Sovereign default and the decline in interest rates

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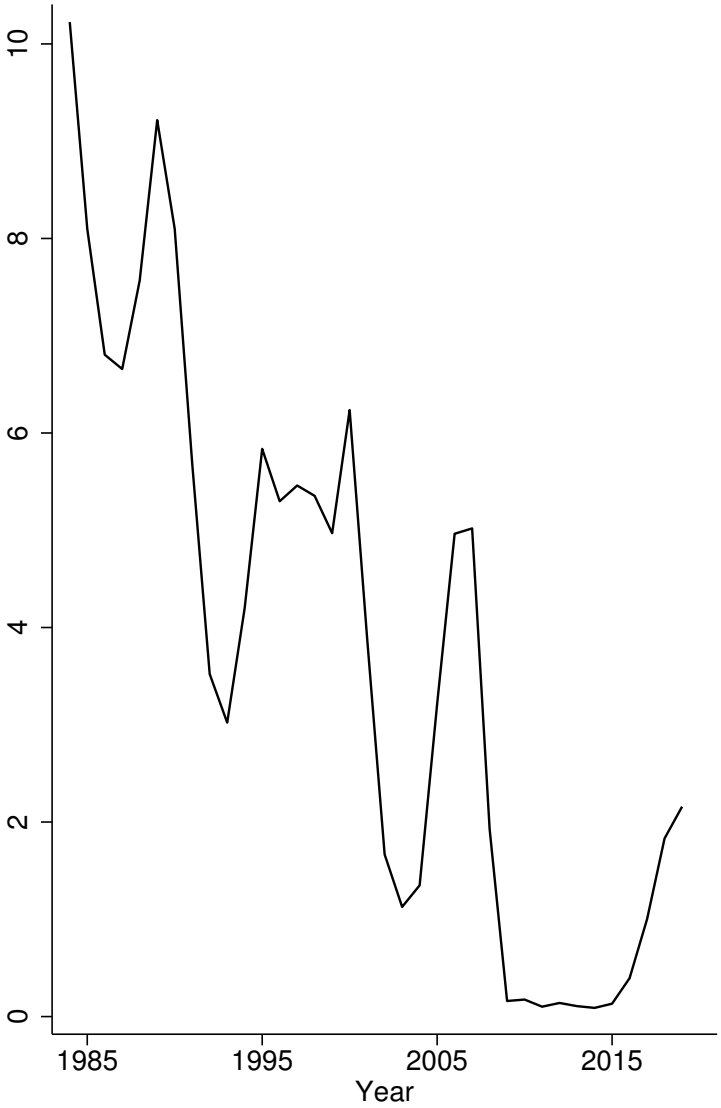
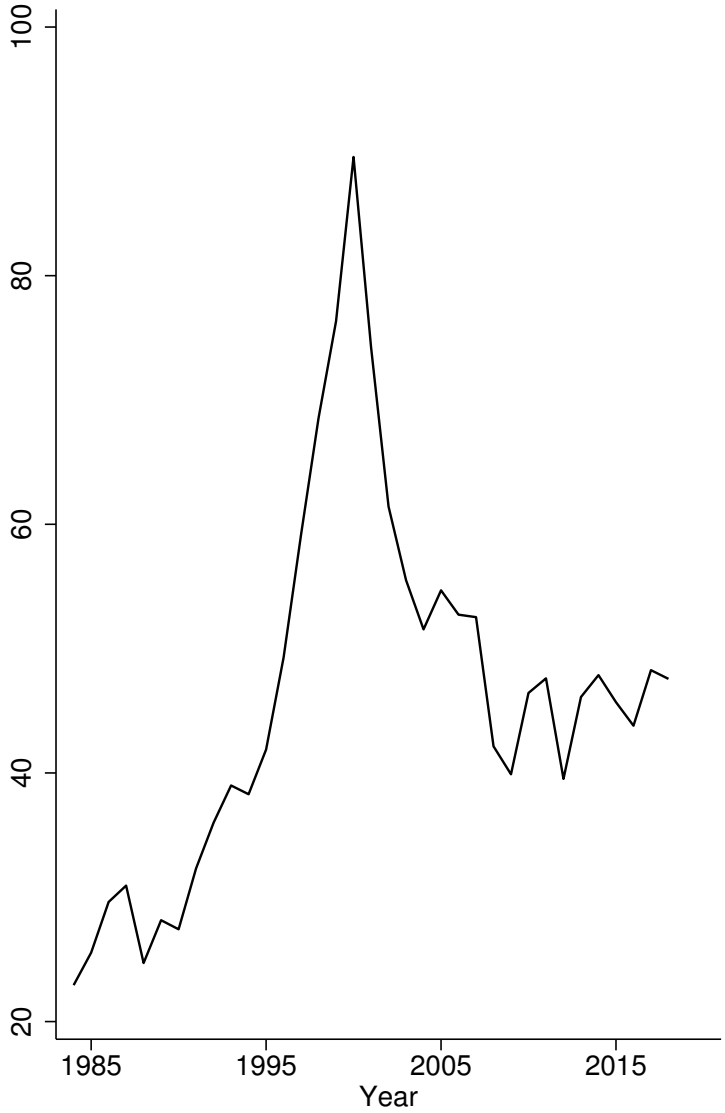
Puzzle: interest rates lower, valuation ratios stable

