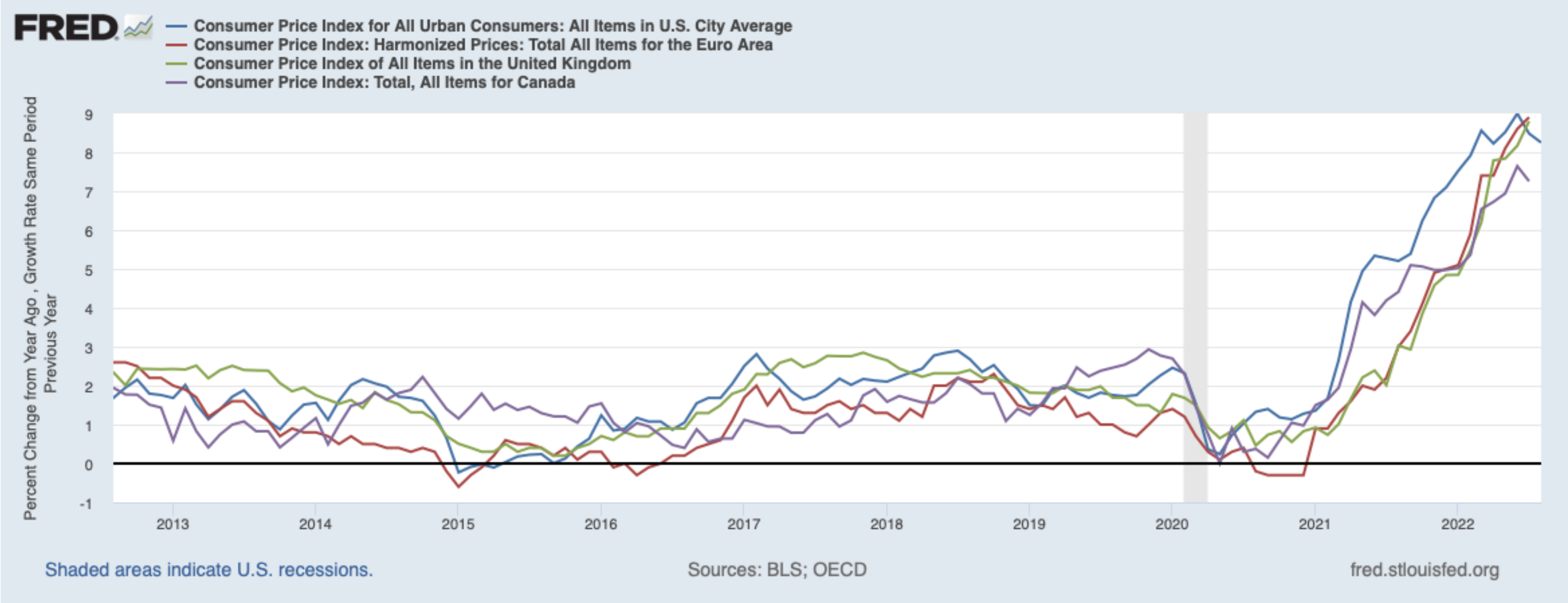


WHICH R*, PUBLIC BONDS OR PRIVATE INVESTMENT? MEASUREMENT AND POLICY IMPLICATIONS

Ricardo Reis
LSE

October, 2022
Brown Bag
FRB Cleveland

Motivation: why is inflation out of control?



The mission reviews: focus on r^*

August 27, 2020

New Economic Challenges and the Fed's Monetary Policy Review

Chair Jerome H. Powell

At "Navigating the Decade Ahead: Implications for Monetary Policy," an economic policy symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming (via webcast)

"...fall in the equilibrium real interest rate, or "r-star" ..." Powell (2020)

"structural developments have lowered the equilibrium real rate of interest" ECB (2021)

Focus on low r^* , natural/neutral real interest rate

- investment = savings and output is at potential
- long-run steady state

Why it has mattered for monetary policy?

- policy too tight, creativity employed for loosening through new tools
- focus on fear of deflation, welcome some inflation (e.g., AIT)
- insufficient demand at the ZLB, worry about stagnation, welcome monetary/fiscal stimulus
- reforms to productivity growth or to credit and capital allocation are second order

What this talk will do:

0) Observation: *all* measures of declining r^* are based on government bond yields.

- *Why would investment = savings there? And we know government bonds are increasingly “special”*
- *Casual inspections (Farhi Gourio, 18): “return on private capital has remained stable or even increased, creating an increasing wedge with safe interest rates”*

1) Measurement of the returns to private investment

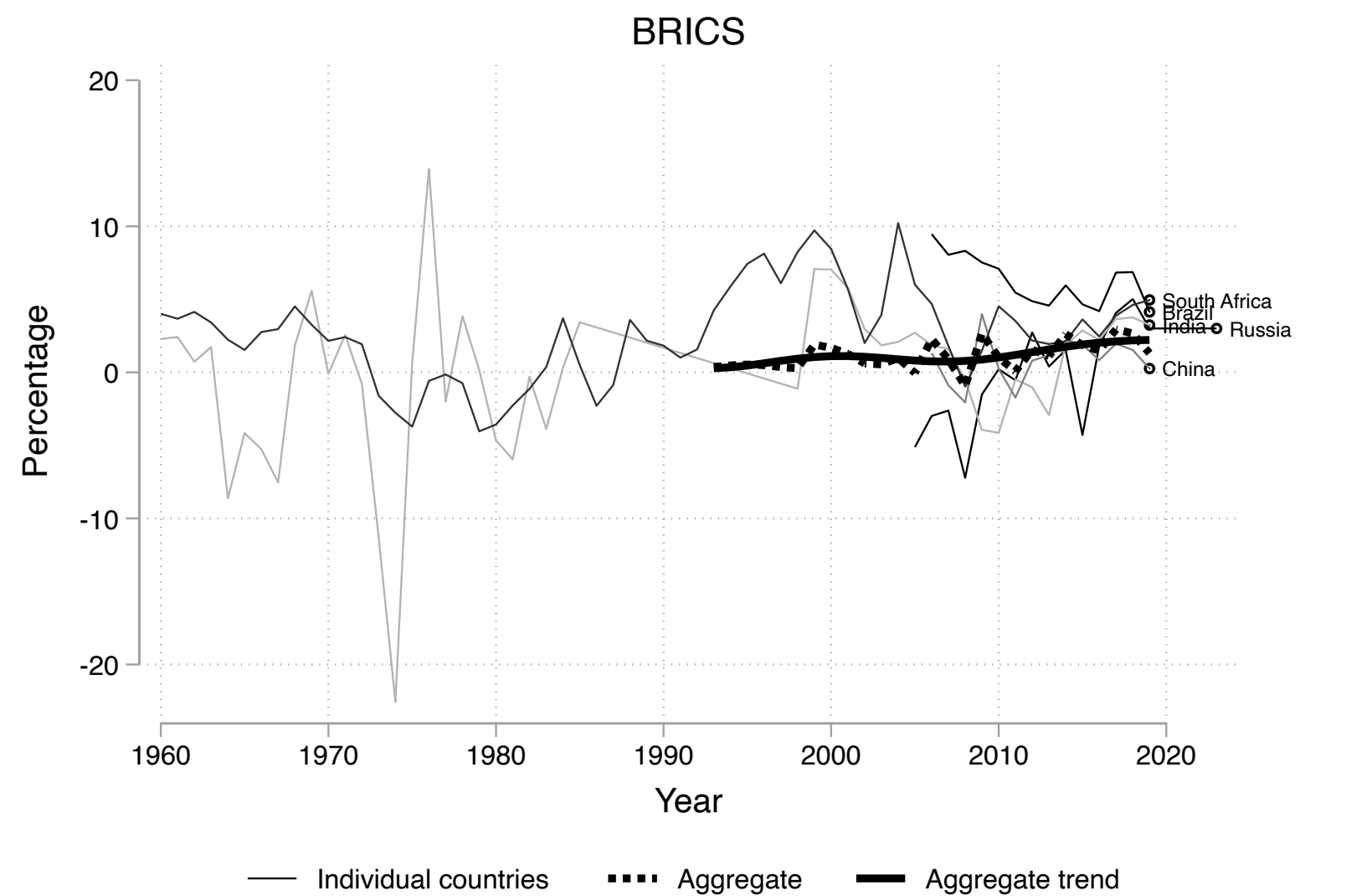
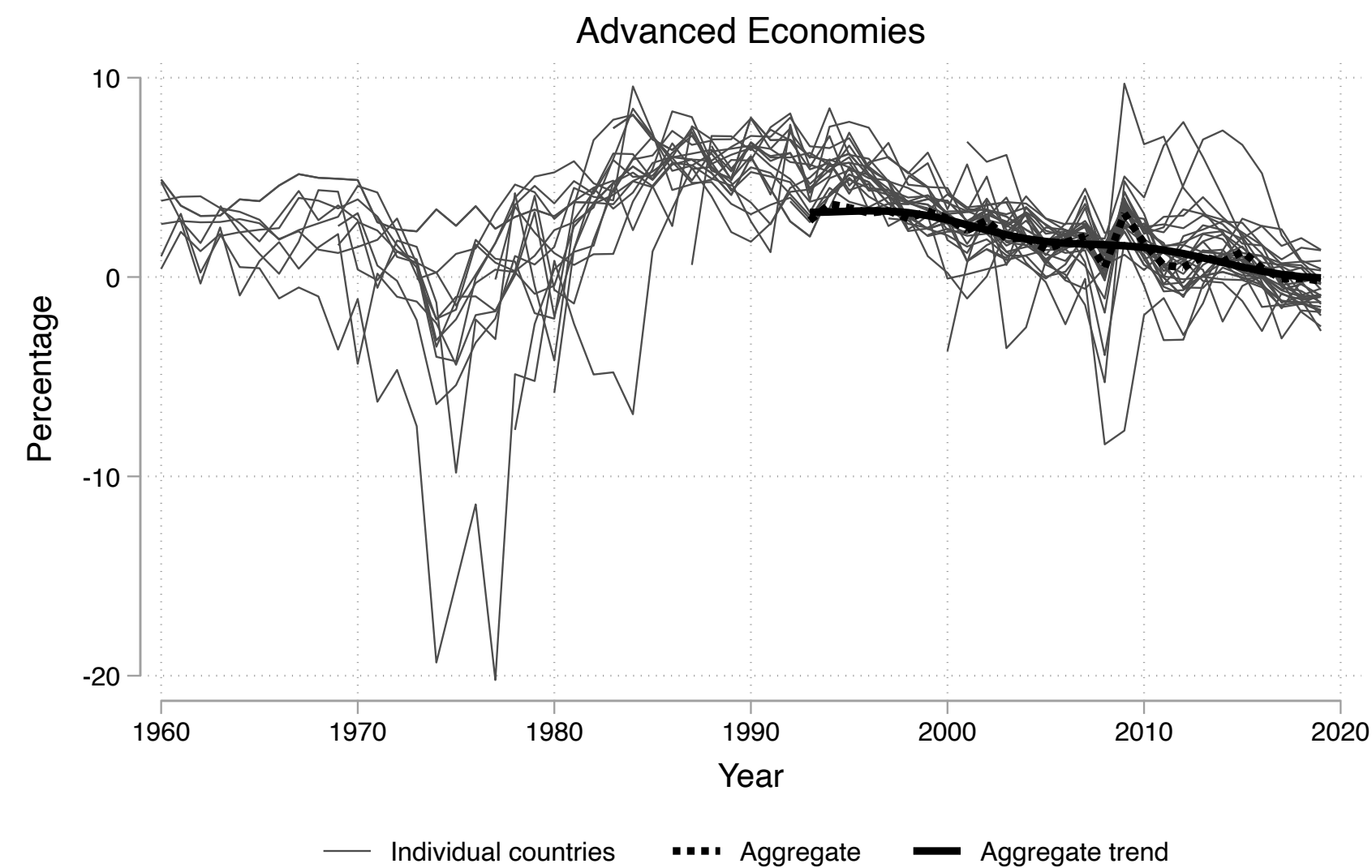
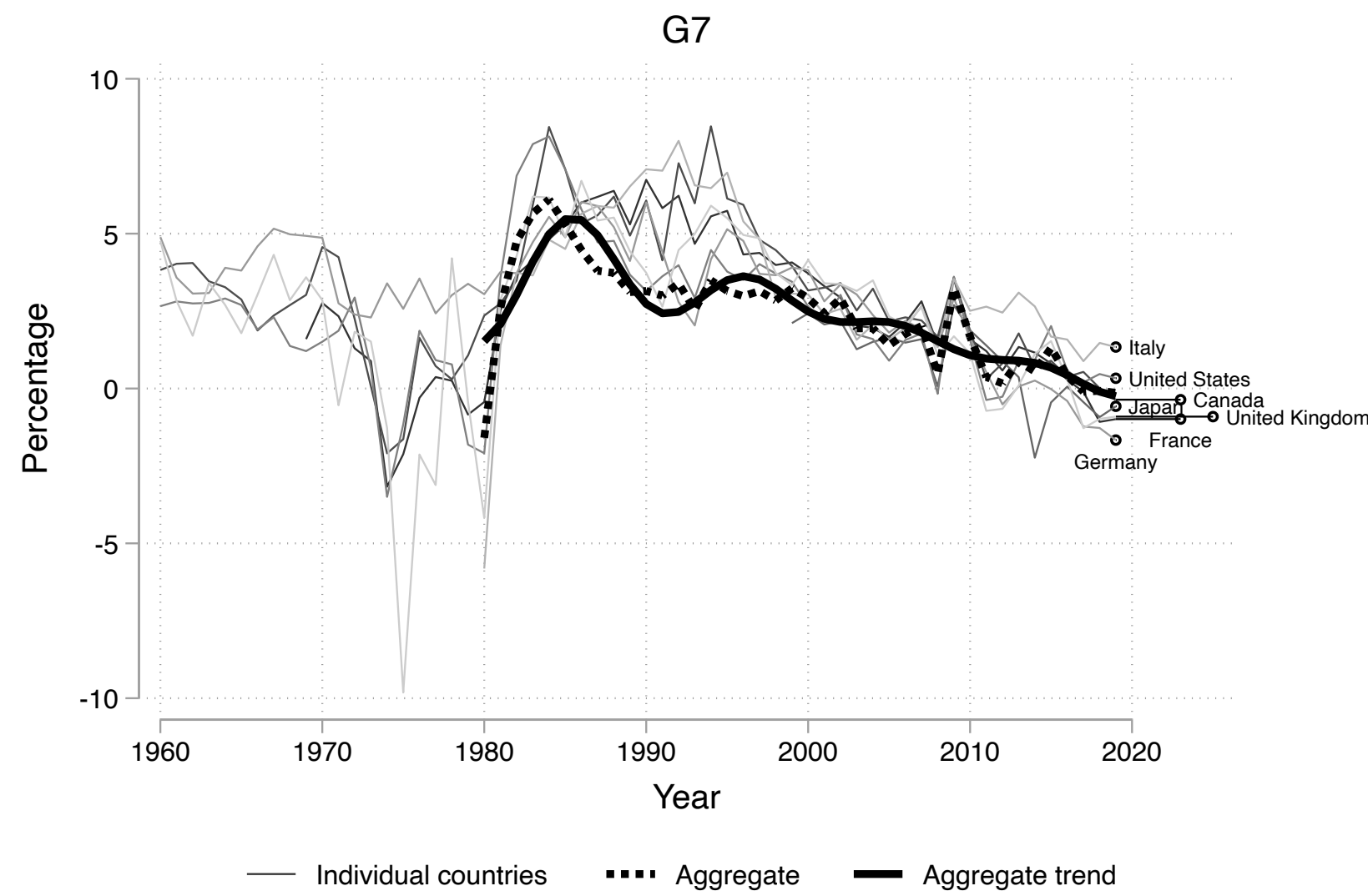
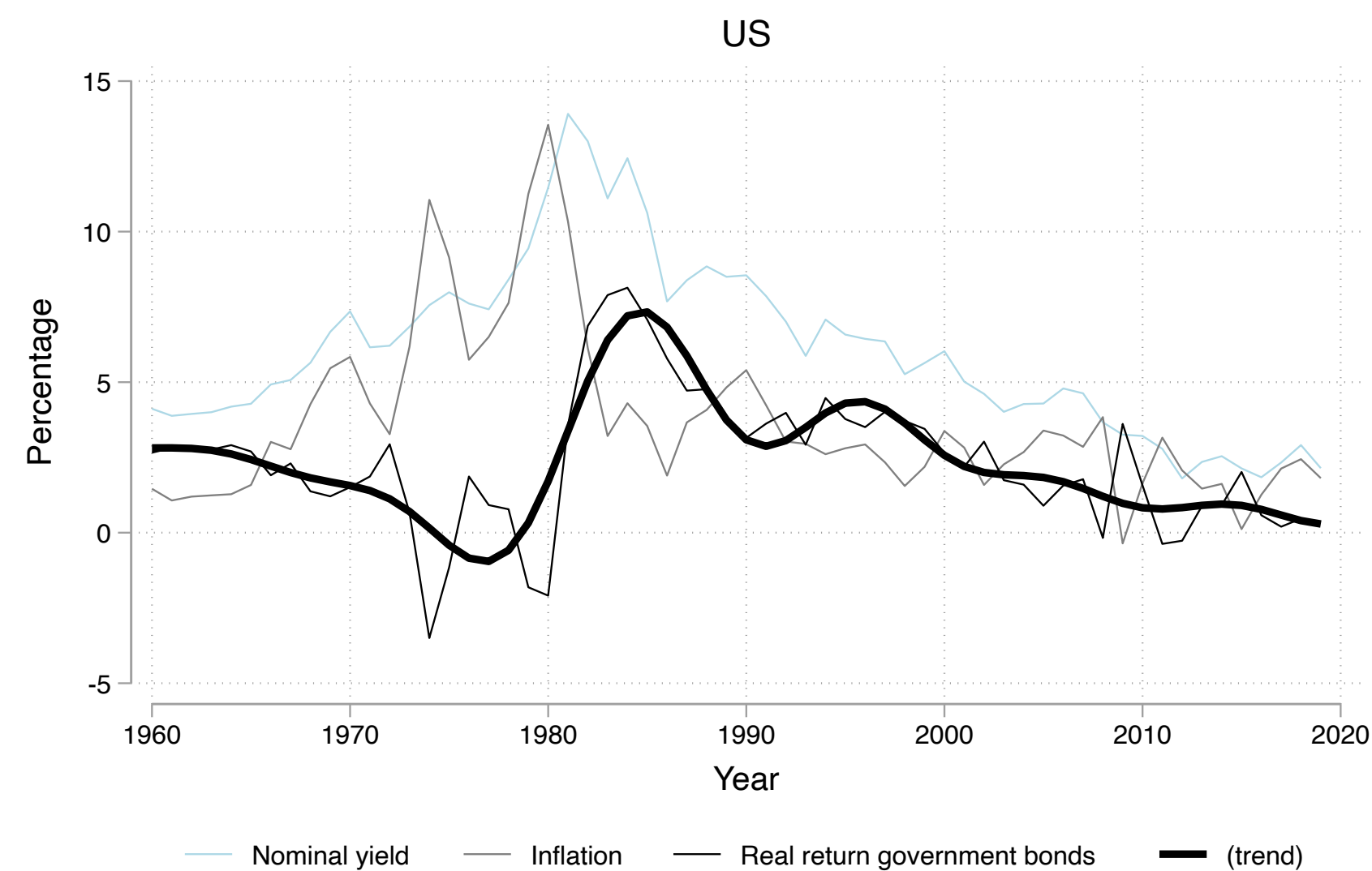
- *Move beyond Gomme Ravikumar Rupert (2011) and their focus on adjusting for taxes*
- *From demand average product with adjustments: (i) price of investment, (ii) depreciation, (iii) self-employment, (iv) cross-country (v) public capital, (vi) taxes (vii) capital gains, (viii) real estate, (ix) intangibles, (x) marginal versus average returns.*
- *From supply of capital: flow of savings from Euler equation, stock of savings from consumption-wealth*

