The Rate of Technology Adoption: Stability Implications for the Macroeconomy and for Asset Prices

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Introduction

- New technologies often associated with **aggregate instability**:
  - output & employment booms
  - stock price booms
  - booms often followed by output falls & spectacular asset price collapses

- Prominent examples:
  - 1990's dotcom boom: internet, biotech
  - 1920's boom: radio, automobiles, aviation,electrification
  - 19th century: railway boom in Britain

Introduction

- Present a simple (!) economic model that quantitatively replicates
  - behavior of postwar U.S. business cycle
  - volatility of postwar U.S. stock prices
  - comovement patterns between business cycle and stock prices

Introduction

- Model is quantitatively successful
  - occasional boom-bust like episodes in stock prices & ec. activity
  - **booms feature a 'Minsky moment':**

    booms followed by depressed ec. activity & stock prices

- Model predicts that the likelihood of boom-bust episodes
  - higher in periods of **high productivity growth**
  - higher in periods of **low real interest rates**

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  Malmendier & Nagel (2011), Adam, Marcet & Beutel (2017)

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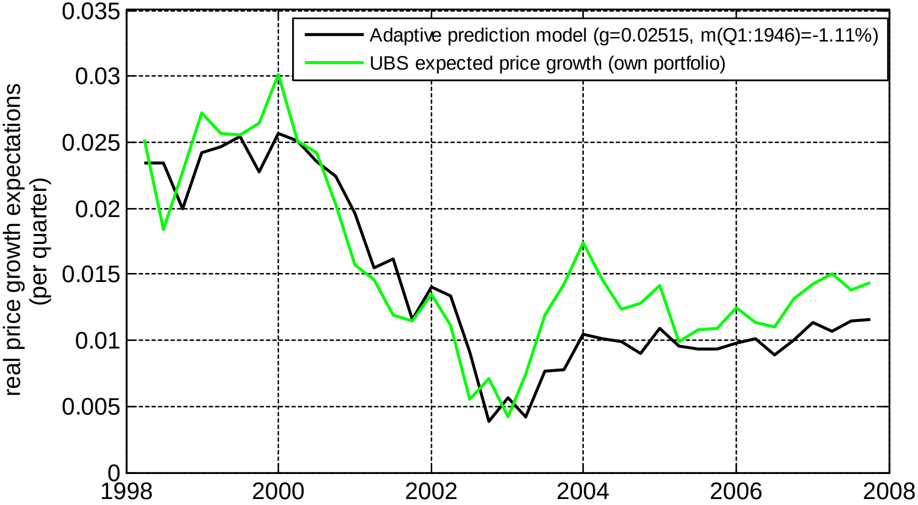
- *Some* amount of extrapolation from past return:

$$E_t^{\mathcal{P}}\left[\frac{P_{t+1}}{P_t}\right] = E_{t-1}^{\mathcal{P}}\left[\frac{P_t}{P_{t-1}}\right] + g\left(\frac{P_t}{P_{t-1}} - E_{t-1}^{\mathcal{P}}\left[\frac{P_t}{P_{t-1}}\right]\right)$$

  Rationalizable as Bayesian learning:$g > 0$ is the Kalman gain

Survey Data and Extrapolative Expectations



Extrapolation as Amplification

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  high capital price trigger investment => output & hours worked

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- **Amplification** stronger when interest rates low or tech growth high

Stock Price Cycles and Business Cycles

- Time-separable household preferences

$$E_0^P \sum_{t=0}^{\infty} \beta^t \left(\log C_t - H_t\right)$$

- Standard 2-sector production structure

$$\begin{aligned} Y_{C,t} &= K_t^{\alpha_z} \left(Z_t H_{c,t}\right)^{1-\alpha_c} \\ Y_{I,t} &\propto \left(Z_t H_{i,t}\right)^{1-\alpha_c} \end{aligned}$$

- Technology shocks (only source of randomness):

$$Z_t = \gamma Z_{t-1} \varepsilon_t$$

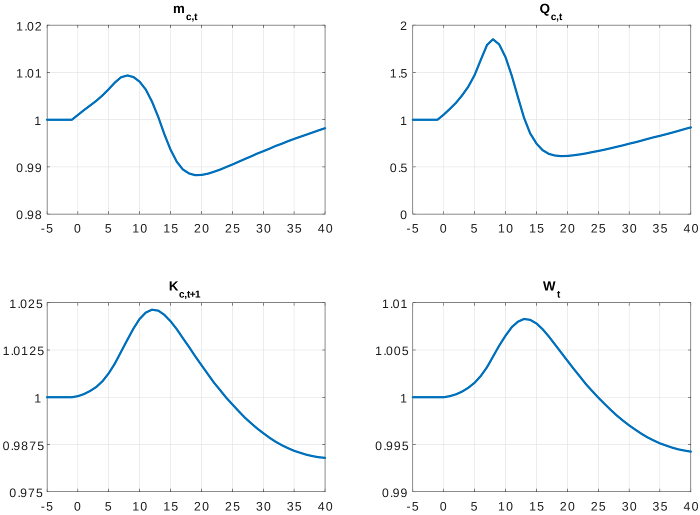
Quantitative Performance: Real Variables

