ECON 411–3: MACROECONOMICS WITH HETEROGENEITY

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STARTING POINT: THE REPRESENTATIVE-AGENT HOUSEHOLD

- Suppose exogenous income is y, real return is r, infinite-horizon problem:

$$\max_{\{c_t,a_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u(c_t)$$

$$c_t + a_t = (1 + r_t)a_{t-1} + y_t$$

- Euler equation is

$$u'(c_t) = \beta(1 + r_{t+1})u'(c_{t+1})$$

- From Euler equation, steady state is only possible if

$$\beta(1 + r) = 1$$

"CONSUMPTION FUNCTION" OF REPRESENTATIVE AGENT

- With constant r satisfying $\beta(1+r)=1$, Euler equation implies constant consumption
- Can solve this constant consumption level, which is

$$c_t = ra_{-1} + \frac{r}{1+r}\sum_{s=0}^{\infty}(1+r)^{-s}y_s$$

  - i.e. that in each period, we consume a fraction $r/(1+r)$ of the date-0 present value of income, plus assets $(1+r)a_{-1}$

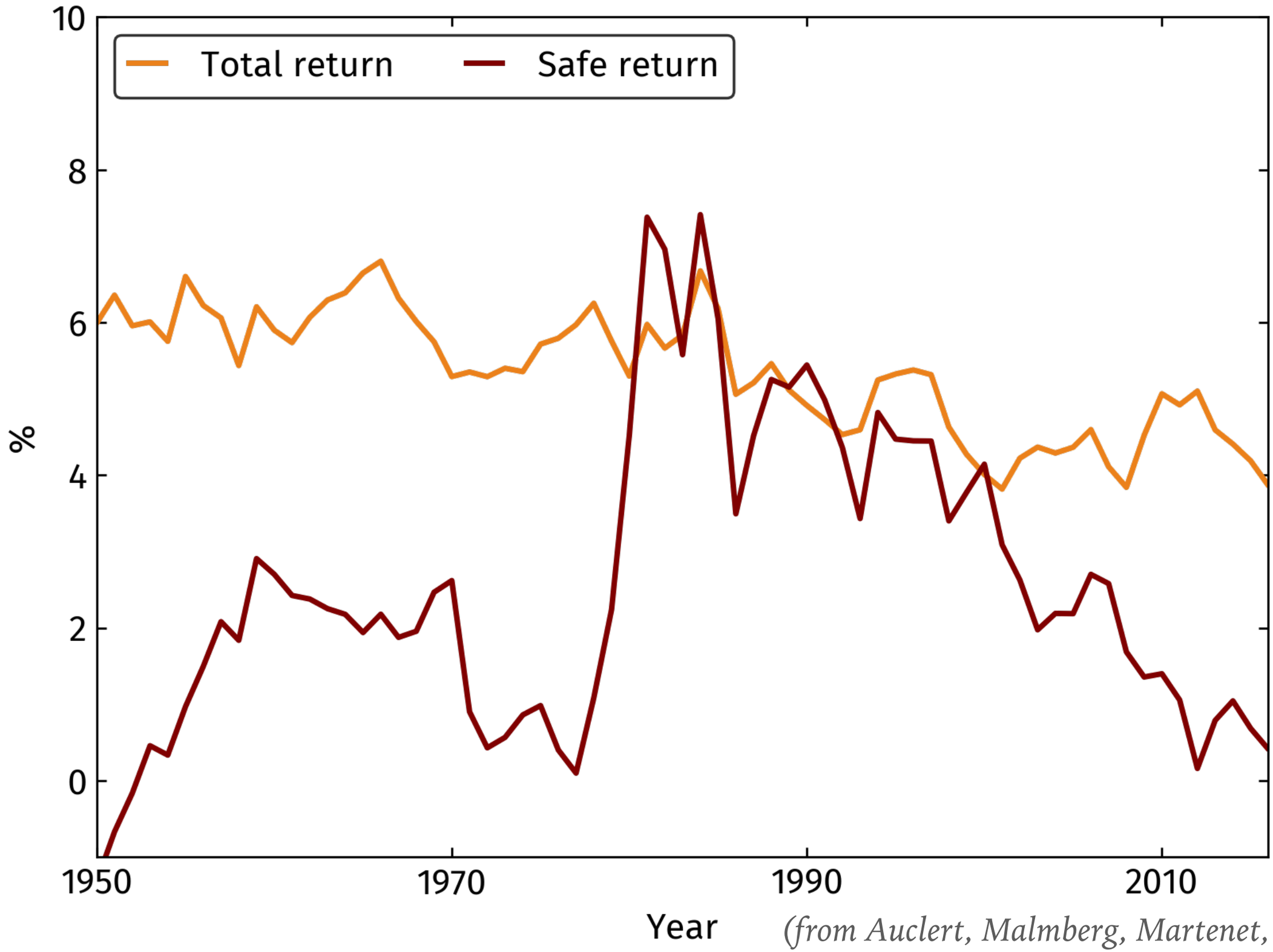
- "Marginal propensity to consume" (MPC) out of a surprise shock to income at date 0 is just $r/(1+r)$
  - if income is anticipated, even less!

