AEA Continuing Education Program

DSGE Models and the Role of Finance

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Finance in Macro Models

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Does finance matter?

- Not much?

  "Where enterprise leads finance follows."

  Joan Robinson (1952)

- A lot?

  "..that financial markets contribute to economic growth is a proposition too obvious for serious discussion."

  Merton Miller (1988)

Some (Contradictory) Views about Finance

- Financial Regulation
  - Deregulation was responsible for the crisis; regulations should be tightened
  - Finance is over-regulated and credit supply is impaired
- Finance and Growth
  - Financial development is important for growth
  - The last useful financial innovation was the ATM
- Finance and Inequality
  - Lack of access to finance creates poverty traps
  - Finance increases income inequality
- Fin-tech and Bitcoins

Financial Contracts

Fundamentals of Financial Contracting

Three Financial Frictions

- Debt overhang, Myers (1977)
- Monitoring & Moral hazard
- Screening & Adverse Selection

Basic Setup

Risk neutral investors, two periods $t = 0, 1$, limited liability

- Legacy assets & liabilities
  - liquidity m, assets a with $p \equiv \Pr\left(a = A^H\right)$, (long term) debt D
- New Investment
  - Invest k to generate *additional* $v = V$ with prob. q, otherwise $v = 0$
- Total income at $t = 1$

$$y = a + v$$

- Borrowing b to close funding gap

$$b = k - m$$

Debt Overhang

	Total	Senior Debt	Equity
p	A^H	D	A^H-D
1-p	A^L	A^L	0

Key Friction: Difficult to Renegotiate Senior Debt

- Free riding among dispersed creditors
- Risk of runs

How New Projects Are Evaluated

$-k$

	Total	Senior Debt	Junior Debt	Equity
p	$A^H + v^H$	D	Rk	$A^H - D + v^H - Rk$
$1-p$	$A^L + v^L$	$A^L + v^L$	0	0

<u>New lenders break even</u>

$R = 1/p$

<u>Shareholder Value</u>: $v^H - Rk$

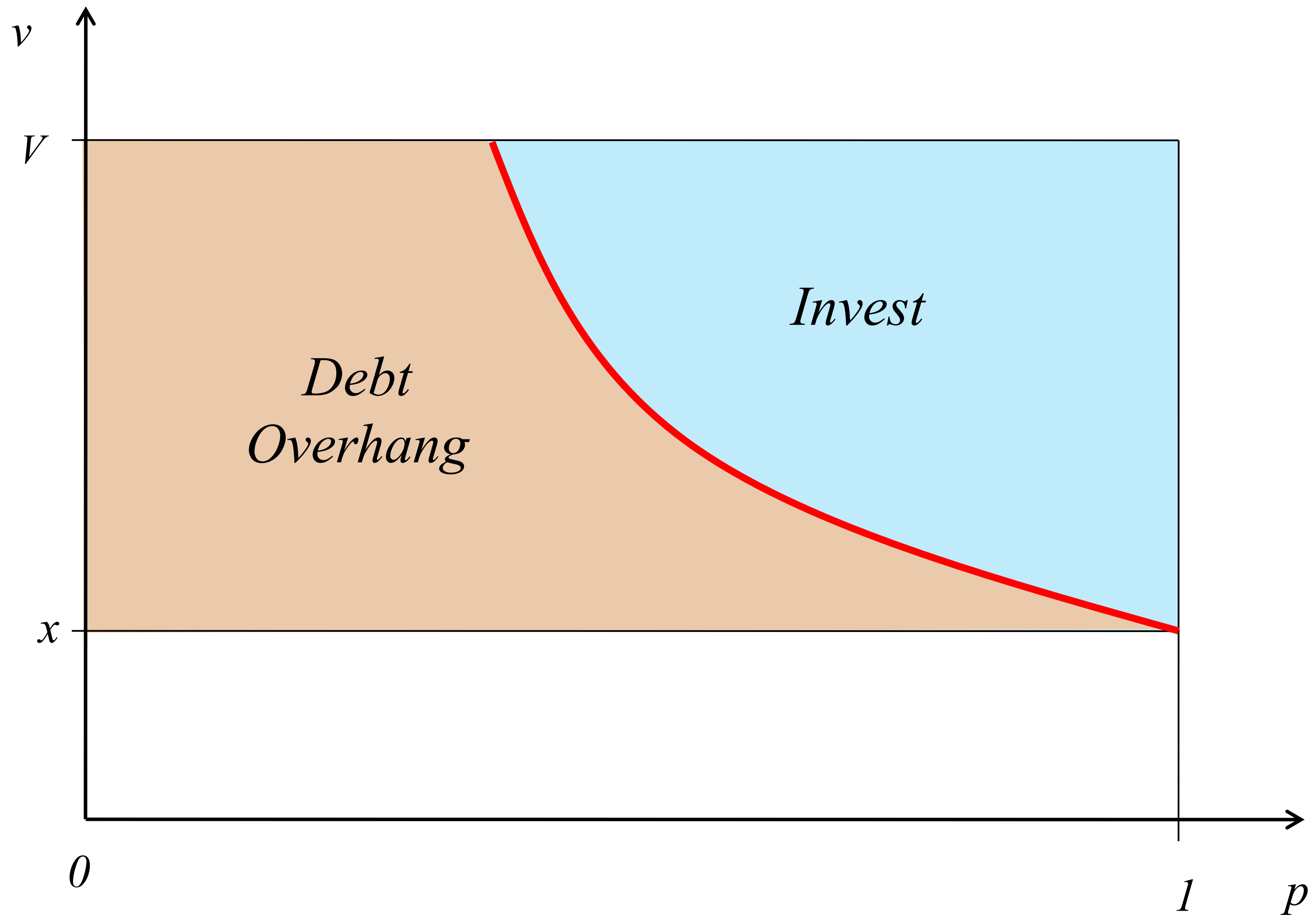
1. Risk shifting: v^L irrelevant
2. Underinvestment: $R > 1$

Underinvestment in Safe Projects

		Total	Senior Debt	Junior Debt	Equity
$-k$	p	$A^H + v$	D	k/p	$A^H - D + v - k/p$
	$1-p$	$A^L + v$	$A^L + v$	0	0

- Myers (1977)
  - Philippon-Schnabl (2009): (p,v) unknown to government
  - Philippon (2010): bailouts in open economy

Philippon-Schnabl (2009)



Risk Shifting

		Total	Senior Debt	Junior Debt	Equity
$-k$	p	$A^H + v$	D	k/p	$A^H - D + v - k/p$
	$1-p$	$A^L - v$	$A^L - v$	0	0

- NPV = $(2p-1)v-k$ can be negative, e.g. when $p<0.5$
- But if $v>k/p$, shareholders like the project

Reluctance to Sell Assets

		Total	Senior Debt	Equity
$-m$	p	$(1-z)A^H+m$	D	$(1-z)A^H-D+m$
	$1-p$	$(1-z)A^L+m$	$(1-z)A^L+m$	0

- Buyers: $m=zE[A]$
- Equity: $A^H-D\ -z(1-p)(A^H-A^L)$

Papers

- Philippon-Schnabl (2009)
- Landier-Ueda (2009)
- Diamond-Rajan (2010)

Moral Hazard: Endogenous q

- Ignore existing assets and liabilities ($a = D = 0$): q is q^H, or q^L with private benefit ψ. Incentive constraint with y^e payment to entrepreneur

$$y^e > y^e_{min} \equiv \frac{\psi}{q^H - q^L}$$

- Therefore pledgeable income is $q^H(V - y^e_{min})$
- Financing constraint is $q^H\left(V - \frac{\psi}{q^H - q^L}\right) > k - m$ and investment condition is

$$m > \hat{m} \equiv k - q^H\left(V - \frac{\psi}{q^H - q^L}\right)$$

  - Existing assets can be used as collateral to increase pledgeable income

Adverse Selection

- Quality of existing assets privately known: bad types $a = A^b$, good types $a = A^g$
  - Good types safe, bad types risky

$$A^b < D < A^g - \frac{k}{q}$$

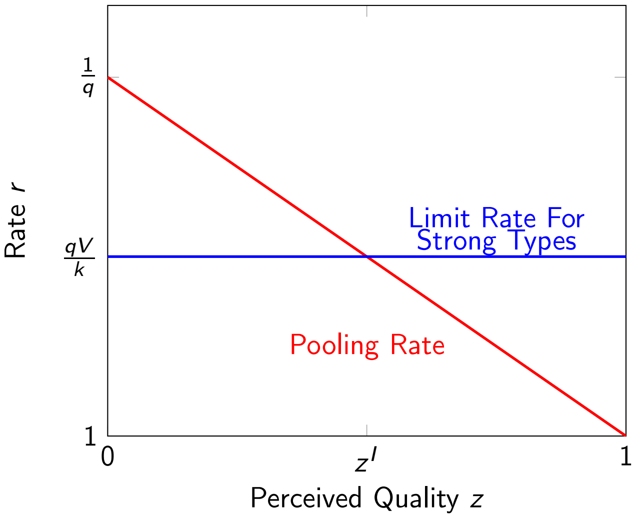
- Issuance game & security design
  - Myers and Majluf (1984), Nachman and Noe (1994)
- Pooling rate given perceived quality z (fraction of good types)

$$r(z) = \frac{1}{q + z(1-q)}$$

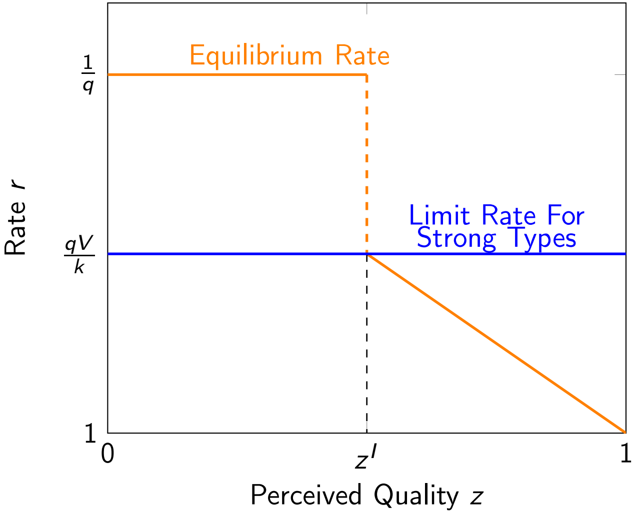
- Good types refuses to invest if

$$rk > qV$$

Time 1: Credit Market



Time 1: Credit Market Equilibrium



Taking Stock

- Debt overhang: legacy debt can limit/distort investment
- Moral Hazard & Adverse Selection: inside liquidity is important
  - Role for intermediation: monitoring (lower private benefit ψ) and screening (acquire information about types)
- Collateralized borrowing: pledging existing assets to fund new investment
  - financial sophistication determines what can be collateralized (e.g., patents in the US)
  - adverse selection can limit pledgeability of existing assets
- How much are agents willing to pay for intermediation?

Intermediation

Measuring Financial Intermediation

Philippon (2015)

Price and Quantity of Financial Intermediation

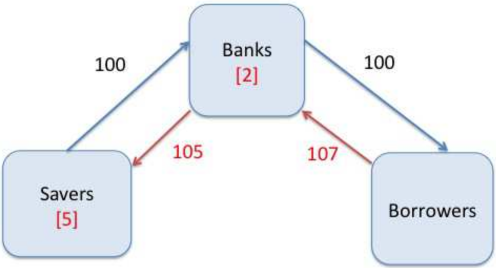
- Price

$$u = r + \psi$$

  - User cost of borrowers, expected return of savers
  - Unit cost of intermediation: ψ
- Quantity
  - Household finance b_c
  - Corporate finance b_k, e_k
  - Liquidity services m

Traditional Banking

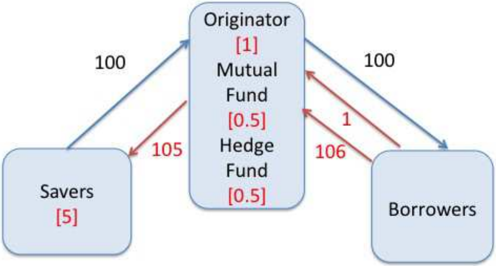
Traditional Banking



Quantity Intermediated = 100
Net interest income = 2
Unit cost = 2%

Modern Finance

Originate and Distribute

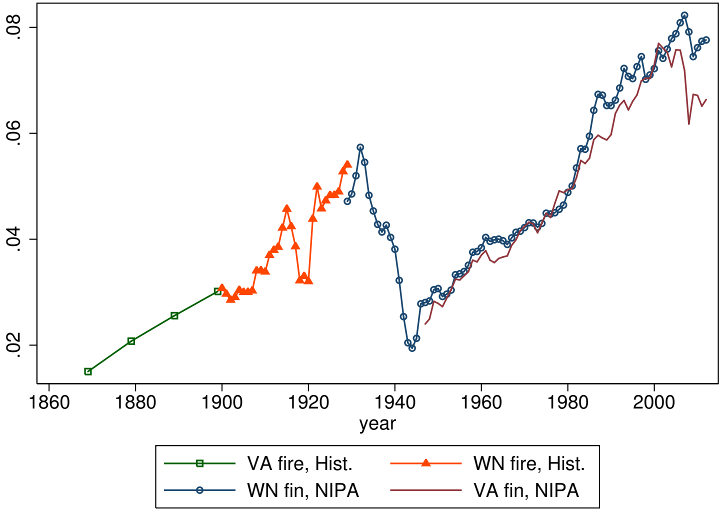


A new division of labor:

