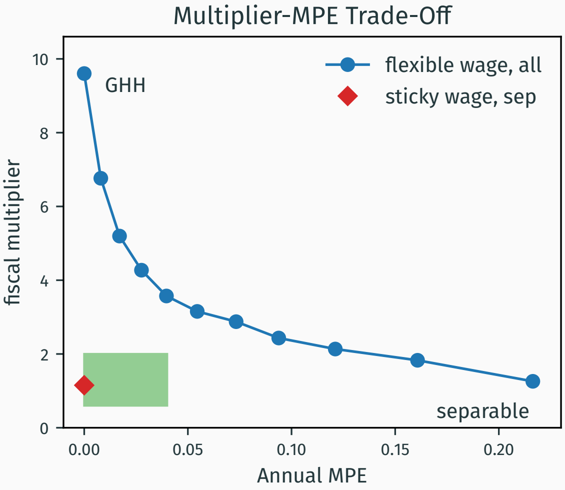
- Yields wage Phillips curve in the spirit of Erceg, Henderson and Levin (2000):

$$\log(1+\pi_t^w) = \kappa N_t \left[\underbrace{\int U_n(c_{it}, N_t)\,\mathrm{d}i}_{\text{avg disutil of labor}} - \left(\frac{\epsilon - 1}{\epsilon}\right) \underbrace{\int w_t(e_i) U_c(c_{it}, N_t)\,\mathrm{d}i}_{\text{avg util from higher wage}} \right] + \beta \log(1+\pi_{t+1}^w)$$

Eliminates trade-off between MPEs and multipliers



Unions represent all households.

Idiosyncratic shocks to household income affect neither wages nor hours.

MPE is 0 by construction.

Aggregate demand-labor feedback loop still a concern $\Longrightarrow$ use low CI (e.g separable prefs).

Sticky-wage model solves the trilemma.

Conclusion

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- New Keynesian models with flexible wages face a **trilemma** between
  1. high MPCs
  2. low MPEs
  3. moderate fiscal multipliers (even when monetary policy is accommodative)

- Our novel **analytical & numerical results** show that this is because consumption-labor complementarity has to be high for Fact 2 and low for Fact 3.

- **One solution** is to use New Keynesian models with
  - well-calibrated household heterogeneity $\implies$ Fact 1 ✓
  - sticky wages and demand-determined labor $\implies$ Fact 2 ✓
  - weak consumption-labor complementarity $\implies$ Fact 3 ✓

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  - well-calibrated household heterogeneity $\implies$ Fact 1 ✓
  - sticky wages and demand-determined labor $\implies$ Fact 2 ✓ alternative: search frictions
  - weak consumption-labor complementarity $\implies$ Fact 3 ✓

Takeaways for macro modelers

1. Don't just assume that **micro heterogeneity** does not matter for macro. ☺
    - solving HANK is easier than you think $\longrightarrow$ https://github.com/shade-econ/sequence-jacobian
2. **Separable preferences** are a good choice in RANK & HANK.
    - key is low CI, GHH can get problematic very easily
    - if want higher CI: high labor wedge, aggressive monetary policy can mask trilemma
3. **Demand-determined labor** (w sticky wages) is a useful device.
    - no labor supply response to idiosyncratic shocks
    - can specify labor income risk directly

Thank you!

Evidence on MPCs, MPEs, multipliers

Facts

- **MPC**: 0.25 quarterly, 0.5 annually
  - Kaplan and Violante (2014): review of large literature

- **MPE**: between 0 and 0.04 annually
  - Cesarini, Lindqvist, Notowidigdo and Östling (2017): Swedish lottery (one-time, small winnings, large sample)
  - Imbens, Rubin, and Sacerdote (2001): MA lottery (20-year annuity that we adjust, small sample)

- **Fiscal multiplier**: between 0.6 and 2 with accommodative monetary policy
  - Ramey (2019): review of large literature

Frisch and EIS definitions

◂ MPC-MPE relationship

- λ: marginal utility of consumption, w: effective wage
- Frisch elasticity of labor supply:

$$\text{Frisch} = \frac{\partial \log n(\lambda, w)}{\partial \log w}$$

- Elasticity of intertemporal substitution:

$$\text{EIS} = -\frac{\partial \log c(\lambda, w)}{\partial \log \lambda}$$

Calibration

◂ Sticky-price model

parameter	name	value/target
	A. Fixed parameters	
$1/\nu$	Frisch elasticity	0.5
ρ_e	persistence of income process	0.966
τ^g	income tax level	0.191
γ	income tax progressivity	0.177
ϵ	elast of substitution for varieties	7
B	government bonds	$0.55 \cdot 4Y$
ρ_B	persistence of public debt	0.9
$\underline{a}$	borrowing constraint	0
	B. Internally calibrated parameters	
β_1	upper discount factor	$r = 0.02/4$
β_2	lower discount factor	$\text{MPC} = 0.25$
$1/\sigma$	U_c curvature	average $\text{EIS} = 0.5$
φ	disutility of labor	$N = 1$
Z	aggregate labor productivity	$Y = 1$
σ_e	std of income shocks	$\text{Var}\left[\log(n_i e_i)\right] = 0.92^2$
F	fixed cost	$p = 0.85 \cdot 4Y$

Bellman equation of labor union

- Union k sets nominal wage W_{kt} to maximize household utility

$$J_{kt}(W_{kt-1}) = \max_{W_{kt}} \int U(c_{it}, n_{it})di - \underbrace{\frac{\epsilon}{2\kappa} \log\left(\frac{W_{kt}}{W_{kt-1}}\right)^2}_{\text{wage adjustment cost}} + \beta\mathbb{E}_t\left[J_{kt+1}(w_{kt})\right]$$

- Subject to labor demand

$$n_{kt} = \left(\frac{W_{kt}}{W_t}\right)^{-\epsilon} N_t$$

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