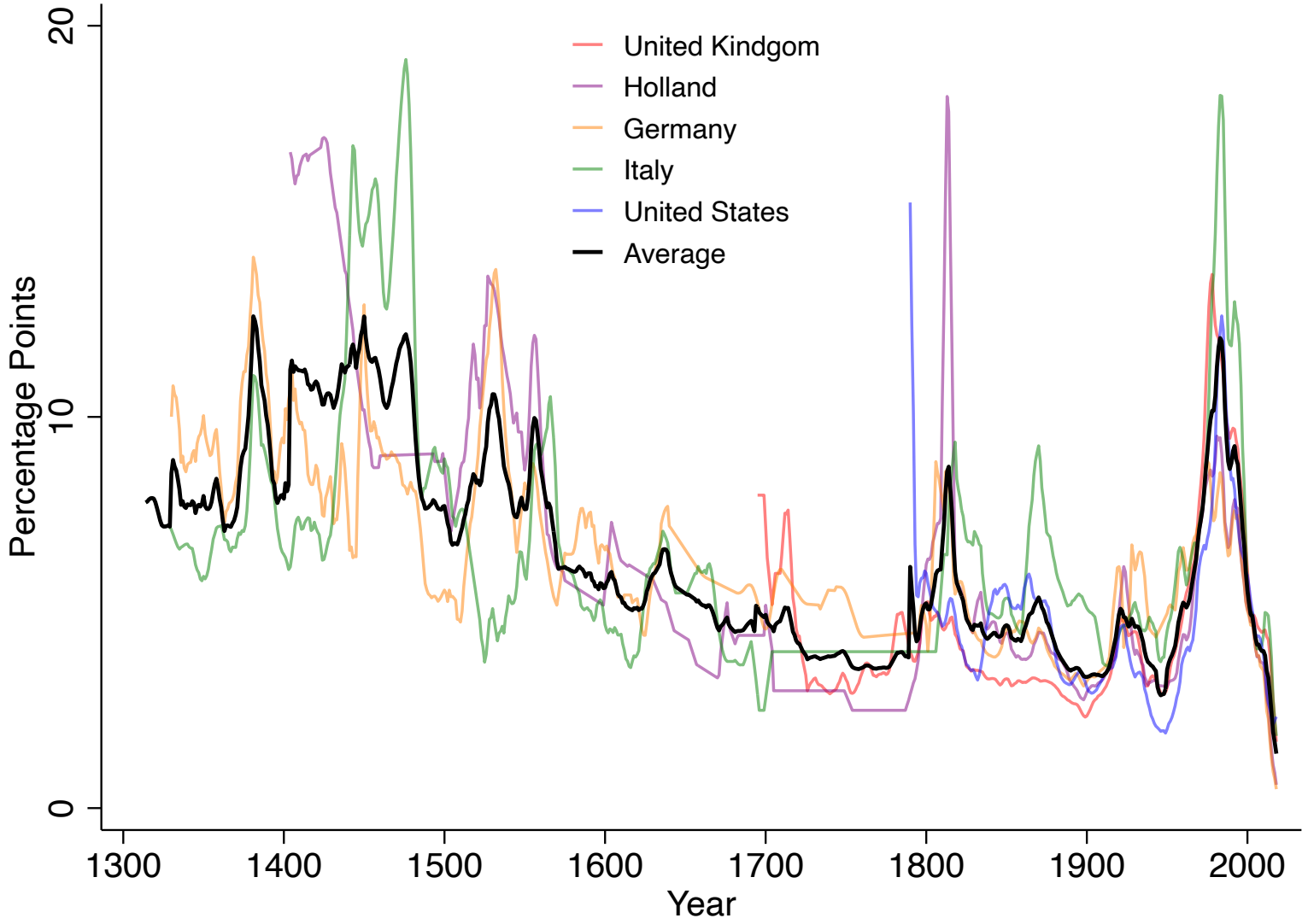
Panel A: Federal funds rate



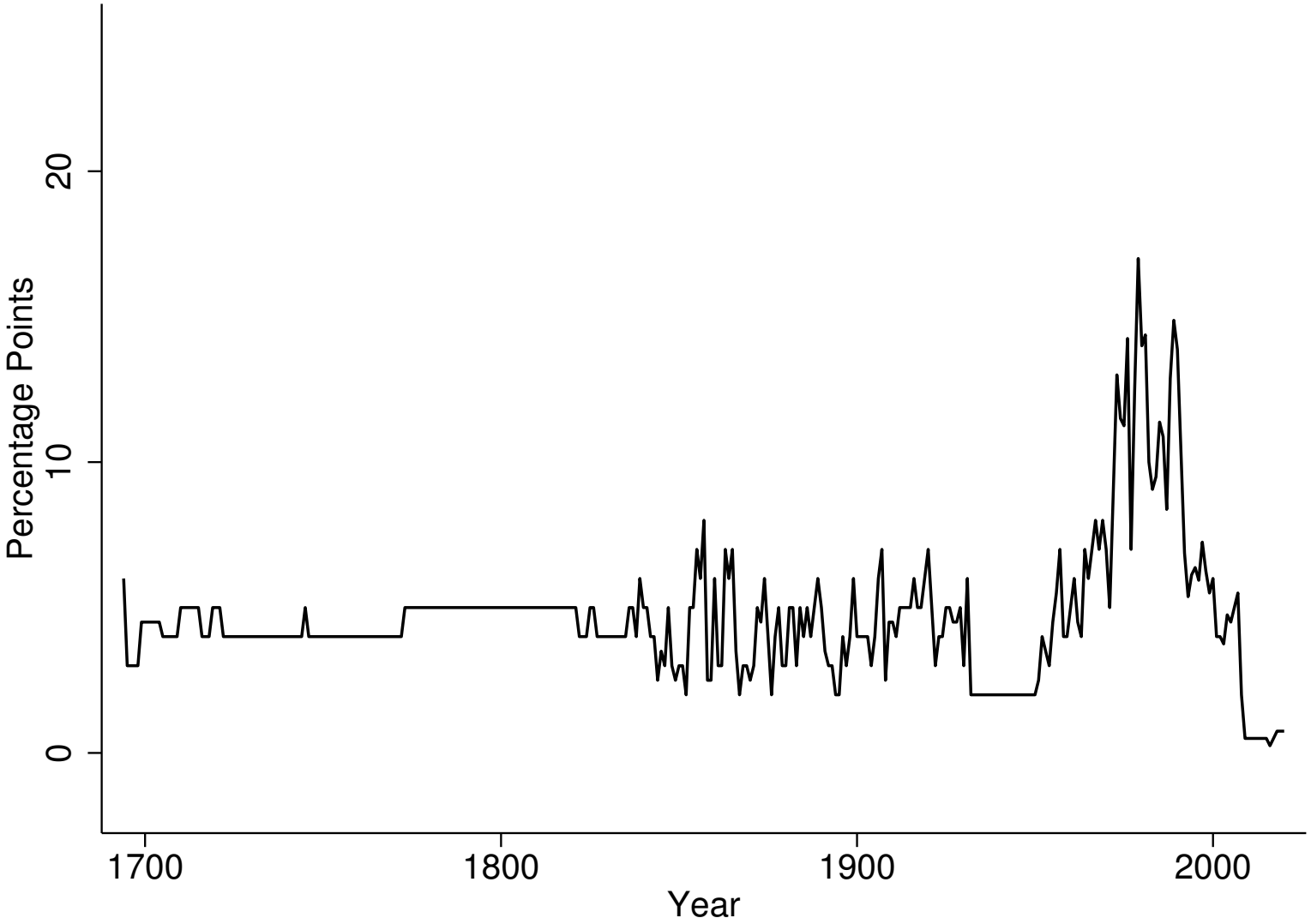