Moment	Data (StdDev)	Model
$\sigma(Y)$	1.72 (0.25)	1.83
$\sigma(C)/\sigma(Y)$	0.61 (0.03)	0.67
$\sigma(I)/\sigma(Y)$	2.90 (0.35)	2.90
$\sigma(H)/\sigma(Y)$	1.08 (0.13)	1.06
$\rho(Y, C)$	0.88 (0.02)	0.84
$\rho(Y, I)$	0.86 (0.03)	0.89
$\rho(Y, H)$	0.75 (0.03)	0.70

Quant. Perf.: Financial Variables, Comovement, Expectations

Moment	Data (StdDev)	Model
$E[P/D]$	152.3 (25.3)	149.95
$\sigma(P/D)$	63.39 (12.39)	44.96
$\rho(P/D)$	0.98 (0.003)	0.97
$E[r^e]$	1.87 (0.45)	1.25
$\sigma(r^e)$	7.98 (0.35)	7.07
$E[r^f]$	0.25 (0.13)	0.78
$\sigma(r^f)$	0.82 (0.12)	0.06
$\sigma(D_{t+1}/D_t)$	1.75 (0.38)	2.46
$\rho(H, P/D)$	0.51 (0.17)	0.79
$\rho(I/Y, P/D)$	0.58 (0.31)	0.69
$\rho(E^{\mathcal{P}}[r^e], P/D)$	0.79 (0.07)	0.52

Boom-Bust Cycles: Real & Financial Variables



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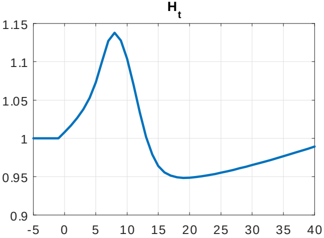

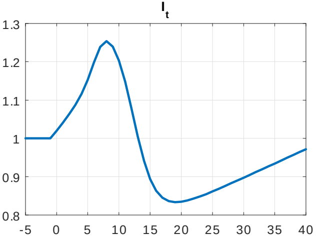

Aggregate Growth and Macro Instability

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- Equilibrium capital price equation (slightly simplified):

$$Q_t = \frac{X_t}{1 - \beta\gamma \cdot m_t},$$

where

$$\begin{aligned} m_t &: \text{ subjective capital gain expectations } E_t^{\mathcal{P}}[Q_{t+1}/Q_t] \\ \beta &: \text{ discount factor } (\beta < 1) \\ \gamma &: \text{ gross aggregate growth rate } (\gamma > 1) \\ X_t &: \text{ end. variable that depend on parameters, technology,} \\ &\quad\ \text{path of capital stock} \end{aligned}$$

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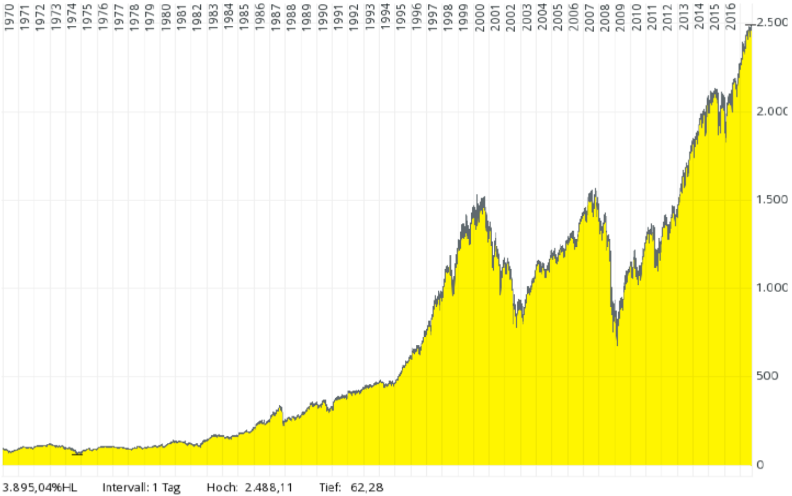
- Quantitative results rather sensitive to changes in $\beta\gamma$

Price Instability since 1970: S&P500



Conclusions

- Extrapolation in asset markets :

  a powerful amplification mechanism of fundamental shocks

- Simple and otherwise standard model:

  quantitatively consistent with BC & stock price evidence

- Model features boom and bust cycles:

  Higher frequency with higher technology growth/lower real rates