SOME UNDESIRABLE FEATURES OF THIS MODEL

- Directly for macro:
  - $\beta(1+r) = 1$ means that **long-run real interest rate** is effectively exogenous
  - MPC close to 0 is counterfactual and shuts off important **feedbacks from current income to consumption**
    - extreme forward-lookingness causes other problems too

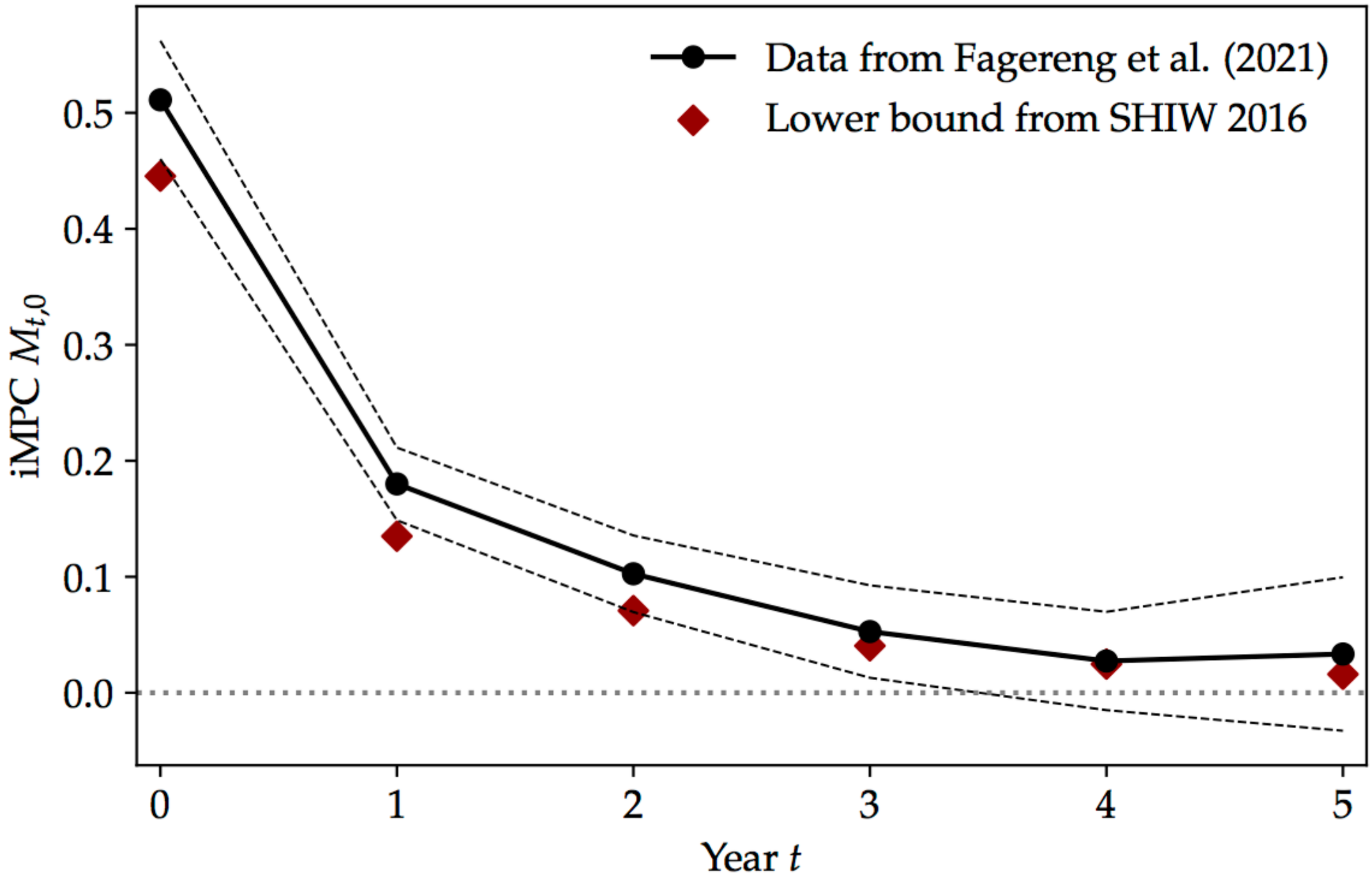
- For micro (with macro implications):
  - Can't speak to **inequality**, income/wealth distribution
  - Can't speak to **life-cycle** phenomena
  - Can't speak to **risk**

LONG-RUN "REAL INTEREST RATES" ARE FALLING…



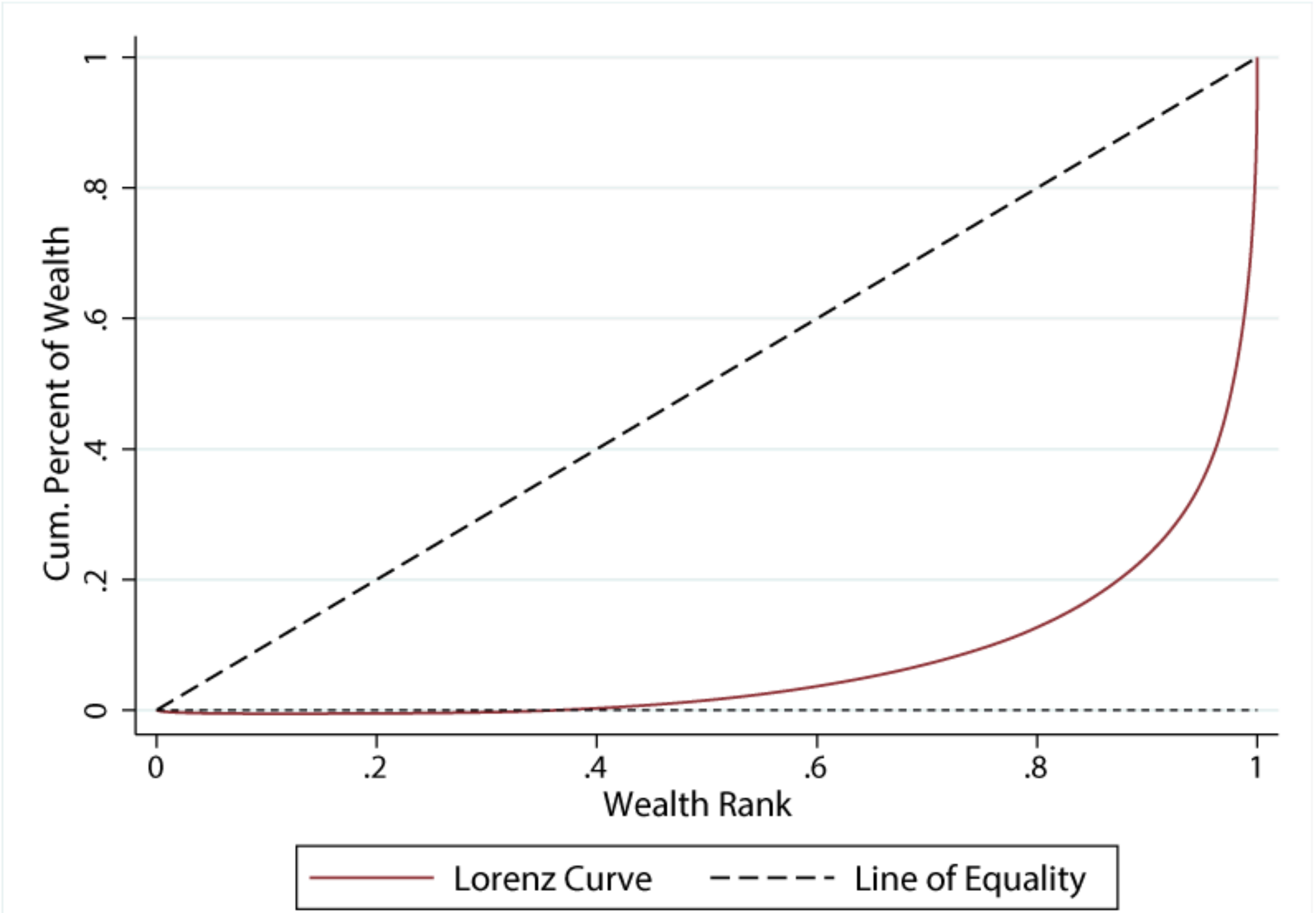
(from Auclert, Malmberg, Martenet, Rognlie)