Panel B: Price-dividend ratio



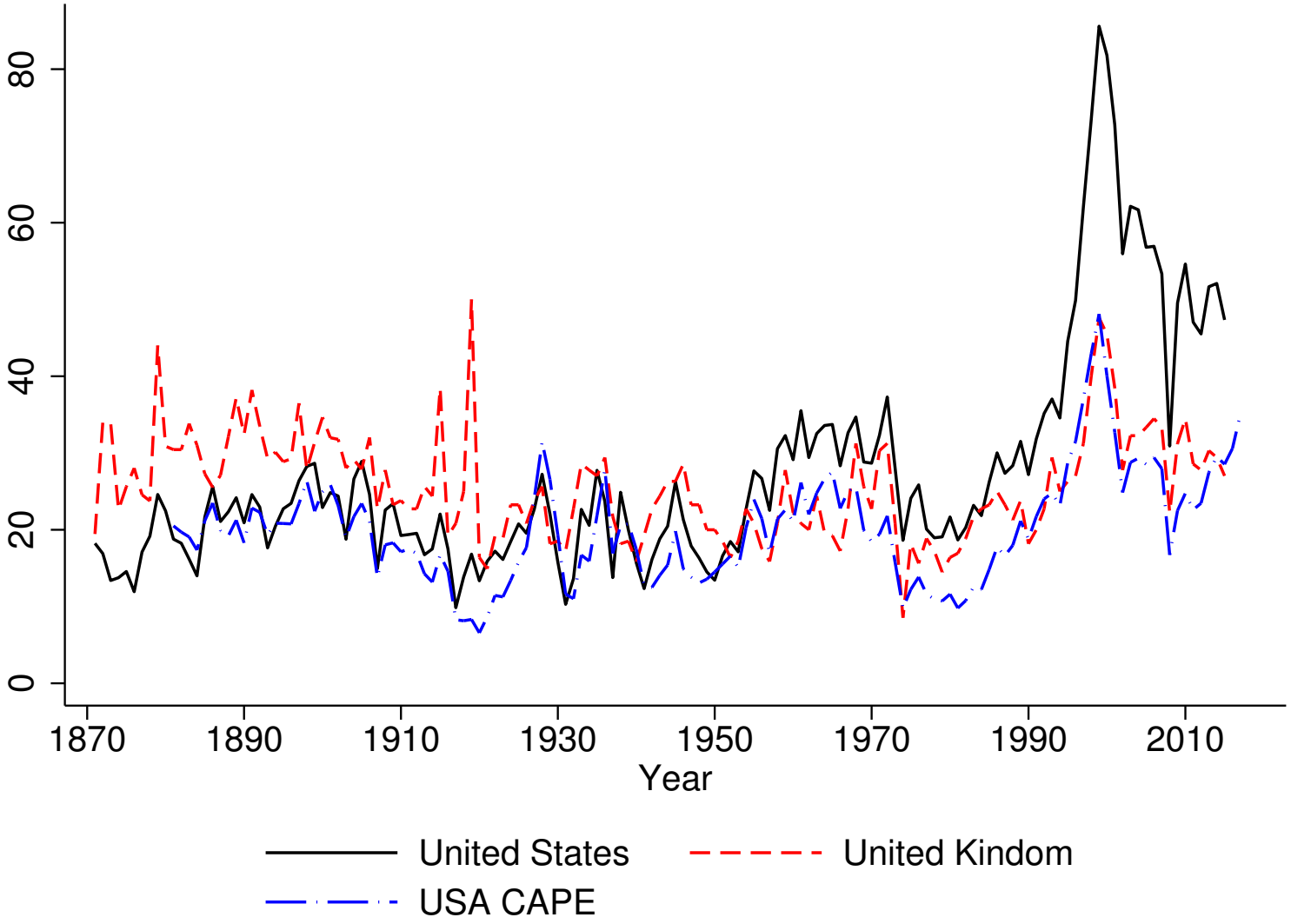
Interest rate decline: a very-long term trend