2) Theory of monetary policy with a gap between r^* 's?

- *Government bond r^* tells you constraint on monetary policy, but private investment r^* tells you transmission*
- *Benefits from aggregate demand policies, or higher inflation at ZLB, are lower*
- *Benefits from aggregate supply policies, allocation of capital, are higher*

Measurement: demand for capital

Long literature on robust decline of r^b



- Trends using Mueller-Watson filter.
- Matches private return to savings only if efficient capital markets, and safe measure only if no arbitrage
- Modigliani-Miller says would need broad financial returns
- National accounts

Measuring returns to private capital: demand

Profits / CapitalStock

$$NOS = py - wl - \delta p^k k$$

$$r^* = \frac{NOS}{p^k k} = \frac{1 - \theta}{p^k k / py}$$

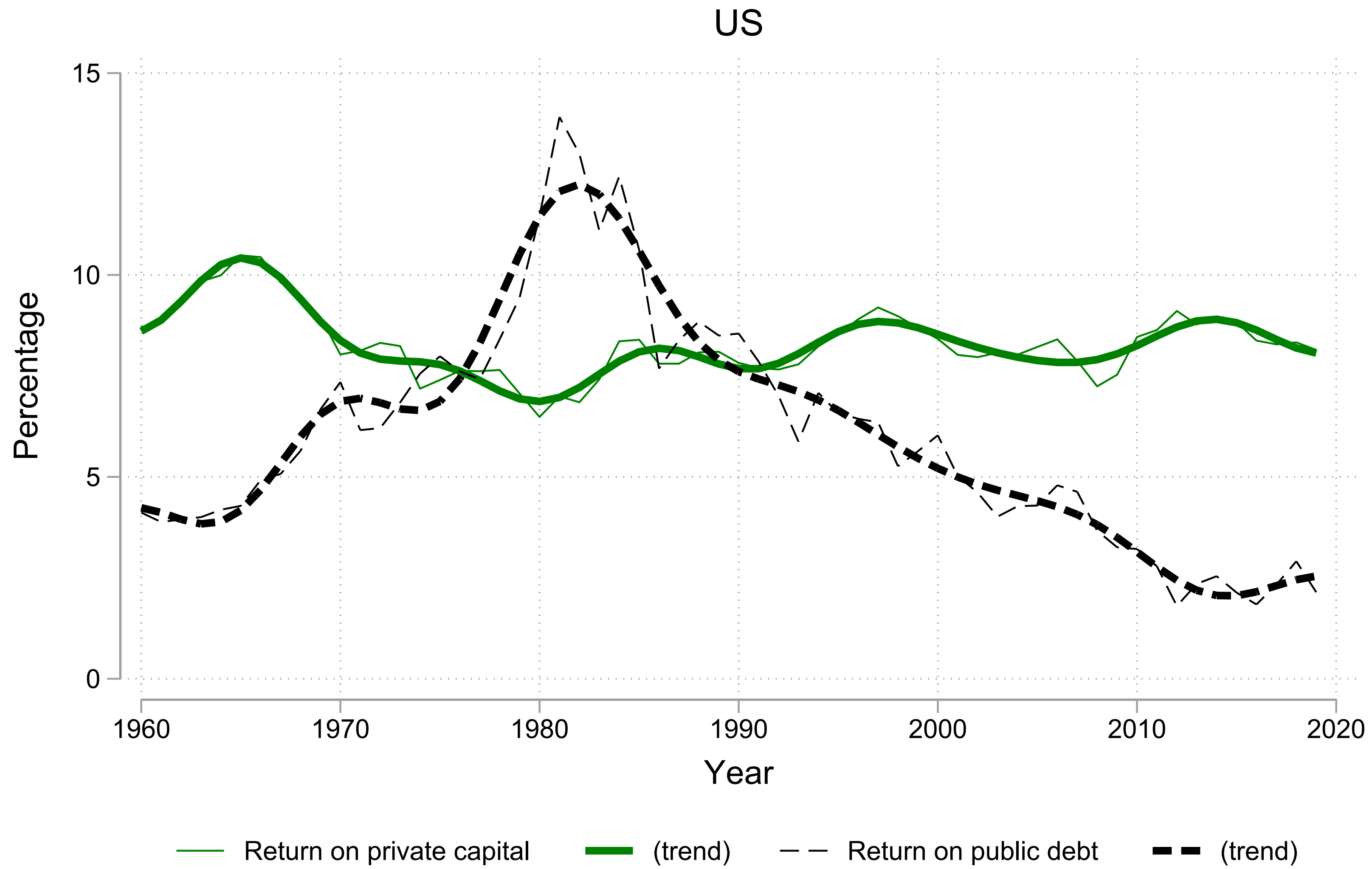
- NOS: operating surplus net of depreciation