MPCS ARE FAR HIGHER THAN ZERO



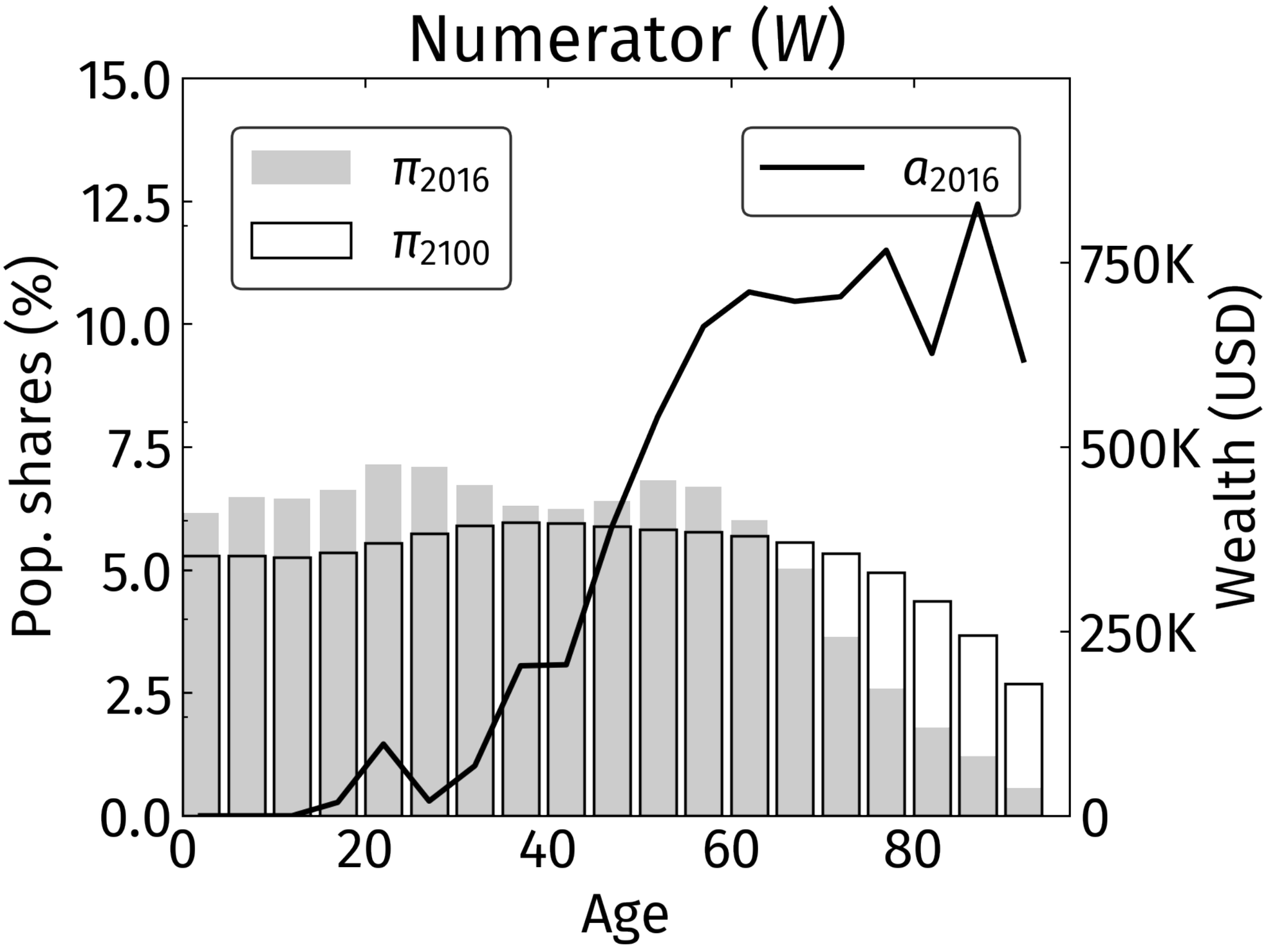
(from Auclert, Rognlie, Straub 2018, "intertemporal MPCs" out of year-0 transfer)

INCOME AND WEALTH DISTRIBUTIONS VERY UNEQUAL



(US wealth Lorenz curve, giving percent of total wealth held by poorest x% of population, from Aladangady and Forde 2021, corresponding to Gini of 0.85, which is gap between curve and 45-deg line times 2)