Nominal bank of England rate

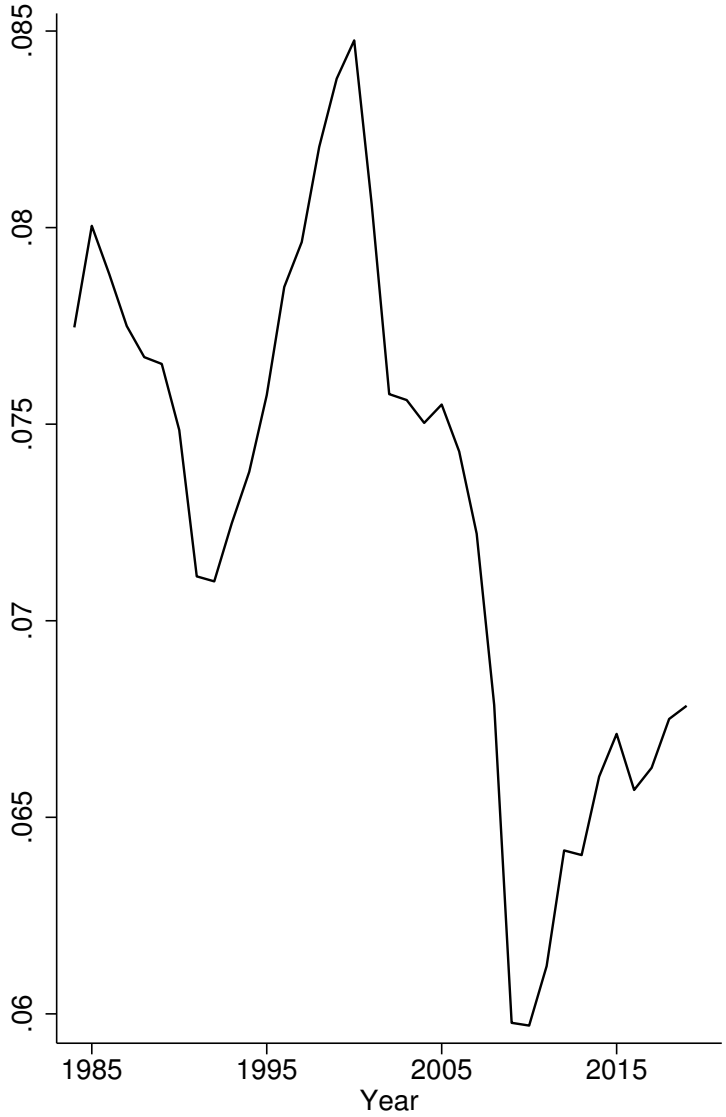


Valuation ratios

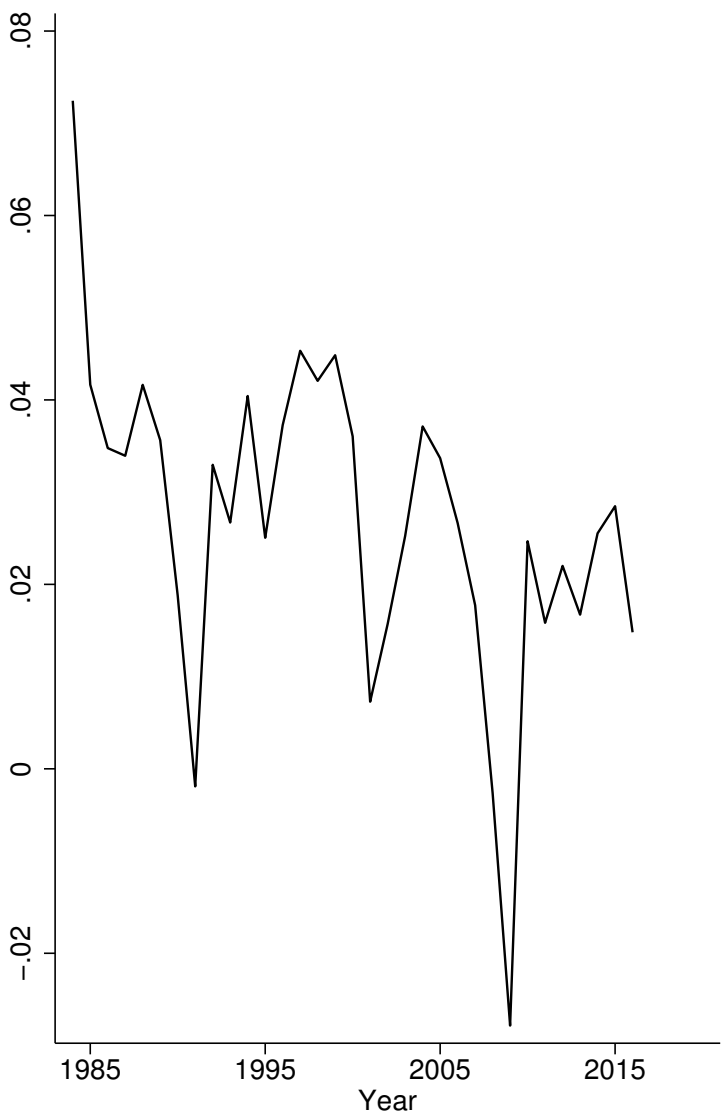


Investment and growth are lower. Related?

Panel A: Investment-capital ratio



Panel B: Real GDP Growth



Outline

1. Model 1: Exchange economy
2. Model 2: Exchange economy with inflation
3. Model 3: Production economy with storage technology.