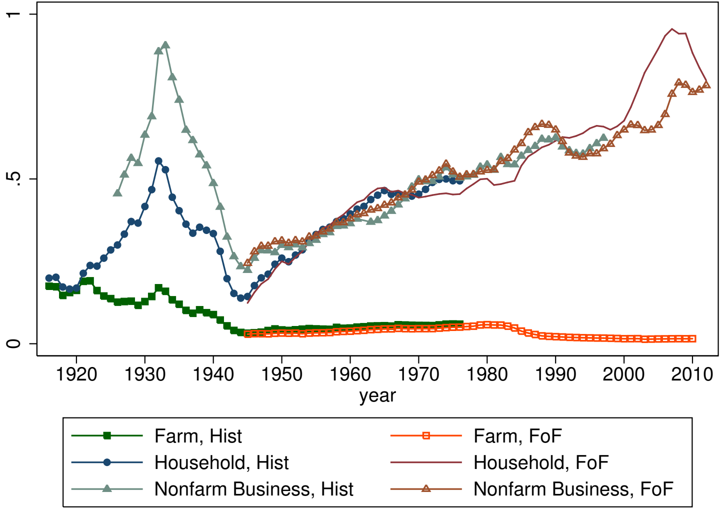
- Monitoring and screening fee = 1
- Asset management fee = 0.5
- Credit risk hedging cost = 0.5

Sum all wages and profits = 2

Income Share of Finance Industry



Outstanding Credit / GDP



Neoclassical Growth with Intermediation

- Households' consumption and liquidity services: $u(c_t, m_t)$, life cycle borrowing/lending
- Costs of intermediation services
  - ψ_m for liquid assets, ψ_c for households credit, ψ_k for firm credit
- Non financial businesses
  - user cost

$$k^{\alpha} = \frac{1-\alpha}{r+\delta+\psi_k},$$

- Financial intermediation income

$$y_t^f = \psi_c b_{c,t} + \psi_m m_t + \psi_k k_t,$$

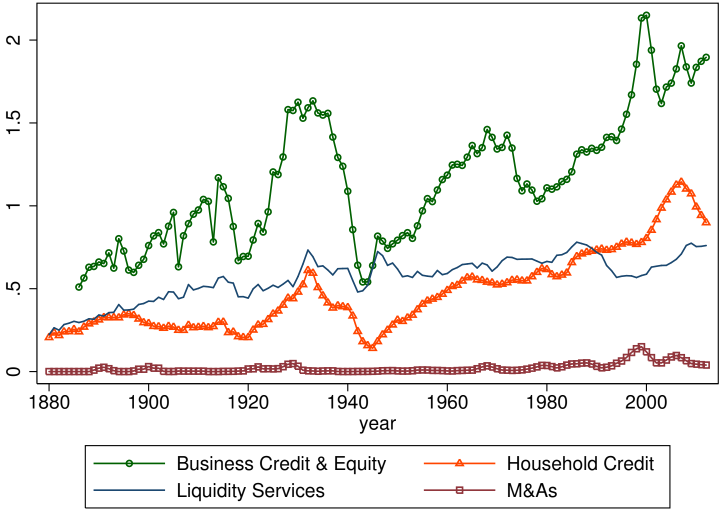
Aggregation

- ***Assumption: Constant Relative Costs:*** $\psi_{i,t} = \mu_i \psi_t$, with the normalization $\mu_c = 1$.
- Quantity of assets

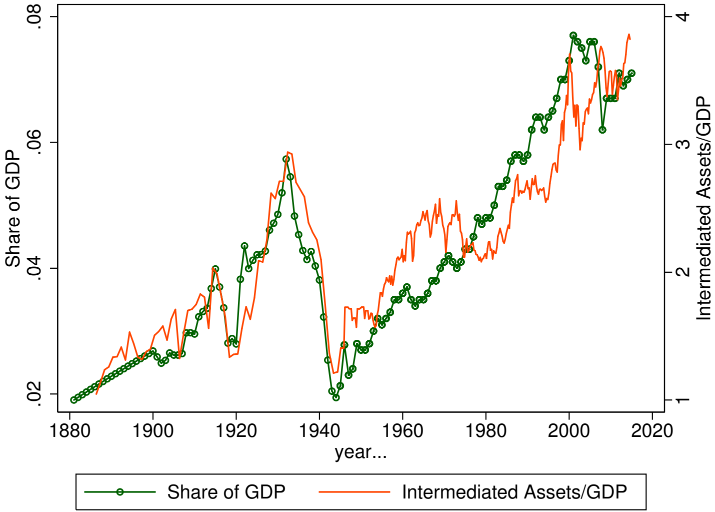
$$q_t \equiv b_{c,t} + \mu_m m_t + \mu_k k_t,$$

- Estimate the $\mu' s$ with micro data on rates, returns and issuance costs

Intermediated Assets & Services

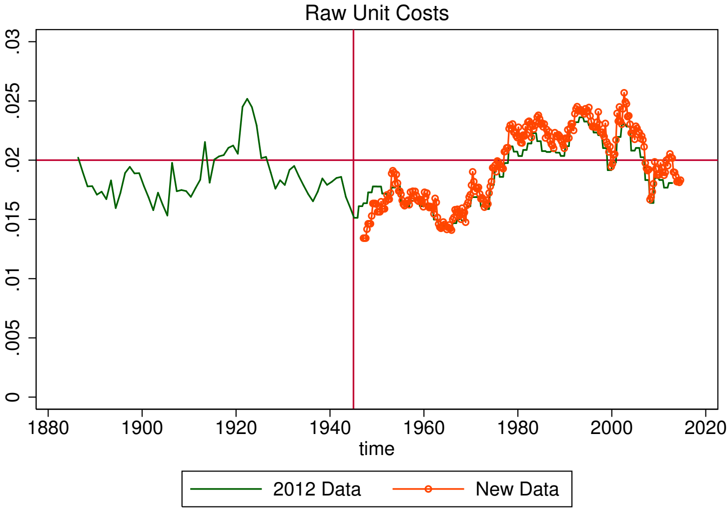


Financial Intermediation (in the U.S.)



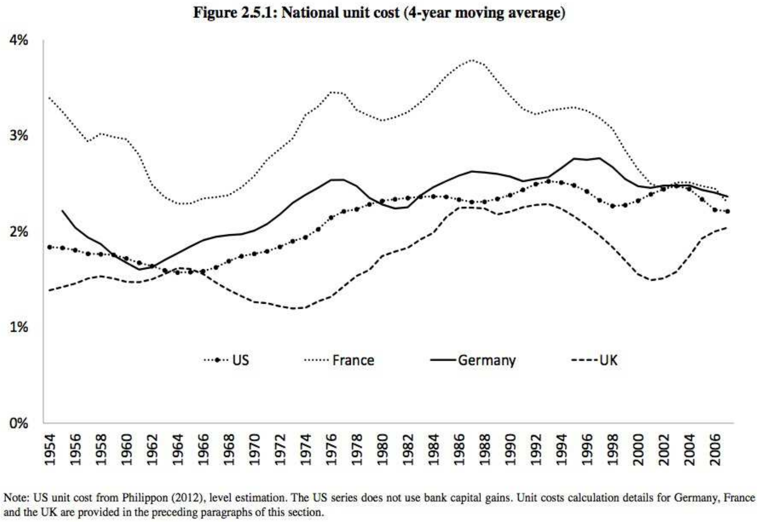
Source: Philippon (AER, 2015)

Unit Cost in the U.S.



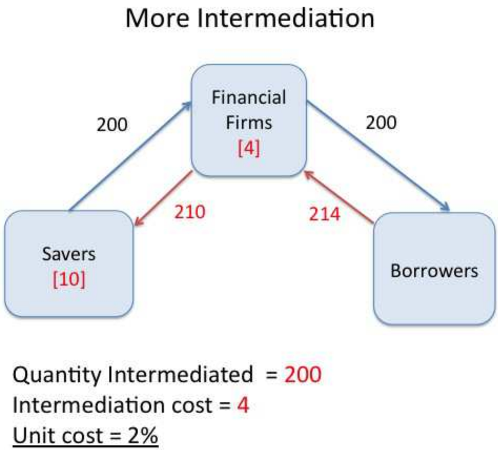
Source: Philippon (AER, 2015)

Unit Costs, Global Comparison

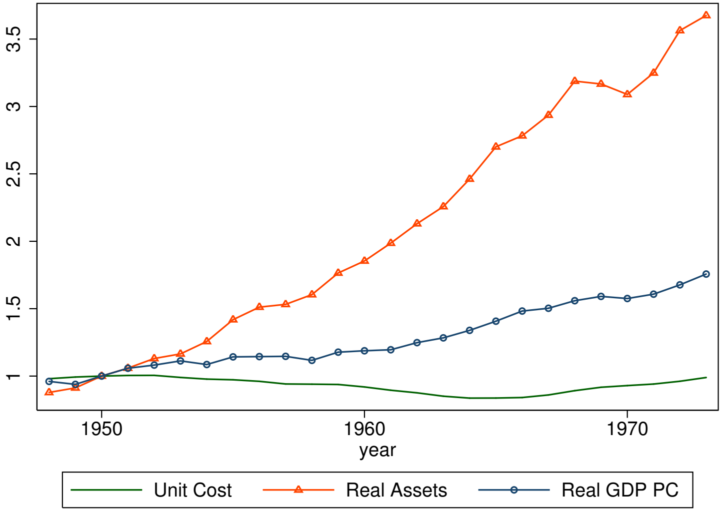


Source: Bazot (2013)

Constant Returns to Scale

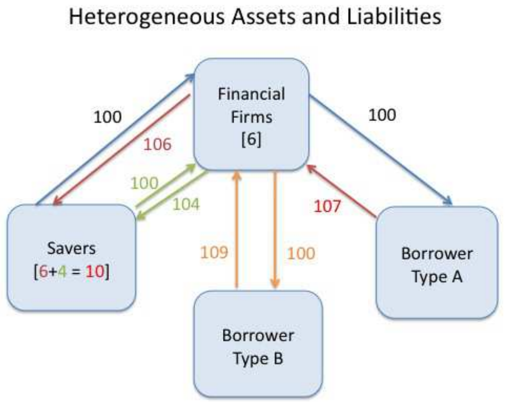


Evidence of Constant Returns to Scale



Notes: Series normalized to one in 1950

Quality Adjustments with Heterogenous Borrowers



Intermediation cost = 6
Intermediated Quantities? 100 + 100 + 100 = 300
Unit Cost? 6/300 = 2%

Corporate Finance

- Heterogenous inside equity (retained earnings) x. Monitoring μ to prevent cash flow diversion.
  - IC constraint, etc.
- Aggregate monitoring

$$\bar{\mu}_t = \mu_h + (1+r)(x_h - x_l)\, s_t,$$

where $s \equiv \frac{k_l}{k_l+k_h}$

- Income from corporate finance intermediation

$$y^f_{k,t} = \varphi_t k_t + \zeta_t \bar{\mu}_t.$$

where φ is an asset management fee

Household Finance

- Heterogenous labor endowment $\eta \sim F(.)$
- Credit: marginal cost φ, fixed cost κw
  - Participation for $\eta > \hat{\eta}$
  - Household debt market

$$\frac{\bar{b}_c}{w} = \frac{1}{2+r} \int_{\eta > \hat{\eta}} \left(\left(\lambda - (1-\varphi)^{-1} \right) \eta - \kappa \right) dF(\eta)$$

  - Income

$$y^f_{c,t} = \varphi \bar{b}_{c,t} + \kappa_t w \left(1 - F(\hat{\eta}_t)\right).$$

Calibration

Rate	Deprec.	Growth	Labor Sh.	CRRA
$r = 0.05$	$\delta = 0.1$	$\gamma = 0.02$	$\alpha = 0.7$	$\rho = 1$

High cash	Low cash	Asset Mgt Fee
$x_h = 0.62$	$x_l = 0.1$	$\varphi = 0.01$

Calibration

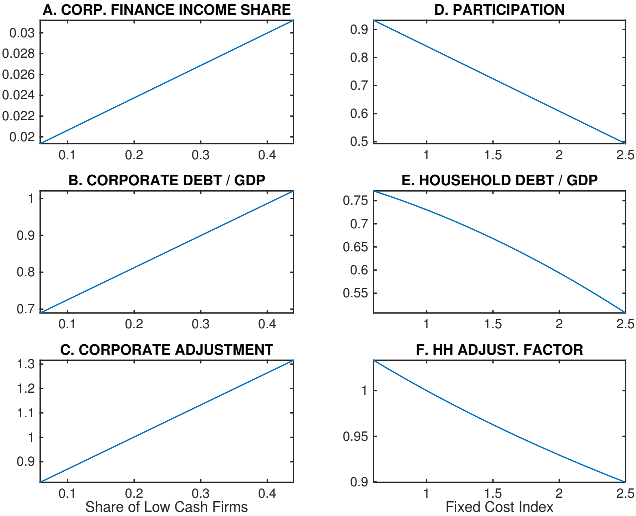
Moments

	B	Cost	share	HH D	Frac	Top 20	Liquid	
	$\bar{b}_k/y$	$\varphi + \zeta \frac{\bar{\mu}_k}{\bar{b}_k}$	s	$\bar{b}_c/y$	$1 - F(\hat{\eta})$	...	m/y	y^f/y
data	0.806	0.0205	0.20	0.73	0.84	0.468	0.71	0.0585
model	0.811	0.0208	0.199	0.73	0.84	0.468	0.71	0.0580

