

Facts and Modeling of the Recent Financial Market Meltdown

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Talk at the MAFIN 09 Conference (Reykjavik, September 2009). It is based on:

- 1. Semmler, W. and L. Bernard (2009), *Boom-Bust Cycles: Leveraging, Complex Securities, and Asset Prices***
- 2. Previously published work with several co-authors on *Leveraging and Asset Pricing***

Sieveking and Semmler, JEDC (2000)

Grüne, Semmler, and Sieveking, Economic Theory, (2005)

Grüne, Semmler, and Bernard, Journal of Credit Risk, (2007)

Grüne, Chen, and Semmler (2008), forthcoming

Grüne and Semmler, JEDC, (2008): On Loss Aversion and Asset Pricing

Introduction & Motivation

Outline

1. Introduction/Motivation
2. Latest Boom-Bust Cycles: Theories/Facts
3. Our Previous Work: Leveraging and Asset Prices
4. New Model: Leveraging and Asset-Price Bubbles
5. First Amplifying Factor: New Financial Instruments (complex securities)
6. Second Amplifying Factor: Inflow of External Funds and Ponzi Schemes
7. Leverage Cycles: Interaction of Leveraging and Asset Price Bubbles
8. Conclusions

Introduction & Motivation

“I can calculate the movement of the stars, but not the madness of people“ - Isaac Newton

Financial boom-bust cycles: South Seas Bubble (1720), Roaring 1920s, IT Bubble of the 1990s



Introduction & Motivation

- Booms in industries, commodities, technology, e.g., Rubber boom, auto boom in the 1920, resource and oil booms, IT Bubble of the 1990
- Most of the boom bust cycles are interacting with financial cycles (see Mazzucato/Semmler, 2003)
- The previous boom bust cycles often left some “real stuff” behind (production capacity, technology, infrastructure, human capital)
- Recent financial bubble: From 1991 to 2008; Debt exceeds GDP, from \$6 to \$19 trillion, financial sector growing from 5% to 10% of GDP and 10 biggest investment firms from 10 % to 50% (due to proprietary trading); but what did the burst of the financial bubble leave us with?

Introduction & Motivation

Studies on recent boom bust cycles:

Well understood:

- The emerging markets and Asian boom-bust cycles, 1997/8
- The IT Bubble, 1990s

Less understood:

- The latest boom bust-cycle – subprime crisis in real estate, US - banking crisis, world-wide financial market meltdown, world-wide real recession.

Forerunners:

- 1966: Credit crunch, 1970, 1974, Franklin National Bank Failure, 1982: Mexican Bailout, 1984: Bailout of Continental Illinois, 1984:: Saving and Loan crisis, 1987: stock market crash, but non of them led to a financial market meltdown, nor to an extended recession

Introduction & Motivation

What is common to most boom-bust cycles? (Minsky: Financing practices (Ponzi finance), Kindleberger: instability of credit, Tobin: financially caused macro instability). Mostly we see some synchronized behavior:

Booms: overconfidence, overvaluation of assets, overleveraging, underestimation of risk, credit expansion without collaterals, relieving liquidity constraints by spending

Busts: confidence loss, loss aversion, undervaluation of asset prices, deleveraging, rise of default premia and spreads, collateral constrained borrowing, less spending and tightening of liquidity constraints

Latest Boom Bust-Cycle Theories

Standard explanations of the recent bubble:

- Monetary policy and interest rates (Greenspan, Bernanke)...
- Baby boomers...Mankiw et al.
- Inflation rates and shift of portfolio (since the 1980s, see Schneider)
- Overshooting (Shiller)
- Securitization of debt, outsourcing of risk, credit boom, real estate asset price boom (MBS, CDOs, CDS), see Kaufmann (2009)
- DSGE Models, technology shocks, misperceived technology shocks
- Bernanke, Gertler et al., Financial accelerator as amplifying mechanism,
- New work on over-leveraging, Brunnermeier, Adrian/Shin, Geanakoplos, leverage cycles, leveraging: collateral value/cash flow (instead of Assets/Equity)
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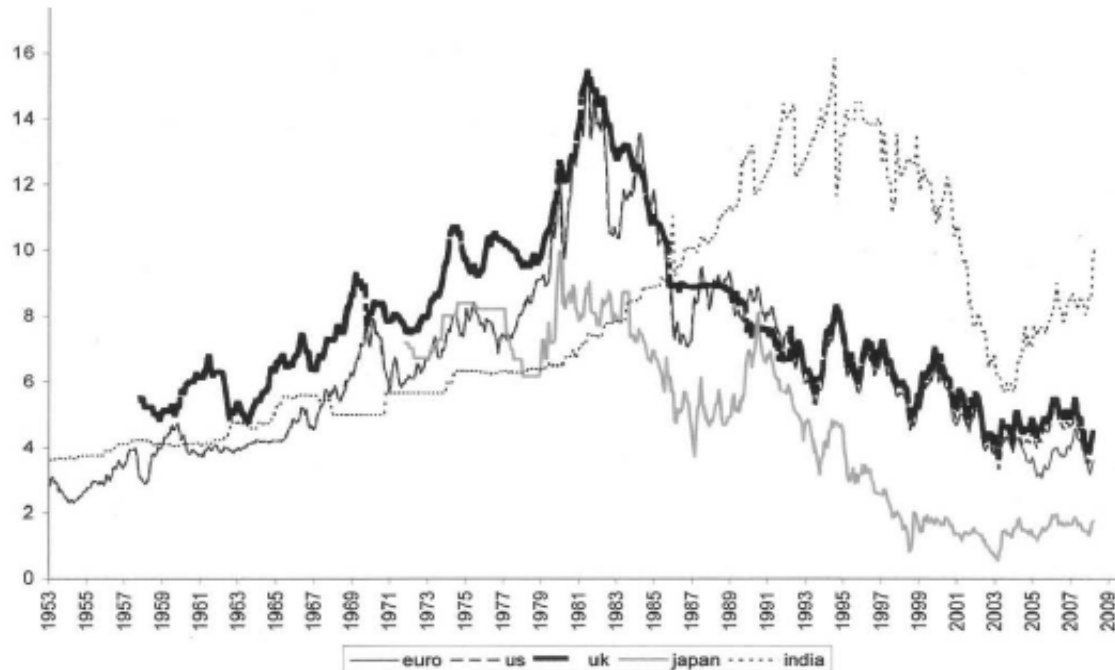
Latest Boom-Bust Cycle Theories

Features of the current boom-bust cycle

- Change of macroeconomic environment (financial market liberalization, deregulation of banks, low interest rates, easy credit, high liquidity, inflow of external funds) ...
- Increased leveraging, new financial instruments (complexity that was introduced due to complex securities, MBS, CDOs, CDS),
 - ❖ leveraging worse than before (Adrian/Shin, Brunnermeyer Geanakoplos, 2009)
 - ❖ this time, two types of leveraging: 1) leveraging of real capital, housing and 2) leveraging to buy assets (complex securities)
 - ❖ change of financial intermediation: from bank based intermediation to market based intermediation
 - ❖ non-robustness of prices of new complex securities (our view, see Semmler and Lucas 2009)