Findings

1. Explaining facts within an exchange economy with no inflation requires an increase in risk, for which there is no evidence.
2. An endowment economy with declining inflation risk can explain interest rates and valuation ratios.
3. It cannot explain lower investment, a zero lower-bound, nor does it account for the existence of costless storage.
4. For this we need a production economy.

Model 1: Exchange economy model

- Aggregate endowment:

$$C_{t+1} = C_t e^{\mu}(1 - \chi_{t+1}),$$

where

$$\chi_{t+1} = \begin{cases} 0 & \text{with probability} \quad 1-p \\ \eta & \text{with probability} \quad p, \end{cases}$$

- Representative investor with recursive CRRA preferences,
- Discount factor $= \beta$.
- Calibrate the model to growth, interest rates, and price-dividend ratios to first and second half of the sample.

Results

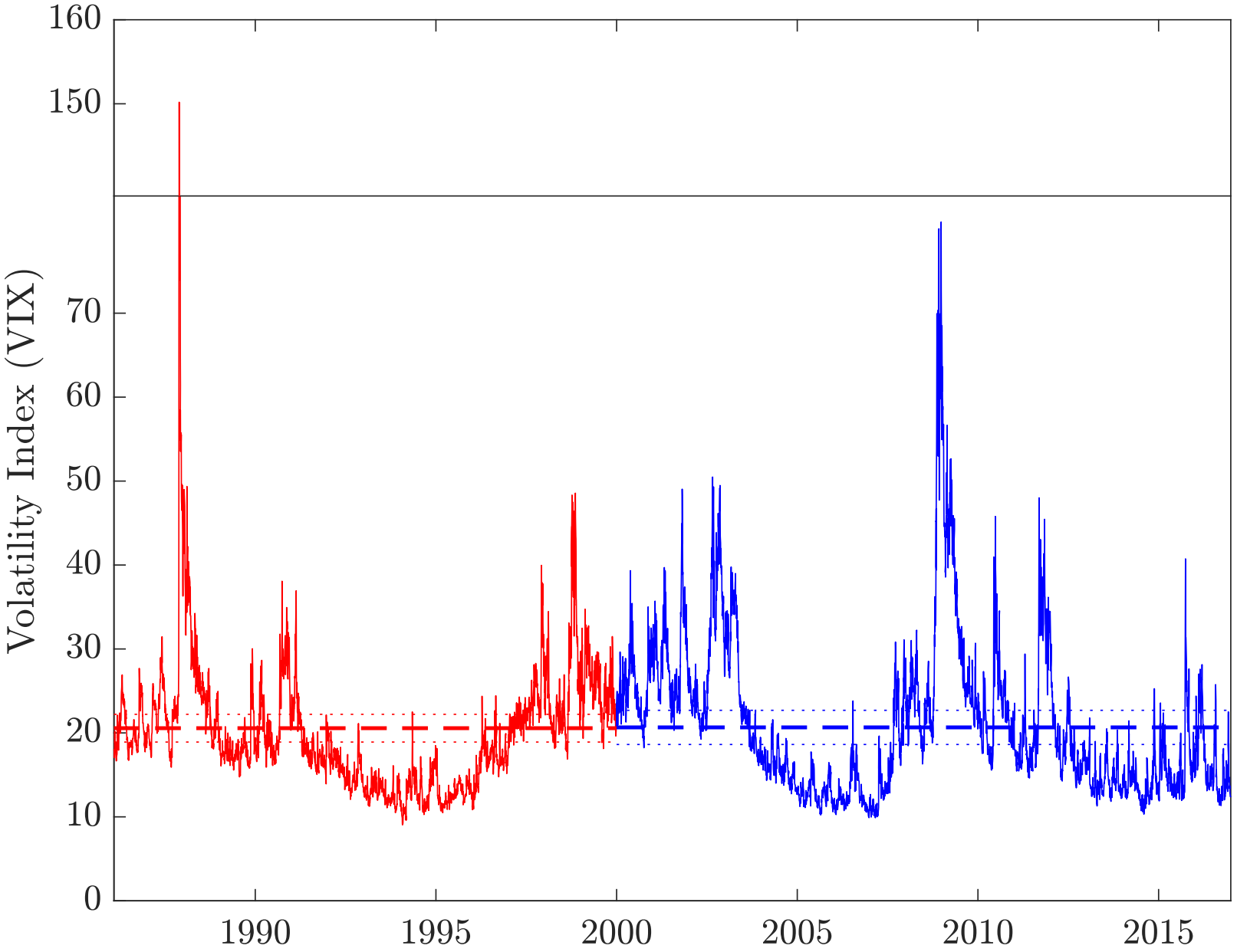
	Values	
	1984–2000	2001–2016
Panel A: Data		
Price-dividend ratio	42.34	50.11
Inflation-adjusted Treasury yield	0.0279	-0.0035
Growth rate	0.0350	0.0282
Panel B: Model, $\mathrm{EIS} = 2$		
Discount factor	0.967	0.979
Disaster probability	0.0343	0.0667
Panel C: Model, $\mathrm{EIS} = 0.5$		
Discount factor	0.997	0.983
Disaster probability	0.0343	0.0667

- Risk aversion $\gamma = 12$, disaster size $\eta = 0.15$.