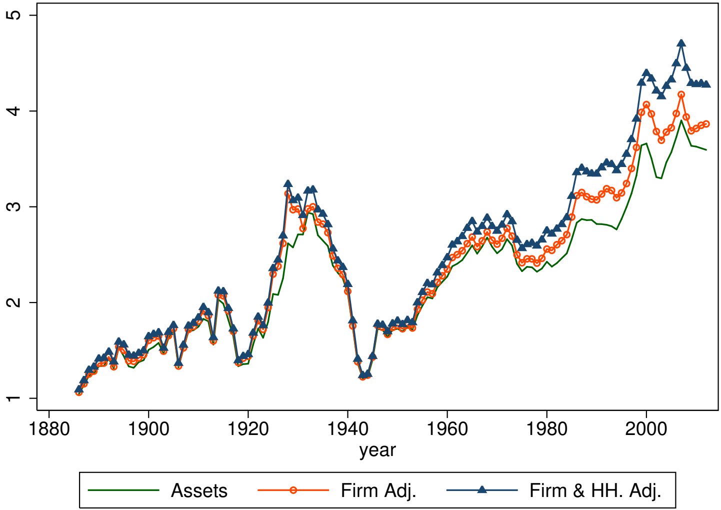
Implied Parameters

Monit	Firms	Slope	Ineq.	Fix	Liq D	Liq S
$\zeta = \frac{r}{3.3}$	$\frac{k_h}{k^*} = 0.622$	$\lambda = 2.07$	$H = 0.875$	$\kappa = 0.023$	$\nu = 0.0181$	$\psi_m = 0.019$

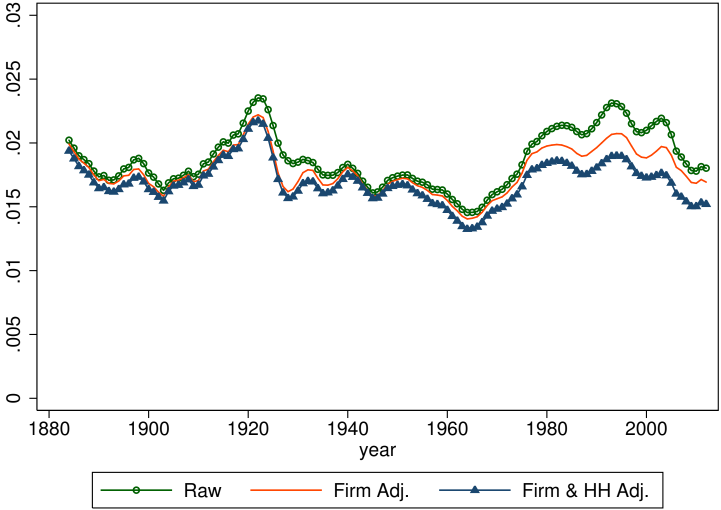
Calibrated Model



Quality-Adjusted Quantity of Intermediation



Adjusted Unit Cost



Dynamics

Macro-Finance Dynamics

Asset Pricing, Cochrane (2017)

- Equity premium 6%
  - Just as likely to be 1% (in good times) or 11% (in bad times)
- Pricing kernel

$$\Lambda_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \Xi_{t+1}$$

  - Aggregate consumption growth not volatile enough, $\gamma = 25$ is just silly.
- Ξ_{t+1} needed. Cochrane (2017) reviews 10 models, including: Habits, LR risk with EZ preferences, disasters, ambiguity aversion, behavioral biases

Epstein-Zin Recursive Utility

- An important class of recursive utility function uses a CES aggregator (ε) where risk aversion is γ

$$U_t = \left((1-\beta)\, C^{1-\varepsilon} + \beta \left(\mathbb{E}_t \left[U_{t+1}^{1-\gamma} \right] \right)^{\frac{1-\varepsilon}{1-\gamma}} \right)^{\frac{1}{1-\varepsilon}}$$

- This leads to a pricing kernel

$$\Lambda_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\varepsilon} \left(\frac{U_{t+1}}{\left(\mathbb{E}_t \left[U_{t+1}^{1-\gamma} \right] \right)^{\frac{1}{1-\gamma}}} \right)^{\varepsilon-\gamma}$$

  - Typical calibration of long run risk model à la Bansal and Yaron (2002) has ε close to 1 and $\gamma > 1$
  - Household worried not only about bad news to consumption but also to future utility
  - See also Cochrane's discussion of disaster risk

Friction-less Benchmark: Q-Theory

- Firm value

$$V_t = \mathbb{E}_t \left[\sum_{j=0}^{\infty} \Lambda_{t,t+j} \Pi_{t+j} \right]$$

- Capital accumulation

$$K_{t+1} = (1 - \delta_t) K_t + I_t$$

- Dividends & Adjustment Costs

$$\Pi_t = R_{k,t} K_t - P_{k,t} I_t - \frac{\varphi_k}{2} P_{k,t} K_t \left(\frac{I_t}{K_t} - \delta_t \right)^2$$

Friction-less Benchmark: Q-Theory

- Recursive

$$V_t(K_t) = \max_{I_t} \Pi_t + \mathbb{E}_t[\Lambda_{t+1} V_{t+1}(K_{t+1})]$$

- Define $\mathscr{V}_t \equiv \frac{V_t}{K_t}$ and net investment $x_t \equiv \frac{I_t}{K_t} - \delta$:

$$\mathscr{V}_t = \max_x R_{k,t} - P_{k,t}(x_t + \delta_t) - \frac{\varphi_k}{2} P_{k,t} x^2 + (1 + x_t)\mathbb{E}_t[\Lambda_{t+1}\mathscr{V}_{t+1}]$$

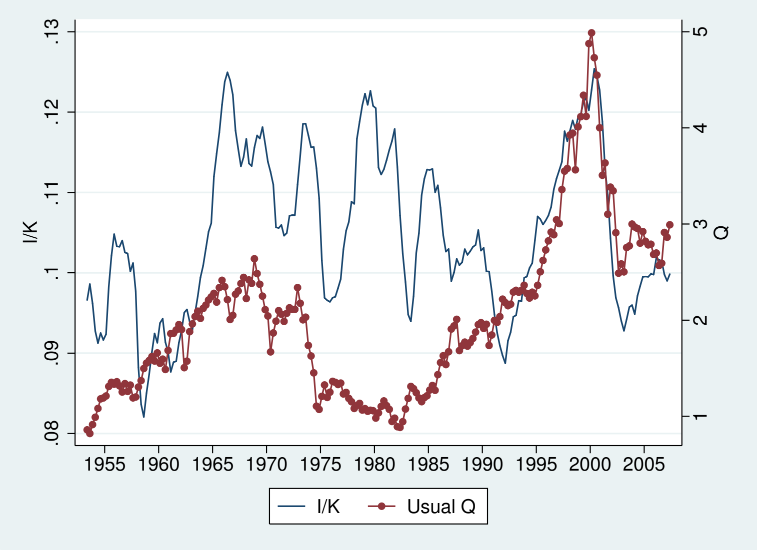
- FOC $P_{k,t}(1 + \varphi_k x_t) = \mathbb{E}_t[\Lambda_{t+1}\mathscr{V}_{t+1}]$ can be written as

$$x_t = \frac{1}{\varphi_k}\left(Q_t^k - 1\right)$$

where

$$Q_t^k \equiv \frac{\mathbb{E}_t[\Lambda_{t+1}\mathscr{V}_{t+1}]}{P_t^k} = \frac{\mathbb{E}_t[\Lambda_{t+1} V_{t+1}]}{P_t^k K_{t+1}}$$

Tobin's q and Investment



Q-Theory: Bonds vs Stocks, Philippon (2009)

- Let $e_t = \frac{\mathbb{E}_t\left[\Lambda_{t+1} V^e_{t+1}\right]}{P^k_t K_{t+1}}$ and $b_t = \frac{\mathbb{E}_t\left[\Lambda_{t+1} V^b_{t+1}\right]}{P^k_t K_{t+1}}$ for equity and bonds

$$q_t = e_t + b_t$$

- Suppose you observe b_t: can you re-construct q_t? Leland (1994) and Leland (1998): debt with coupon c and average maturity $1/\phi$. One unit of principal at t repays

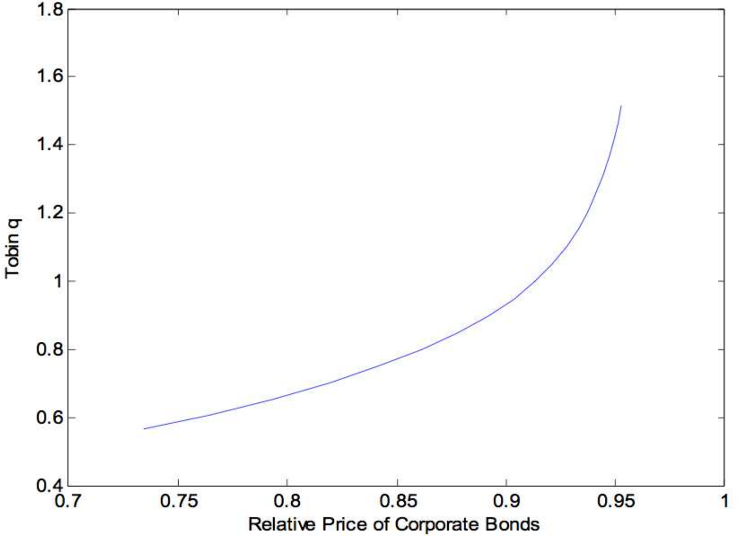
$$\begin{array}{lllll} t+1 & t+2 & \ldots & \tau & \ldots \\ c+\phi & (1-\phi)(c+\phi) & \ldots & (1-\phi)^{\tau-t-1}(c+\phi) & \ldots \end{array}$$

- Risk "neutral" debt pricing, with book leverage l, in state ω:

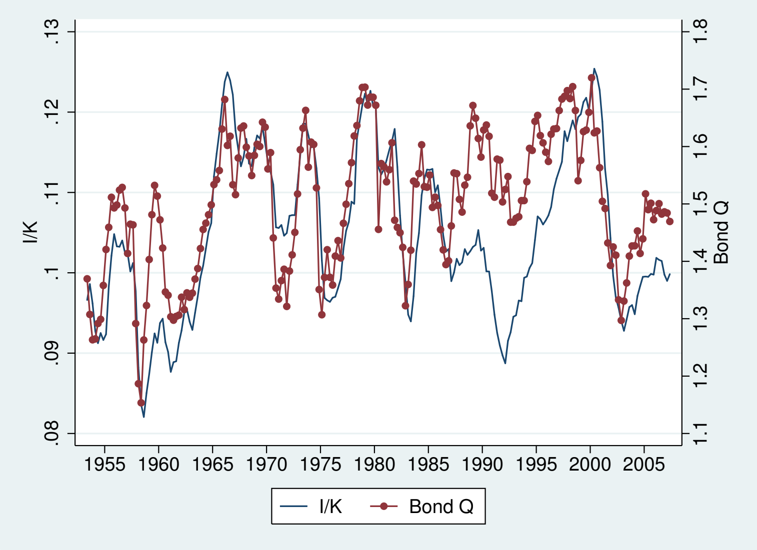
$$b(\omega) = \frac{1}{1+r(\omega)} E^{\pi}\left[\min\left\{(c+\phi)\, l + (1-\phi)\, b(\omega')\,; \mathscr{V}(\omega')\right\} | \omega\right]$$

Bond q and Investment, Philippon (2009)

Figure 1: Tobin's q and the price of corporate bonds relative to treasuries.



Bond q and Investment, Philippon (2009)



Models with Financial Frictions

- Financial Accelerator
  - Financial frictions can amplify and propagate macroeconomic shocks
- First generation: Backward loop, Bernanke and Gertler (1989); Bernanke et al. (1999)
  - Based on simple moral hazard model: dynamics of cash on hand
  - Bad shock: $m_t \searrow \Longrightarrow K_{t+1} \searrow \Longrightarrow m_{t+1} \searrow$
- Second generation: Forward loop, Kiyotaki and Moore (1997)
  - Collateralized borrowing by "specialists"

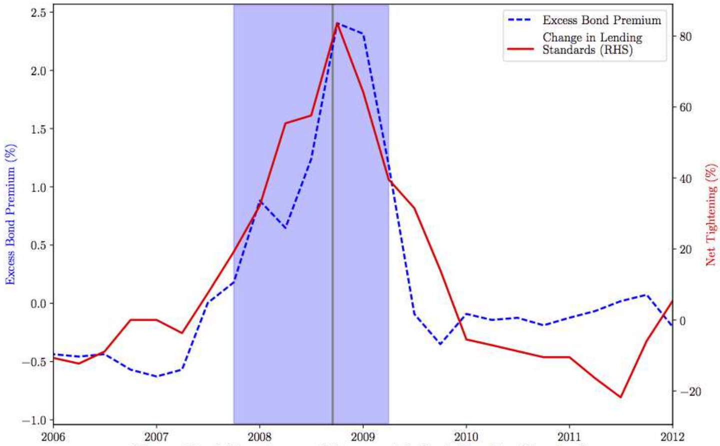
$$B_t \leq \theta_t Q_t K_{t+1}$$

  - Second best use of capital and fire sales: if constraint binds, K needs to be operated by non-specialists, and Q goes down
  - Bad shock: $Q_t \searrow \Longrightarrow K_{t+1} \searrow \Longrightarrow Q_{t+1} \searrow$
  - But Q is forward looking $Q_t \searrow \Longleftarrow \mathbb{E}_t [Q_{t+1}] \searrow$

Intermediary-Driven Crisis

- The 2008-2009 crisis centered around financial intermediaries

Intermediary-Driven Crisis



Excess Bond Premium and Commercial Bank Lending Standards

Intermediary-Driven Crisis

- New models focused on financial intermediaries, such as He and Krishnamurthy (2012) and Gertler and Kiyotaki (2013).
  - Banker with survival probability σ maximizes

$$V_t = \mathbb{E}_t \left[\Lambda_{t+1} \left((1-\sigma)\, n_{t+1} + \sigma V_{t+1} \right) \right]$$

subject to budget constraint

$$Q_t k_t = d_t + n_t$$

and incentive/collateral constraint

$$\theta Q_t k_t \leq V_t$$

- Promised rate on deposits is R_t so

$$n_t = (Z_t + Q_t)\, k_{t-1} - R_t d_{t-1}$$

Discussion

- What we get from Gertler and Kiyotaki (2013)
  - value function is linear in net worth $V_t = v_t n_t$, so aggregation is straightforward
  - key choice for intermediary is leverage $\frac{Q_t k_t}{n_t}$
  - recessions driven by liquidity and intermediation risk
- Notes
  - What is missing from Fig 1 in GG?
  - What is the link between Ξ, time varying risk aversion, and the Gilchrist-Zakrajsek EBP (excess bond premium)?