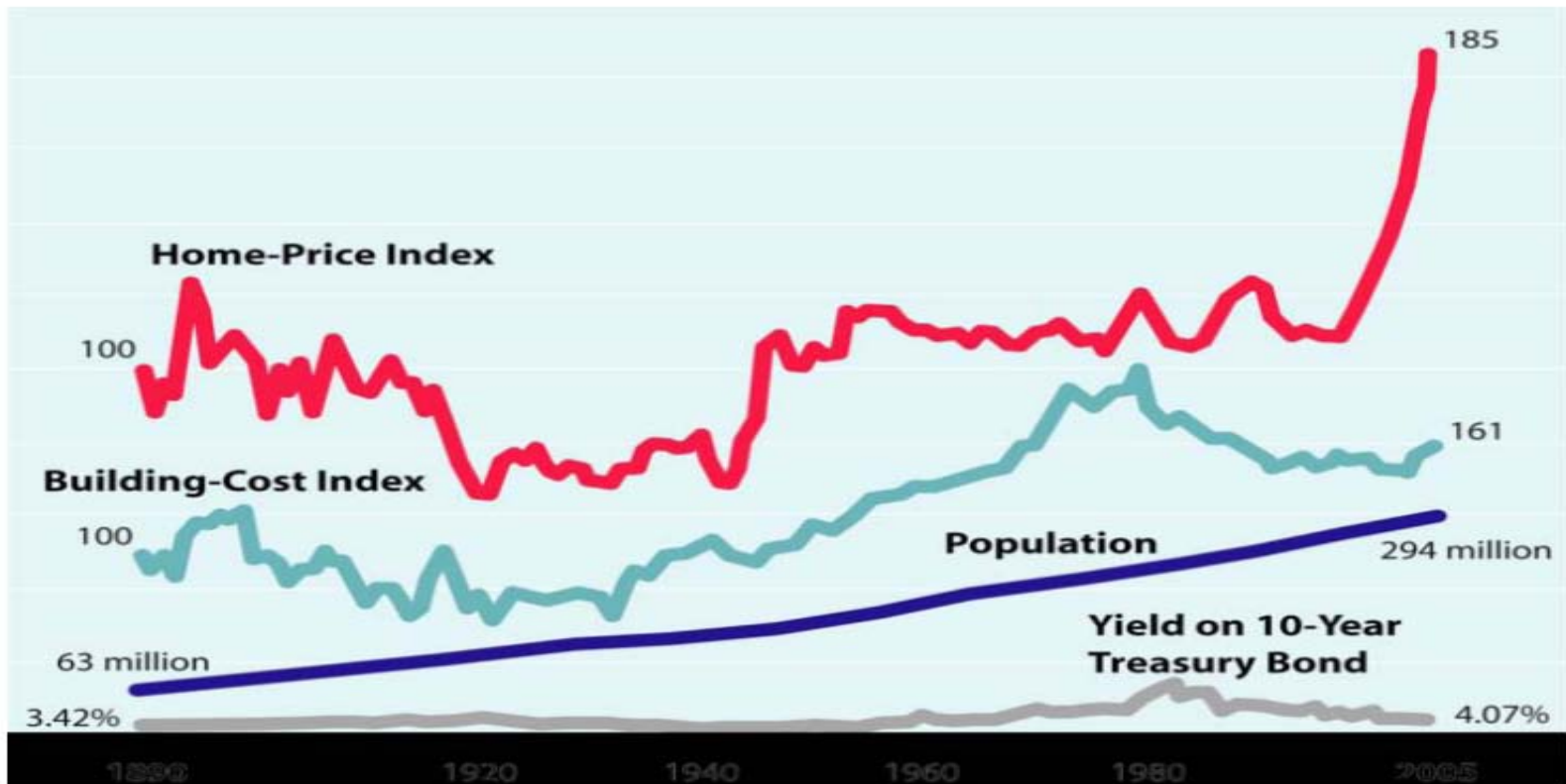
Latest Boom-Bust Cycle Facts

Figure 1: Interest rates, 5 countries



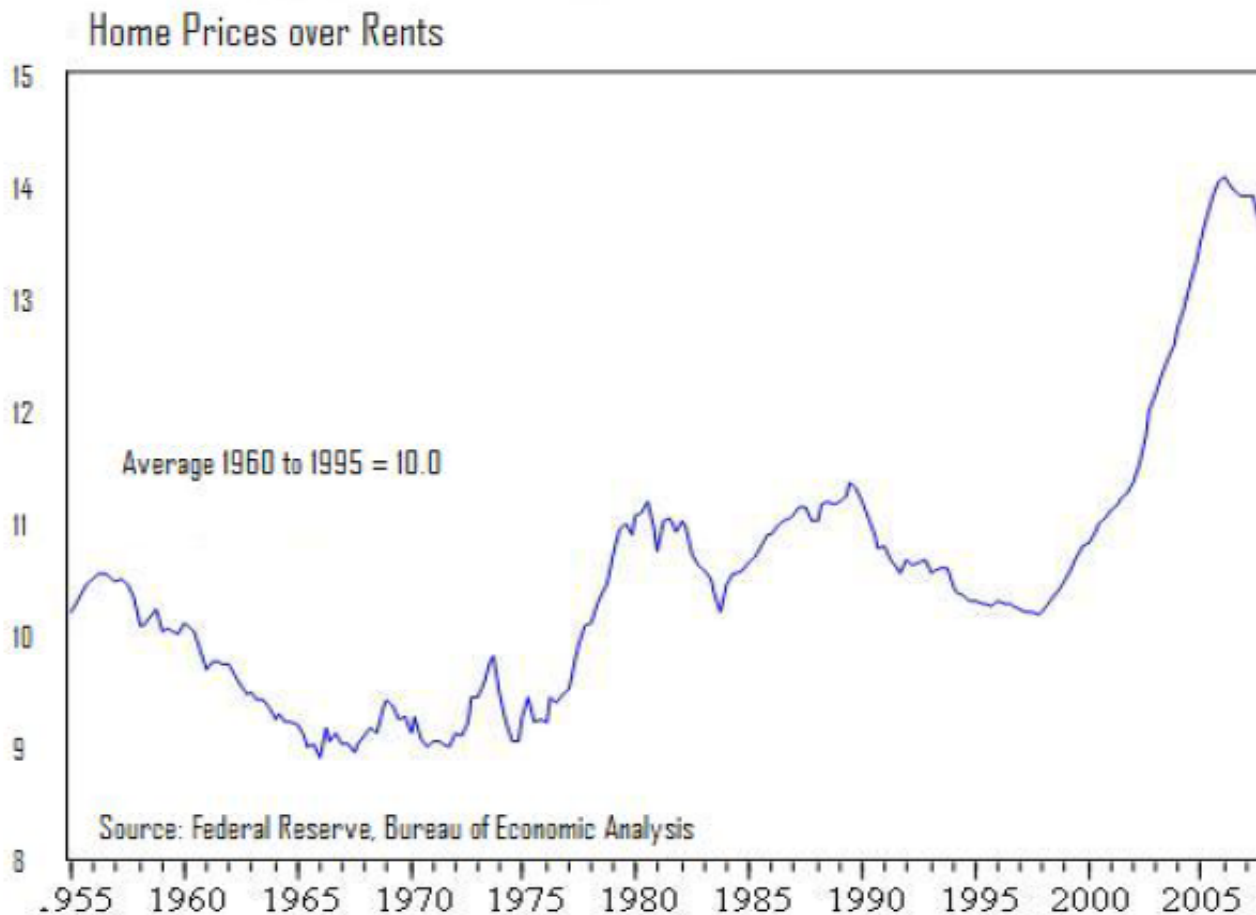
Latest Boom-Bust Cycle Facts

Figure 2: Home Price Index



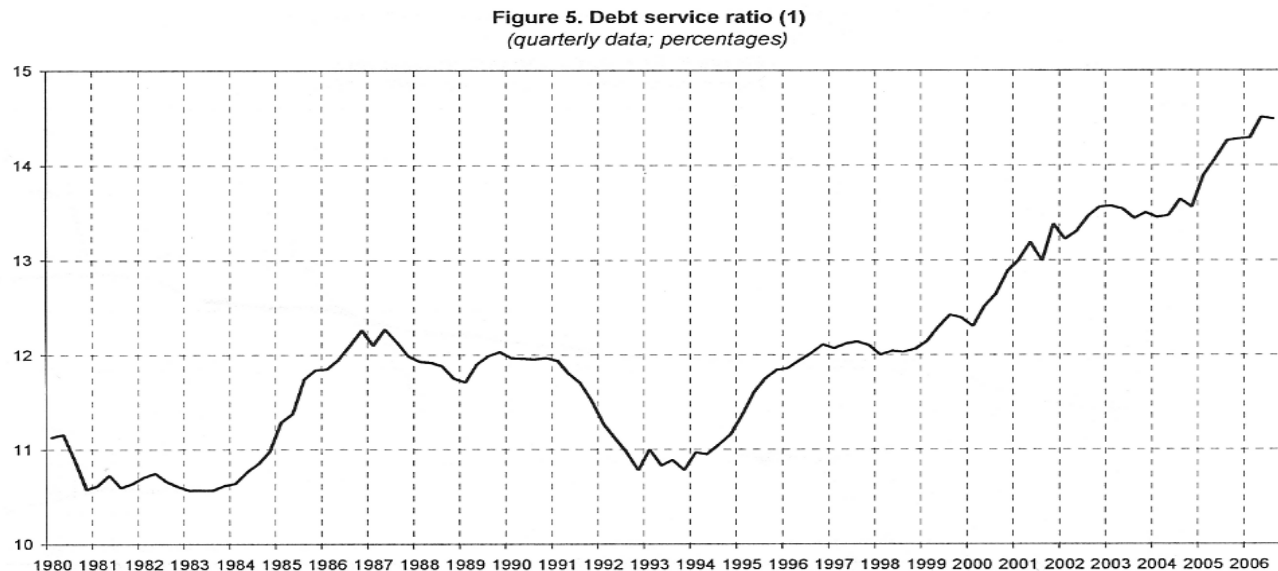
Latest Boom-Bust Cycle Facts

Figure 3: Price-dividend ratio



II. Latest Boom-Bust Cycle Facts

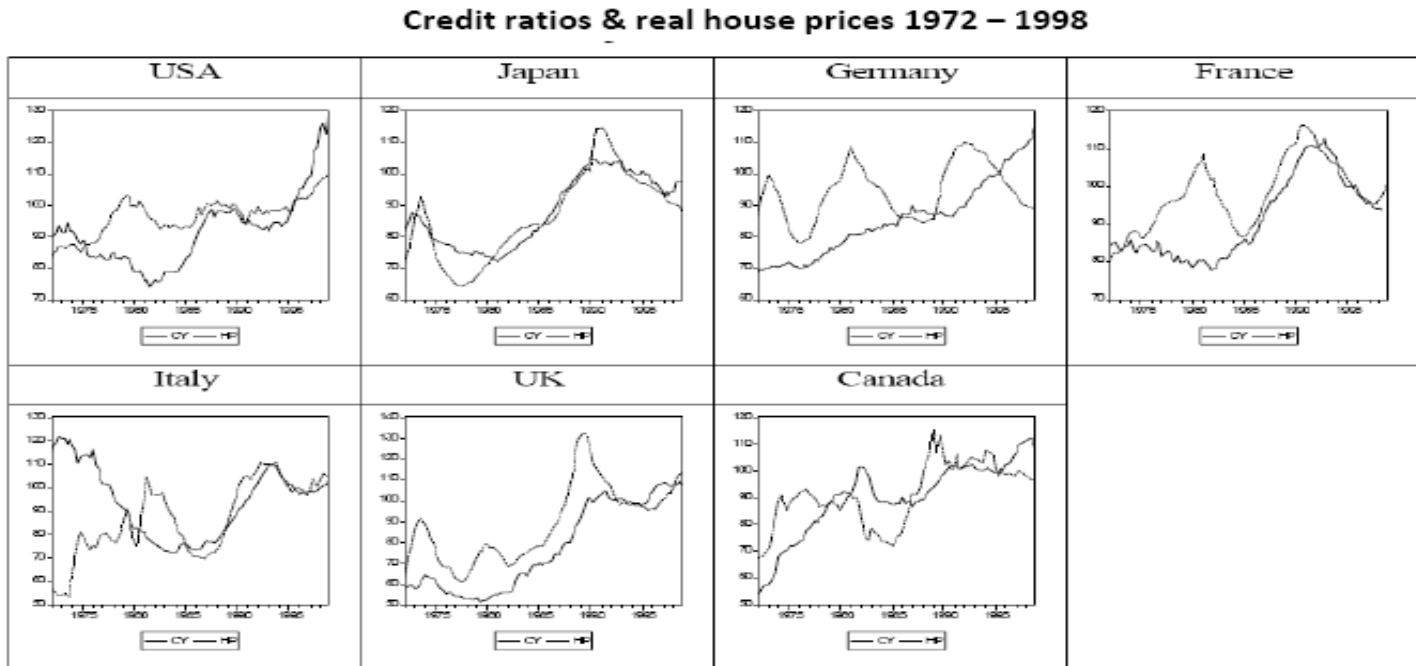
Figure 4: Debt Service ratio (debt service to disposable income)



Source: Federal Reserve. (1) Ratio of interest and minimum contracted principal payments and disposable income.

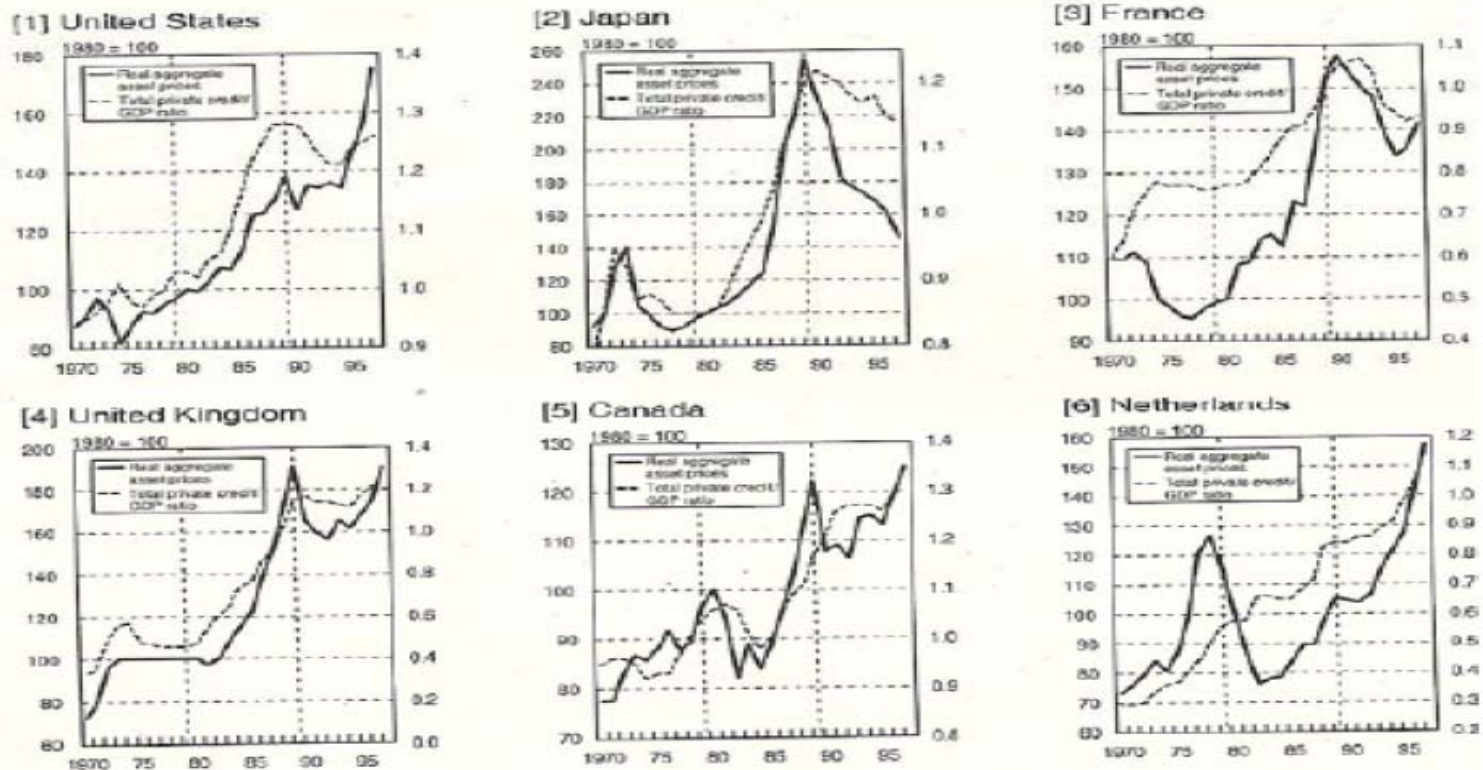
II. Latest Boom Bust Cycle-Facts

Figure 5: Credit Boom and House Price Boom (Goodhart et al., 2005)