AND LIFE-CYCLE PATTERNS OF ASSET ACCUMULATION ARE KEY



(from Auclert Malmberg Martenet Rognlie, showing average wealth held ins US by age, and shifting age dist)

WHIRLWIND TOUR OF COURSE

FIRST EXPAND OUR HORIZONS WITH TWO ALTERNATIVE MODELS

- **Standard incomplete markets model (SIM)**
  - households consume and save subject to (uninsured) shocks to income and a borrowing constraint
  - aka income fluctuations problem, aka Bewley-Huggett-Aiyagari-Imrohoroglu-Zeldes-Deaton-Carroll model

- **Life-cycle / OLG models**
  - households consume and save over the life-cycle subject to income and consumption needs that vary by age
  - we'll generally allow them to insure against longevity (annuities)
  - can be combined with SIM!

FIRST STEP: BASIC PARTIAL EQUILIBRIUM IMPLICATIONS

- What are MPCs in these models?
- How sensitive are long-run assets to long-run r?
- What does the distribution of assets look like?

- These models will be useful, but with limitations:
  - e.g. SIM can match high MPCs but only with low wealth
  - SIM can endogenously generate wealth inequality, but not the fat right tail of the wealth distribution (for that we need other models, which we will briefly cover)

NEXT (BRIEF) STEP: NEOCLASSICAL GE IMPLICATIONS

- How are long-run real interest rates determined in these models?
- How might different shocks (to the age distribution, inequality, demand for capital, etc.) affect rates?

- Also: a bit on optimal policy

THEN: ON TO DYNAMICS

- "Partial equilibrium" dynamics—how household sector responds to some shock—are fairly straightforward
- "General equilibrium" dynamics for heterogeneous-agent economies a lot harder:
  - the **aggregate state includes the entire distribution of households**, which affects r and w in GE—infinite (or at least very high) dimension!
- Traditional Krusell-Smith approach: hope that "approximate aggregation" holds and not every aspect of distribution matters
  - hard, and doesn't apply in interesting cases

BETTER APPROACH: SOLVE FOR IMPULSE RESPONSE TO "MIT SHOCK"

- Assume start in steady state…
  - then at date 0 everyone learns there is some shock away from steady state
  - with perfect foresight from date 0 onward

- Called an "**MIT shock**"
  - seems crude, but a surprisingly powerful tool!
  - GE is reduced to solving for **sequences** (e.g. path r_t of real interest rate)
  - for small shocks, gives the same answer as assuming agents know shocks might happen ("certainty equivalence"; see Boppart Krusell Mitman 2018)

IMPLEMENTATION

- Key question: how to solve for equilibrium sequences
  - e.g. what path of r_t clears asset market
  - usual approach: **guess and update**, e.g. lower rates in periods where people are saving too much and vice versa
  - much better approach: use **"sequence-space Jacobians"**

- What can we do with these?
  - To first order in shocks, can simulate, obtain covariances at all leads and lags of different series, etc., all very easily

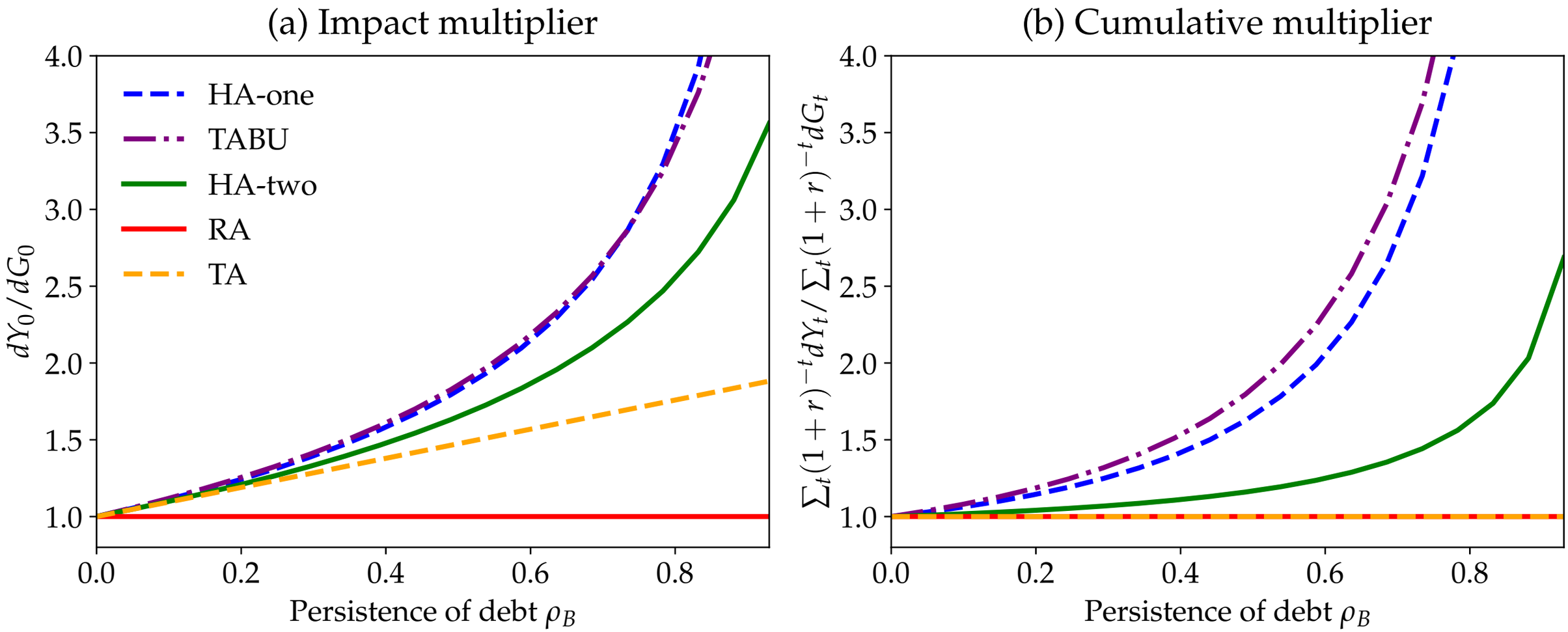
A KEY APPLICATION: HANK

- "HANK" models: **heterogeneous-agent New Keynesian**
  - sticky prices/wages create role for monetary policy and make output "demand determined", as in RANK
  - SIM and similar models, with high MPCs, create feedbacks from income to demand, lessen intertemporal substitution