A Prototypical Crisis Model

- The basic elements of a modern financial crisis model are:
  - Output depends on asset price

$$Y = Y(Q) \leq Y^*$$

  - Asset price is forward looking

$$Q = \frac{\mathbb{E}[Z' + Q']}{R_k}$$

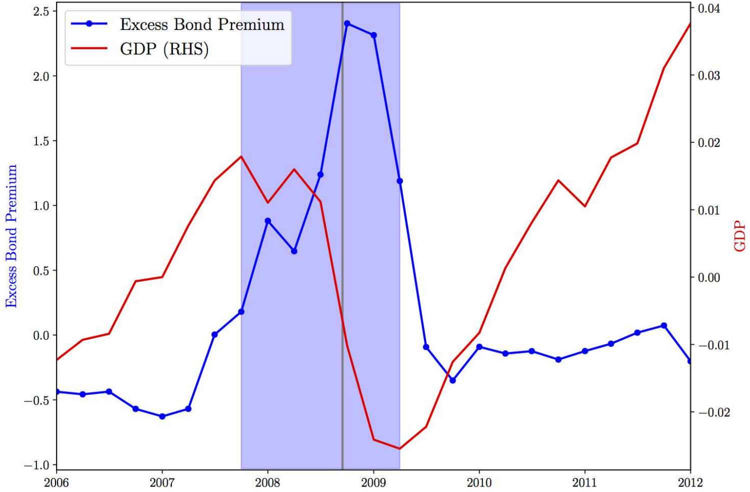
  - Risk spread increases with intermediary distress

$$s = R_k - r$$

  - Monetary policy is constrained

$$r \geq 0$$

Intermediary-Driven Crisis



Household Finance

- Most macro finance of the 1990's models had representative agent. Action was on firm side
- Household balance sheet were important in the crisis. Two classes of models
  - Two agents with different β Eggertsson and Krugman (2012)
  - Bewley-style models Kaplan and Violante (2011)

Greece

Greece: A Macro-Financial Tragedy

Three Financial Frictions

- In 2007, Greek GDP per capita was around 22,600 euros and the unemployment rate was 8.4%.
- In 2014, Greek GDP per capita was around 17,000 euros and the unemployment rate was 26.6%
- What happened?

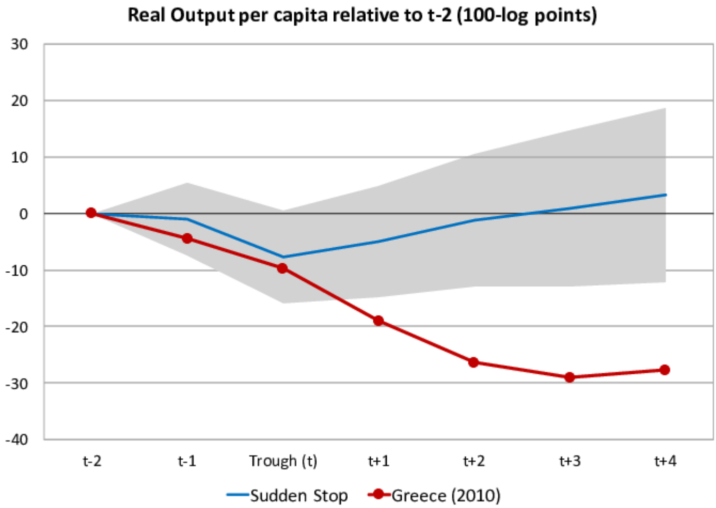
Benchmarking: the Comparison Group

- Sudden Stops
  - Combination of capital flow reversal & large drop in domestic output
  - Extend Calvo et al (2006), Korinek & Mendoza (2013)
  - 49 sudden stops
- Sovereign Defaults
  - from Gourinchas & Obstfeld (2012) based on literature
  - default on domestic or external debt
  - 65 default episodes
- Lending booms/busts
  - defined as in Gourinchas et al (2001)
  - deviation of credit/output from trend
  - 114 boom/busts

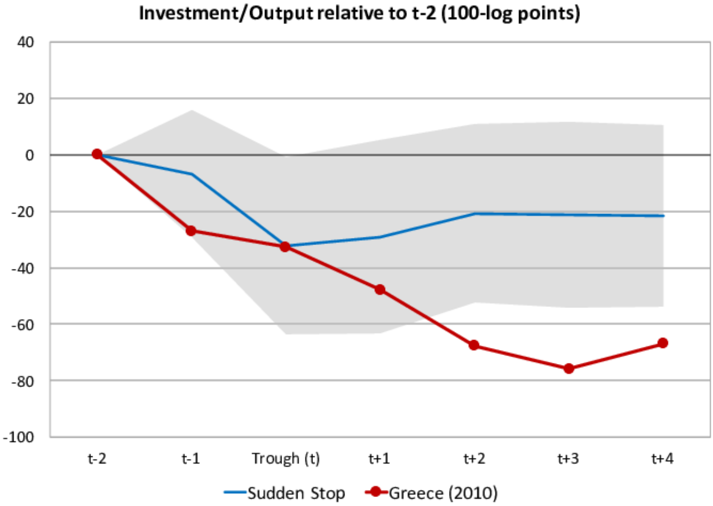
The Incidence of Crises

	Sudden Stop	Defaults	Credit Booms	'Trifecta'	#
AE	13	Greece	18	Greece	22
EM	36	64	96	9	57
Total	49	65	114	10	79

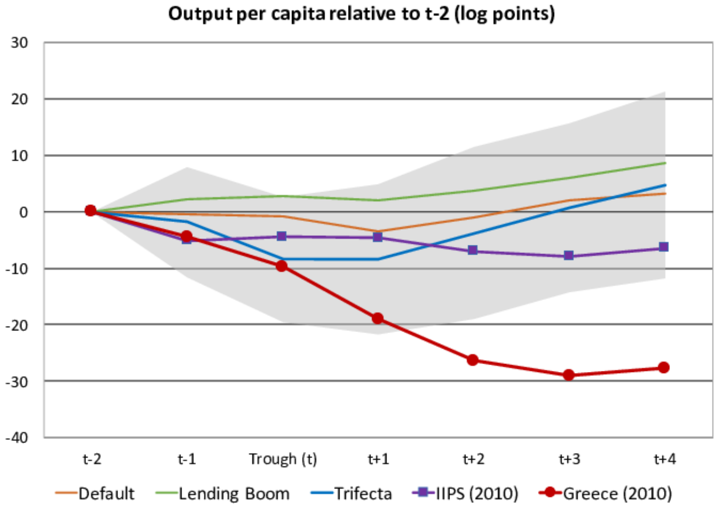
Benchmarking 1: GDP Relative to All Sudden Stops



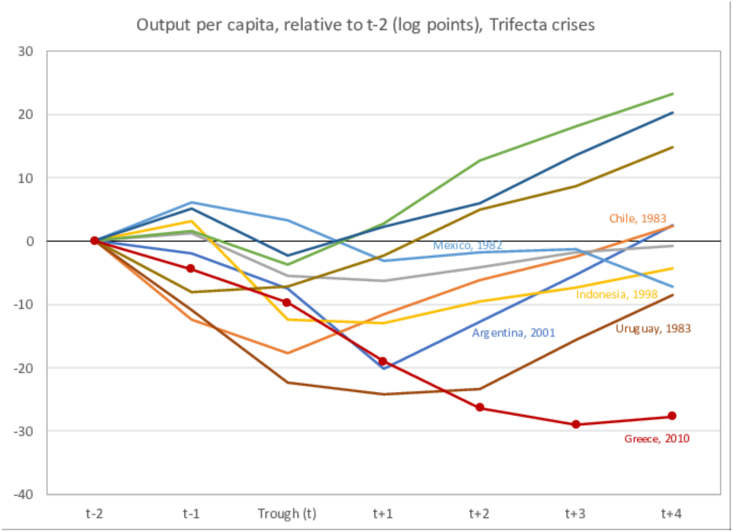
Benchmarking 1: Aggregate Domestic Investment/Output



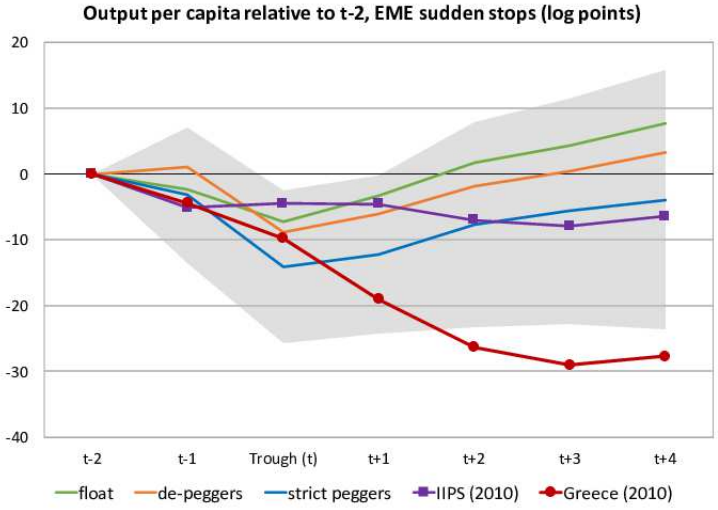
Benchmarking 2: Other Crises



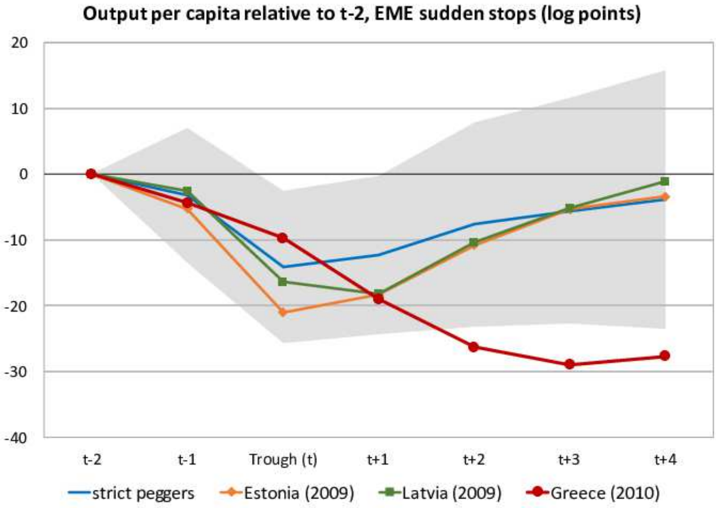
Sovereign Default? Credit Bust?... Trifecta



Benchmarking 3: Compared to EM Floaters & Peggers



Benchmarking 4: Endogenous Peg?



Empirical Lessons

1. Greek crisis significantly more severe persistent and backloaded than typical sudden stop
2. Greek crisis significantly more severe persistent and backloaded than ‘Trifecta’ episodes
3. Greek crisis more severe than for peggers (even Estonia or Latvia)
4. Collapse in aggregate investment unprecedented in its persistence and magnitude

Model

- Small Open Economy in a currency union (r, π^F exogenous)
- Standard NK DSGE à la Galì (2011) with financial frictions
  - Government (B^g, T, G, r^g)
  - Banks (V, r^d)
  - Households (B^h, C, r^h)
  - Firms (I, K, r^k)
- Various shocks

$$\zeta_t^{\#} = \rho^{\#} \zeta_{t-1}^{\#} + \sigma^{\#} \varepsilon_t^{\#}$$

Government

- Budget constraint

$$\frac{B_t^g}{R_t^g} + \tau_t Y_t = G_t + T_t + \frac{B_{t-1}^g}{\Pi_t^H}$$

- Fiscal rule (spending and social transfers)

$$g_t = F_l g_{t-1} - F_n n_t - F_r r_t^g - F_b b_t^g + \zeta_t^{spend}$$

- Tax rate

$$\tau_t = \bar{\tau} + \zeta_t^{tax}$$

- Government funding cost

$$\begin{aligned} r_t^g &= r_t + d_t^g \\ d_t^g &= \bar{d}_g \frac{B^g}{Y}\left(b_t^g - \mathbb{E}_t\left[y_{t+1}\right] - \mathbb{E}_t\left[\pi_{t+1}^h\right] + \zeta_t^{dg}\right) \end{aligned}$$

Households

$$U^i = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_i^t \left(\frac{\left(\mathbf{C}_t^i\right)^{1-\gamma}}{1-\gamma} - \frac{\left(N_t^i\right)^{1+\phi}}{1+\varphi} \right) \quad ; \quad \mathbf{C}_t^i \equiv \left[(1-\varpi)^{\frac{1}{\varepsilon_h}} C_{H,t}^{i\,\frac{\varepsilon_h - 1}{\varepsilon_h}} + \varpi^{\frac{1}{\varepsilon_h}} C_{F,t}^{i\,\frac{\varepsilon_h - 1}{\varepsilon_h}} \right]^{\frac{\varepsilon_h}{\varepsilon_h - 1}}$$

- **Borrowers**, mass χ, $B_t^h \leq \bar{B}_t^h$,

$$\mathbf{P}_t \mathbf{C}_t^b = (1-\tau_t) W_t N_t^b + \frac{P_{H,t} B_t^h}{R_t^h} - \left(1 - d_t^p\right) P_{H,t-1} B_{t-1}^h + P_{H,t} T_t^b$$

$$d_t^p = -\bar{d}_y y_t + \bar{d}_b b_t^h + \zeta_t^{def}$$

$$\bar{b}_t^h = \psi_{bh} \bar{b}_{t-1}^h - \xi^{bh} r_t^d + \zeta_t^{bh}$$

- **Savers**, $\beta > \beta_b$ (mass $1-\chi$),

$$\mathbf{P}_t \mathbf{C}_t^s = (1-\tau_t) W_t N_t^s + \tilde{R}_t P_{H,t-1} S_{t-1} - P_{H,t} S_t + P_{H,t} T_t^s$$

Non-Financial Firms

- Capital-producing firms:
  - Q theory
- Goods-producing firms:
  - Convert capital and labor into goods.
  - Cobb-Douglas with constant TFP.
  - Financing friction: pay part of wage bill in advance. Intra-period loan with funding cost r^k.