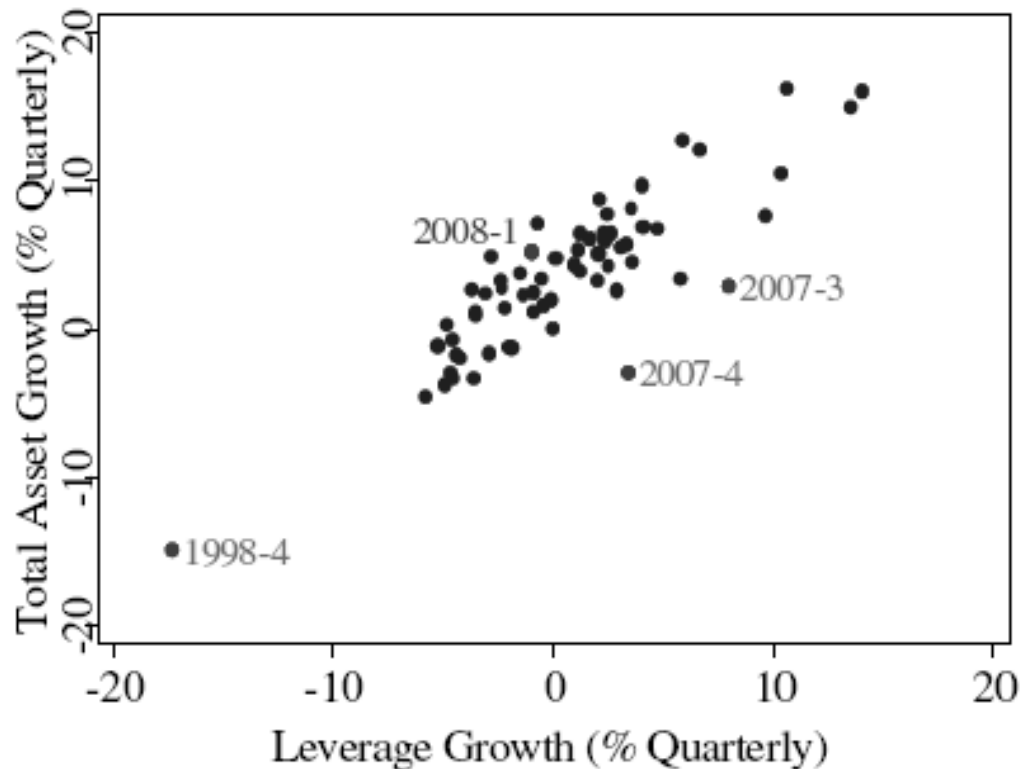
II. Latest Boom Bust Cycle-Facts

Figure 6a: Credit boom and asset price boom: Levels (Bank of International Settlements)



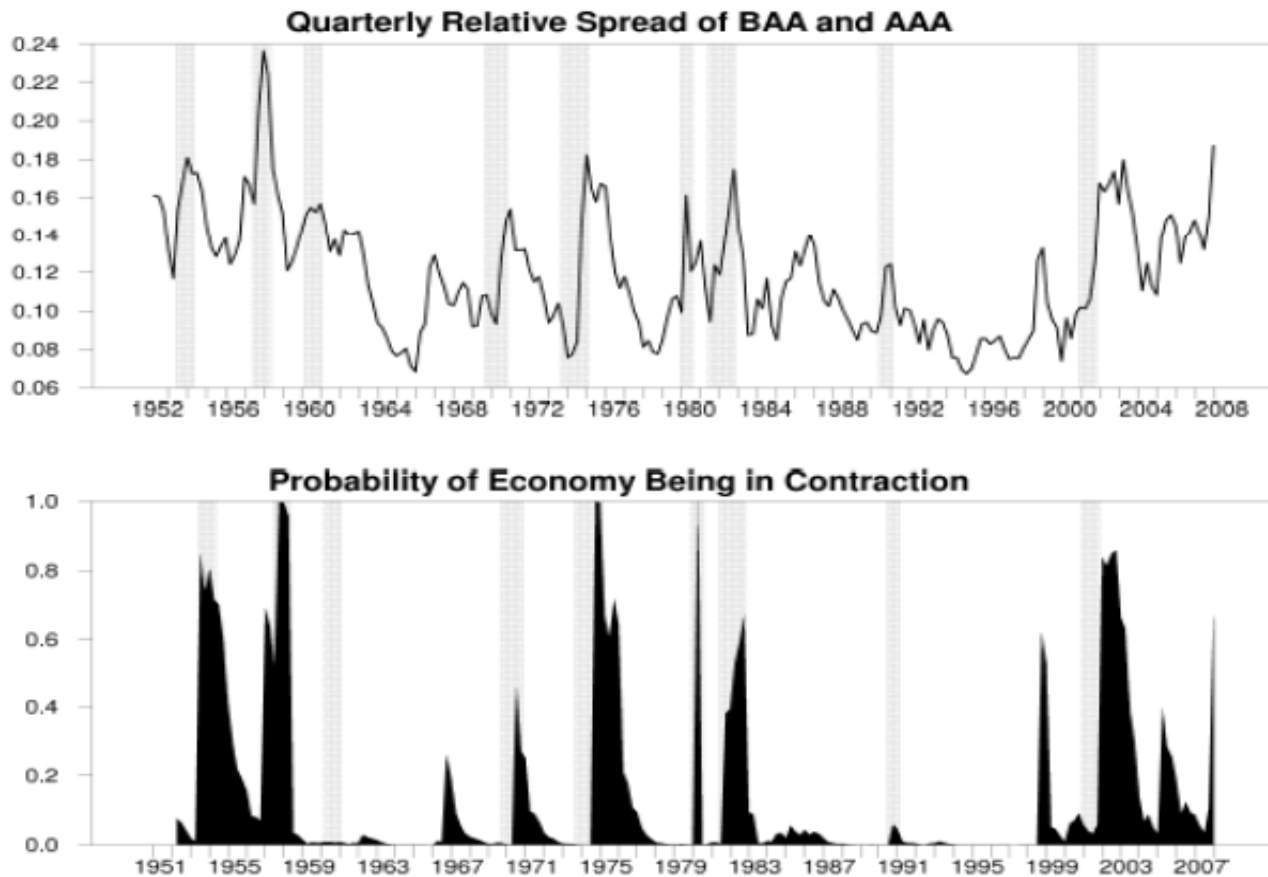
Latest Boom-Bust Cycle Facts

Figure 6b: Credit boom and asset price boom: Growth rates (given $A(=B+E)/E$: Leverage and asset growth of US investment banks)



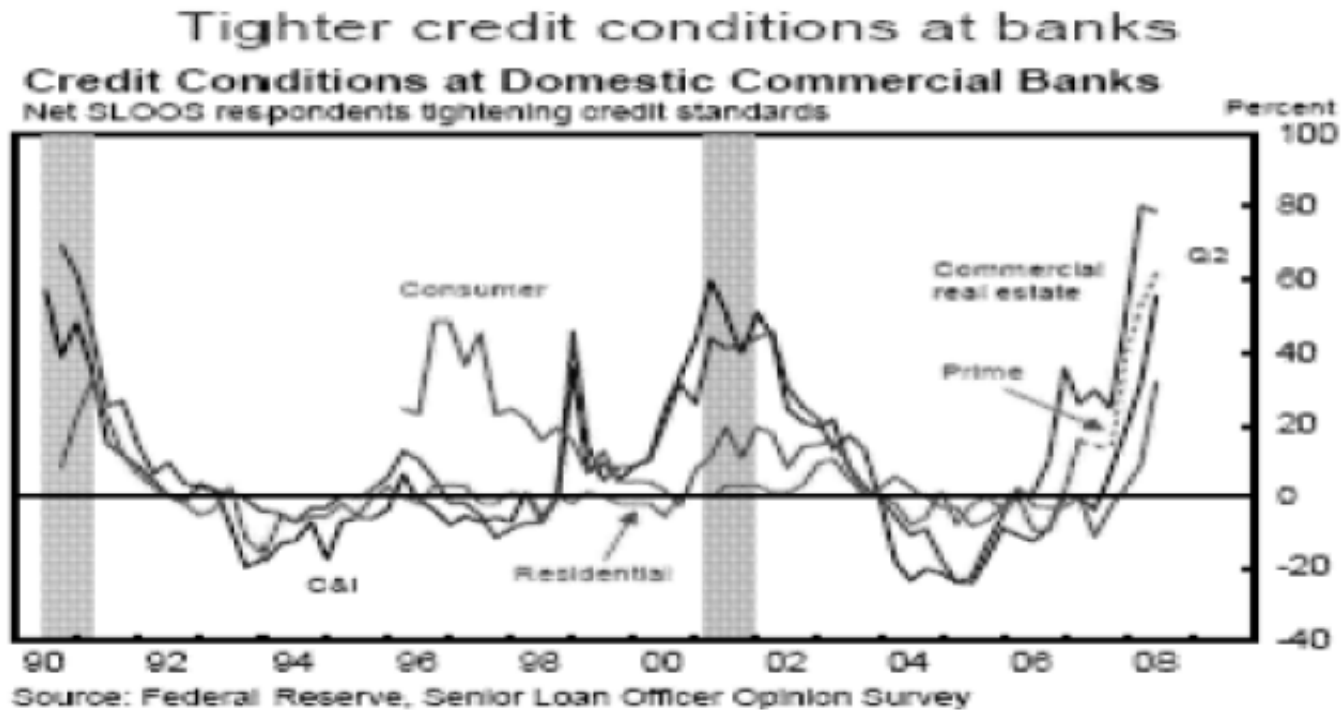
Latest Boom-Bust Cycle Facts

Figure 7: Default premia and probability of recession (libor, repo rate, Ted spread: difference between libor and Tbill)



Latest Boom-Bust Cycle Facts

Figure 8: Ease and tightness of credit



Our Previous Work: Leveraging and Asset Prices

We show (in Grüne and Semmler, JEDC 2004, Grüne, Semmler and Sieveking, 2005, ET, Grüne, Semmler, and Bernard, 2007)::

- There is no “fundamental value“ of assets: Default premia and tightness of borrowing (collateral constrained borrowing) impact asset value
- There is a nonlinear interaction of leveraging, default premia and asset prices
- There is default (and possibly bankruptcy propagation), if the size of debt exceeds the value of assets ($V-B < 0$, for deterministic version, for stochastic version, probability of default)

Our Previous Work: Leveraging and Asset Prices (dependence of asset prices on leveraging)