- θ : net labor share

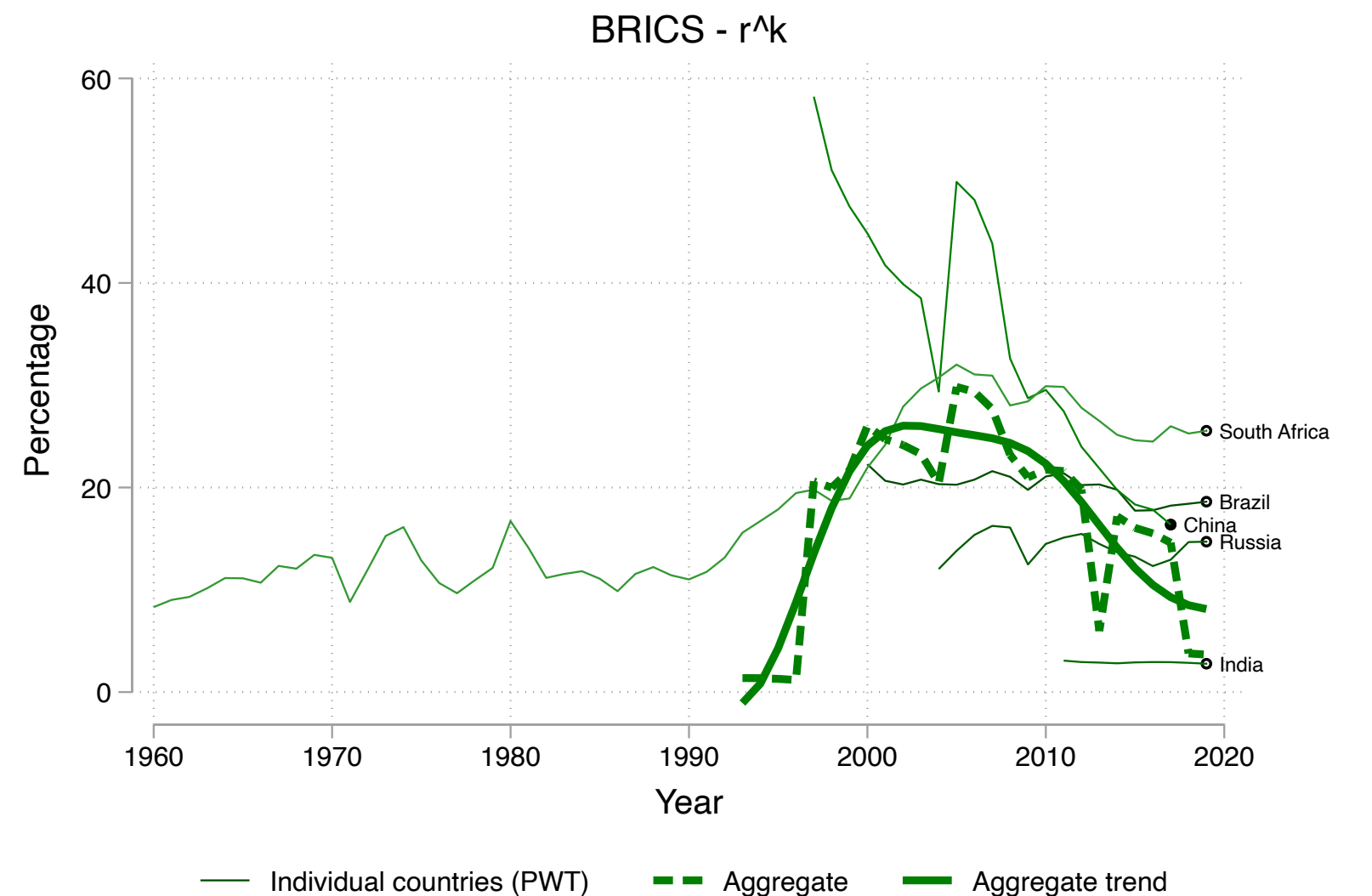
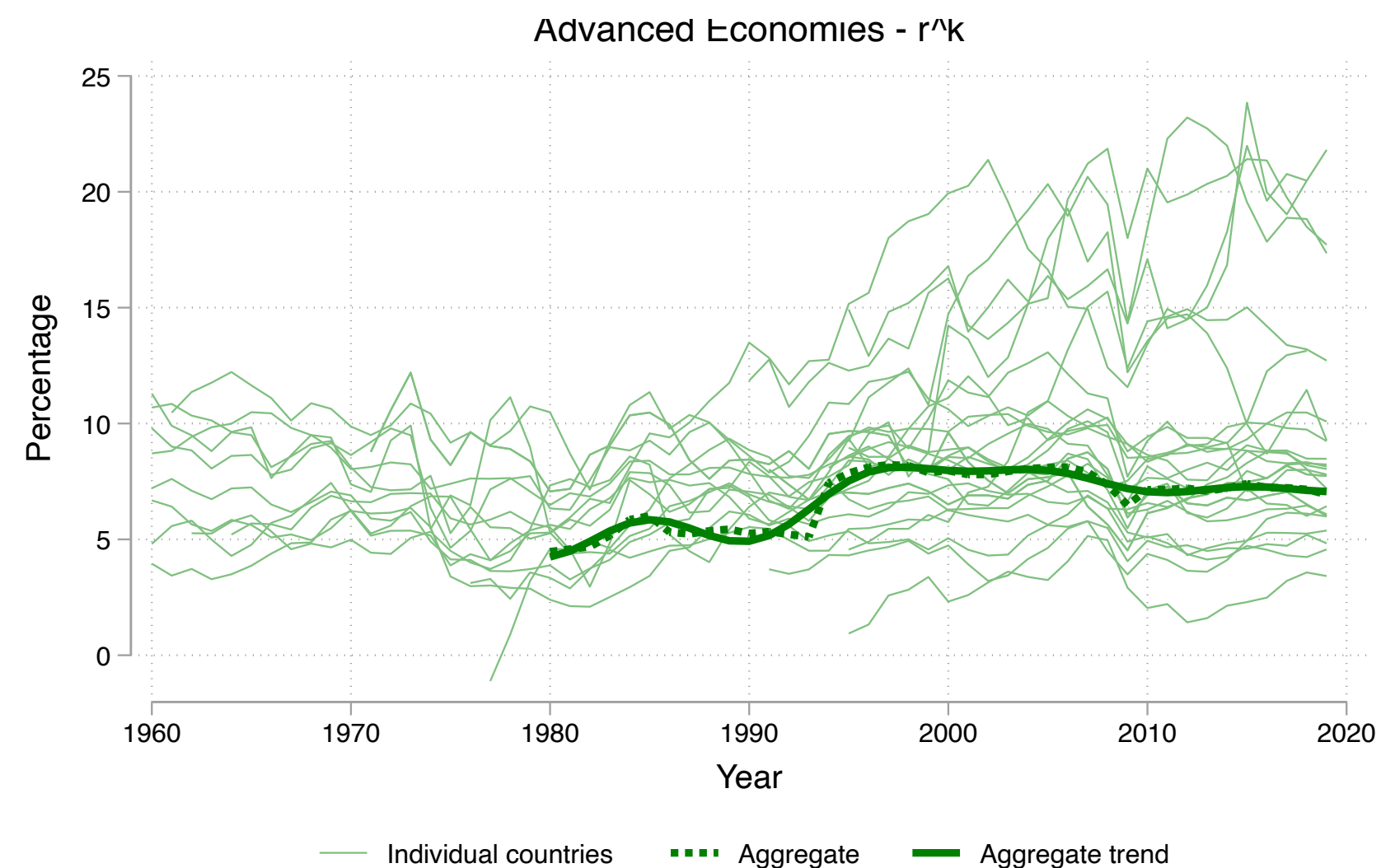
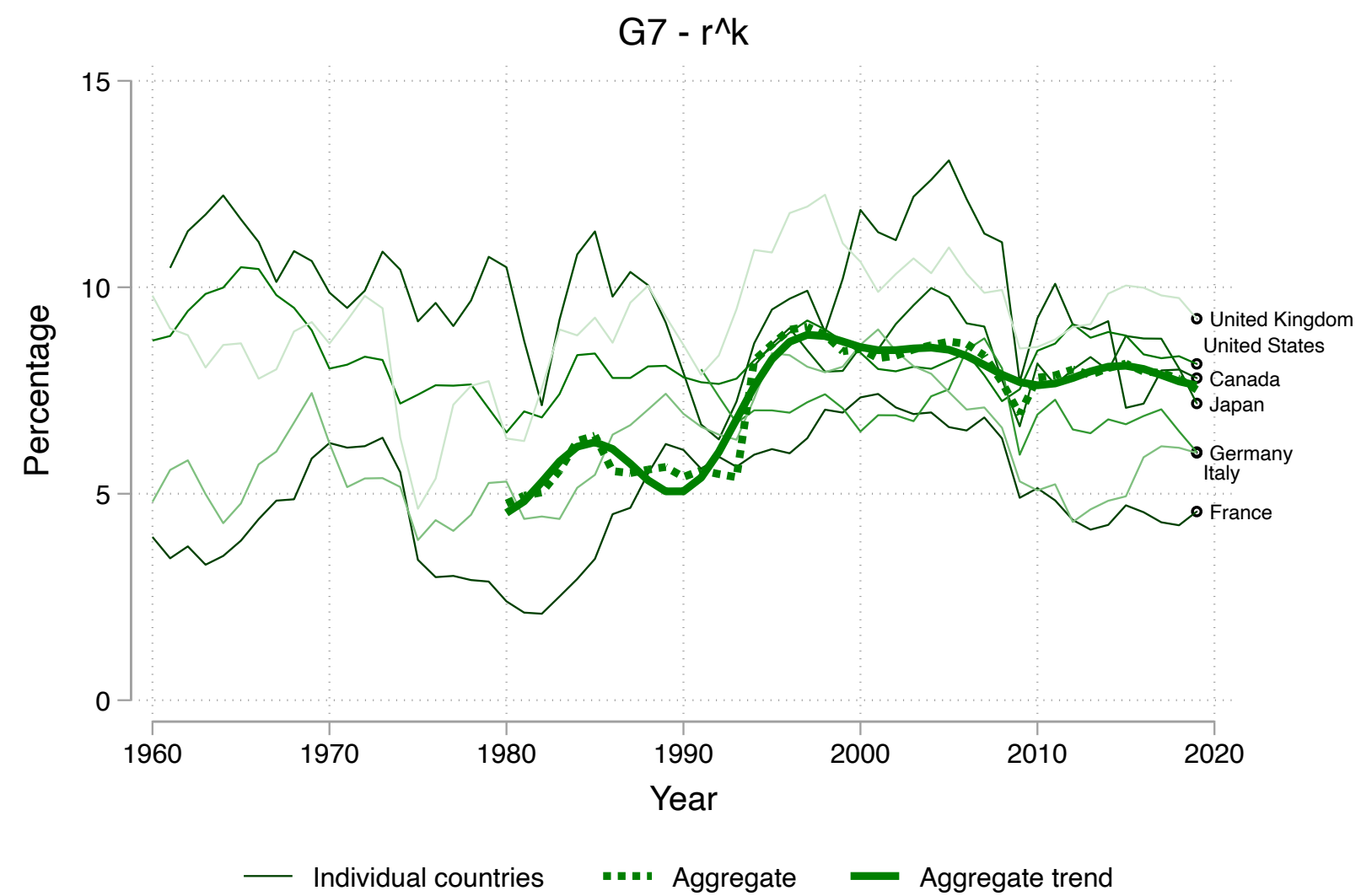
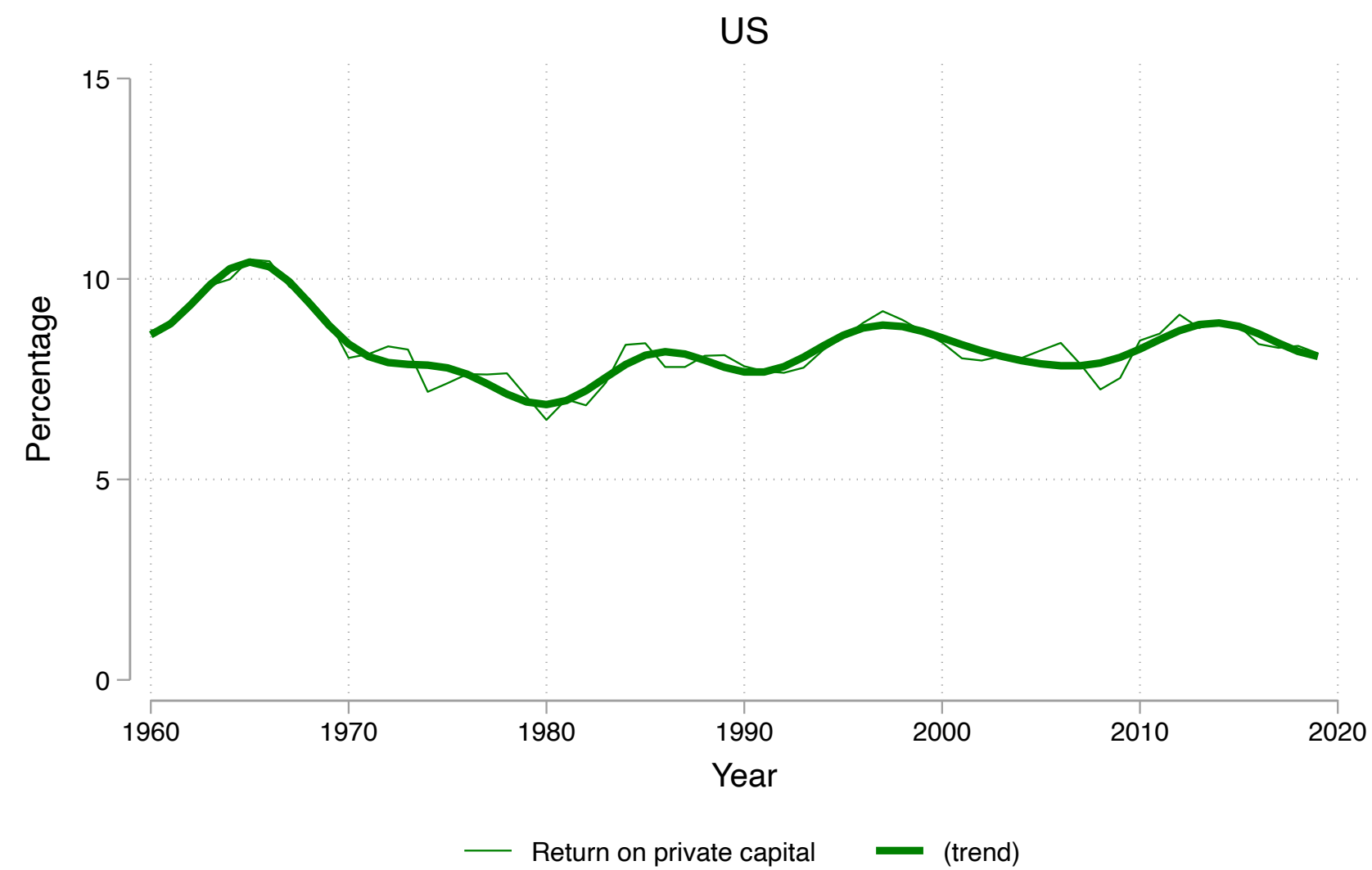
Careful with:

- I) nominal capital to output ratio, otherwise trend in relative price of investment.
- II) labor share net of measured depreciation, otherwise trend in depreciation rates and intangibles
- III) net operating surplus adjusted for self-employment, otherwise trend in move from informal to formal economy.