Price and Wage Rigidity

- Wage-calvo process yields a Phillips curve for wages

$$\pi_t^w = \beta \mathbb{E}_t \pi_{t+1}^w - \lambda_w \left(w_t - \gamma c_t - \varphi n_t \right) + \zeta_t^w$$

- Price-calvo process yields a Phillips curve for domestic prices

$$\pi_t^h = \beta \mathbb{E}_t \pi_{t+1}^h + \lambda_p \mathtt{mc}_t + \zeta_t^{\pi h},$$

  where $\mathtt{mc}_t$ is log real marginal cost in terms of domestic goods.

- ζ_t^w : wage markup shock, $\zeta_t^{\pi h}$: domestic price markup shock

Banks

- Domestic deposits and foreign loans
- Lend to households, firms and government
- Subject to capital requirement

$$V_t \geq \kappa \left(\frac{B_t^k}{R_t^k} + \frac{B_t^h}{R_t^h} \right)$$

  where V_t is franchise value.
- No capital requirement for sovereign exposure
- Bank funding costs

$$r_t^d = r_t + \zeta_t^{rd} + \xi^d L \mathbb{E}_t \left[d_{t+1}^p \right]$$

Summary of Funding Costs

- Key equations
  - Funding cost: banks –> households & firms

$$r_t^k = r_t^d$$

  - Banks: sudden stop and capital loss

$$\begin{aligned} r_t^d &= r_t + \zeta_t^{rd} + \xi^d L \mathbb{E}_t \left[d_{t+1}^p \right] \\ d_t^p &= -\bar{d}_y y_t + \bar{d}_b b_{t-1} + \zeta_t^{def} \end{aligned}$$

  - Government

$$\begin{aligned} r_t^g &= r_t + d_t^g \\ d_t^g &= \bar{d}_g \frac{B^g}{Y} \left(b_t^g - \mathbb{E}_t \left[y_{t+1} \right] - \mathbb{E}_t \left[\pi_{t+1}^h \right] + \zeta_t^{dg} \right) \end{aligned}$$

  - Households

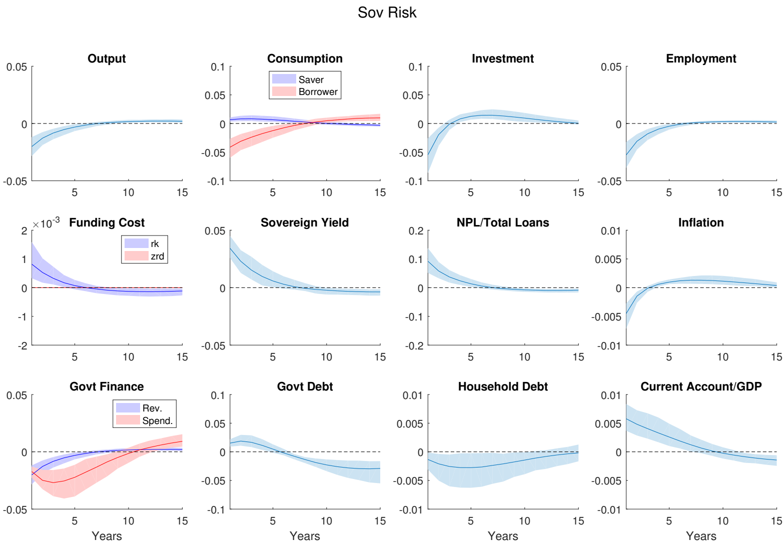
$$r_t^h = r_t^d + \mathbb{E}_t \left[d_{t+1}^p \right]$$

Doom Loops

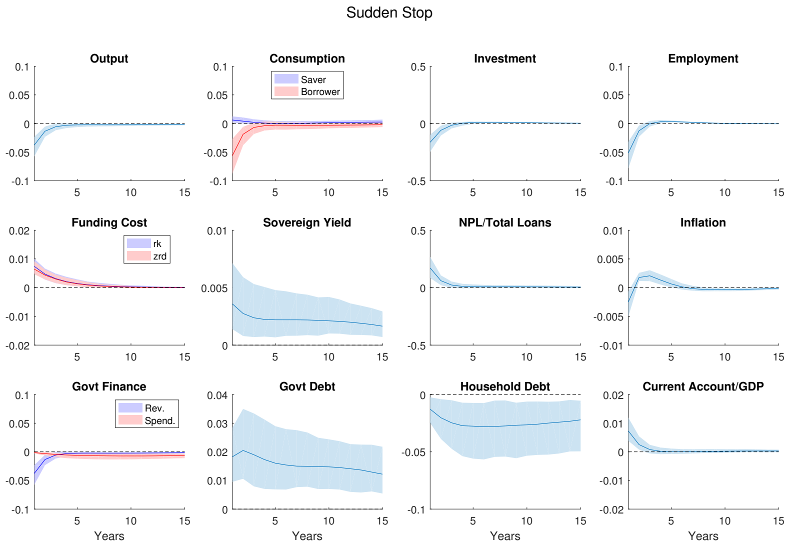
No direct doom loop, but indirect GE feedback loops:

- Sovereign risk shock ζ_t^{dg}:
  - Government funding costs increase $\rightarrow$ Government raises taxes and reduces expenditure $\rightarrow$ Output declines $\rightarrow$ Expected costs of default on private-sector loans increase $\rightarrow$ Funding costs for private sector increase and investment drops.
- Sudden stop ζ_t^{rd}:
  - Funding costs for private sector increase $\rightarrow$ Output and investment drop $\rightarrow$ Fiscal revenues drop $\rightarrow$ Expected costs of default on sovereign loans increase $\rightarrow$ Government funding costs increase.

Impulse Response: Sovereign Risk Shock



Impulse Response: Sudden Stop



Bayesian Estimation of the Model

- Standard techniques (Herbst & Schorfheide (2015))
- Period: 1999 to 2015
- Calibrate steady state parameters
- Estimate dynamic parameters

Observable	Description	Shock	Shock Description
$G_t + T_t$	Government spending	ζ_t^{spend}	Govt. spending shock
$\tau_t Y_t$	Government revenues	ζ_t^{tax}	Tax rate shock
R_t^g	Greek government spread over EZ average	ζ_t^{dg}	Sovereign risk shock
R_t^k	SME spread over EZ average	ζ_t^r	Funding cost shock
$\exp\left(d_t^p\right)$	Non-performing loans/total loans, $def = npl$	ζ^{def}	Private default shock
Π_t	Greece CPI - EZ CPI	$\zeta^{\pi h}$	PPI cost push shock
B_t^h	Household debt	ζ_t^{bh}	Household credit shock
Π_t^w	Greek Wage Inflation - EZ Wage Inflation	ζ^w	Wage inflation shock

Table: **Observables and Shocks**

Calibrated Parameters-I

Parameter	Description	Value
β	Discount Factor	0.97
α	Capital Share	1/3
ε_h	Elasticity between H and F	1
ε_f	Elasticity between exports	1
φ	Inverse labor supply elasticity	1
γ	Risk Aversion	1
ϑ	Price Stickiness	0.5
ε	Elasticity of Substitution Goods	6
ϑ_w	Wage Stickiness	0.5
ε_w	Elasticity of Substitution Labor	6
ε_r	Elasticity of R to NFA	0.0001
φ_k	Adjustment Cost	1
δ	Depreciation	0.07
FC	Fixed cost of production, 10% of Y	0.0955

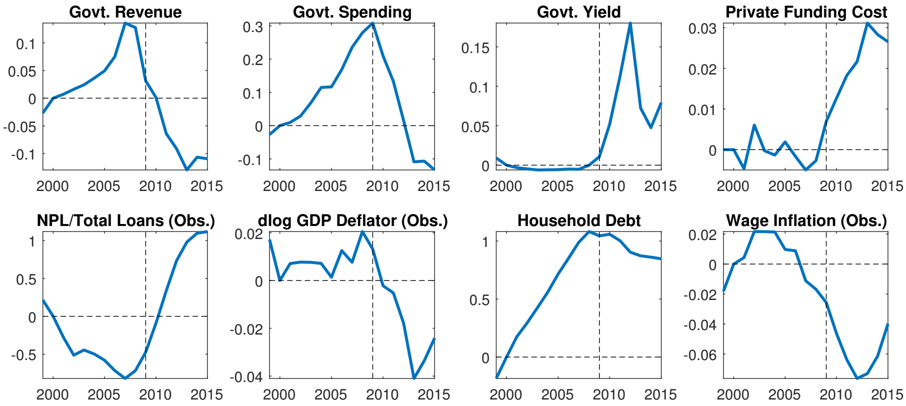
Calibrated Parameters-II

Parameter	Description	Value
ϖ	Openness (Martin and Philippon (2014))	0.3
χ	Fraction of Impatient (Martin and Philippon (2014))	0.65
Δ	Annual lending spread of 2%	1.02
$\frac{\bar{B}^h}{Y}$	Household debt to GDP of 50%	0.5
$\frac{B^g}{Y}$	Government debt to GDP of 120%	1.2
$\frac{G}{Y}$	Government consumption to GDP of 20%	0.2
$\frac{T}{Y}$	Public social expenditure to GDP of 20%	0.2
$\bar{d}^h$	Steady state default rate for Households	5.4%
$\bar{d}^k$	Steady state default rate for Corporates	5.4%
$\frac{B^k}{Y}$	Corporate debt to GDP of 50%	0.5
ψ_{sk}	Working Capital Constraint	1
τ	Tax rate, budget balance in SS	0.436
L	Leverage scaling	1

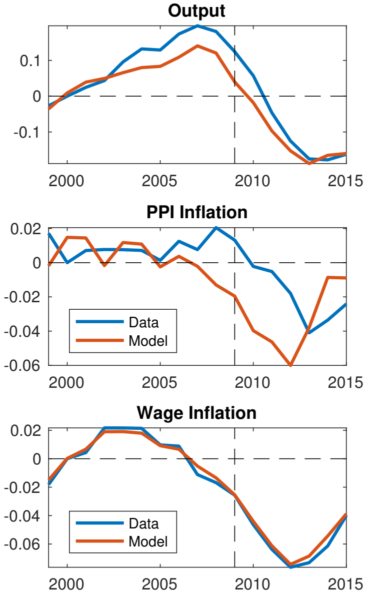
Calibrated Parameters-III

Parameter	Description	Value
F_b	Elasticity of govt. spending to public debt	0.05
F_n	Elasticity of govt. spending to employment	0.025
F_r	Elasticity of govt. spending to the int. rate	0.5
F_l	Persistence of govt. spending	0.75

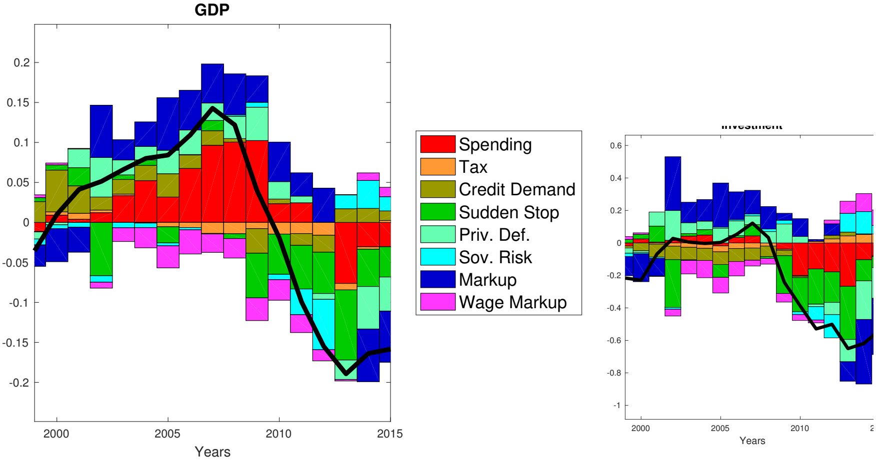
Data Inputs


Govt. Revenue
0.1
0.05
0
-0.05
-0.1
Govt. Spending
0.3
0.2
0.1
0
-0.1
Govt. Yield
0.15
0.1
0.05
0
Private Funding Cost
0.03
0.02
0.01
0
NPL/Total Loans (Obs.)
1
0.5
0
-0.5
dlog GDP Deflator (Obs.)
0.02
0
-0.02
-0.04
Household Debt
1
0.5
0
Wage Inflation (Obs.)
0.02
0
-0.02
-0.04
-0.06
2000 2005 2010 2015