- We assume: $B^* = F(V(B^*))$, with spread in the deterministic case: : finance or default premium (see Bernanke and Gertler 1998):

$$H(k(t), B(t)) = \frac{\alpha_1}{\left(\alpha_2 + \frac{N(t)}{k(t)}\right)^\mu} \theta B(t) \quad (4)$$

with $H(k(t), B(t))$ and net worth, $N(t) = k(t) - B(t)$

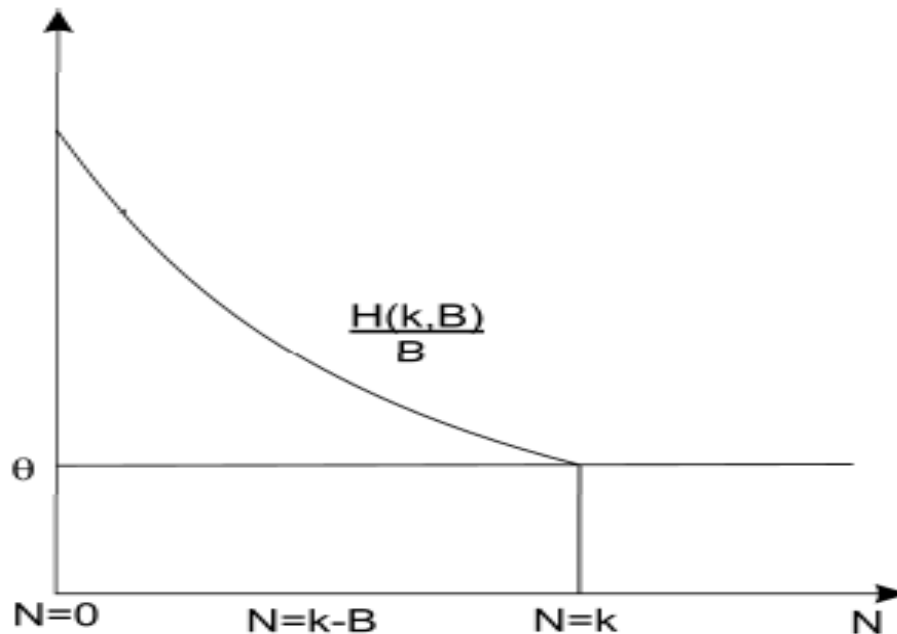


Figure 7: Endogenous Credit Cost

Our Previous Work: Leveraging and Asset Prices (dependence of asset prices on leveraging)

- With default risk and risk premium, we have for the firm

$$V(k) = \underset{j}{Max} \int_0^{\infty} e^{-\theta t} f(k(t), j(t)) dt \quad (8)$$

$$\dot{k}(t) = j(t) - \sigma k(t), \quad k(0) = k. \quad (9)$$

$$\dot{B}(t) = H(k(t), B(t)) - f(k(t), j(t)), \quad B(0) = B_0 \quad (10)$$

The firm's net income

$$f(k, j) = ak^{\alpha} - j - j^{\beta} k^{-\gamma} \quad (11)$$

Our Previous Work: Leveraging and Asset Prices (dependence of asset prices on leveraging)

- Example of the appropriate HJB equation:

$$H(k, B^*(k)) = \max_j \left[f(k, j) + \frac{dB^*(k)}{dk} (j - \sigma k) \right]$$

$$B^*(k) = \max_j H^{-1} \left[f(k, j) + \frac{dB^*(k)}{dk} (j - \sigma k) \right]$$

whith $H(k, B) = B^\kappa \theta$ where, with $\kappa > 1$. Thus,

$$B^*(k) = \max_j \left[f(k, j) + \frac{dB^*}{dk} (j - \sigma k) \right]^{\frac{1}{\kappa}} \theta^{-\frac{1}{\kappa}}$$

Our Previous Work: Leveraging and Asset Prices (dependence of asset prices on leveraging)