Estimates



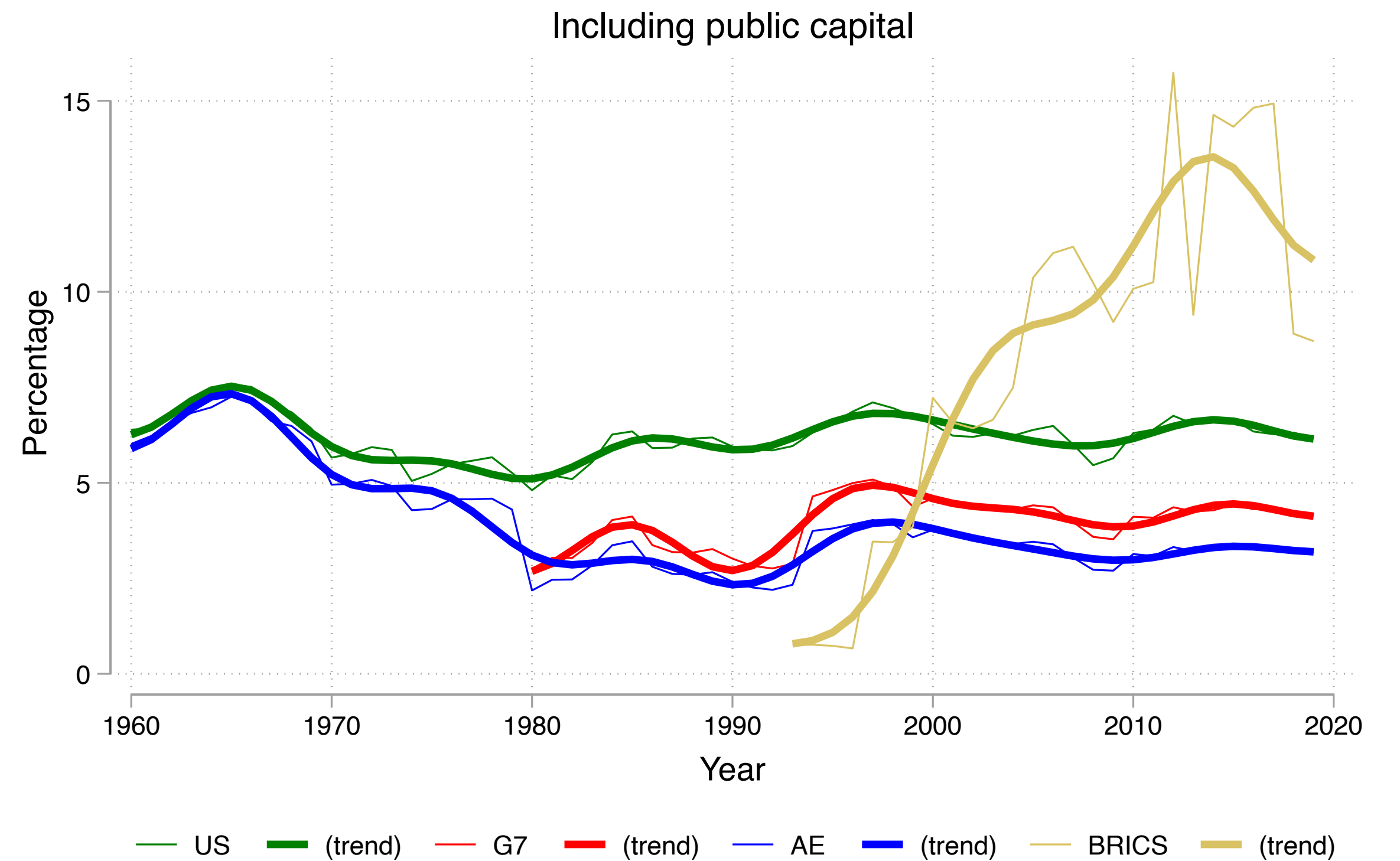
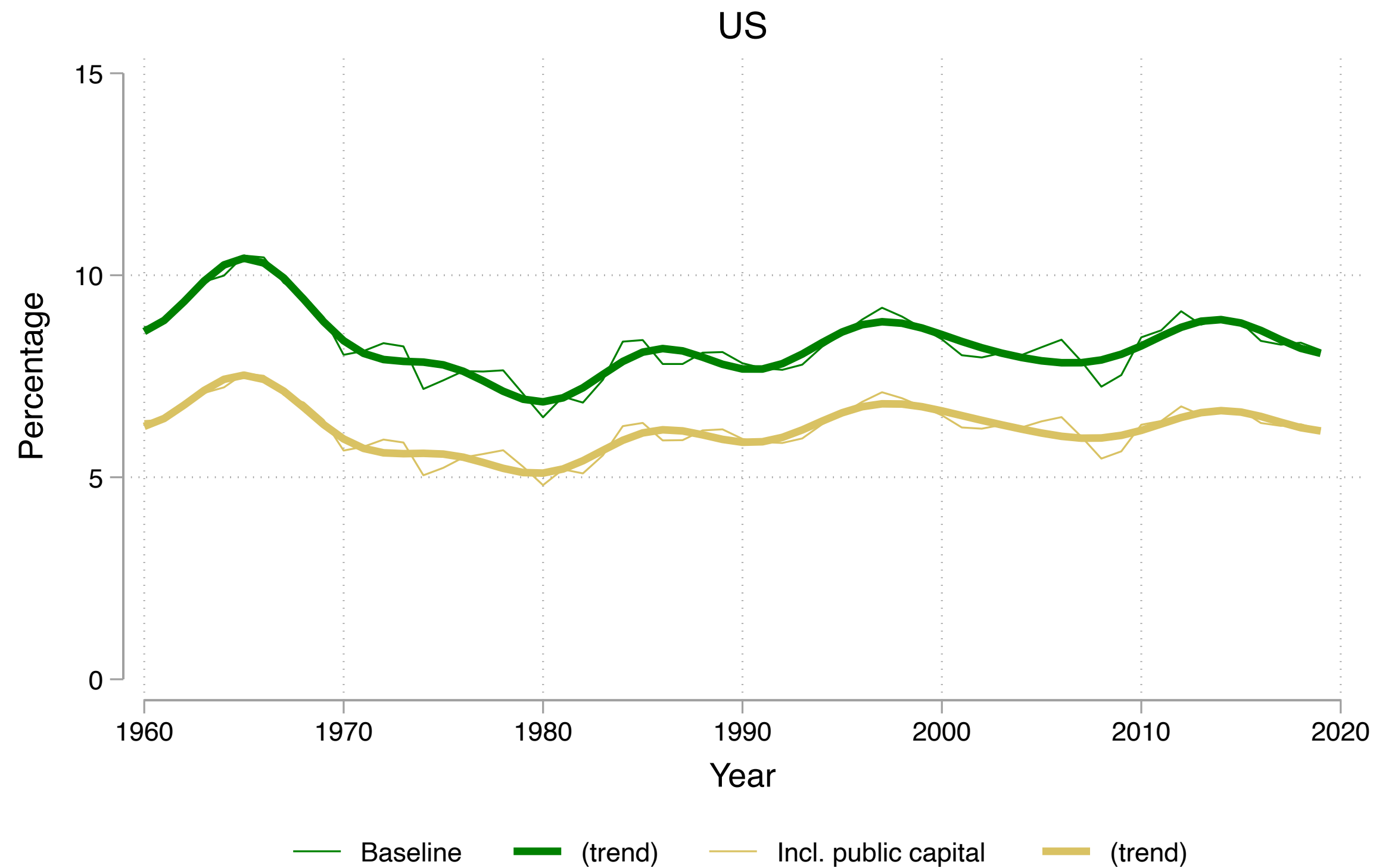
Concern iv) true across countries?



- G7: use national accounts
- AEs: use AMECO, OECD, concern ii)
- BRICS national accounts for NOS, IMF for K, concerns ii) and iii)
- Averages by GDP weighting.

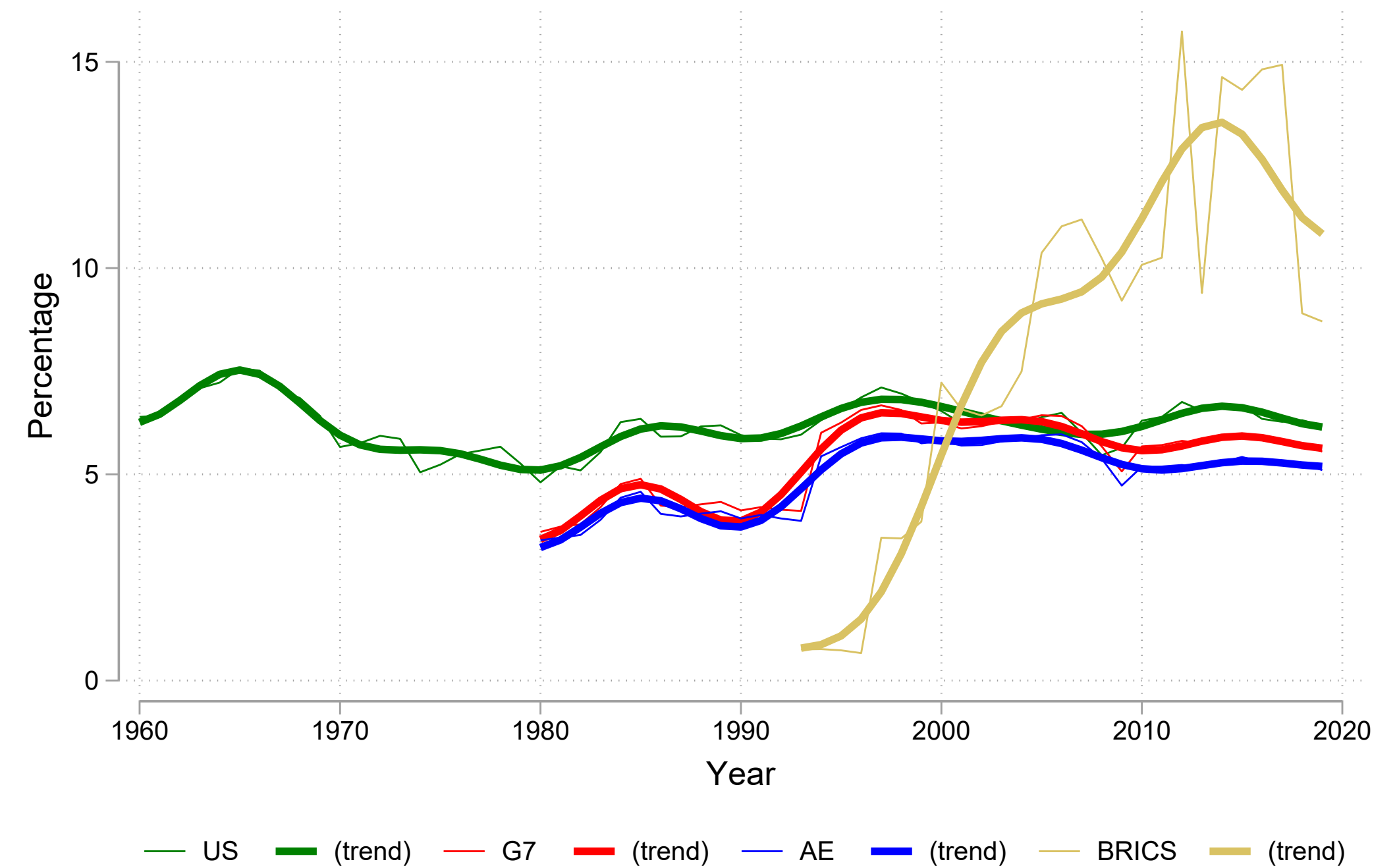
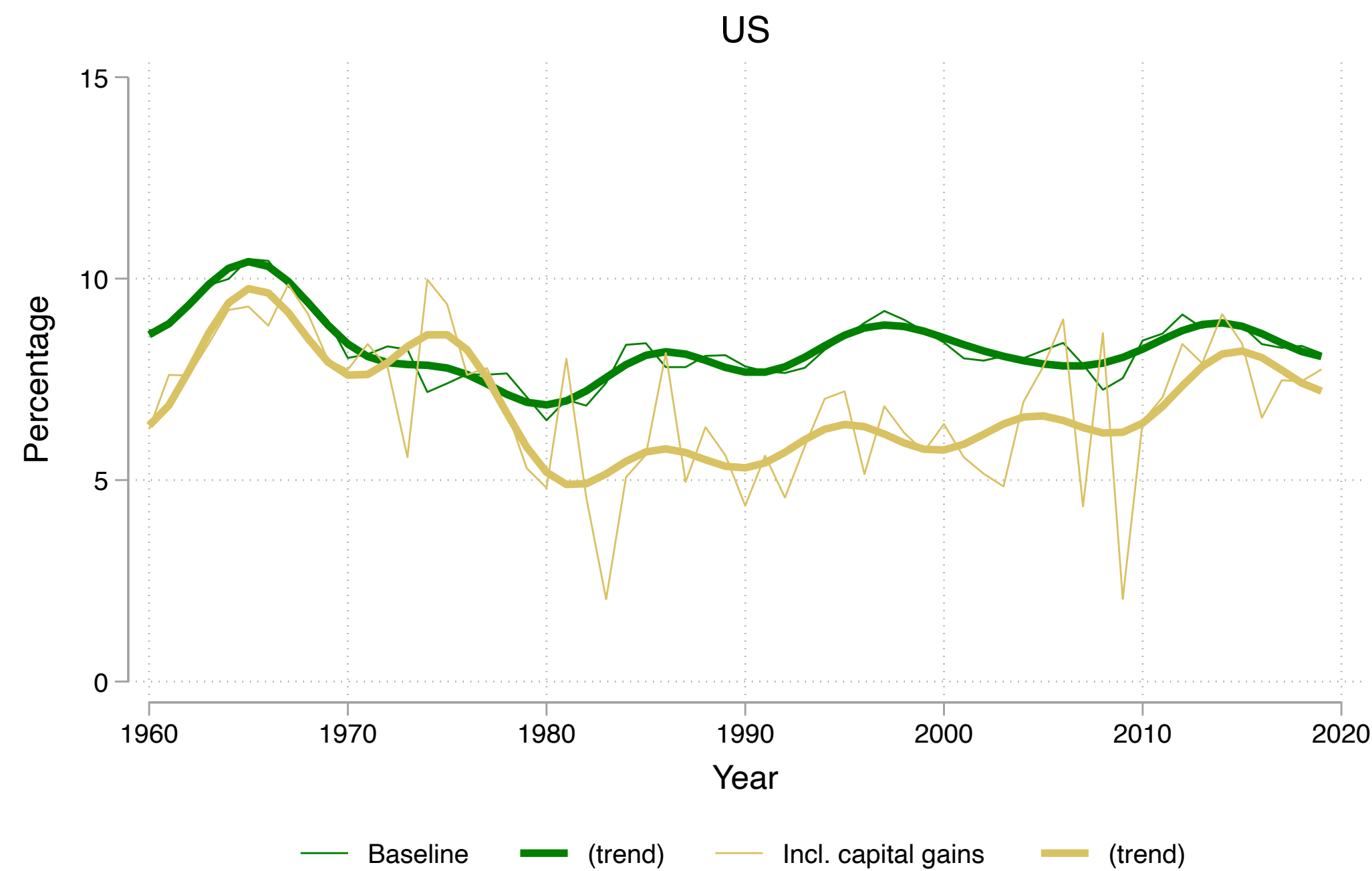
Concern v) public capital stock?