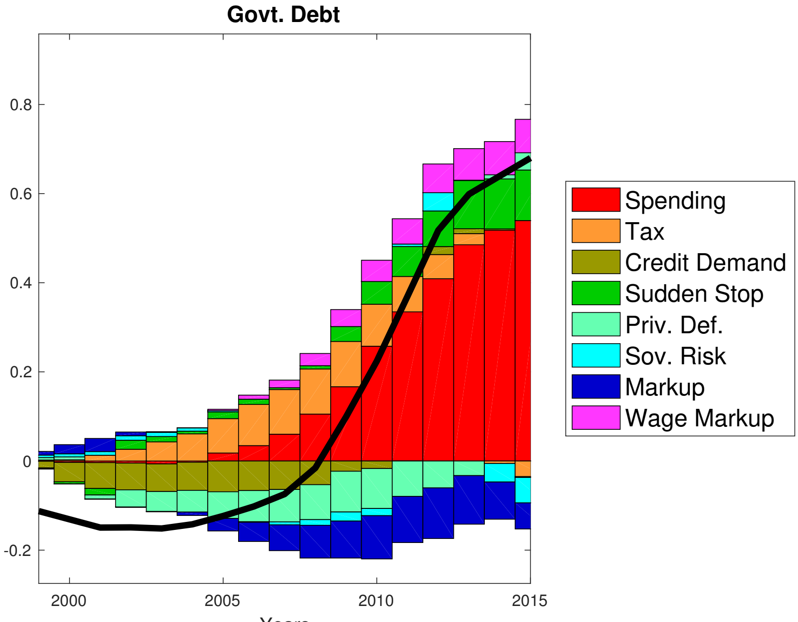
Fit of the Model



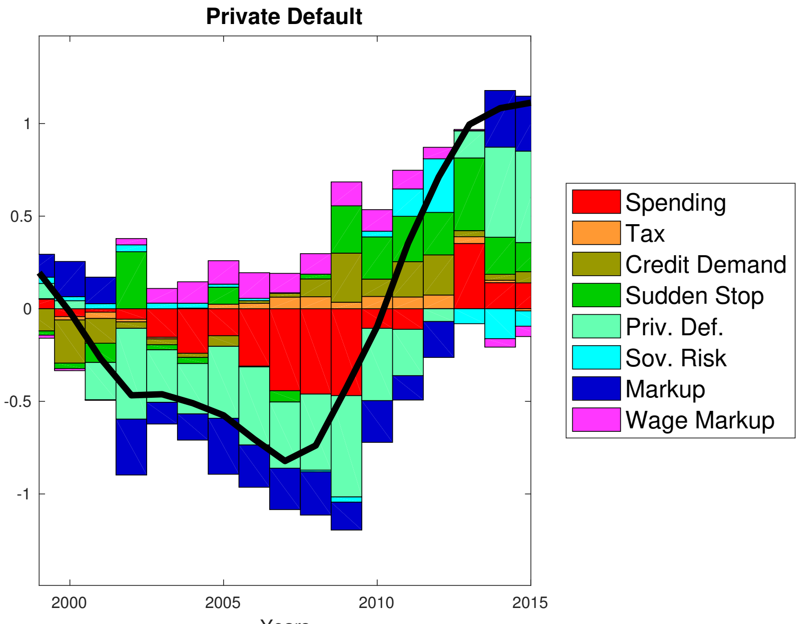
Decomposition of Output and Investment



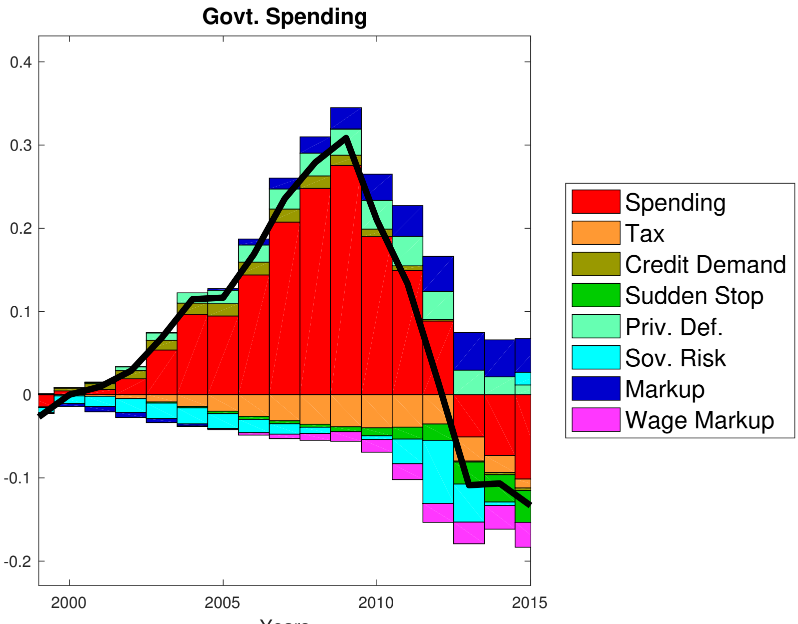
Decomposition of Sovereign Debt



Decomposition of Private Default



Decomposition of Government Spending



Key Lessons

- Fiscal trajectory prior to 2009 unsustainable. Stimulates output initially, but depresses it later on.
- First phase of the crisis (2009-2013)
  - Sovereign risk
  - Sudden stop
- Second phase of the crisis (2013-..)
  - Non-performing loans
  - Price markups.

4 Counterfactual Exercises

1. Low leverage (EME leverage)
2. Banking union
3. Fiscal discipline
4. Price flexibility (Latvia)

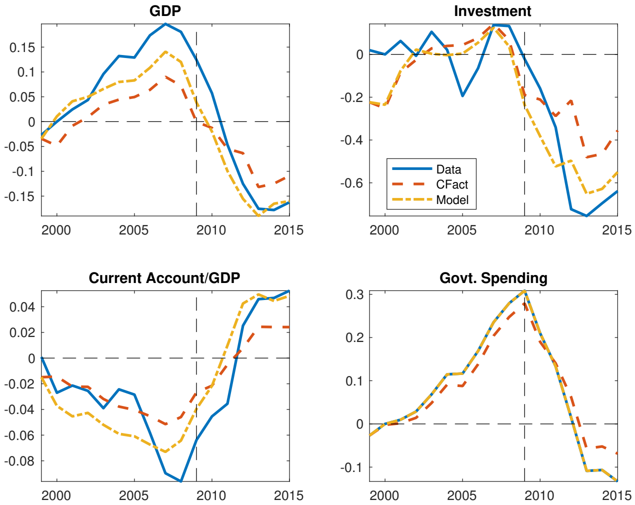
Counterfactual I: EME Leverage

	Greece	Typical EME	Min	Max
Credit / GDP	1.01	0.46	0.025	1.46
Sovereign Debt / GDP	1.38	0.343	0.063	0.68
Current Account /GDP	-0.083	-0.039	-0.10	+0.17

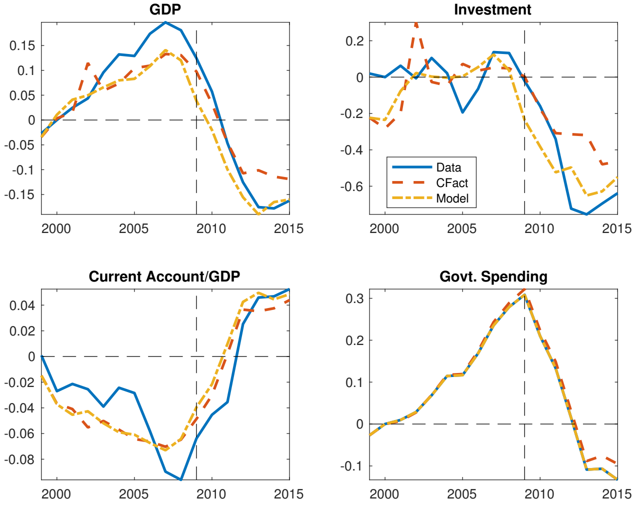
Table: **Leverage and Imbalances Before Sudden Stop**

Notes: Average from t-6 to t-2 where t is sudden stop.

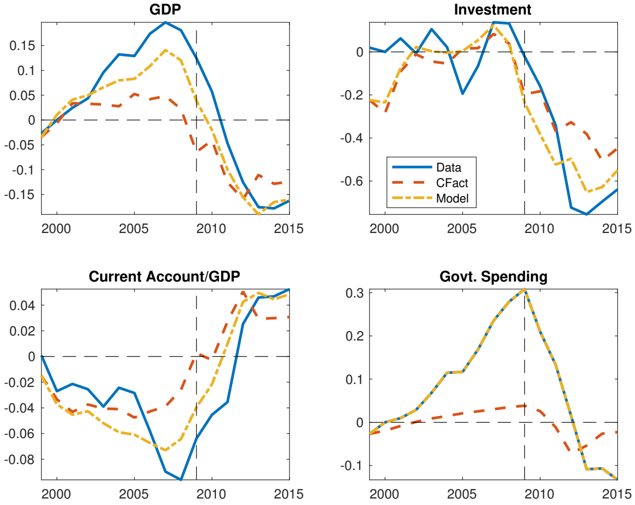
Counterfactual I: EME Leverage



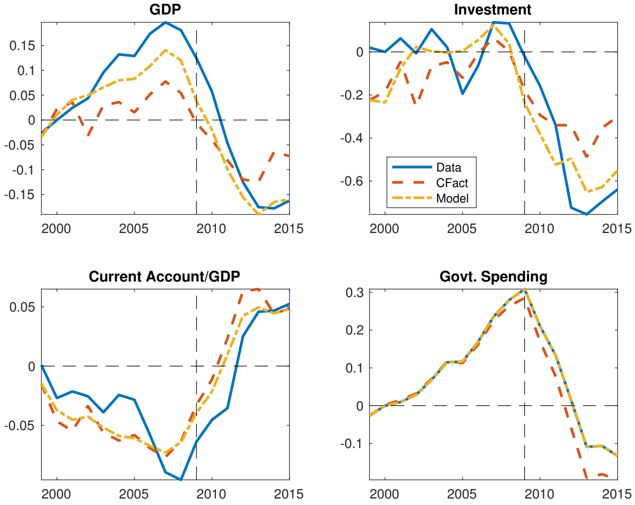
Counterfactual II: Banking Union



Counterfactual III: No Discretionary Spending



Counterfactual V: Low Price Stickiness



Greece, Conclusion: What Would Have Helped?

- What we can say
  - Exposure Y+10%, I+15%
  - Banking union Y+10%, I+30%
  - Sound fiscal Y+15%, I+20%
  - More flexible prices Y+15%, I+20%
- Open issues
  - Uncertainty (political, EZ risk)?
  - Early sovereign default?
  - Devaluation?

Regulation

Systemic Risk

Systemic Risk (with Acharya, Pedersen, and Richardson)

- Need to avoid two pitfalls
  - Too narrow: only leveraged, short-term wholesale-funded banks are systemic
  - Too broad: "Everything is systemic"
- Not much consensus beyond banking
  - Are insurance companies systemic?
  - Asset managers?
- Regulatory approach
  - Size + Interconnectedness + Substitutability
- Our initial approach (2010)
  - Systemic risk when aggregate capital shortfall
  - Tax/regulate contribution to shortfall –> SES

Basic Model of Systemic Risk

- J financial firms, $i = 1, ..J$, two dates $t = 0, 1$, normalize $r^f = 0$
- Time 0

$$a_i = w_{i,0} + b_i$$

- Time 1, random gross return q

$$w_i = q_i a_i - d_i$$

- Debt priced fairly

$$b_i = \mathbb{E}\left[\min\left(q_i a_i, d_i\right)\right].$$

Basic Model of Systemic Risk

- Firm i's problem

$$U_i = \max_{d_i, \tilde{q}_i} \mathbb{E}\left[\max\left(q_i a_i - d_i; 0\right) - w_{i,0} - \tau_i\right]$$

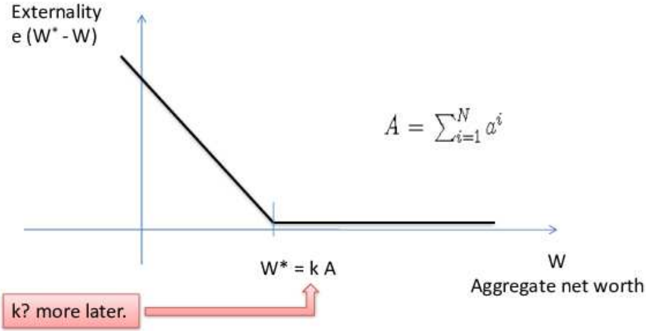
- Regulator cares about aggregate externality:

$$\max_{\{\tau_i\}_i} \sum_{i=1}^{J} U_i + \mathscr{E}$$

s.t.

$$\mathscr{E} \equiv -e\mathbb{E}\left[1_{W-\kappa A}\left(\kappa A - W\right)\right].$$

Reduced Form Externality



Optimal Pigouvian tax

Proposition

In the simple model with exogenous externality, the efficient outcome is obtained by a tax