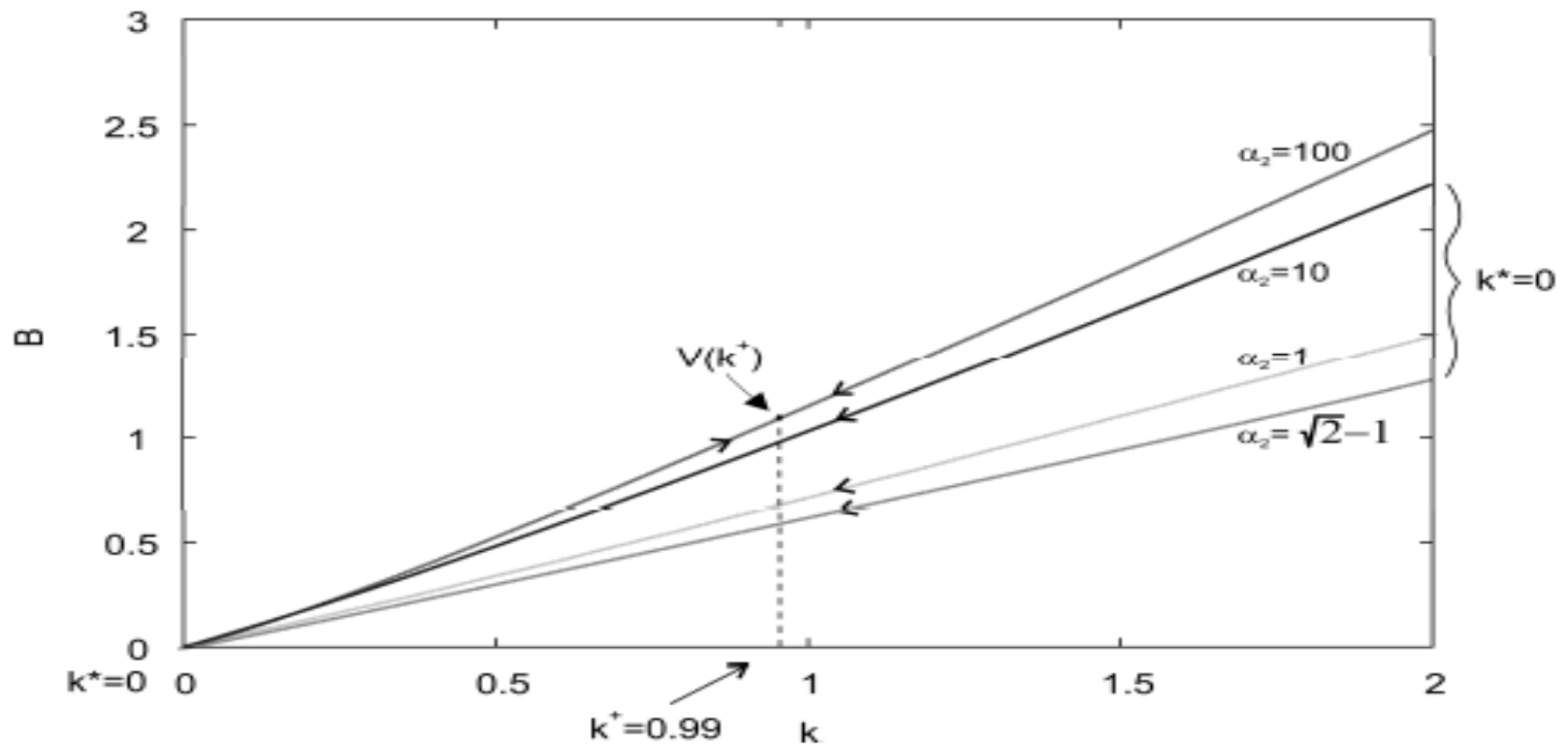


Figure 9: Present value curve $V(k)$ for different α_2

... Stochastic Case: no Shocks

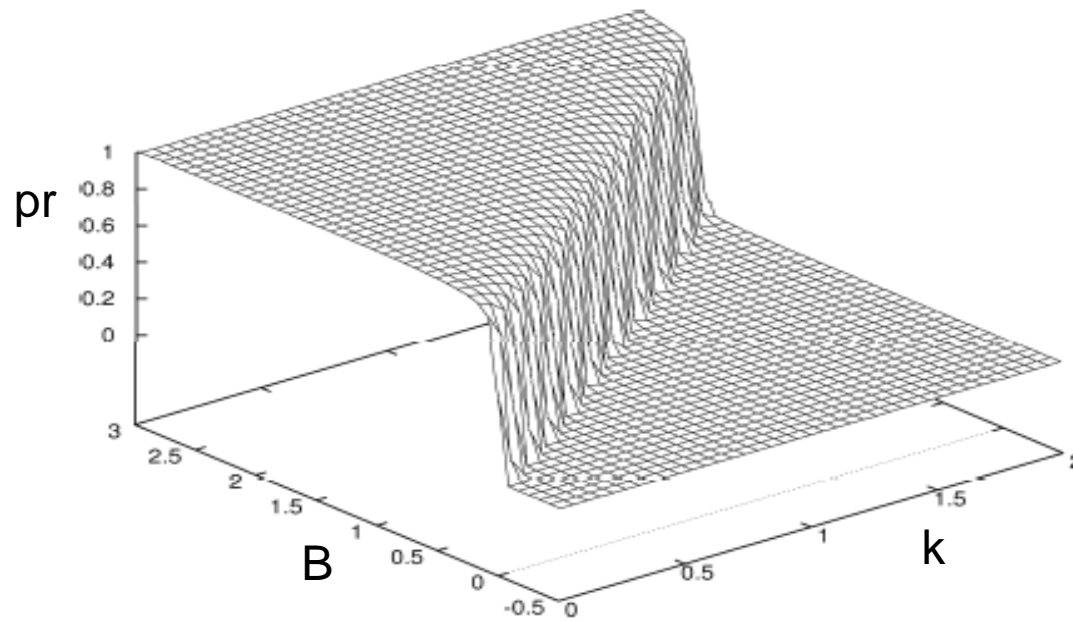


Figure 13: Numerically determined probabilities for $\delta_k = 0$

... Stochastic Case: with correlated Shocks

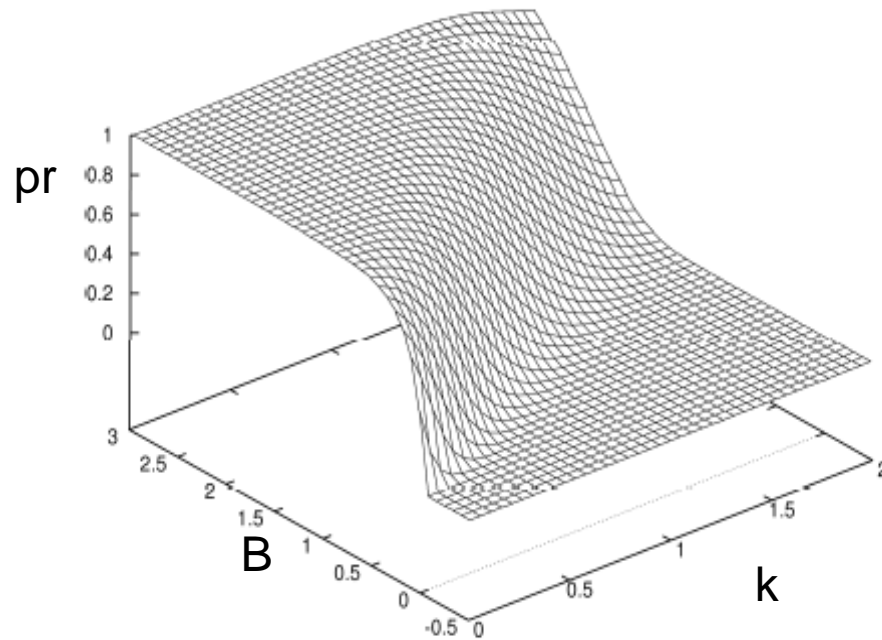


Figure 14: Numerically determined probabilities for $\delta_k = 0.1$

... Stochastic Case: with correlated Shock

With large shocks

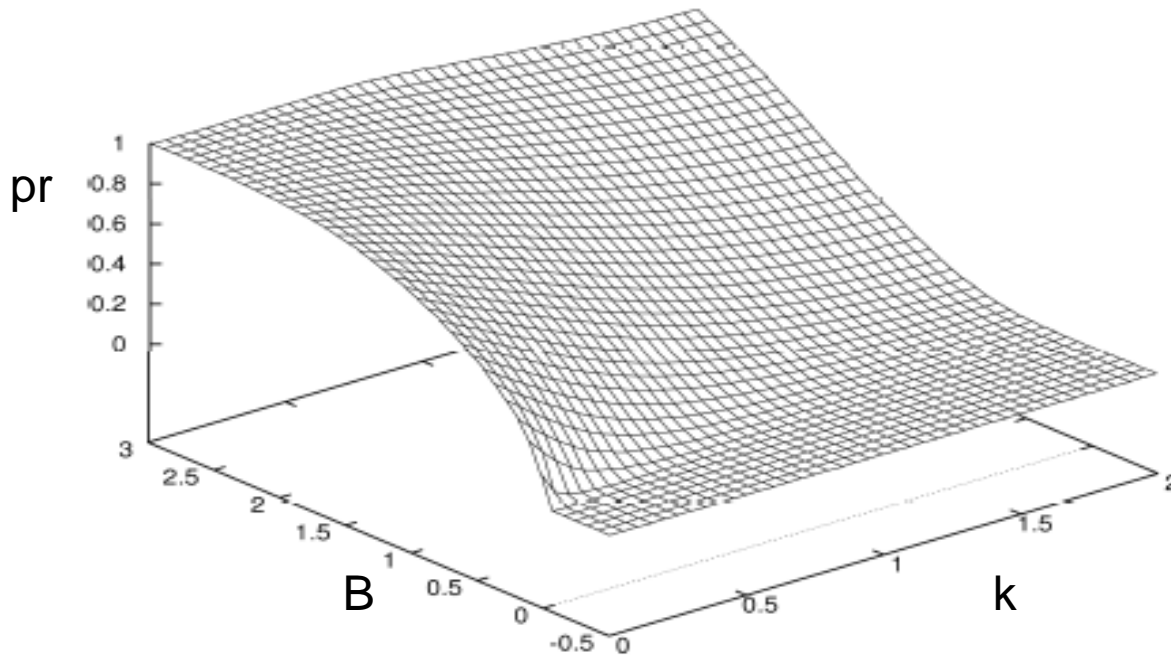


Figure 15: Numerically determined probabilities for $\delta_k = 0.5$

... Debt Sustainability Can Be Tested

Computing debt capacity, distance to default model,

- According to Merton (1974), the debt payment at maturity date T is $F(V, T) = \min(V, \bar{B})$ with V

$$dV = (\alpha_V V - C_V)dt + \sigma_V V dz.$$

$$\text{Distance-to-Default} = \frac{[\text{Market Value of Assets}] - [\text{Default Point}]}{[\text{Asset Volatility}]}$$

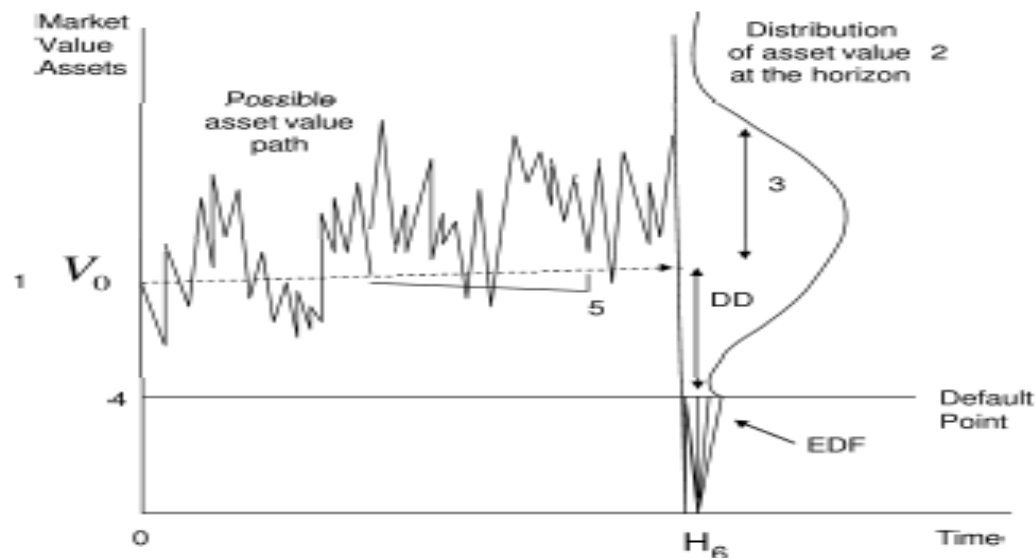


Figure 6: Distance-to default

New Model: Leveraging and Asset Price Bubbles

The Common Mechanism

Common to most: Boom Bust Cycles (Minsky: Ponzi finance, Kindleberger: instability of credit, Kalecki: leveraging and profit expectations)

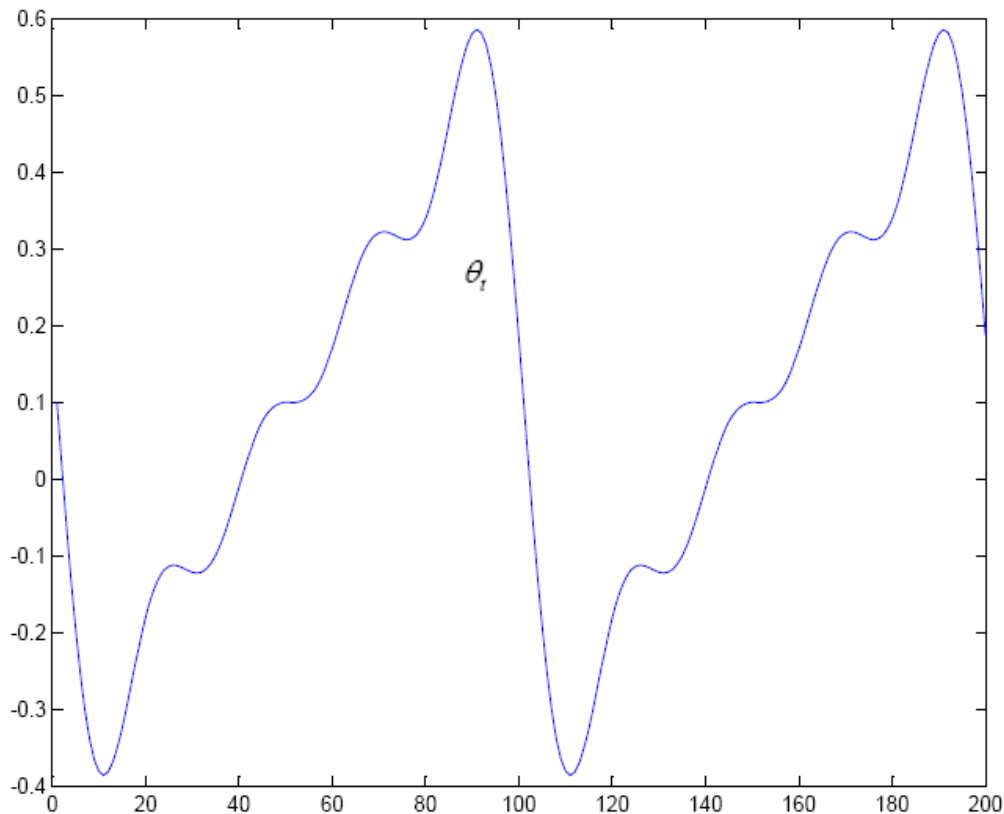
Booms: though there is collateralized credit expansion, it gets weaker, credit expansion without collateral (short term loans), but borrowing (and spending) relieves borrowing and liquidity constraints of other agents, and rise of cash flow expectations and self validation (synchronizing and positive externality)

Busts: when the burst is triggered --- rise of default premia and spreads, rise of collateral constrained borrowing, tightening of liquidity constraints, loss aversion, credit crunch, deleveraging (synchronizing and negative externality)

New Model: Leveraging and Asset Price Bubbles

Expectations of Cash Flows: Self-confirming with synchronizing behavior (see Asian fire flies)

Cash flow expectations and leveraging



New Model: Leveraging and Asset Price Bubbles

Pay-off bubble approximated by DFT (solved by DP)

$$V(k) = \text{Max}_j \int_0^{\infty} e^{-rt} f(k(t), j(t)) dt$$

$$\dot{k}(t) = j(t) - \sigma k(t), \quad k(0) = k.$$

$$\dot{b}(t) = rb(t) - f(k(t), j(t)), \quad b(0) = b_0$$

$$f(k, j) = ak^{\alpha} - j - \varphi(k, j) + \theta(b).$$

$$\theta(b) = \theta(k)$$

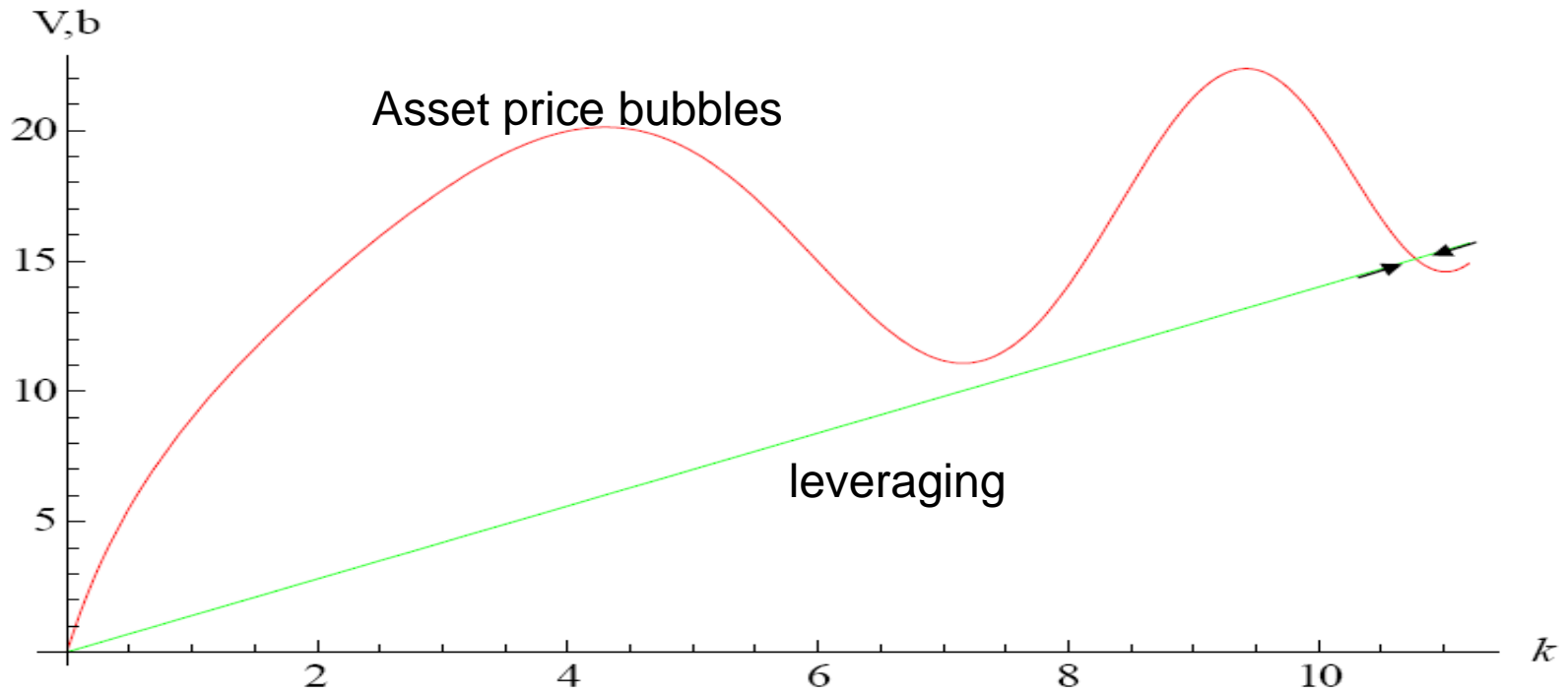
$$\theta(k) = \sum_{i=1}^2 \left(a_i \sin(k) + b_i \cos(k) \right)$$

$$\theta(t) = \sum_{i=1}^2 \left(a_i \sin\left(\frac{2\pi}{\tau_i}(t)\right) + b_i \cos\left(\frac{2\pi}{\tau_i}(t)\right) \right)$$