- If it is a productive input that generates the NOS, should include it, lower returns.
- Trend in public investment over last ten years (austerity)



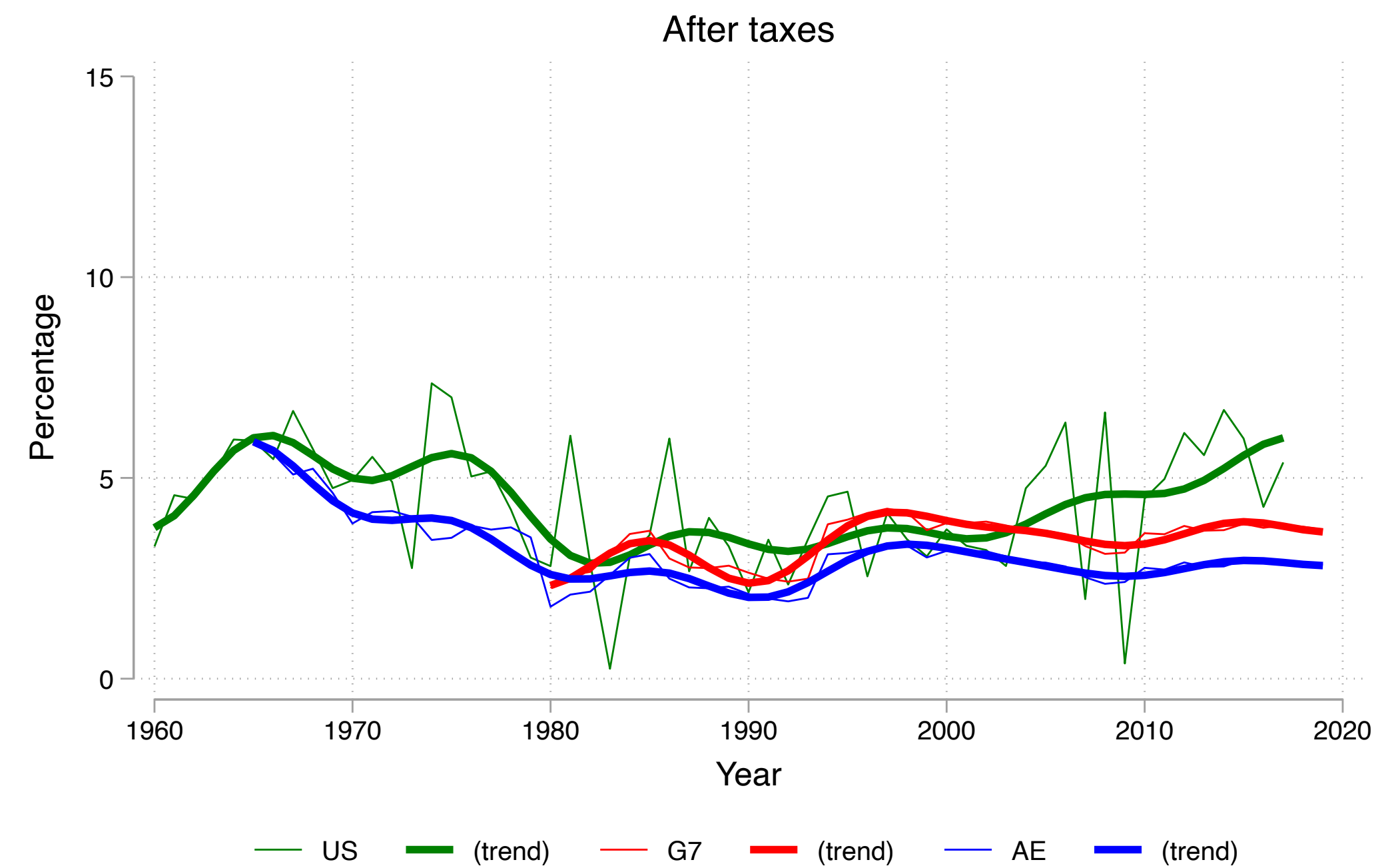
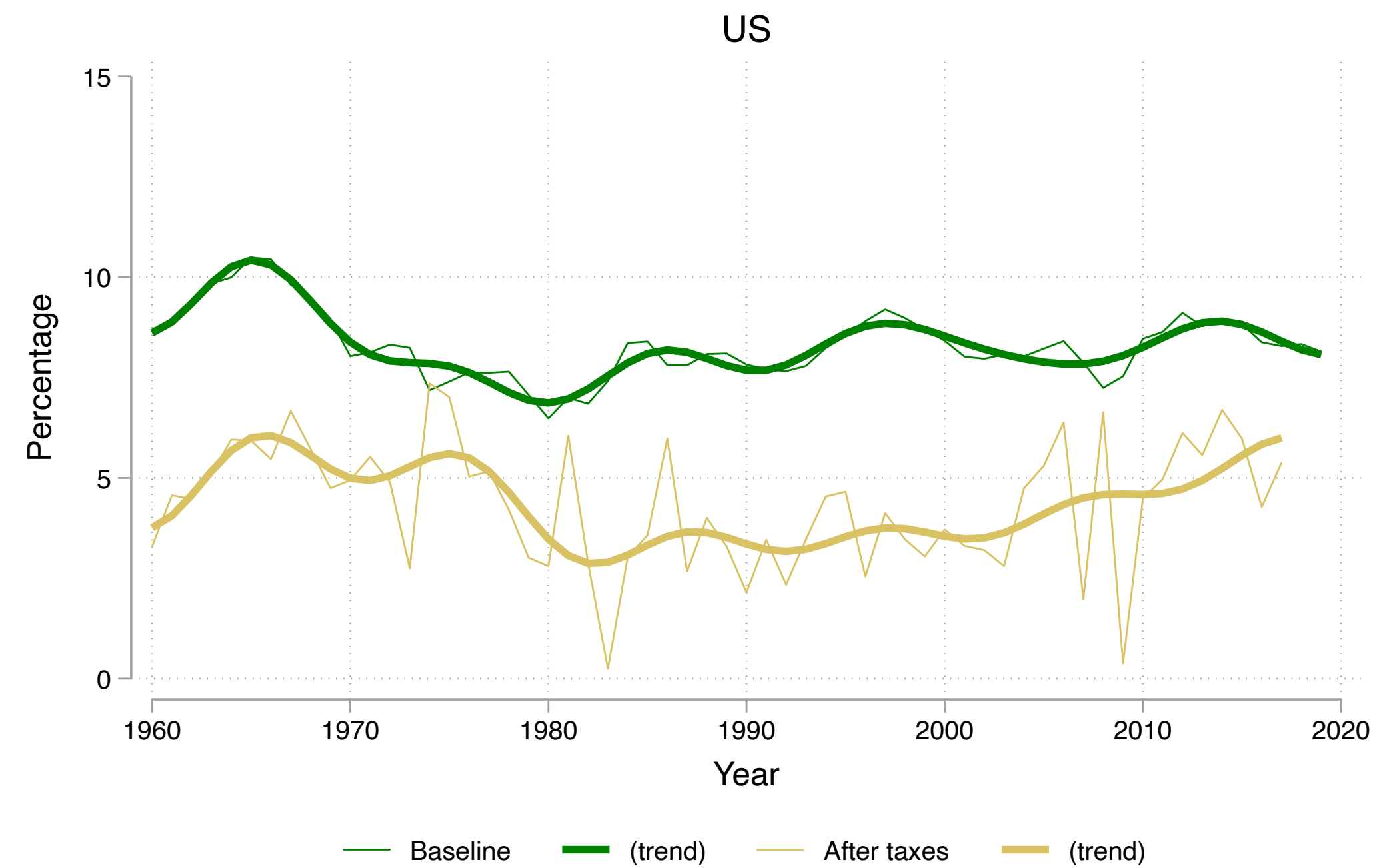
Concern vi) include capital gains?

- From increase in capital good prices. $\frac{p_{t+1}^k/p_t^k}{p_{t+1}/p_t}$
- If capital is reversible on aggregate, should include it p_{t+1}/p_t



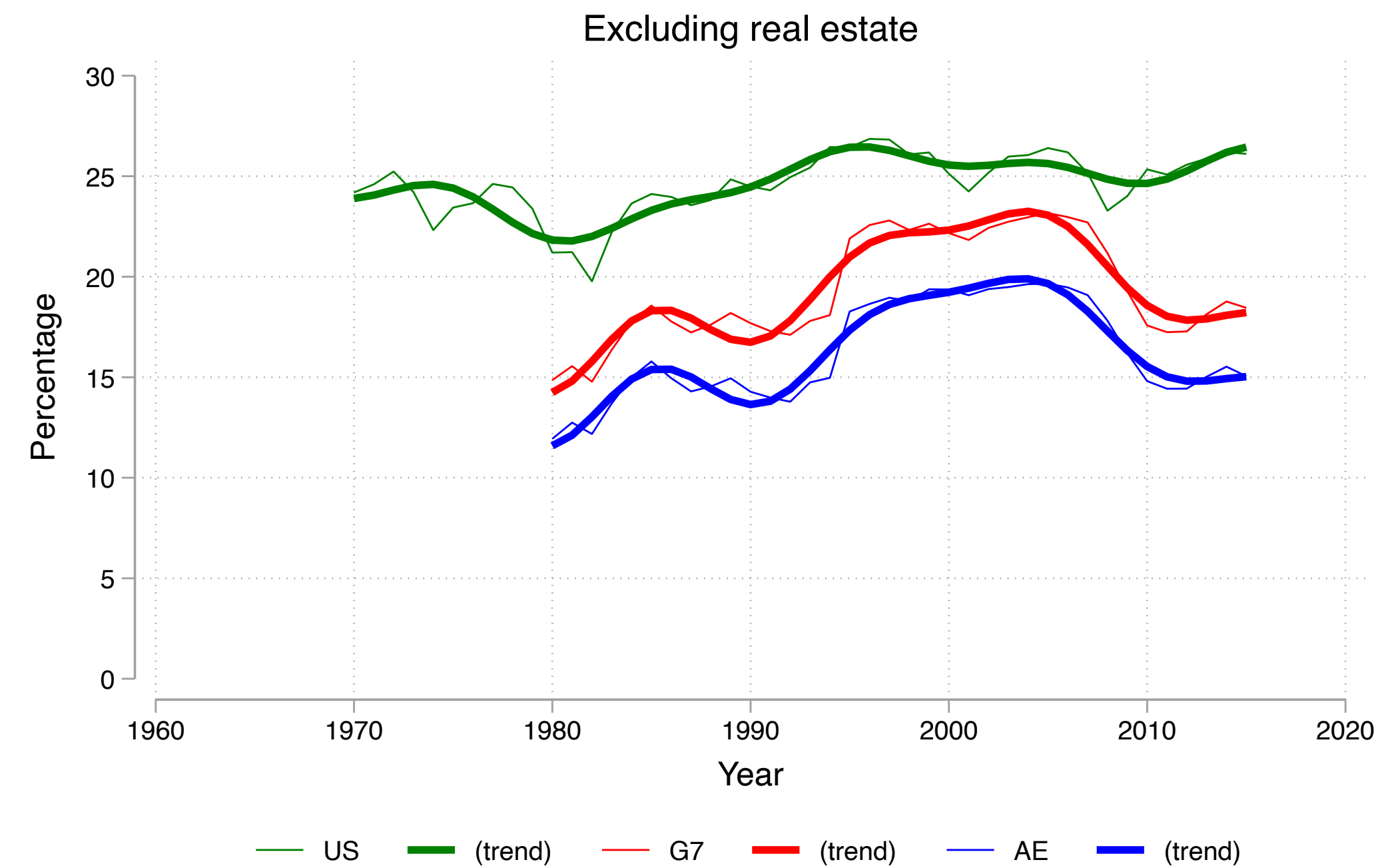
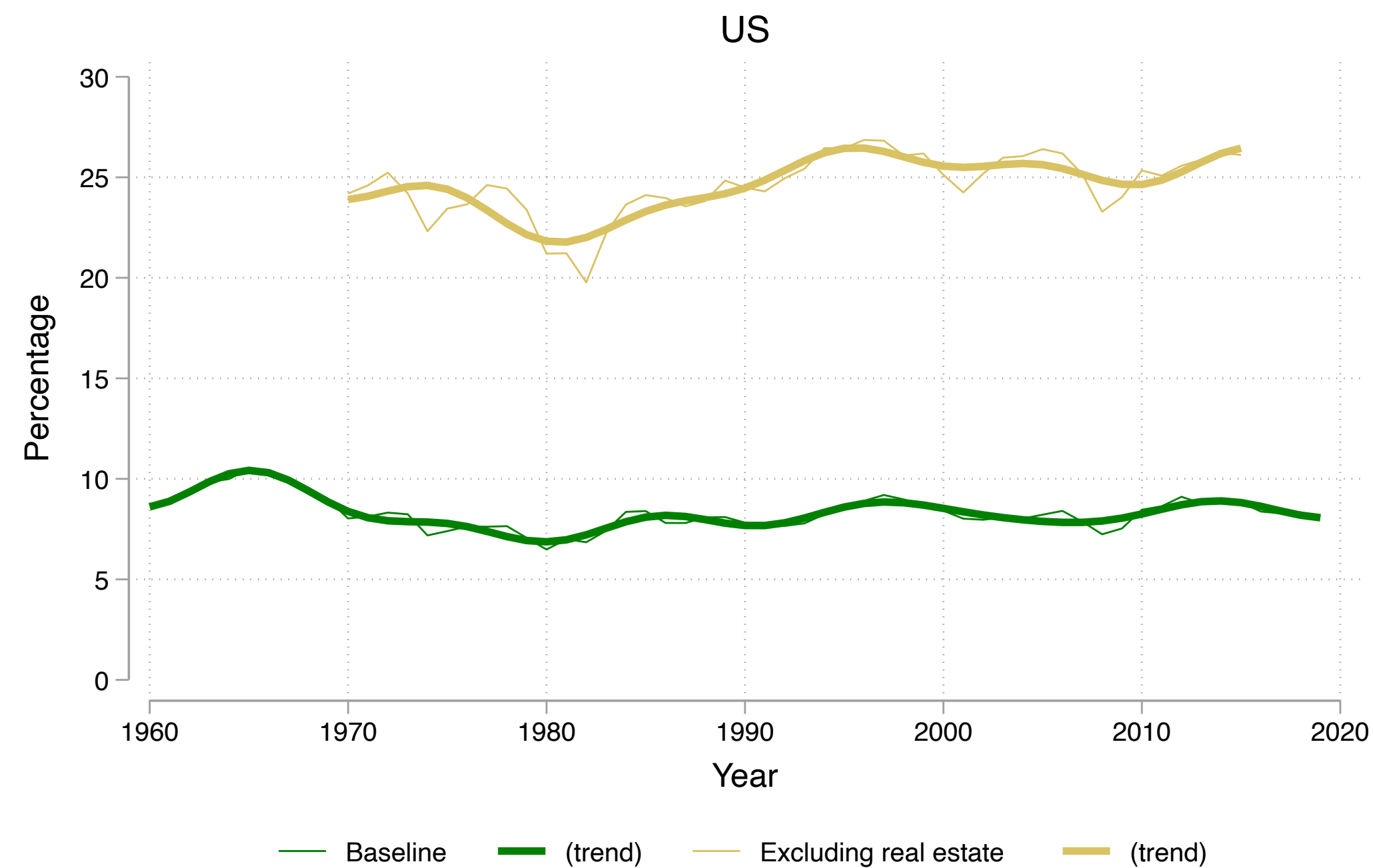
Concern vii) take out taxes on investment