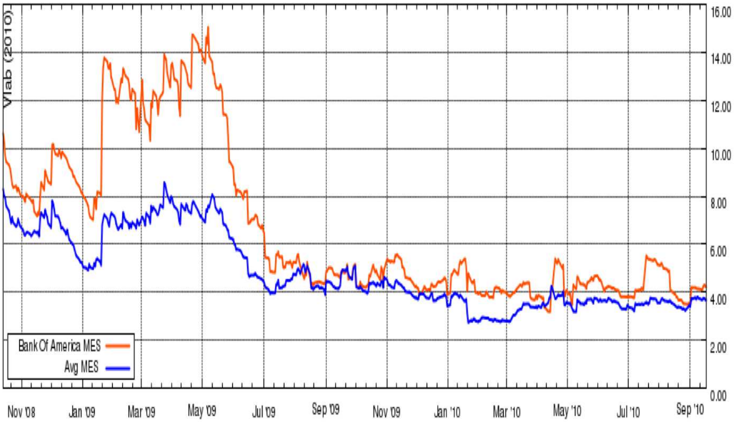
$$\tau_i = e \times \Pr(W < \kappa A) \times MES_i + \tau_0$$

where the **systemic expected shortfall** is defined by

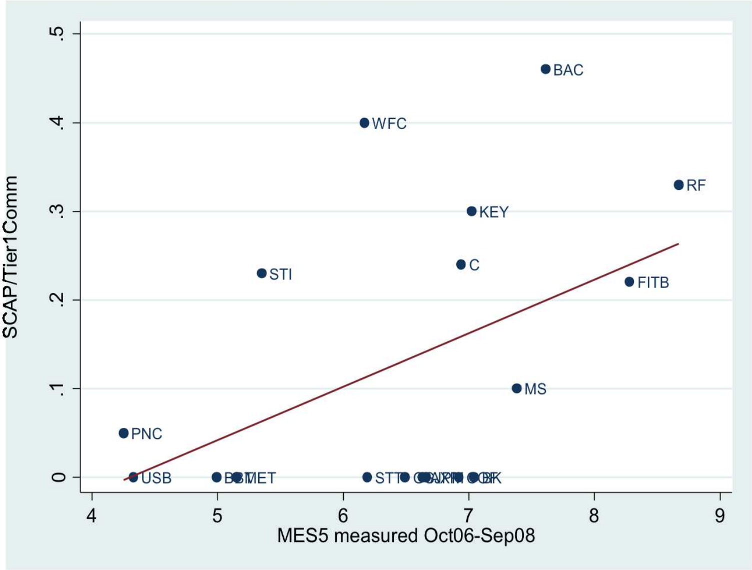
$$MES_i \equiv \mathbb{E}[\kappa a_i - w_i \mid W < \kappa A]$$

- Look for MES at `https://vlab.stern.nyu.edu`

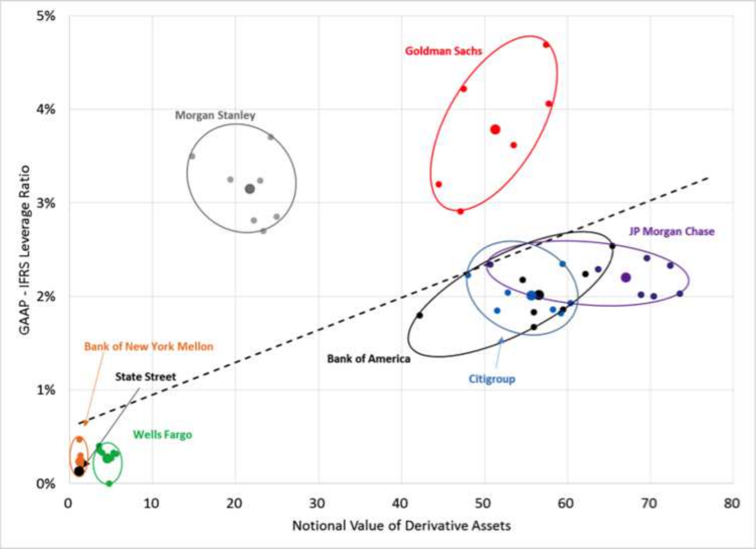
BAC MES


Vlab (2010)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Bank Of America MES
Avg MES
Nov '08
Jan '09
Mar '09
May '09
Jul '09
Sep '09
Nov '09
Jan '10
Mar '10
May '10
Jul '10
Sep '10

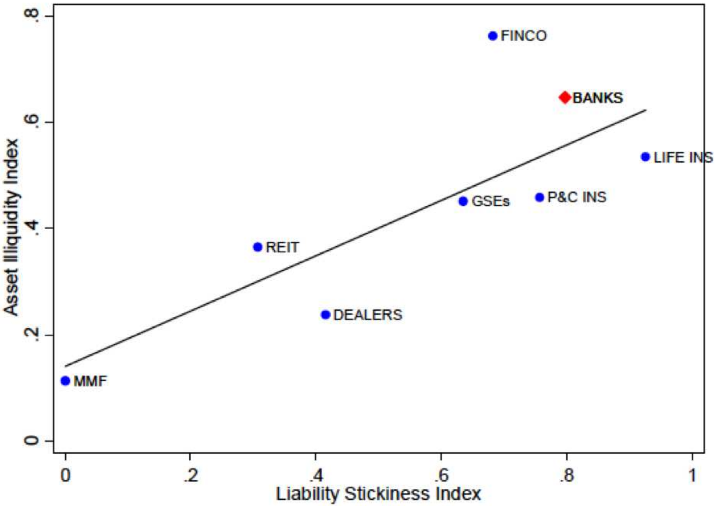
MES & SCAP


SCAP/Tier1Comm
0
.1
.2
.3
.4
.5
4
5
6
7
8
9
MES5 measured Oct06-Sep08
BAC
WFC
RF
KEY
C
STI
FITB
MS
PNC
USB
STT

Measuring Leverage Not Easy



Liquidity & Maturity



Source: Hanson, Shleifer, Stein, Vishny, 2014

Bank Capital Regulations

- ? identify four constraints on bank equity
- $ equity per $1 of asset
  - Risk based capital (RBC): $k_{RBC} \times w_i$, capital requirement * risk weight
  - Supplementary leverage ratio (SLR): k_{SLR}
  - Post stress RBC: $k_{RBC,STRESS} \times w_i + NLR_i$, RBC + net loss rate
  - Post stress SLR: $k_{SLR,STRESS} \times w_i + NLR_i$
  - GS more likely to be bound by SLR, while WF bound by RBC

Required Capital Ratios

	Required ratios (%)			
	Tier 1 Ratio	SLR	CCAR Tier 1 Ratio	CCAR SLR
G-SIBs:				
JPMorgan Chase	12.0	5.0	6.0	3.0
Bank of America	11.5	5.0	6.0	3.0
Citigroup Inc.	11.5	5.0	6.0	3.0
Morgan Stanley	11.5	5.0	6.0	3.0
Goldman Sachs	11.0	5.0	6.0	3.0
Wells Fargo	10.5	5.0	6.0	3.0
Bank of New York Mellon	10.0	5.0	6.0	3.0
State Street	10.0	5.0	6.0	3.0
Other Large BHCs:				
U.S. Bancorp	8.5	3.0	6.0	3.0
PNC Financial Services	8.5	3.0	6.0	3.0
Capital One Financial	8.5	3.0	6.0	3.0
HSBC North America	8.5	3.0	6.0	3.0
TD Group US	8.5	3.0	6.0	3.0

Distance from Requirements

	Distance from Requirement (%)			
	Tier 1 Ratio	SLR	CCAR Tier 1 Ratio	CCAR SLR
G-SIBs:				
JPMorgan Chase	2.2	1.5	2.4	0.9
Bank of America	2.1	2.0	2.4	1.3
Citigroup Inc.	4.3	2.6	3.5	1.5
Morgan Stanley	8.5	1.4	4.3	0.2
Goldman Sachs	5.6	1.5	2.2	0.1
Wells Fargo	2.3	2.6	3.0	2.3
Bank of New York Mellon	4.5	1.0	5.6	1.8
State Street	4.7	0.9	3.1	0.6
Other Large BHCs:				
U.S. Bancorp	2.5	4.3	1.9	2.2
PNC Financial Services	3.5	5.6	1.6	2.4
Capital One Financial	3.1	5.5	1.1	2.4
HSBC North America	11.6	4.3	5.6	1.0
TD Group US	5.2	4.1	5.3	2.8

?

Estimated Capital Charges

- Compute capital charge for bank j under j's most binding constraint

G-SIB Banks:	Tightest constraint	C&I	Residential Mortgages	Other Mortgages	Credit Cards	Other Consumer	Treasuries
JPMorgan Chase & Co.	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
Bank of America Corporation	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
Citigroup Inc.	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
Morgan Stanley	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
Goldman Sachs Group, Inc.	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
Wells Fargo & Company	Tier 1 Ratio	10.5	5.3	10.5	10.5	10.5	0.0
Bank of New York Mellon Corporation	SLR	5.0	5.0	5.0	5.0	5.0	5.0
State Street Corporation	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
Other Large BHCs:							
U.S. Bancorp	CCAR Tier 1 Ratio	8.7	1.1	8.7	5.8	5.4	-1.7
PNC Financial Services Group, Inc.	CCAR Tier 1 Ratio	8.7	1.1	8.7	5.8	5.4	-1.7
Capital One Financial Corporation	CCAR Tier 1 Ratio	8.7	1.1	8.7	5.8	5.4	-1.7
HSBC North America Holdings Inc.	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3
TD Group US Holdings LLC	CCAR SLR	5.7	1.1	5.7	2.8	2.4	1.3

?

Banks vs Non-Banks

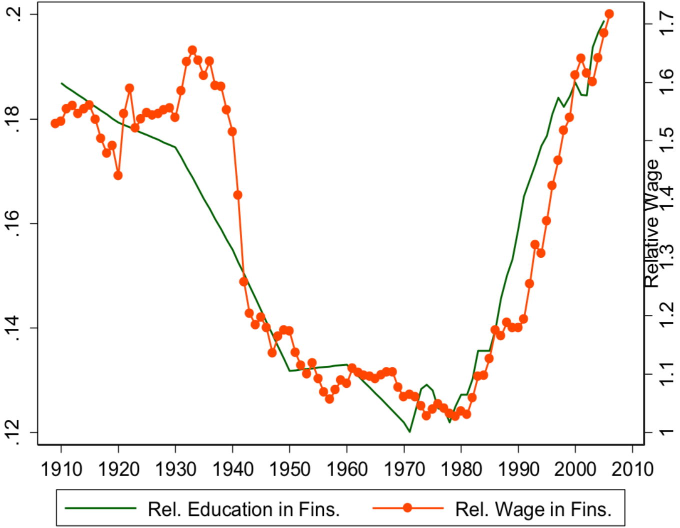
- Agreement that banks (and shadow banks) can create systemic risk
- Much more controversial for non-banks
  - MetLife sued FSOC January 2015 over their decision to designate MetLife as a SIFI
- Insurance Companies play important role in financial system
  - 30%–35% of bonds issued by European financial firms
  - Fire sales can happen (Dick-Nielsen-Feldhutter-Lando, Ellul-Jotikasthira-Lunblad, Manconi-Massa-Yasuda)
  - Market activities: McDonald and Paulson (2015)

FinTech

Are Financial Innovations Useful?

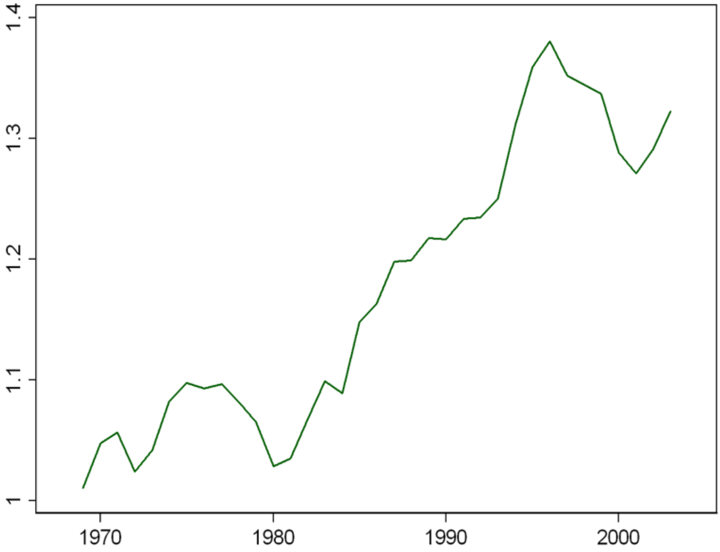
What did NOT happen in Finance

Relative Wage & Eduction in Finance



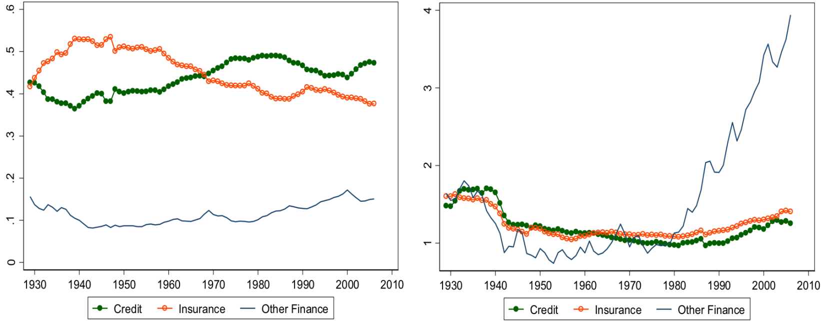
Source: Philippon & Reshef (QJE, 2012)