The mechanism

Panel A: $\mathrm{EIS} = 2$					
	Parameter values			Targeted moments	
	β	μ	p	PD ratio	r_f
Baseline calibration (1984–2000)	0.967	0.0350	0.0343	42.34	0.0279
Higher β	0.979	0.0350	0.0343	94.74	0.0151
Higher β & lower μ	0.979	0.0282	0.0343	71.44	0.0117
Baseline calibration (2001–2016)	0.979	0.0282	0.0667	50.11	-0.0035
Panel B: $\mathrm{EIS} = 0.5$					
	Parameter values			Targeted moments	
	β	μ	p	PD ratio	r_f
Baseline calibration (1984–2000)	0.997	0.0350	0.0343	42.34	0.0279
Lower β	0.983	0.0350	0.0343	25.63	0.0428
Lower β & lower μ	0.983	0.0282	0.0343	31.27	0.0292
Baseline calibration (2001–2016)	0.983	0.0282	0.0667	50.11	-0.0035

Evidence from options



Summary so far

Difficulties with standard "more patient investors" explanation:

1. Requires higher risk (for which there is no evidence)
2. Compatibility with lower growth is parameter-dependent.

Alternative: inflation risk

- Investors the same
- Endowment the same
- Interpret Treasury bill as a defaultable bond
- Default can be outright or through unexpected inflation (isomorphic)
- Nominal yield less ex post average inflation:

$$y_b = r_f + p\lambda\eta((1-\eta)^{-\gamma} - 1) + p\lambda\eta$$

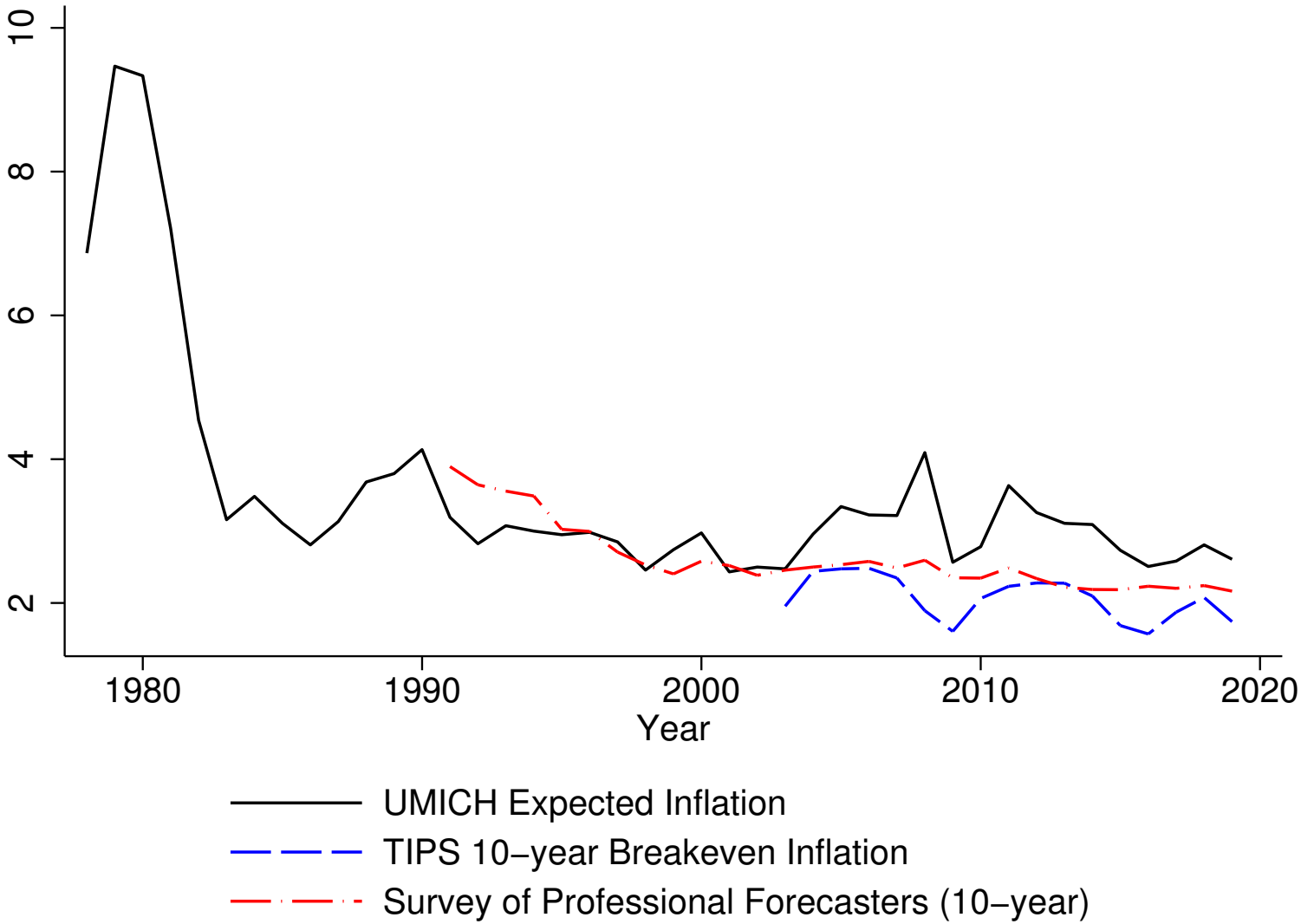
- A decline in λ captures a decline in inflation risk