- Corporate income taxes put wedge in relative returns.
- GRR (II): take out personal income taxes, but they fall on government bond holdings too



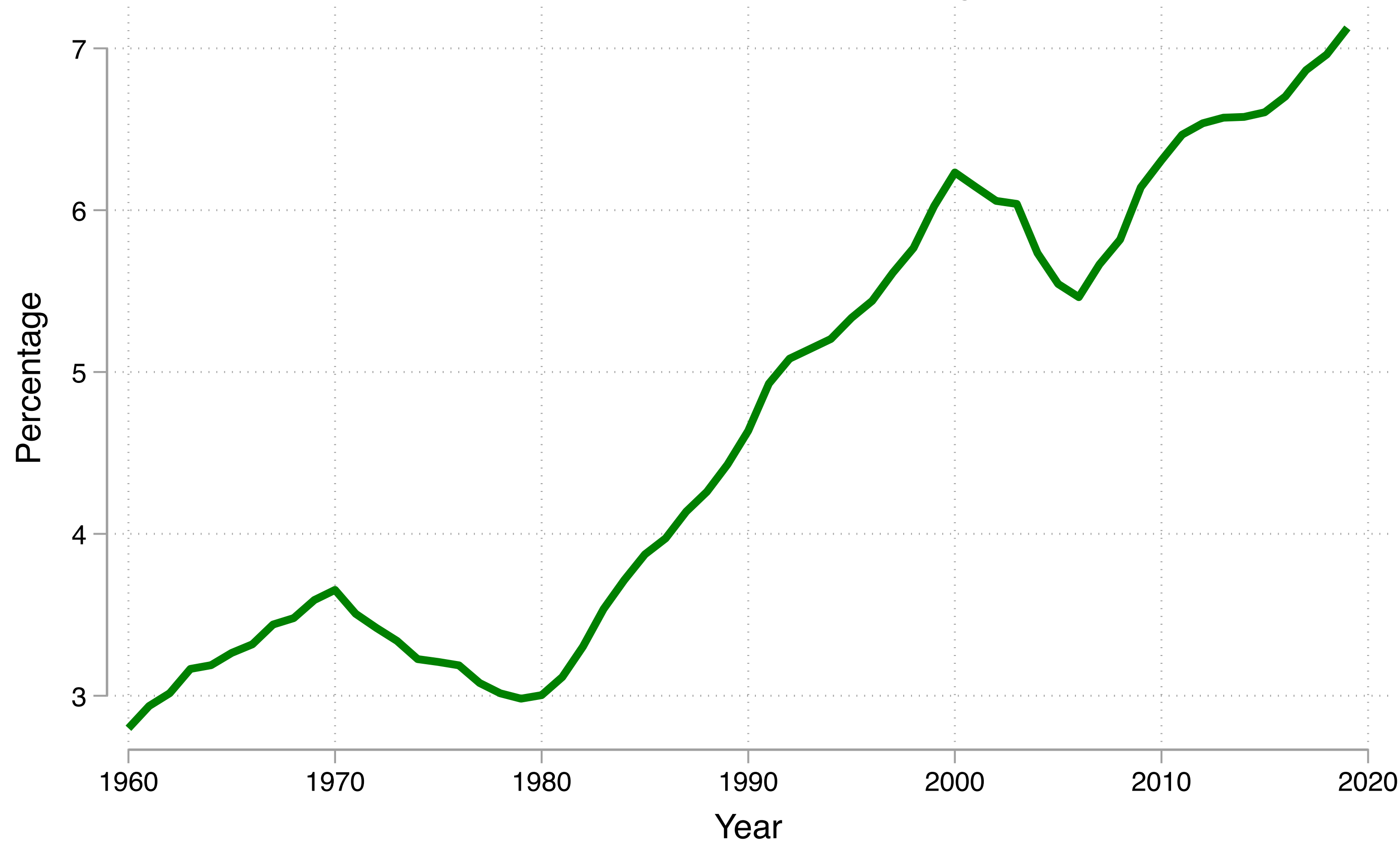
Concern viii) exclude real estate?

- If land is not accumulated, may give returns, but not relevant for aggregate investment
- Previous literature estimates (Gutierrez Piton following Rognlie), but gross



Concern ix) intangibles

Share of capital which is intangible

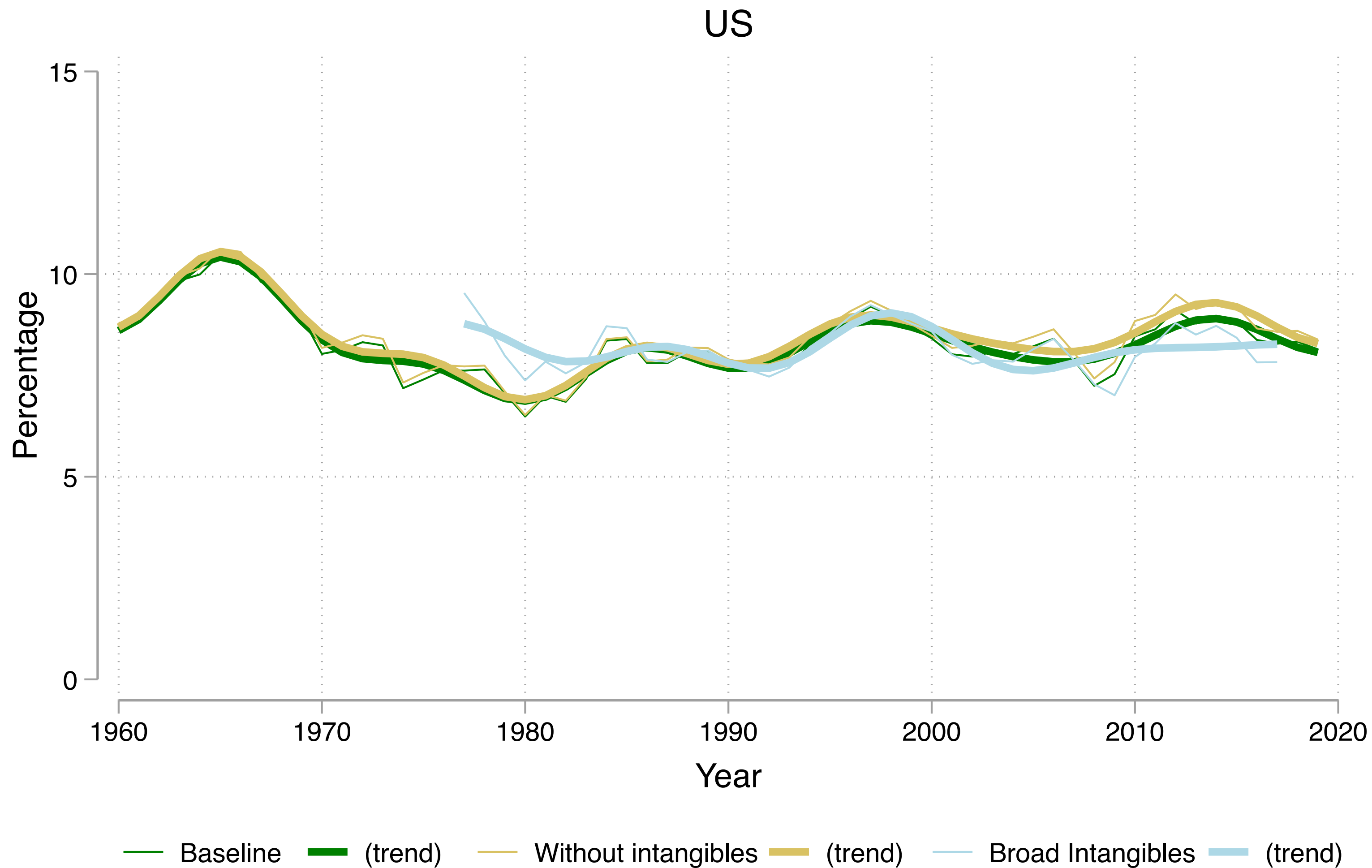


- Rising, already partly incorporated in BEA revision of NIPA in 2013
- Raises capital stock, but also raises NOS, as intangible investment no longer intermediate good

$$r_t^{k,new} = \frac{NOS_t + Inv_t^I - Dep_t^I}{K_t + K_t^I}$$

- At first, raises r^k because higher numerator. In steady state lowers r^k because higher denominator.
- Including intangibles could produce a downward trend in r^k .

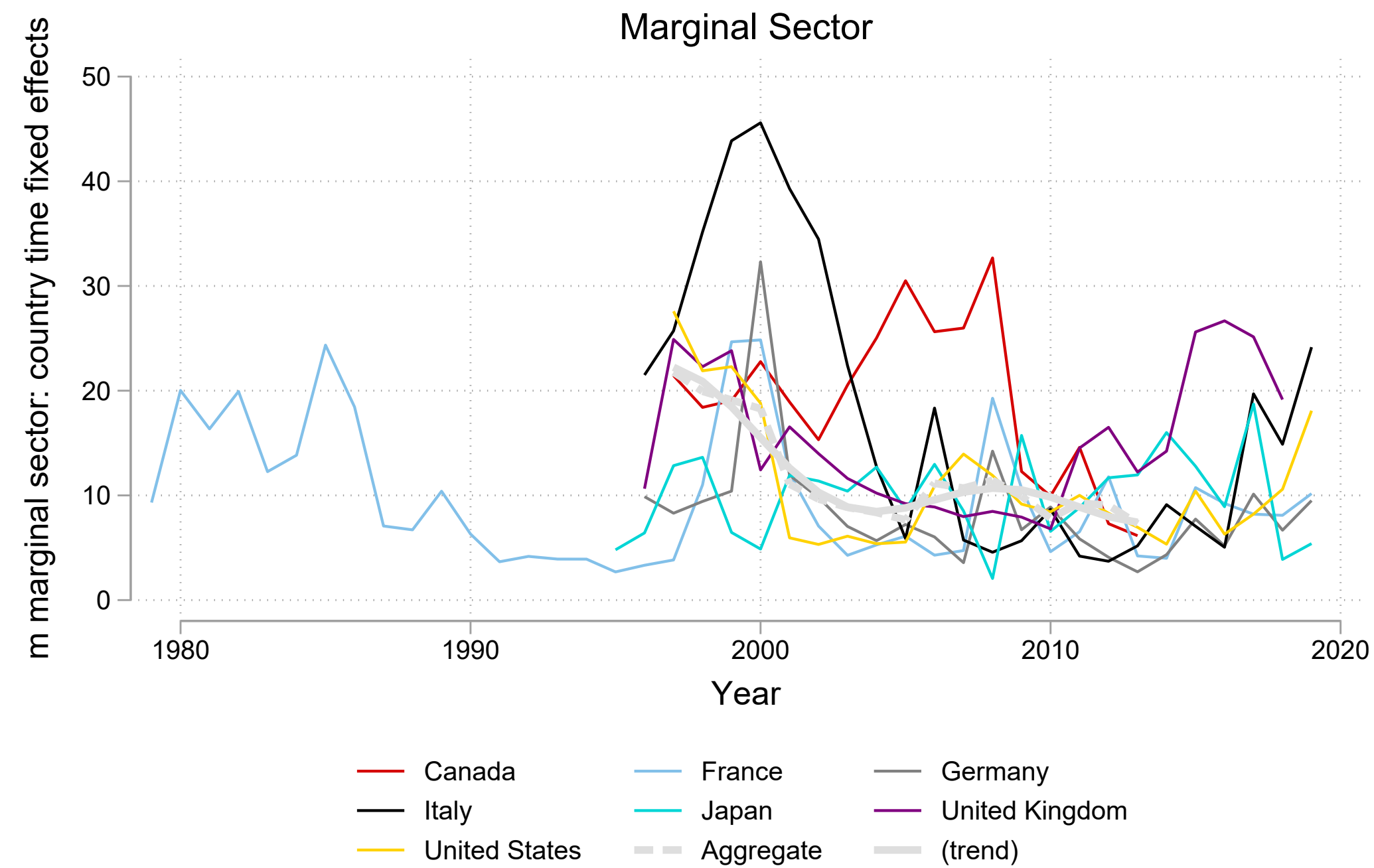
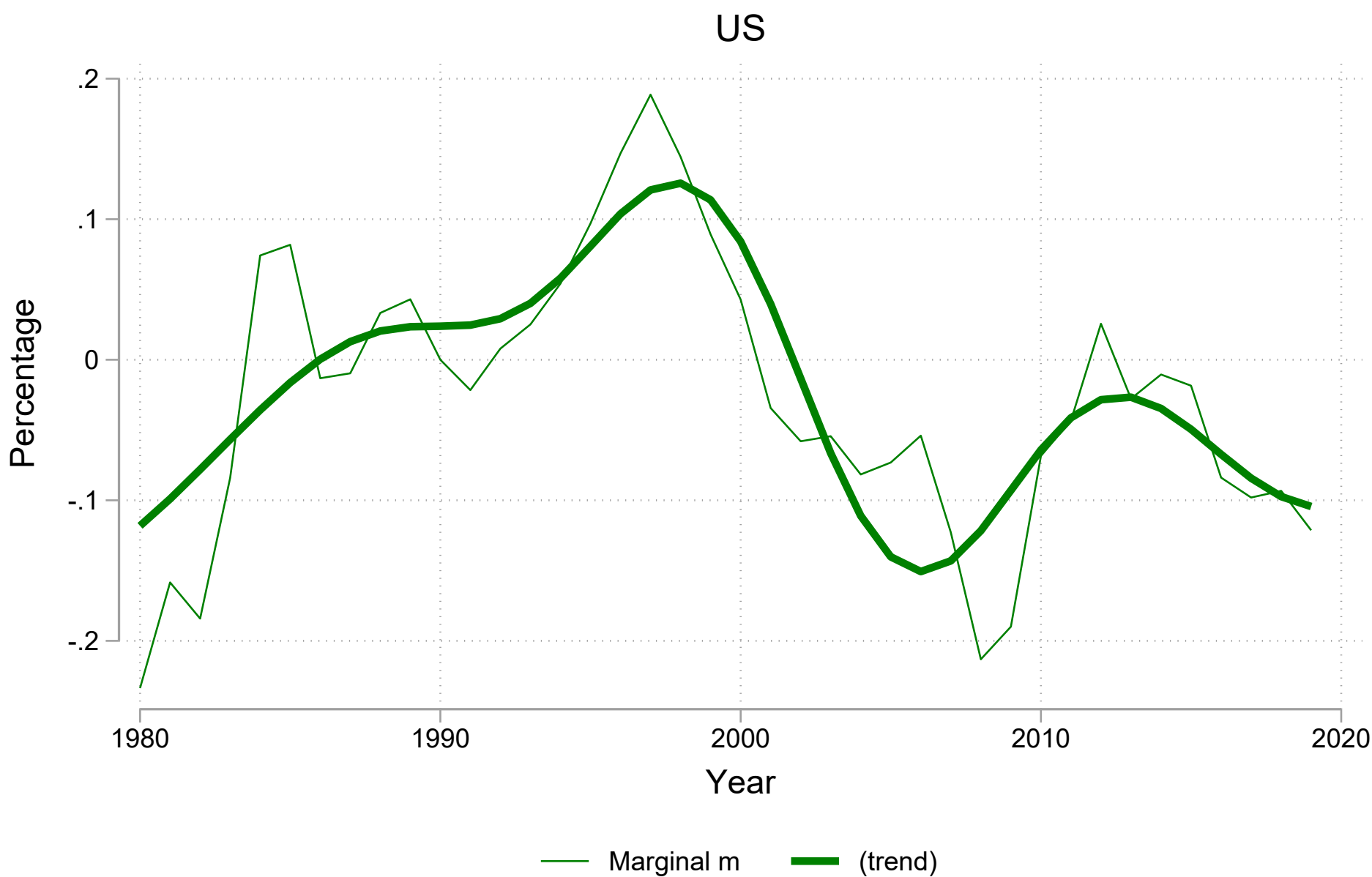
Concern ix) intangibles