- Two key messages:
  - Deficit-financed **fiscal policy**: much more stimulative
  - **Monetary policy**: not necessarily more powerful, but works through different channels

DEFICIT-FINANCED FISCAL POLICY: BIGGER MULTIPLIERS

Figure 5: Multipliers according to the IKC



From Auclert, Rognlie, Straub (2023), "Intertemporal Keynesian Cross", showing multipliers in quantitative model. The "HA" models (heterogeneous-agent model with high MPCs) have the highest multipliers, followed by the "TA" model, which has high static (but not intertemporal) MPCs from hand-to-mouth households

MONETARY POLICY: DIFFERENT TRANSMISSION CHANNELS

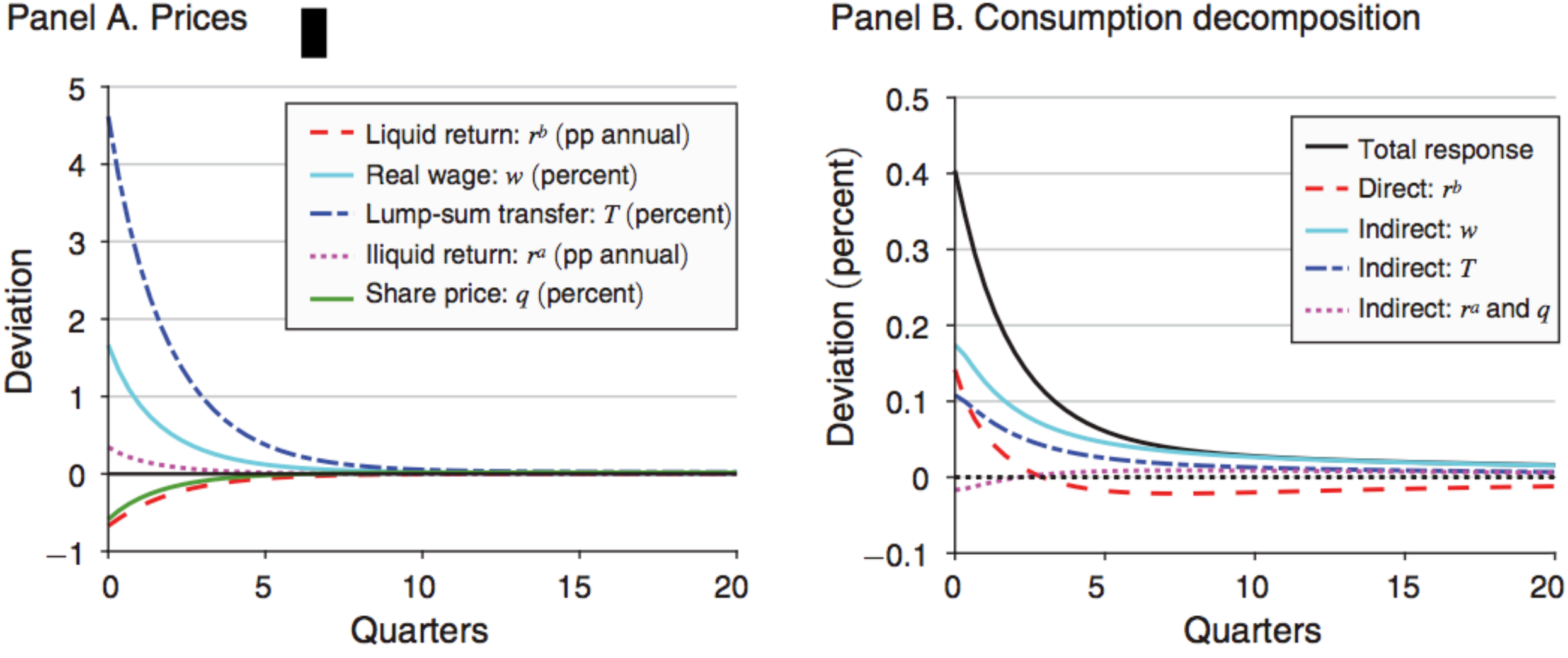


FIGURE 4. DIRECT AND INDIRECT EFFECTS OF MONETARY POLICY IN HANK

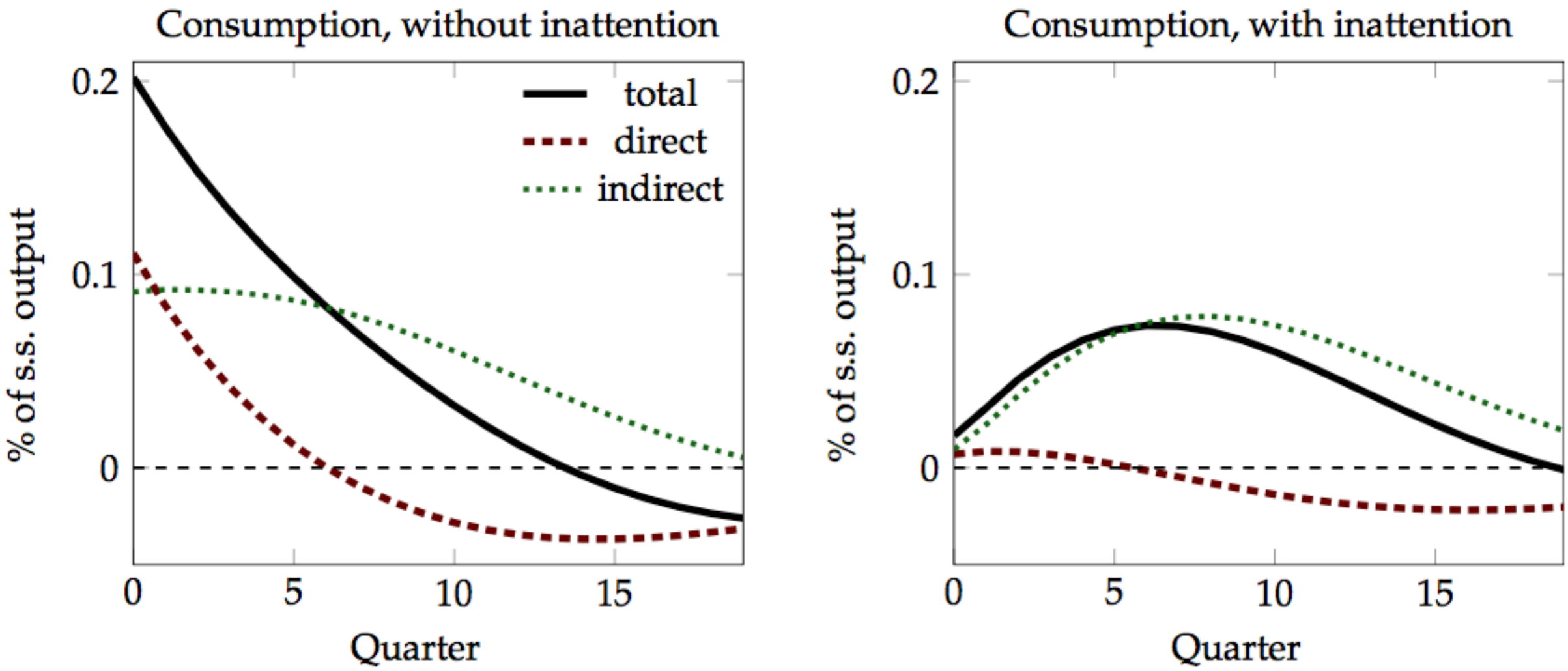
From Kaplan, Moll, Violante (2018), "Monetary Policy According to HANK". The right panel shows the increase in consumption in a HANK model from different sources. The "direct" change in the bond real interest rate, which accounts for most of the effect in a representative-agent model, is smaller here.

DEVIATING FROM FIRE (FULL-INFORMATION RATIONAL EXPECTATIONS)

- Both in RANK and HANK, expectations matter
  - usual assumption: full information and rational expectations ("FIRE")