Results

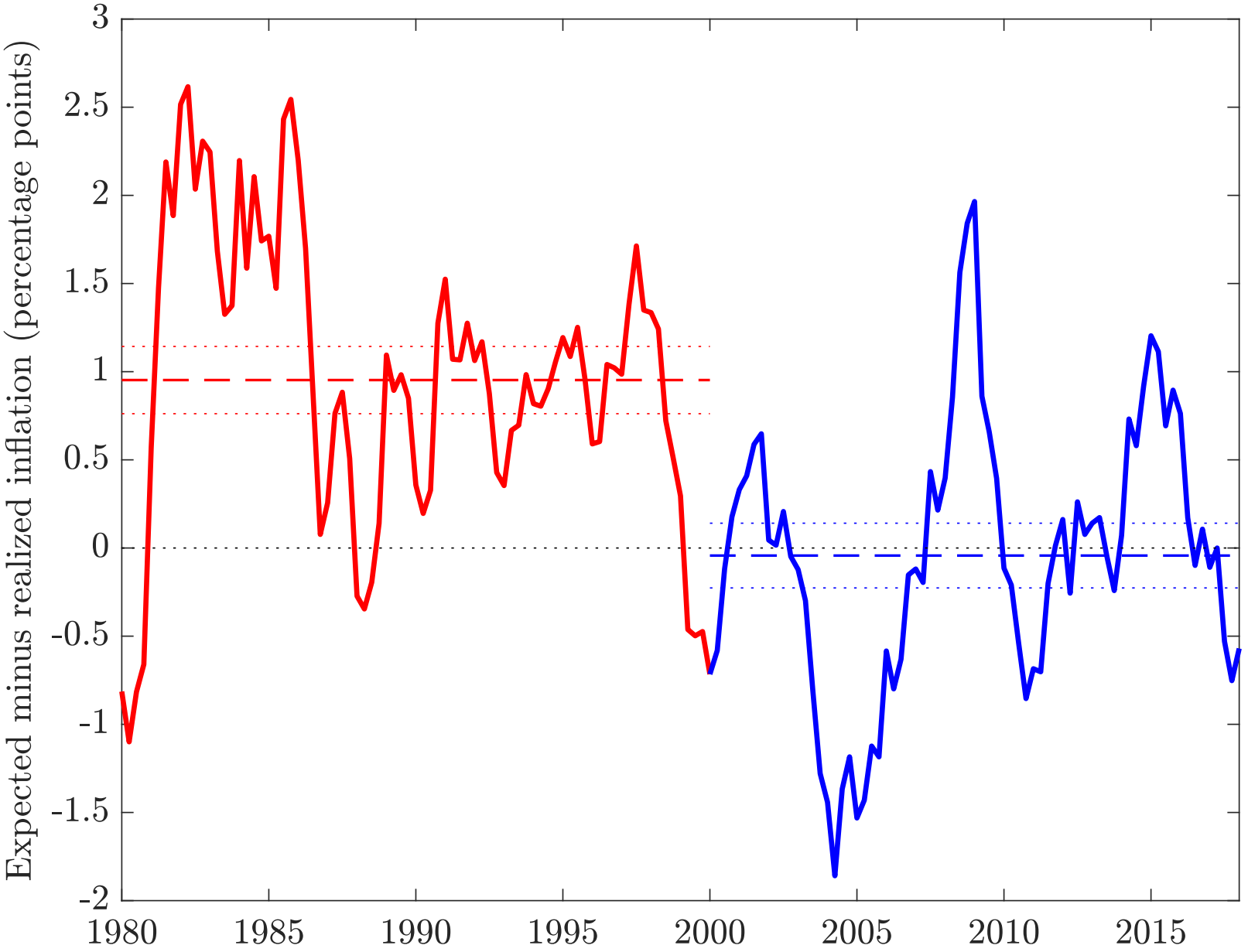
	Values	
	1984–2000	2001–2016
Panel A: Data moments		
Price-dividend ratio	42.34	50.11
Inflation-adjusted Treasury yield	0.0279	-0.0035
Growth rate	0.0350	0.0282
Panel B: Model		
Discount factor	0.977	0.980
Disaster probability	0.0343	0.0343
Treasury bill loss in disasters	0.163	0.016

- Risk aversion $\gamma = 5$, EIS $= 1$, disaster size $\eta = 0.30$,

Inflation expectations



Inflation expectations versus realizations



Summary thus far

- The model with inflationary default can account for the data
- But is ill-equipped to understand decline in investment

Implications of low growth, & low sovereign risk

- Real rate (EIS $= 1$):

$$r_f = -\log\beta + \mu - p(1-\eta)^{-\gamma}\eta$$

- Nominal yield

$$y_b = r_f + p\lambda\eta(1-\eta)^{-\gamma}$$

- For sufficiently low μ and $\lambda \approx 0$, $r_f, y_b < 0$.
- Existence of money as a medium of exchange $\Rightarrow \exists$ storage technology
- In equilibrium $y_b = r_f = 0$.
- Storage crowds out productive investment

The production model with inventory

Assume EIS $= 1$, agent maximizes $V(W_t)$, by choosing

- Consumption C_t
- Bondholdings B_t (may become inventory)
- Planned capital $\tilde{K}_t \geq 0$.

Budget constraint:

$$W_t = C_t + B_t + \tilde{K}_{t+1}$$

Then

$$W_{t+1} = B_t R_f + \tilde{K}_{t+1} R_{K,t+1}$$

Equilibrium

- $R_f^* \equiv$ equilibrium riskfree rate without inventory.
- Fraction of wealth in productive technology: $\alpha = \tilde{K}_{t+1}/(W_t - C_t)$
- 2 cases.

1. If sufficient productive opportunities, $R_f^* \geq 1$, $I_t = B_t = 0$, $\alpha = 1$ (note $I_t \geq 0$).
2. If productive opportunities insufficient, $R_f^* < 1$. If $R_f = 0$, markets clear at, $B_t = I_t > 0$, and $\alpha < 1$.