- Three measures:
 1. Old NIPA, no intangibles
 2. NIPA, narrow intangibles
 3. Corrado et al: broader int.
- Indeed from 1 to 3, get more of a trend down in returns.
- But in practice, just too small to matter for $r^k - r^b$ wedge

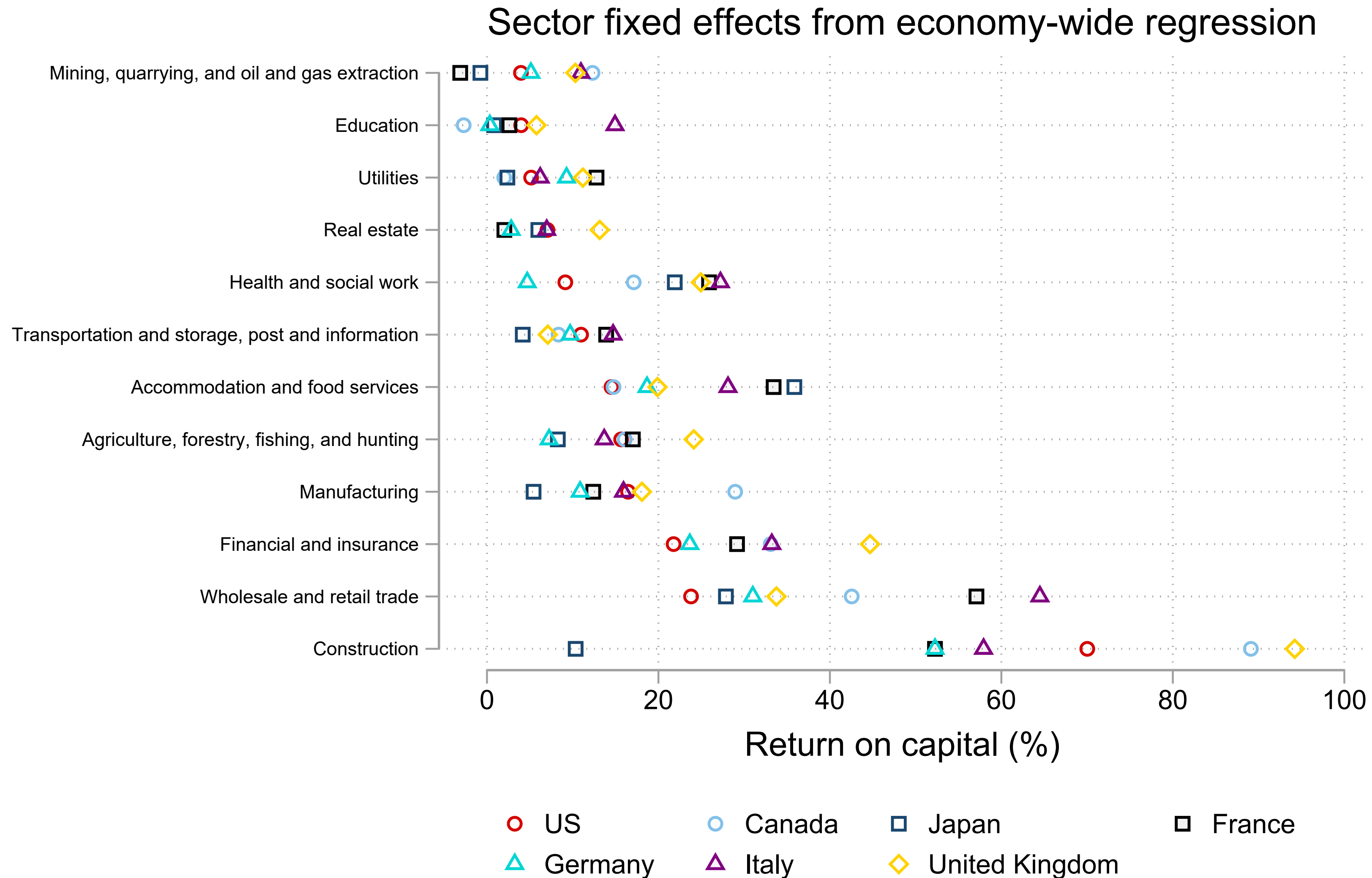
Concern ix) marginal versus average

- Impossible problem



- Estimates a trans-log
- Use sectoral data, regress in panel regression with time fixed effects, weighted by share of change in capital due to that sector

Sectoral heterogeneity



- Same panel regression on sectoral data
- But now plot sectoral fixed effects, using size of sector as weights.
- Vast heterogeneity that is consistent across countries

Estimates from the supply of capital

Modern revision of inverse supply of savings

$$r^* = g(y)^{1/\nu} / \beta$$

$$g(c) = (1 - \chi)\beta[\alpha \times lev \times m + (1 - \alpha)r]^\nu + \chi g(wl)$$

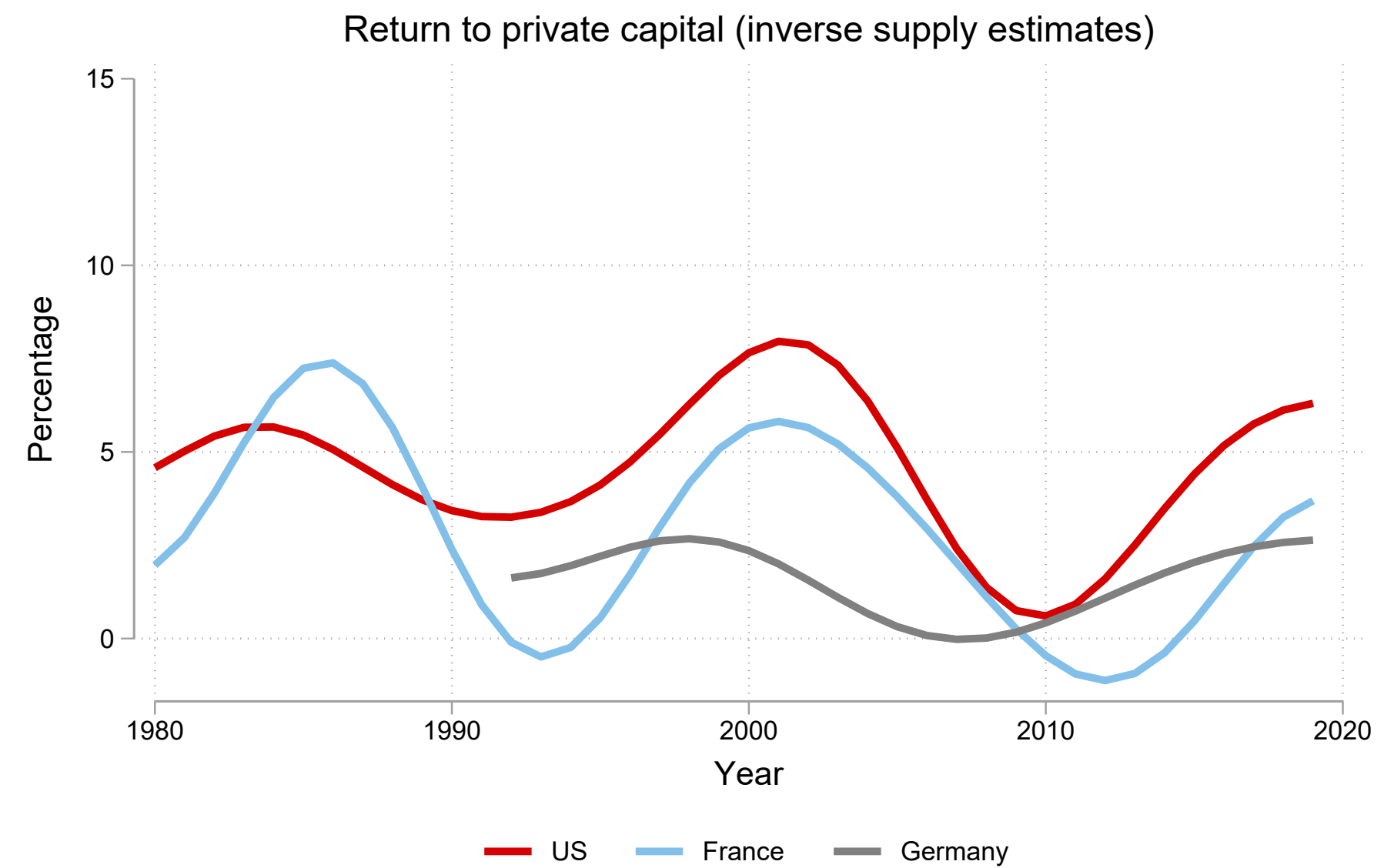
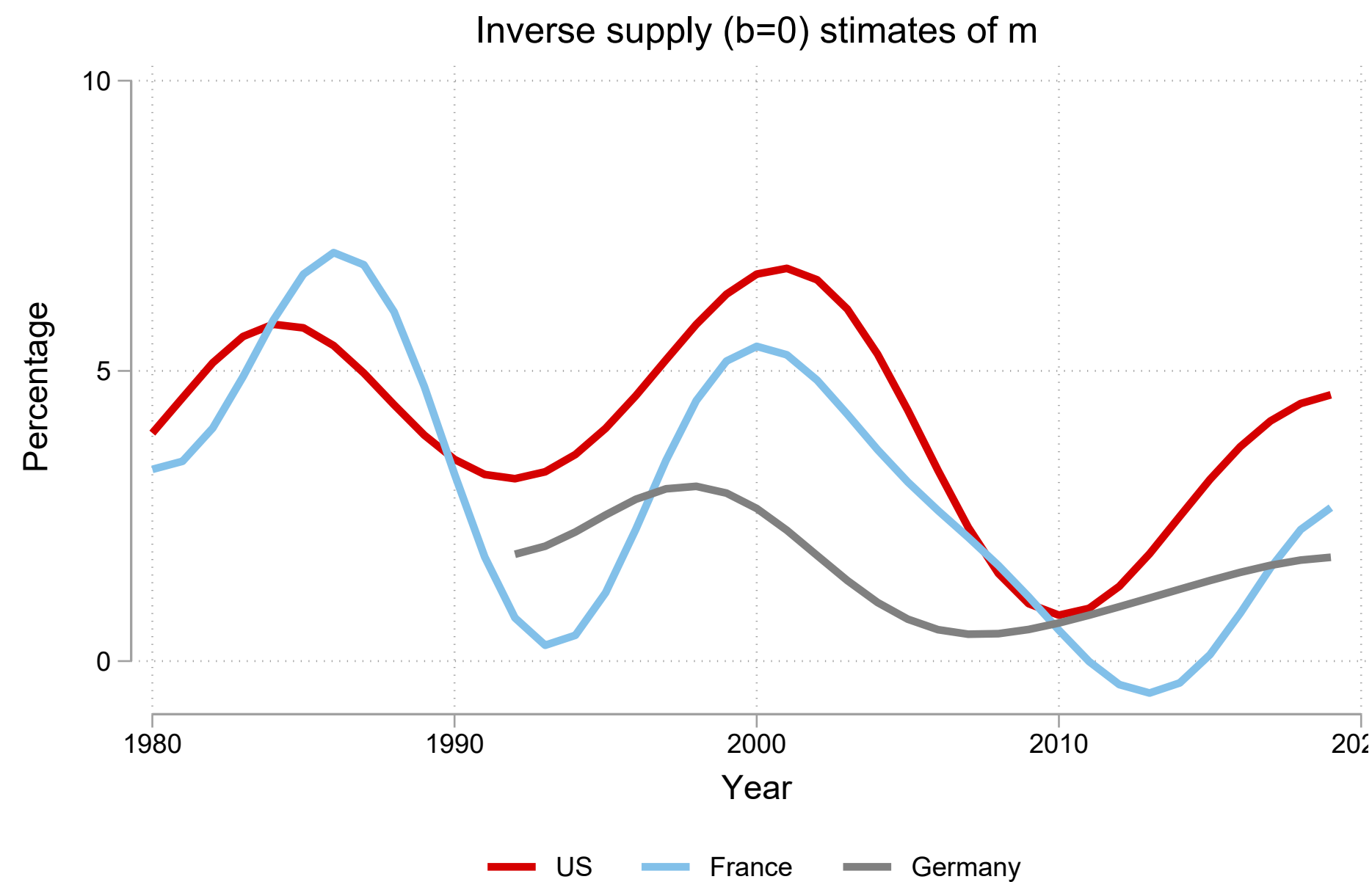
$$m = r + \left(1 + \frac{b}{k}\right) \left(\frac{x}{\nu} - r\right)$$

$$x = \log \left(\frac{g(1 - s) - \chi g(1 - \theta)}{1 - \chi} \right) + \log(g(y))$$