New Model: Leveraging and Asset Price Bubbles

Self confirming bubbles in pay-offs with synchronizing behavior

Asset pricing with bubbles (red line) and leveraging (green line, exogenous). But leveraging might be endogenous, rising with asset prices --- a source of leverage cycles, as will be shown below



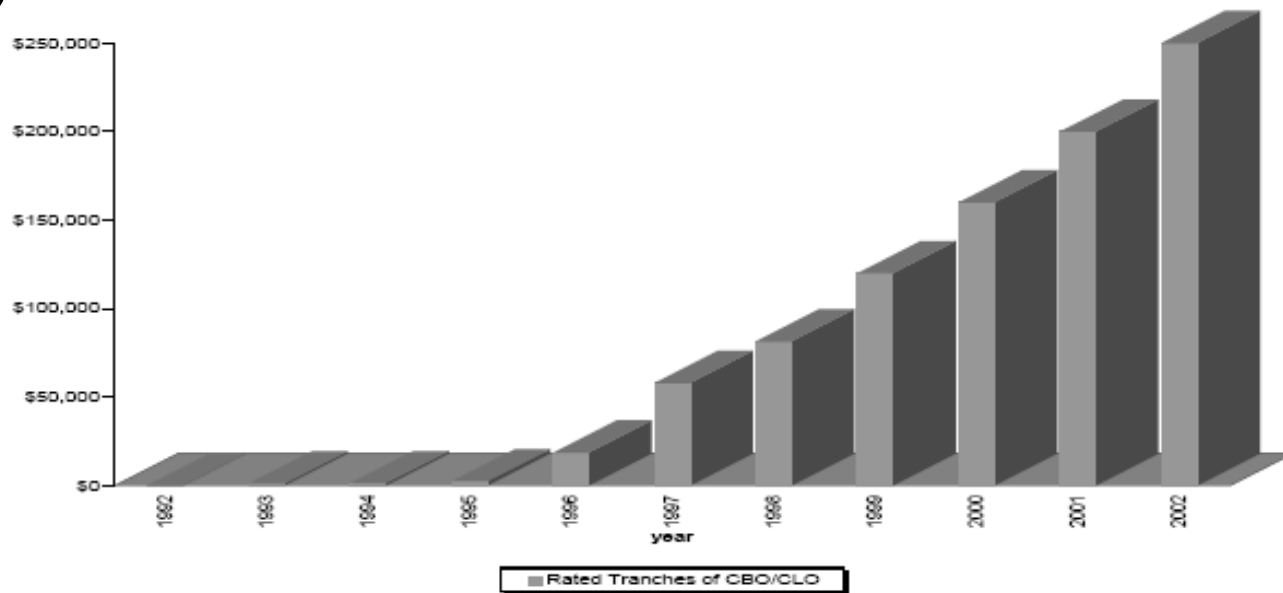
First Amplifying Factor: Complex Securities

Features of the latest boom-bust cycle

1. Change of macroeconomic environment (liberalization and deregulation, low interest rates, easy credit, high liquidity)
 2. Increased leverage and complexity that was introduced due to new financial tools (complex securities)
- leveraging worse than before (Adrian/Shin, Brunnermeyer Geanakoplos, 2009)
 - leveraging not only for 1) real capital, housing, but particularly 2) for buying assets (complex securities)
 - financial intermediation changed: from bank based to market based intermediation (credit risk assessment by market instruments)
 - non robustness of pricing of complex securities (due **delinquency rates**, interest rates, default risk and default correlations, **recovery rates**)

First Amplifying Factor: Complex Securities

Securitization of debt: Complex securities (rise of CDS, MBS, CDOs)



First Amplifying Factor: Complex Securities

Modified model with financial market intermediation through complex securities:

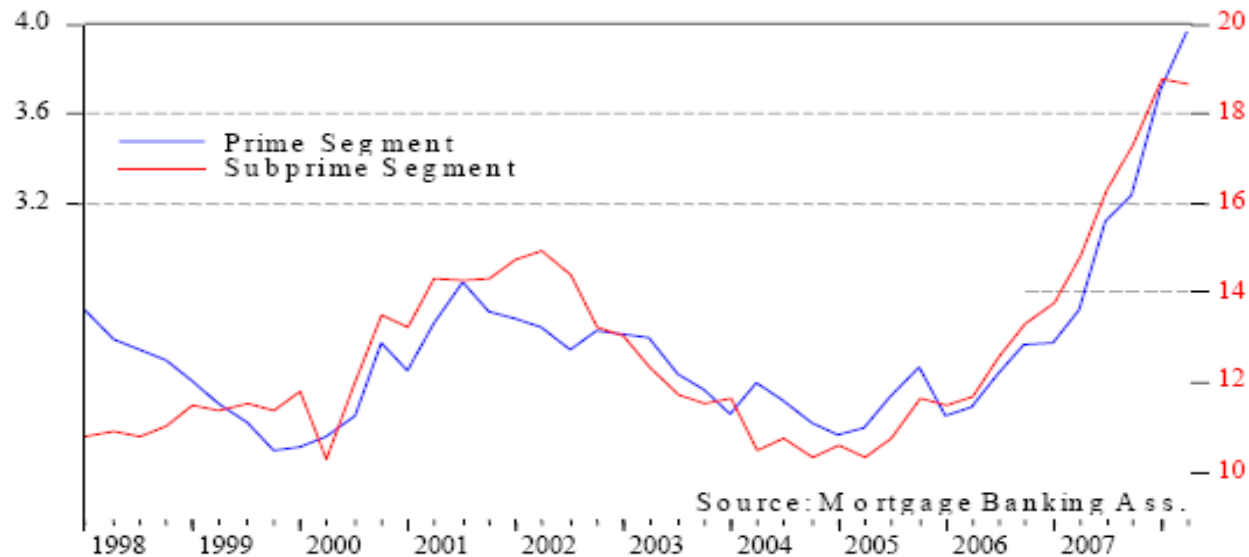
A fraction of mortgages is financed through CDOs

$$\dot{W}(t) = (r_W - \delta_W)W(t) + (r_h - (\alpha r_c + (1 - \alpha)r_f))h(t) - d(t), \quad W(0) = W_0.$$

First Amplifying Factor: Complex Securities

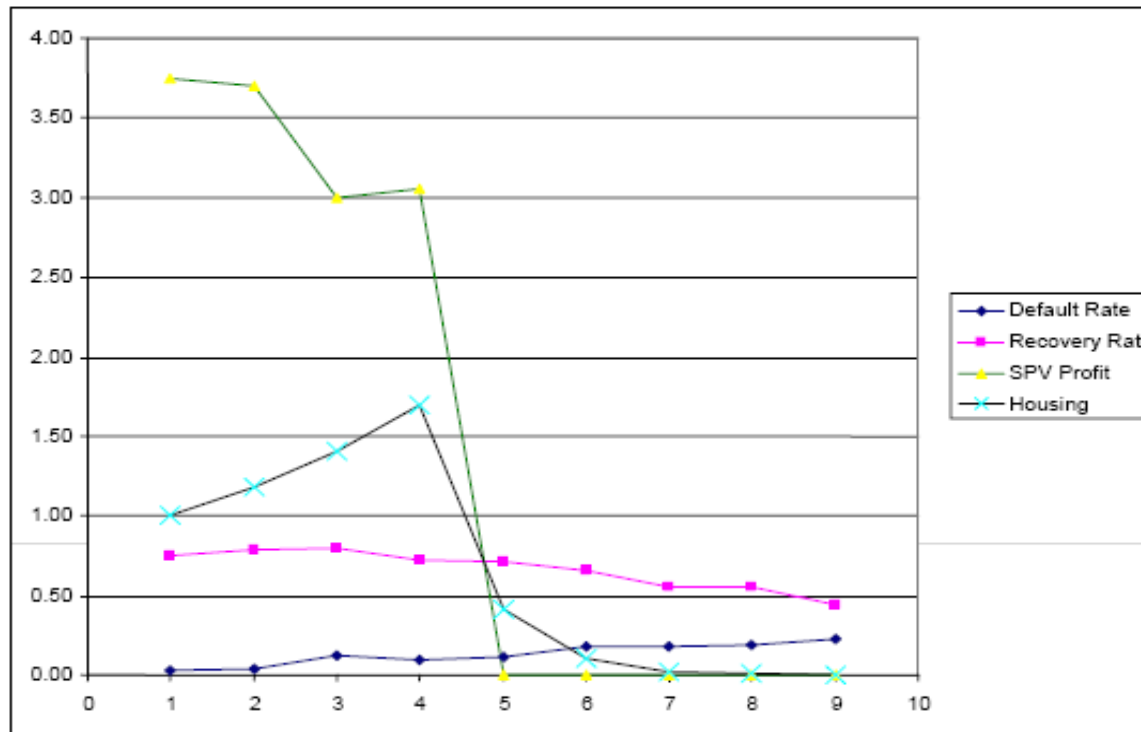
Pricing of complex securities (figure on actual delinquency rates):

$$V_t = V_0 \exp\left(\left(r - \frac{\sigma_V^2}{2}\right)t + \sigma_V \sqrt{t} z\right)$$



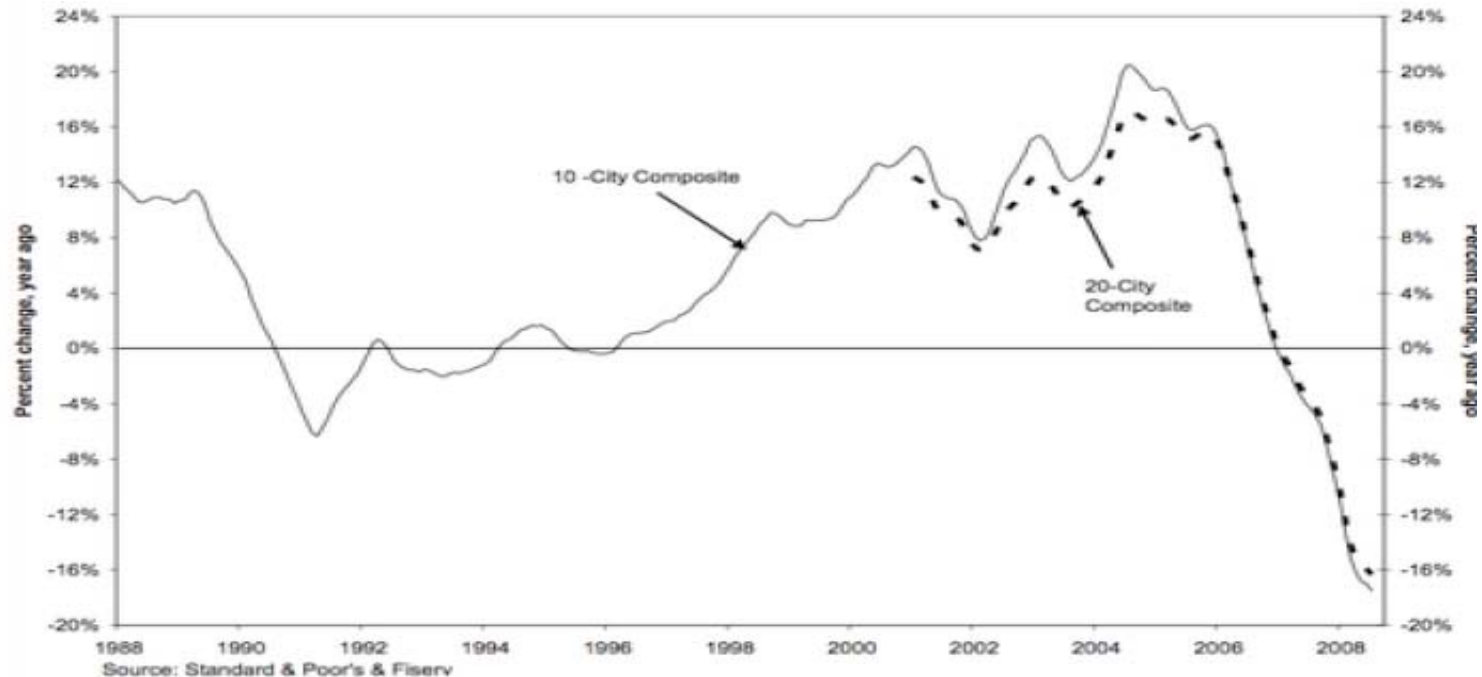
First Amplifying Factor: Complex Securities