  - results in very forward-looking behavior, e.g. intertemporal substitution in RANK or anticipation of income in HANK
    - seems unrealistic both intuitively and empirically

- We'll learn an easy way to implement some fixes, e.g.
  - *sticky information/expectations*: only occasionally revise plans in response to aggregate shocks
  - *cognitive discounting*: "discount" future deviations from steady state
  - *level-k thinking*: only iterate best responses finitely many times

STICKY EXPECTATIONS DELIVER HUMP-SHAPED IMPULSES



From Auclert, Rognlie, Straub (2020), "Micro Jumps, Macro Humps". Shows decomposition of response to monetary shock into direct and indirect effects a la Kaplan, Moll, Violante, in model with rational expectations (left) and sticky expectations (right). The latter delivers hump-shaped impulse more consistent with macro data and further weakens the direct vs. indirect effect.

THAT'S MOST OF THE COURSE! WHAT ELSE?

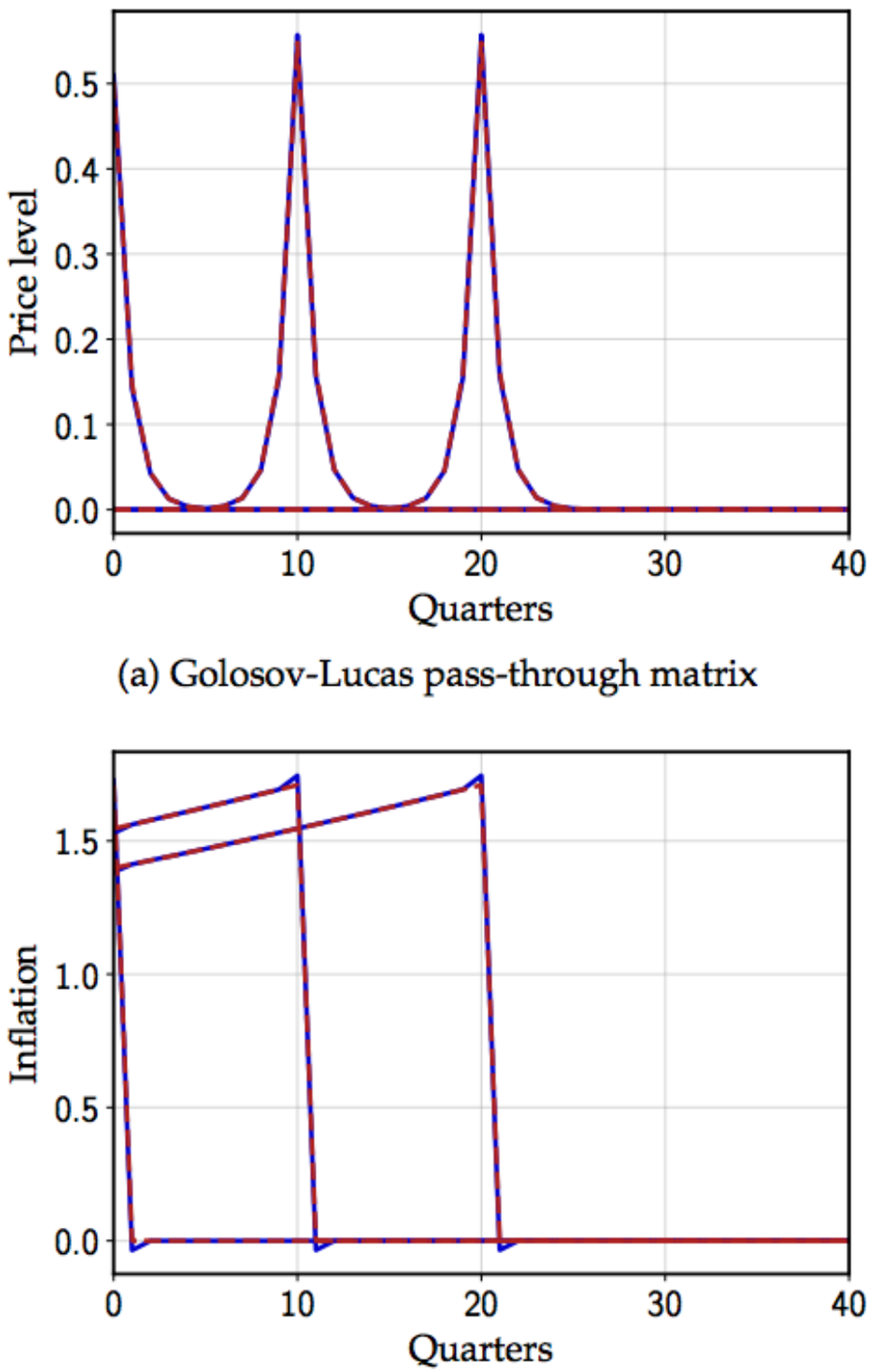
- So far, **key elements in modern macro with heterogeneity**:
  - non-RA models; their PE and steady-state GE consequences
  - how to solve for GE dynamics
  - application to HANK modeling
  - deviations from FIRE