Investment

- $\delta =$ depreciation
- $Y_t = AK_t$ output
- Evolution of capital:

$$\begin{aligned} \tilde{K}_{t+1} &\equiv X_t + (1-\delta)K_t \\ K_{t+1} &\equiv \tilde{K}_{t+1}(1-\chi_{t+1}), \end{aligned}$$

- Return to capital:

$$R_{K,t+1} = (1-\delta+A)(1-\chi_{t+1})$$

No-inventory case: matching the data

	Values	
	1984–2000	2001–2016
Panel A: Moments in the data		
US CAPE ratio	25.97	26.73
Inflation-adjusted Treasury yield	0.0279	-0.0035
US GDP growth	0.0368	0.0191
Panel B: Fitted parameters		
Discount factor	0.963	0.964
Treasury bill loss in disasters	0.107	0.055
Capital depreciation	0.043	0.063
Panel B: Implied moments		
Risky capital share	1.000	1.000
Investment-capital ratio	0.080	0.082

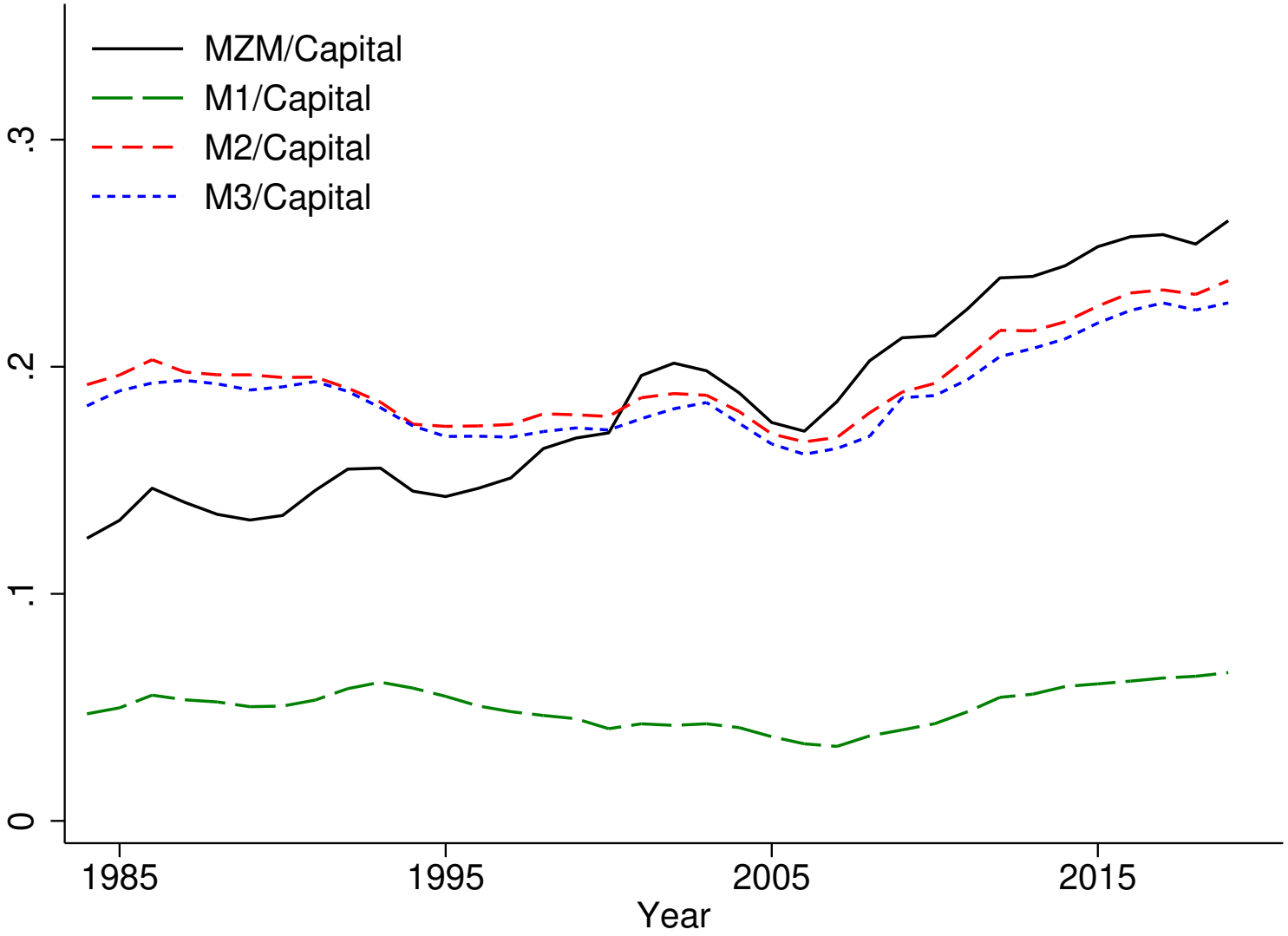
- Risk aversion $\gamma = 6$, EIS $= 1$, disaster size $\eta = 0.30$, MPK $A = 0.12$.

With inventory

	Values	
	1984–2000	2001–2016
Panel A: Moments in the data		
US CAPE ratio	25.97	26.73
Inflation-adjusted Treasury yield	0.0279	-0.0035
US GDP growth	0.0368	0.0191
Panel B: Fitted parameters		
Discount factor	0.963	0.964
Treasury bill loss in disasters	0.107	-0.018
Capital depreciation	0.043	0.057
Panel B: Implied moments		
Risky capital share	1.000	0.912
Investment-capital ratio	0.080	0.077

- Risk aversion $\gamma = 6$, EIS $= 1$, disaster size $\eta = 0.30$, MPK $A = 0.12$.

Evidence of inventory (preliminary)



Conclusions

- Accounting for decline in interest rates and stability of valuation ratios requires an increase in macro risk for which there is no independent evidence
- Accounting is knife-edge with respect to the EIS
- In contrast, a decline in sovereign default risk robustly explains the data and has independent support.
- If sovereign risk is low enough, money becomes an inventory asset, leading to crowding out of investment and still lower growth.