Modeled: Non robustness with respect to **delinquency rates**, interest rates, default risk and default correlations, **recovery rates**



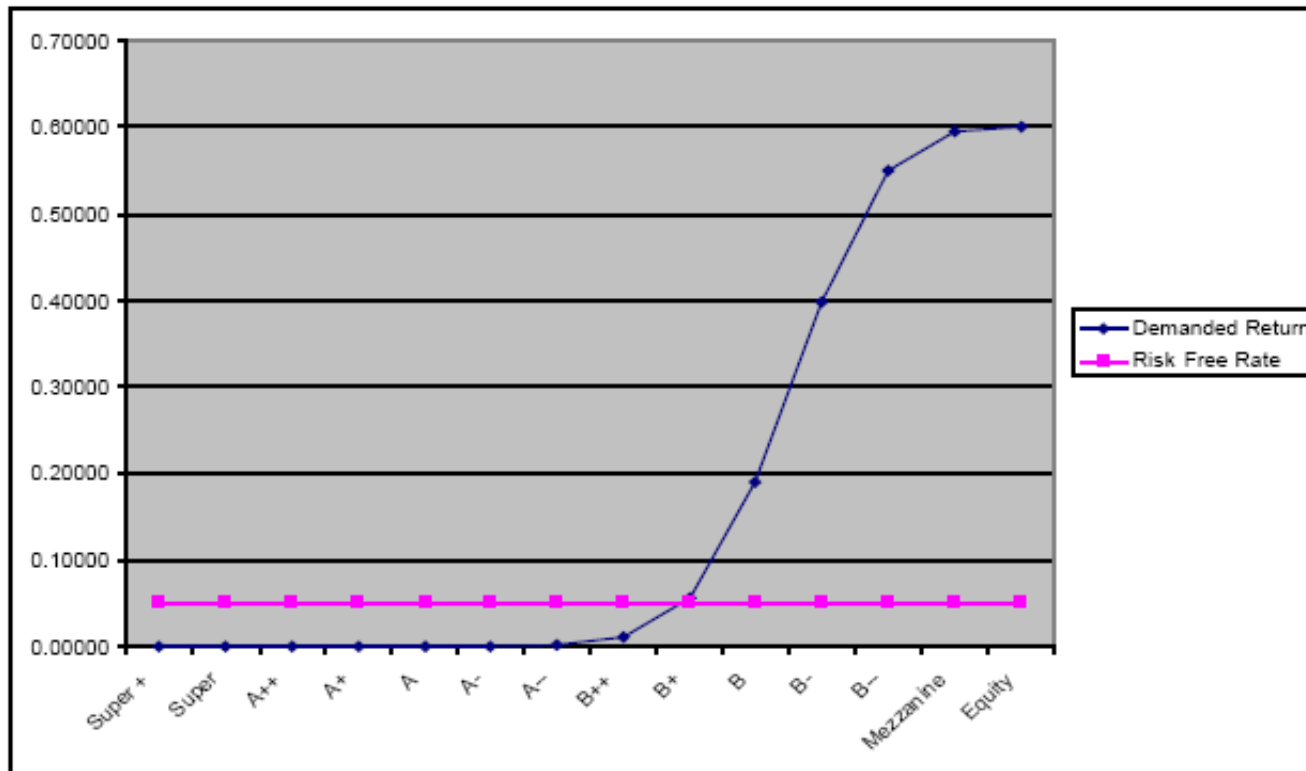
First Amplifying Factor: Complex Securities

Actual: change of house prices



First Amplifying: Complex Securities

Monetary Policy Challenge: Huge spreads (see default premia, libor rate, repo rate)



First Amplifying Factor: Complex Securities

To sum up: What has amplified the boom bust cycle

- Leveraging worse than before; higher leveraging to buy assets (complex securities)
- Change of financial intermediation: from bank based intermediation to market based intermediation (Adrian/Shin, 2009, Brunnermeyer, 2009)
- Non-robustness of pricing of complex securities (with respect to **delinquency rates**, interest rates, default risk and default correlations, **recovery rates**), possibly triggering a critical transition to a new regime (see Brock et al. 2009)

Second Amplifying Factor: External Inflow of Funds and Ponzi Schemes

External inflow of funds and Ponzi schemes:

- Some countries (US, Ireland, Iceland) and investment banks were perceived as safe havens and experienced huge inflow of external funds (Caballero et al., 2009)
- Those funds were attracted by promises of high and safe returns (looked like safe havens)
- Those funds were flowing into the treasury market (US) and into banks and investment firms (US, Iceland, Ireland)
- Yet, the returns on those funds, flowing into commercial and investment banks and hedge funds, could only be sustained due to the inflow of new funds (Minsky Ponzi scheme)

Second Amplifying Factor: External Inflow of Funds and Ponzi Schemes

Three Brownian motions:

$$\dot{W}_t = \{[\alpha_t(r_t + x_t) + (1 - \alpha_t)r_t]W_t - d_t - r^f \gamma_t W_t\}dt + \sigma_w W_t dz_t$$

$$\dot{x}_t = \lambda(\bar{x} - x_t)dt + \sigma_x dz_t$$

$$\dot{r}_t = \kappa(\theta - r_t)dt + \sigma_r dz_t$$

$[\alpha_t(r_t + x_t) + (1 - \alpha_t)r_t]W_t =$ portfolio, generating wealth

$d_t =$ consumption of domestic asset holders

$x_t =$ equity premium

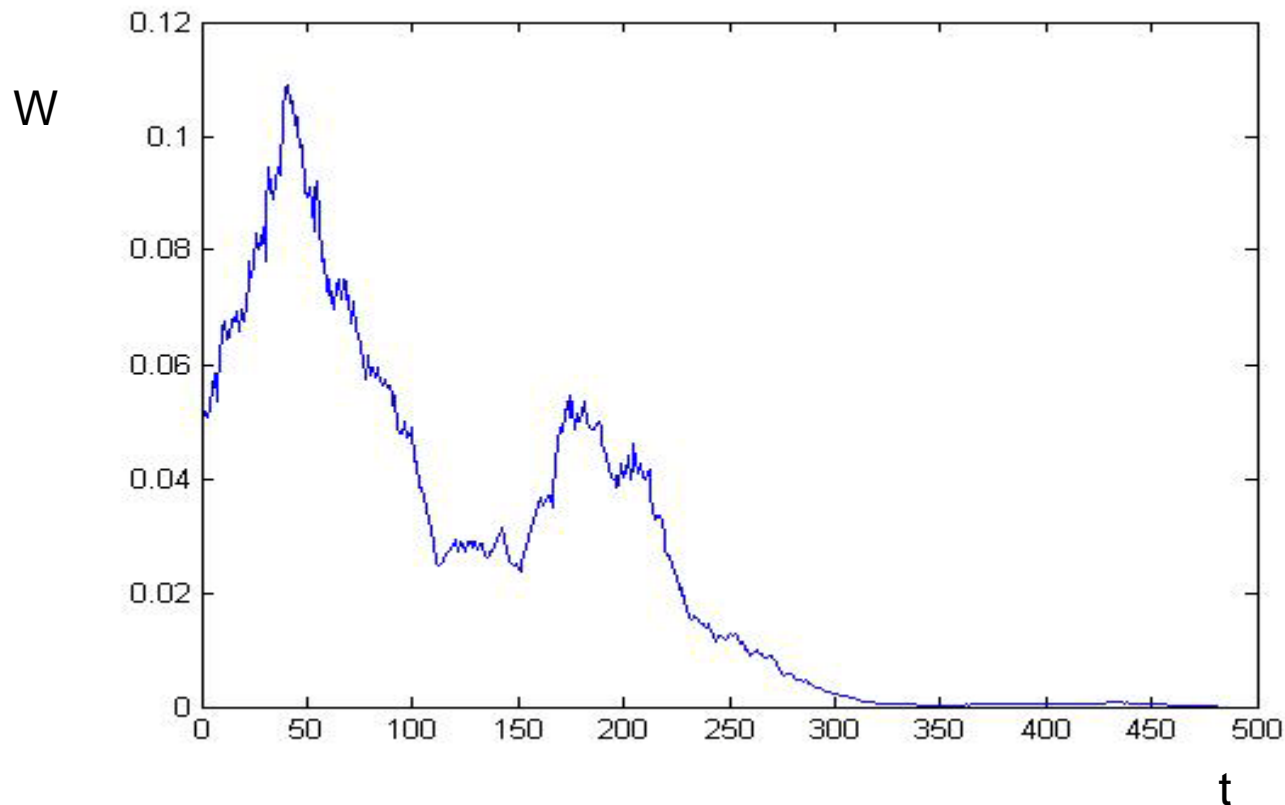
$r_t =$ risk free rate

$r^f \gamma_t W_t =$ payment to foreign asset holders ($\gamma_t = B^f / W_t$)