- Will more briefly cover **three additional topics**:
  - price-setting and inflation
  - production with multiple sectors and input-output relationships
  - macro data, national accounts, and important secular trends

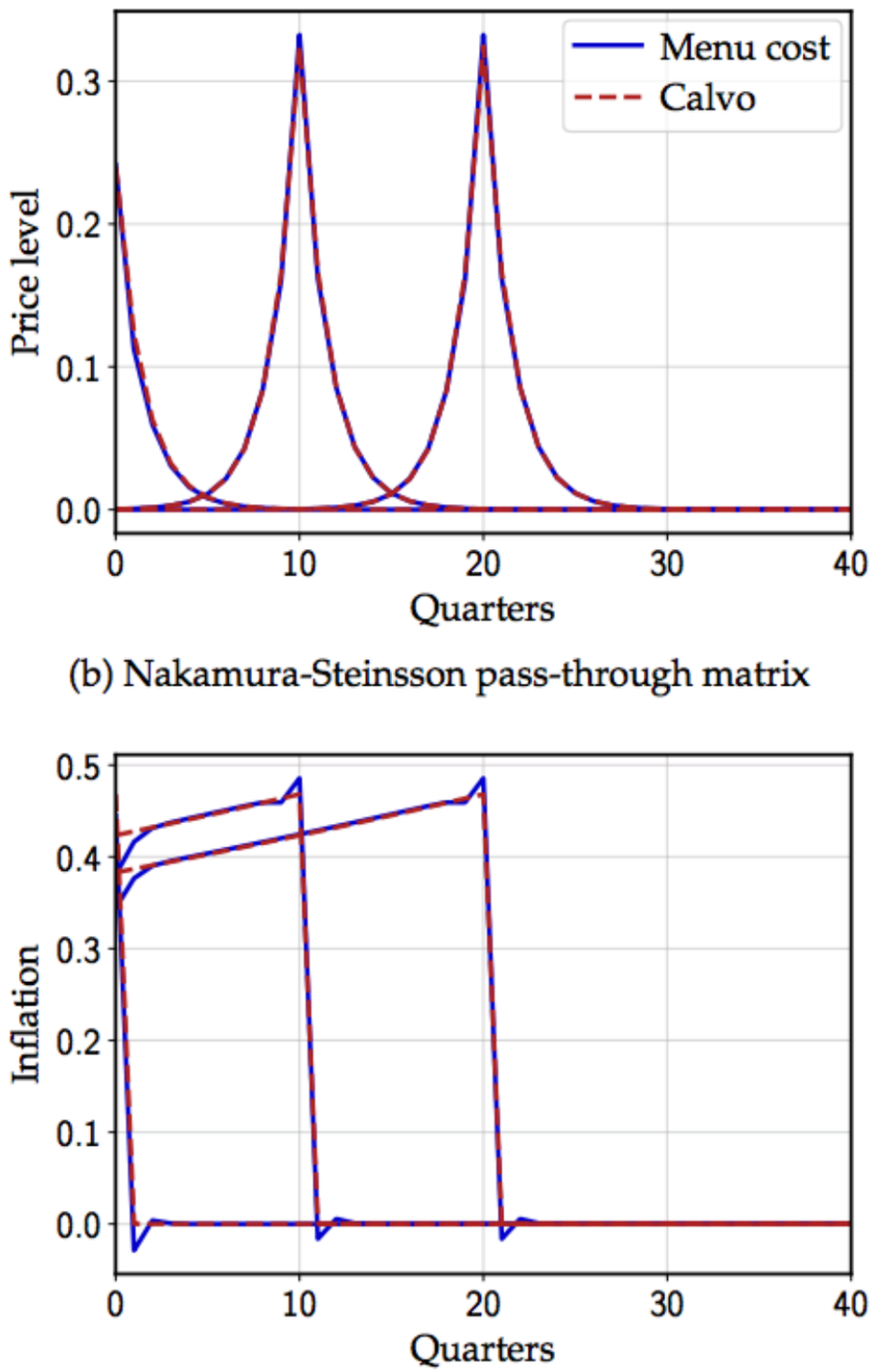
PRICE-SETTING AND INFLATION

- Three main trends in modeling of prices and inflation
- **1. Microfounded models of price-setting, w/micro data**
  - Golosov-Lucas, Nakamura-Steinsson, Alvarez-Lippi…
  - Auclert, Rigato, Rognlie, Straub (2023): resulting aggregate Phillips curve looks the same as from Calvo
- **2. Multisector and input-output models of price-setting**
  - Rubbo (2022), Afrouzi and Bhattarai (2023), …
- **3. Deviations from FIRE**
  - Angeletos and Lian (2018), Gabaix (2020), …