- Classic Euler equation
- Modern Euler equation: hand to mouth (χ) and heterogeneous returns (α)
- Returns on capital are leveraged up through private credit
- If $b=0$, then $m=x/\nu$, just as in classic case, but adjusted for fgrwoh in consumption instead of income. Otherwise average two returns

Inverse supply of savings

- No clear trend



Fall in first decade,
increase in second
decade

Because:
(i) savings rate trend
down,
(ii) labor income
trend down
(iii) credit trend up

Consumption function

$$p_t^k k_{t+1} + p_t^c c_t = m_t p_t^k k_t + w_t l_t$$

$$\frac{1}{CW_{t+1}} = m_{t+1} \left(\frac{p_t^c c_t}{p_{t+1}^c c_{t+1}} \right) \left(\frac{1}{CW_t} - 1 + \frac{w_t l_t}{p_t^c c_t} \right)$$

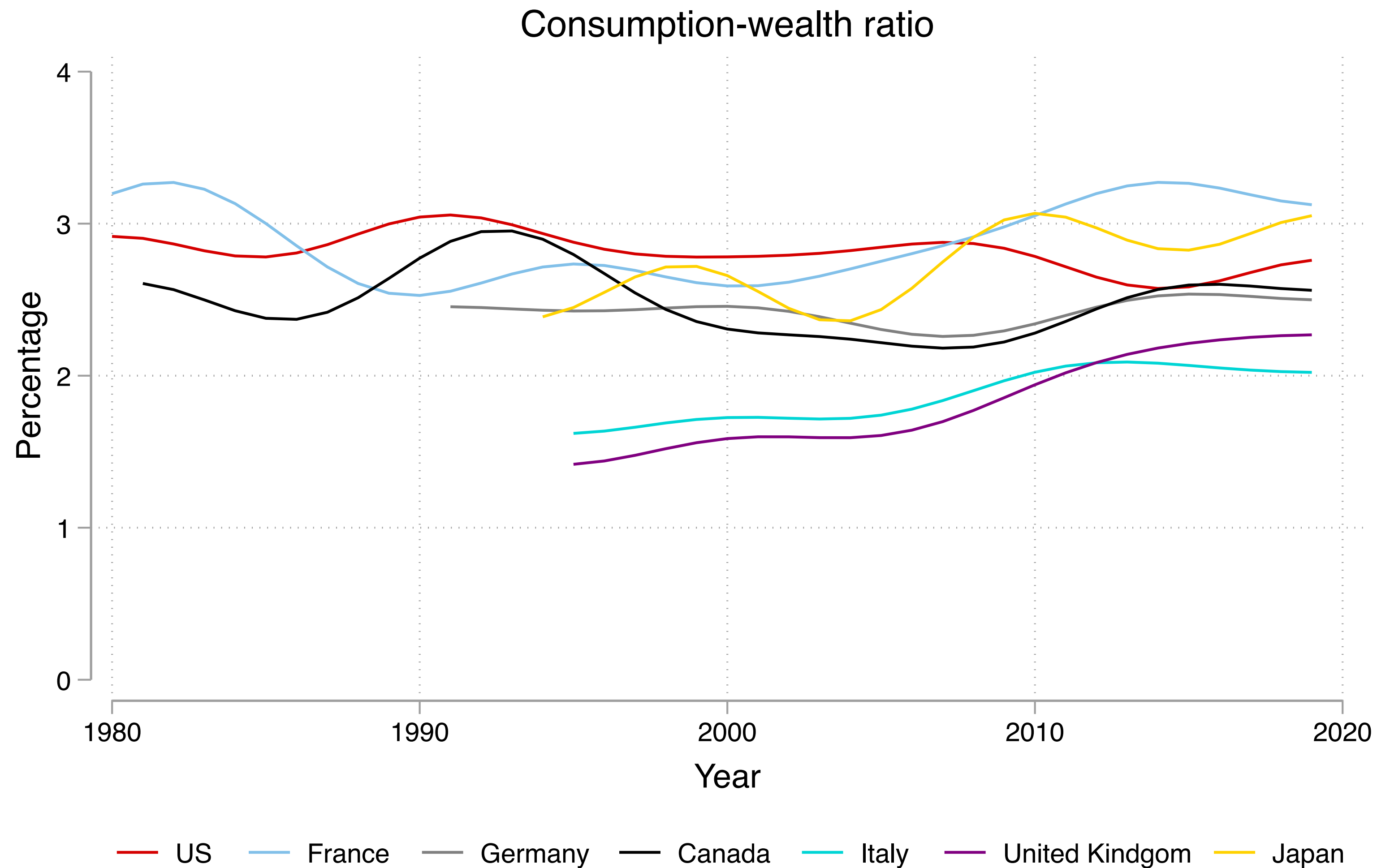
- Resource constraint

• Consumption-wealth ratio, with wealth $CW = p^c c / p^k r^k k$

$$\hat{C}\hat{W}_t = \mathbb{E}_t \left[\sum_{s=1}^{\infty} \rho^s \left(\hat{m}_{t+s} - \Delta(\hat{p}_{t+s}^c + \hat{c}_{t+s}) \right) \right]$$

- Log-linearization around $C/W=\rho$, take expectations and and iterate forward, to get consumption function

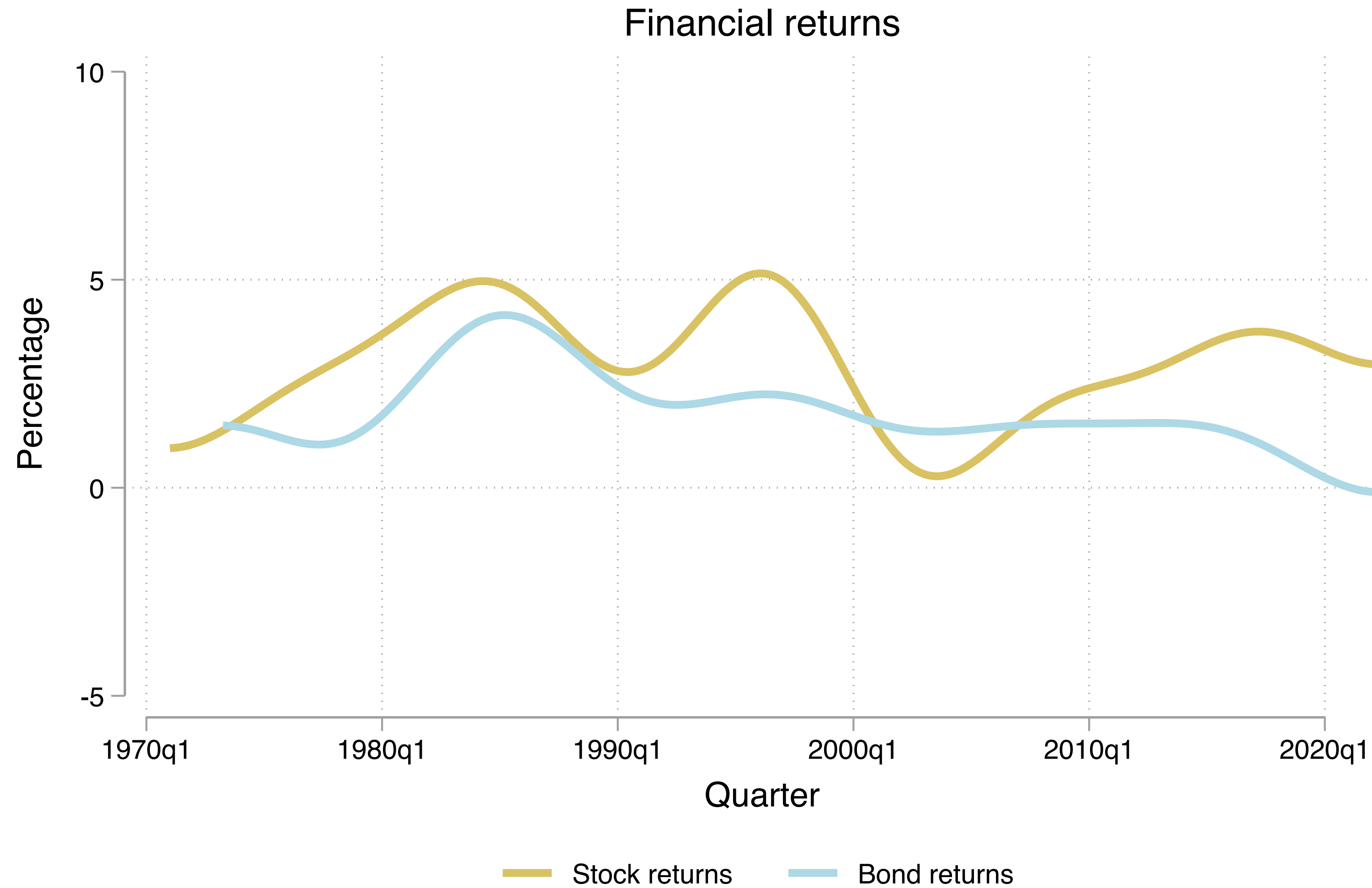
Consumption-wealth in the data



- Null hypothesis: no change in forward-looking expected m
- Implies there would be no downward trend in the consumption-wealth ratio.
- Plot in the data confirms it

Financial returns

- Broad stock index
- Broad corporate bond index



A model

Firms and workers

- Cobb-Douglas production function

$$y = k^\theta (Al)^{1-\theta}$$

- Standard monopolists of varieties

$$\mu = \frac{(1 - \theta)y/l}{\omega}$$

- Labor supply from hand-to-mouth workers with one unit of inelastic supply

Consumers and financial frictions

- Alternate between being capitalists (access to production technology) or savers (access to credit markets). Both can hold government bonds

$$V(a, cap) = \max_{rz \leq \gamma mk} \left\{ \log(a + z - k) + \beta\alpha V(mk - rz, cap) + \beta(1 - \alpha)V(mk - rz, sav) \right\}$$

$$V(a, sav) = \max \left\{ \log(c) + \beta\alpha V(r(a - c), cap) + \beta(1 - \alpha)V(r(a - c), sav) \right\}$$

- Financial frictions: (i) equity $\alpha < 1$ and (ii) credit $\gamma < 1$

Government and market clearing

- Government budget constraint

$$b_{t+1} = r_t b_t + g k_t$$

- Market clearing for assets

$$k = \alpha(b + k) + z$$

- Labor markets, different cases

- Focus on steady state for this talk (work in progress on dynamics)

Neoclassical benchmark

- Full employment and financial frictions do not bind

$$\alpha + \gamma > 1$$

- All returns are equated

$$m = r$$

- Steady state condition

$$r = 1/\beta$$

- Decline in r because more patient/less productivity growth. *Secular stagnation.*
- Problem: m did not fall.

With financial frictions

- Solve for three equations sequentially:

$$\left(\frac{1}{\beta r} - 1\right) \left(1 + \frac{g}{1-r}\right) = \frac{1}{\gamma} \left(1 - \alpha - \frac{\alpha g}{1-r}\right) - 1 \quad \text{for } r$$

$$m = r + \left(\frac{1}{\beta} - r\right) \left(1 + \frac{g}{1-r}\right) \quad \text{for } m$$

$$y = \frac{A}{(m - 1 + \delta)^{\frac{\theta}{1-\theta}}} \left(1 - \frac{1-\theta}{\mu}\right)^{\frac{\theta}{1-\theta}} \quad \text{for } y$$

- Can generate:

$$r < 1 < 1/\beta < m$$

With financial frictions

- Secular stagnation (higher β): lowers r , but closes the $m-r$ gap
- Fall in r , rise in $m-r$ consistent with rising misallocation and stagnant investment (higher g , too little k).
- Once the effect of m is taken into account, a change in r has no effect on the level of capital, labor or output. Strong neutrality of r result.

With liquidity trap and price stickiness

- Sticky wages downwards

$$w_t = \max \{ \omega_t p_t ; (w_{t-1} \pi_t^e)^\eta (\omega_t p_t)^{1-\eta} \}$$

- Under-employment in steady state with inflation below wage expectation

$$l = \left(\frac{\pi}{\pi^e} \right)^{\frac{\eta}{\theta(1-\eta)}}$$

- Monetary policy and inflation

Either $\pi_t = \pi^*$ if $r_t \pi^* > \zeta$ or $\pi_{t+1} = \zeta / r_t$

Secular stagnation and r vs m

- Constraint on policy: Fall in r is what gets economy stuck in secular stagnation:

$$\pi < \pi^* \text{ and } r = \zeta/\pi > r^*$$

$$\text{so } l < 1, k < k^*, y < y^*$$

- Transmission of policy: r matters for l , but m is what matters for transmission of policy to investment and so for for k

$$y = A \left(1 - \frac{1 - \theta}{\mu} \right)^{\frac{\theta}{1 - \theta}} \underbrace{\left(\frac{\zeta}{r\pi^e} \right)^{\frac{\eta}{\theta(1 - \eta)}}}_{\propto l} \underbrace{\left(\frac{1}{m - 1 + \delta} \right)^{\frac{\theta}{1 - \theta}}}_{\propto k}$$

With secular stagnation and monetary policy

- An increase in the inflation target or relaxation of ZLB
Can exit stagnation, will boost employment
- An increase in government spending (g)
Boosts inflation, raises employment in both models
Raises investment with $m=r$, lowers it with $m-r$ wedge
- Increase in productivity growth (β)
Lowers inflation, lowers employment in both models
Lowers investment with $m=r$, raises it with $m-r$ wedge
- Improvement in financial markets ($\alpha + \gamma$)
Neutral with $m=r$, very effective with $m-r$ wedge

Fiscal policy

- Write government budget constraint as

$$\frac{b}{k} = -\frac{g}{m-1} + \frac{(m-r)b}{m-1}$$

- When $r < m$, have a debt revenue, can run a deficit forever
- Countries have used this extra fiscal capacity. It comes from debt revenue, not from future surpluses.

Conclusion

Points made in this talk

1. In advanced economies, the fall in r^* has come with an increase in m^*-r^*
 - robust fact across countries and views on capital
2. Focussing on m^* with r^* :
 - r^* tells you about constraint on policy, m^* tells you about transmission
 - higher inflation is not always good
 - raising aggregate demand is less powerful
 - raising productivity growth not so bad, actually welcome
 - improving efficiency of financial frictions is good in short and in long run