$\sigma_w W_t dz_t =$ net inflow of funds

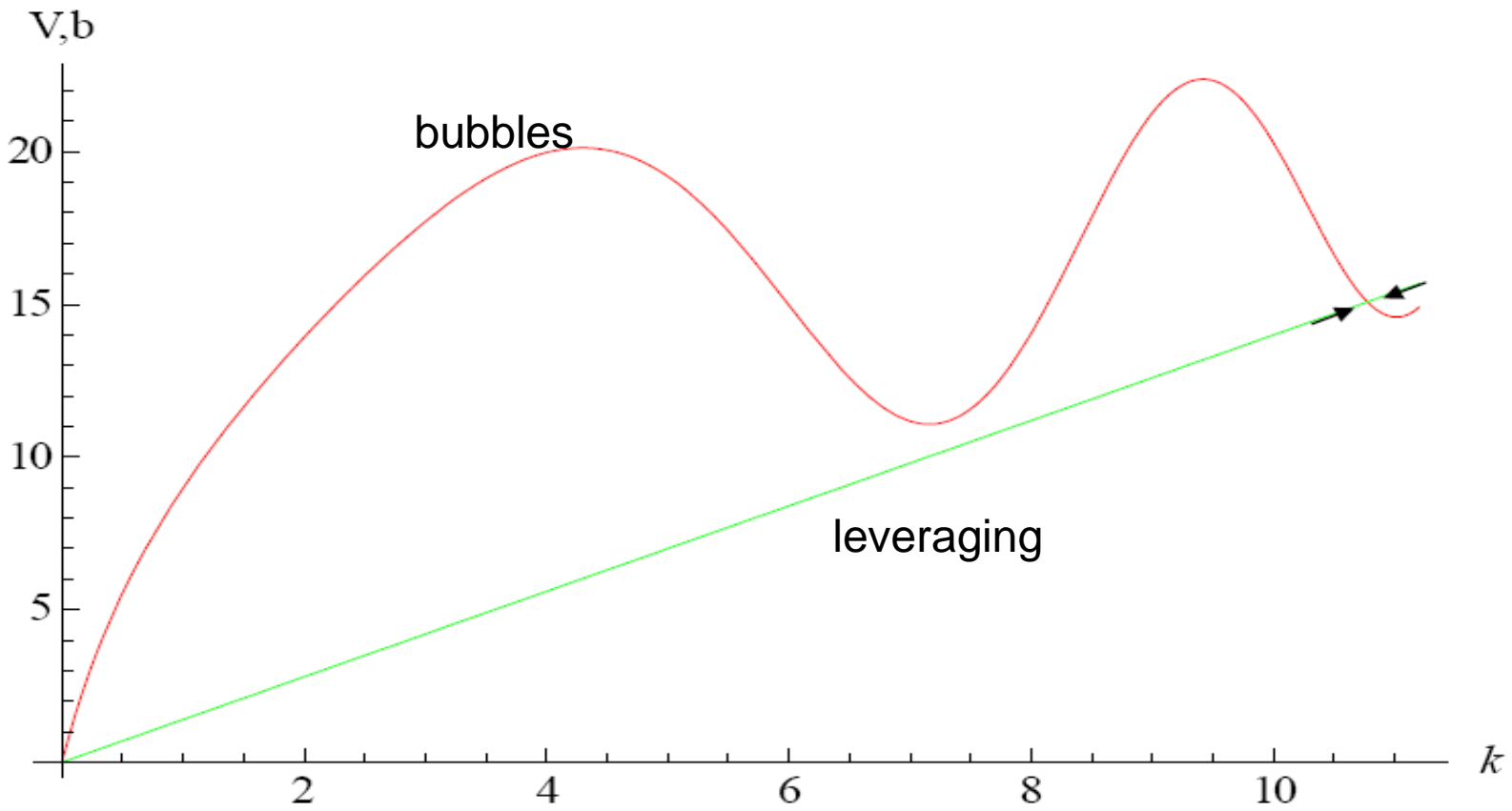
Second Amplifying Factor: External Inflow of Funds and Ponzi Schemes

Collapse as the music stops playing (as the inflow of funds stops)



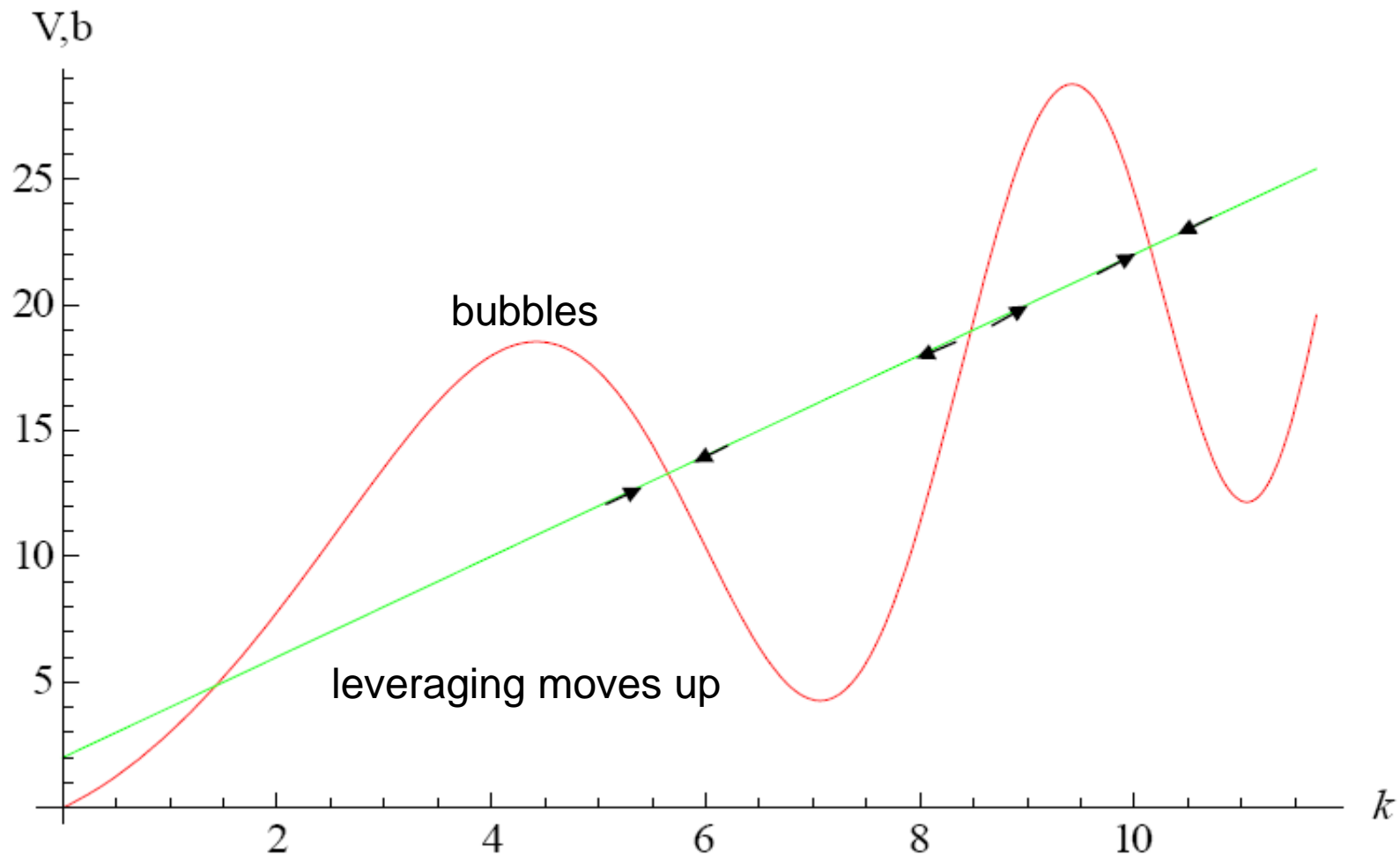
Leverage Cycles: Interaction of Asset Price Bubbles and Leveraging

Asset price bubble with endogenous leveraging: single equilibrium (solved by DP)



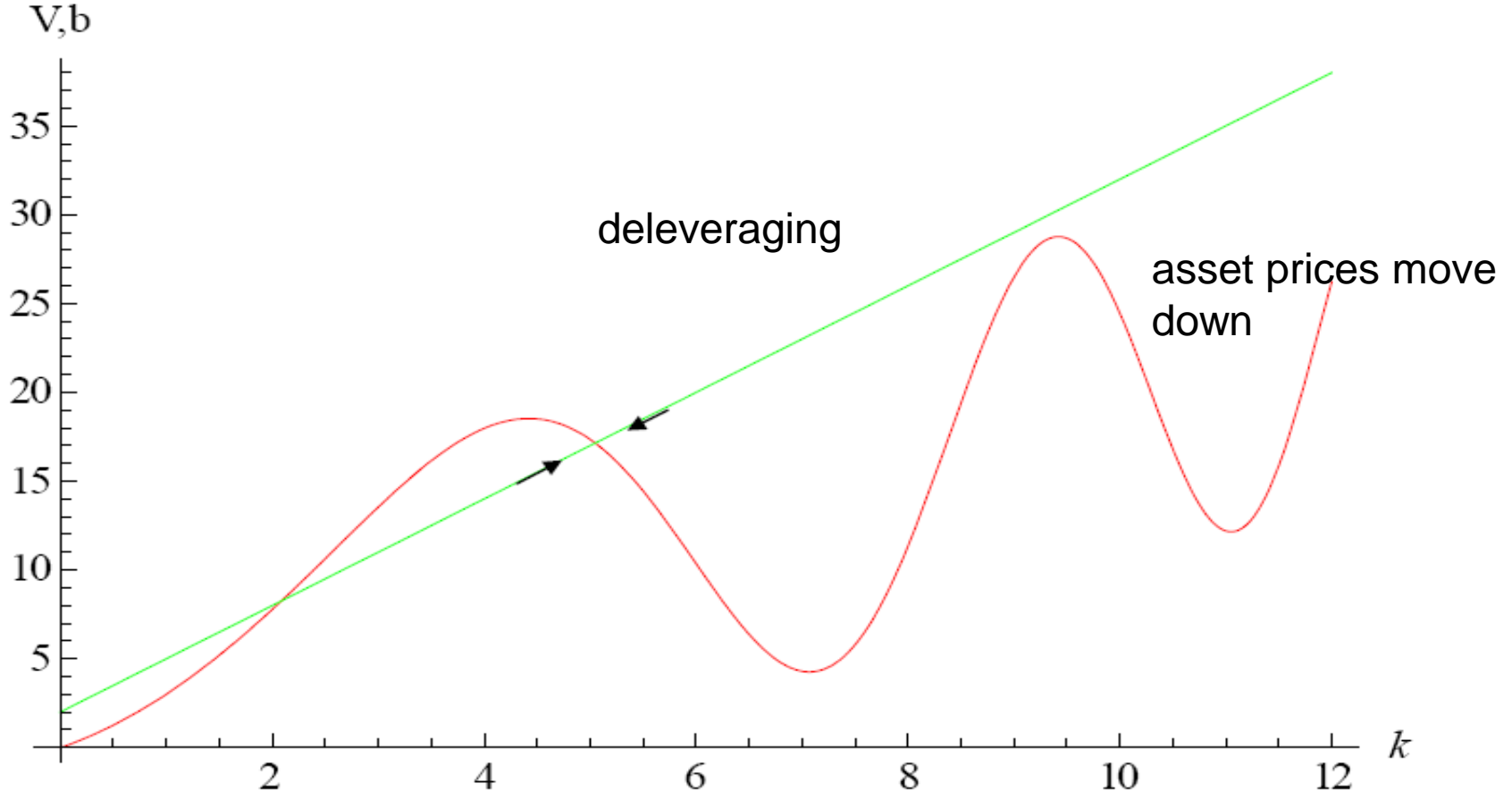
Leverage Cycles: Interaction of Asset Price Bubbles and Leveraging

Asset price bubbles and endogenous leveraging: multiple equilibria, when leveraging moves up



Leverage Cycles: Interaction of Asset Price Bubbles and Leveraging

Bubbles with endogenous leveraging: when bubble moves down, lower equilibrium is an attractor, forcing deleveraging—after a while a new leverage cycle may begin



Conclusions

- Where there is endogenous leveraging, the interaction with asset prices creates bigger bubbles and busts and leads to “leverage cycles“
- Not all bubbles are bad: there are real bubbles that leave some productive capacity, infrastructure, new technology and human capital behind (not the last financial bubble)
- Boom-bust cycles can be destructive (and should be constrained) if they are highly leveraged: huge negative externalities and contagion effects when the bubble bursts (too many innocent by-standers are hit)
- Boom-bust cycles cannot be totally controlled, but they should be constrained and the negative externality avoided
- But how should overleveraging be measured:
1. flow measure: collateral/cash flow, 2. stock measure: assets (debt + equity)/equity (debt sustainability)

Conclusions

Given the interaction of asset prices and leveraging (with externalities), **regulatory efforts** should focus on (see Goodhart et al. 2009, Nell and Semmler, Constellations, 2009):

- Shrinking of the financial sector ---no proprietary trading
- Leveraging monitored and capital requirements should be increased, in particular for complex securities, and the provision for loans losses should rise in the boom and relaxed in a recession
- Testing, regulation and licensing of new financial tools such as complex securities, particularly in the asset price boom (the tranquil periods are the causes of the instability, Minsky)
- Reducing maturity mismatch (borrowing short to fund long term leveraging– short term financing of long term positions, Minsky)
- Bankruptcy propagation through: 1) critical transition, 2) interconnectedness, 3) fire sales (macro-prudential regulation needed to complement micro-prudential regulation, Goodhart et al. 2009)