MICROFOUNDATIONS ON THEIR OWN DON'T GIVE US MUCH NEW



(a) Golosov-Lucas pass-through matrix



(b) Nakamura-Steinsson pass-through matrix

(c) Golosov-Lucas generalized Phillips curve

(d) Nakamura-Steinsson generalized Phillips curve

From Auclert, Rigato, Rognlie, Straub (2023), shows impulse responses of menu cost model vs. Calvo model to nominal (top) and real (bottom) marginal cost shocks at various horizons

MULTI-SECTOR PRODUCTION WITH INPUT-OUTPUT RELATIONSHIPS

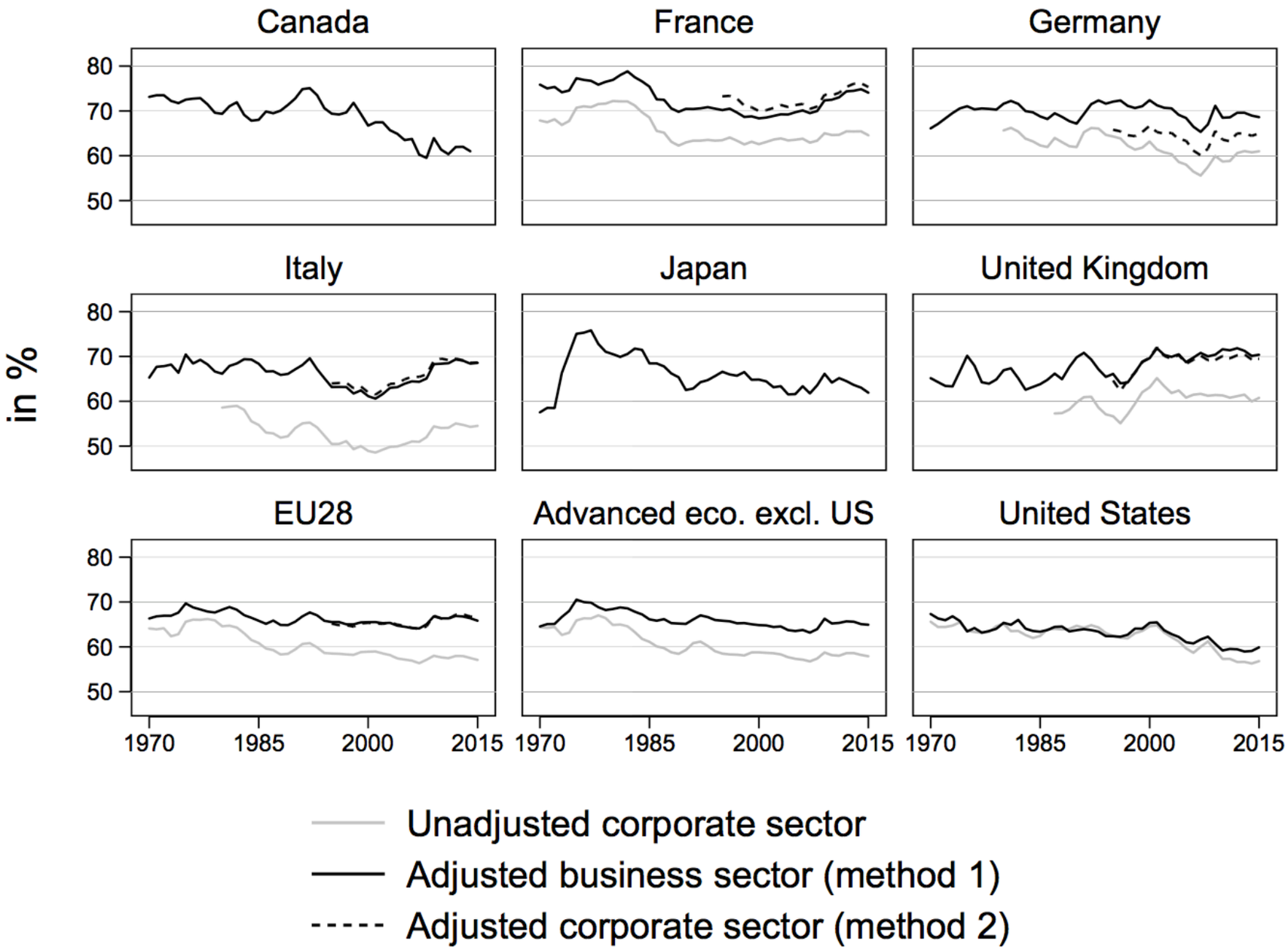
- Directly builds on neoclassical production theory, but a surprising amount one can get out of it:
  - first-order effects of TFP shocks simple (Hulten 1978)
  - … except with inefficiencies (e.g. Baqaee and Farhi 2020)
  - second-order more complex (e.g. Baqaee and Farhi 2019)
  - related to elasticities of substitution, interesting in their own right (e.g. Oberfield and Raval 2021)
  - generally an explosion of recent work!

AGGREGATE DATA, NATIONAL ACCOUNTS, SECULAR TRENDS

- We'll motivate with data throughout the course
- But I'll end with extra coverage of macro data
  - How do national accounts (and other key macro data measures) work, and what are some key relationships?
- Meaning of commonly cited secular trends:
  - labor share
  - savings rate
  - investment prices

SECULAR TRENDS CAN BE TRICKY!

Figure 1 – Domestic gross labor share in advanced economies, 1970-2015



From Gutierrez and Piton (2020): adjustments to remove housing and self-employment causes the secular decline in the labor share to mostly disappear outside the US