Relative Wage: Financiers vs Engineers



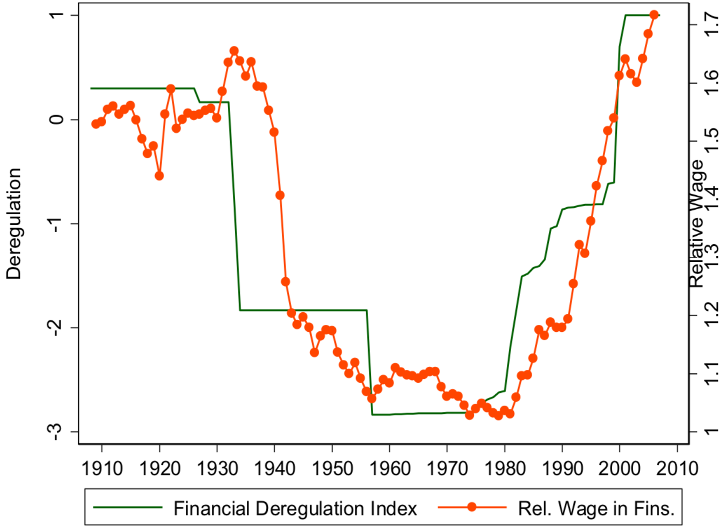
Source: Philippon & Reshef (QJE, 2012)

Employment Shares & Relative Wages



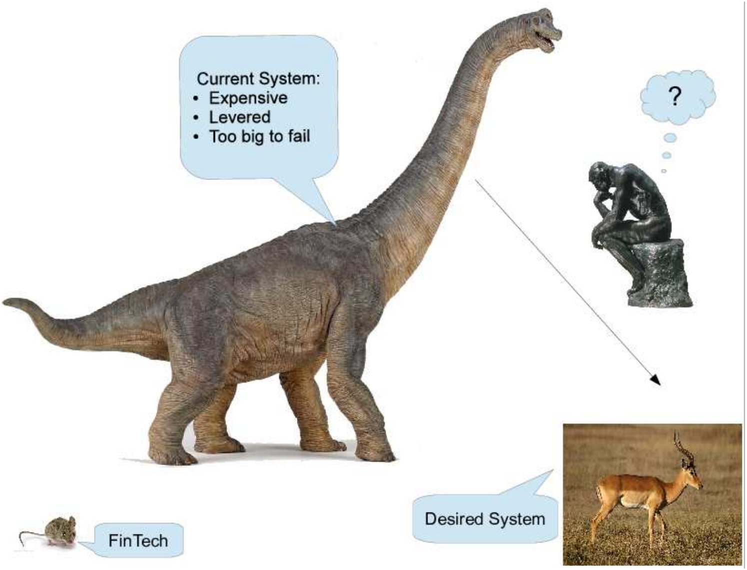
Source: Philippon & Reshef (QJE, 2012)

Pay & Regulation

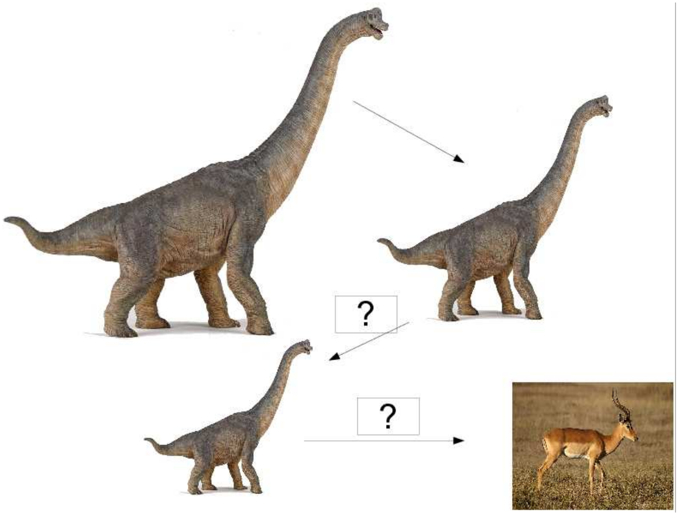


Source: Philippon & Reshef (QJE, 2012)

Regulation: Where We Are & Where We Want To Be

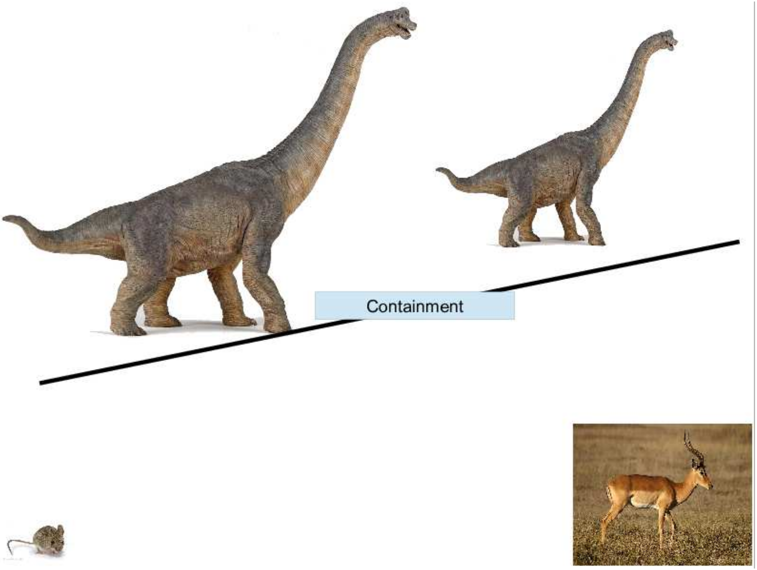


Current Strategy Has Run Its Course

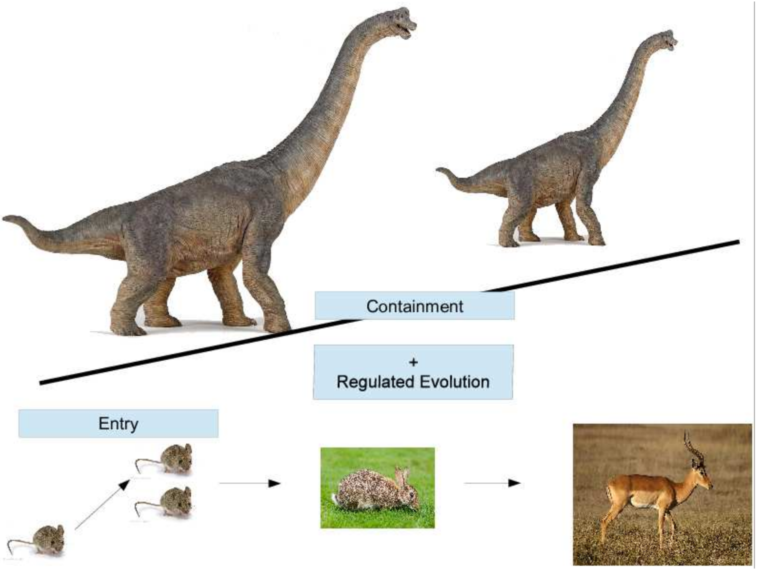


Will not work: entrenched interests, coordination costs, intractable design problem

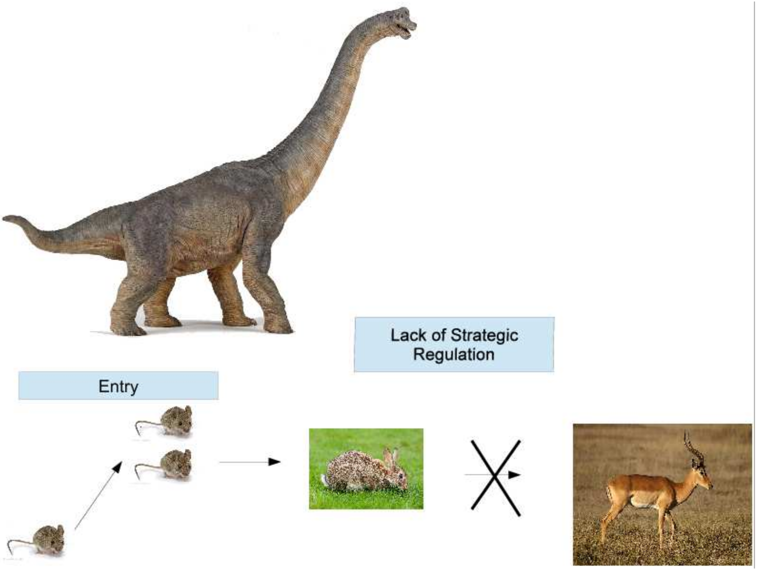
My Proposal: Strategy 2



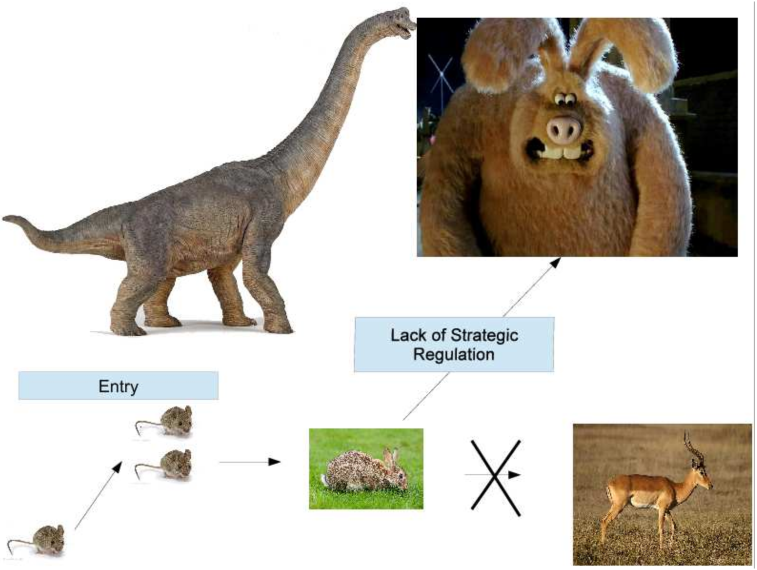
My Proposal: Strategy 2



This Will Not Happen Automatically



This Will Not Happen Automatically



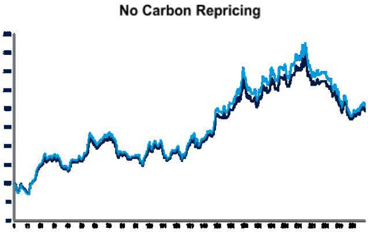
Finance and Climate Change

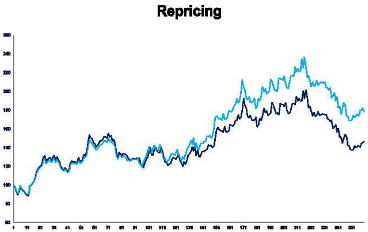
- New risks
- Insurance
  - impact on insurance liabilities from climate- and weather-related events, such as floods and storms that damage property or disrupt trade
- Asset management
  - Revaluation risks from adjustment towards a lower-carbon economy
  - Stranded assets : Fossil fuels companies: mainly valued on their reserves. But reserves exceed the budget of the planet: 2,795 GtCO2, but budget : 1,437 GtCO2

Low Carbon Indices

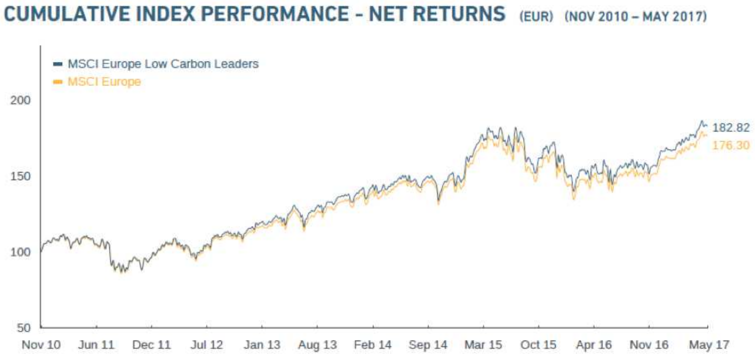
- How would you go about providing financial incentives for reducing carbon footprint
- Option 1: exclude poluters from portfolio and/or bet on replacements
  - very costly and complicated
- How do you buil an investment strategy when you think there is a risk in the long run but you have no idea when risk might materialize?
- Option 2: start from existing indexes and reduce footprint
  - start from MSCI index & match with carbon emission data
  - choose porfolio that achieves X% reduction of Emission Intensity and Z% reduction in exposure to stranded assets
  - optimize and re-balance regularly : low tracking error

Low Carbon Indices: Theory





Low Carbon Indices: Historical Performance



References I

Bansal, R. and A. Yaron (2002). Risks for the long run: A potential resolution of asset pricing puzzles. forthcoming, Journal of Finance.

Bernanke, B. and M. Gertler (1989). Agency costs, net worth and business fluctuations. *American Economic Review 79*, 14–31.

Bernanke, B., M. Gertler, and S. Gilchrist (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics*, Volume 1C. Elsevier Science, North Holland.

Cochrane, J. H. (2017). Macro-finance.

Eggertsson, G. and P. Krugman (2012). Debt, deleveraging, and the liquidity trap:a fisher-minsky-koo approach. *Quarterly Journal of Economics* (127(3)), 1469–1513.

Gertler, M. and N. Kiyotaki (2013). Banking, liquidity and bank runs in an infinite horizon economy. Working Paper, NYU.

References II

He, Z. and A. Krishnamurthy (2012). A model of capital and crises. *Review of Economic Studies*.

Kaplan, G. and G. L. Violante (2011, August). A Model of the Consumption Response to Fiscal Stimulus Payments. NBER Working Papers 17338, National Bureau of Economic Research, Inc.

Kiyotaki, N. and J. Moore (1997, Apr). Credit cycles. *Journal of Political Economy 105*(2), 211–248.

Leland, H. E. (1994). Bond prices, yield spreads, and optimal capital structure with default risk. Working Paper 240, IBER, University of California, Berkeley.

Leland, H. E. (1998). Agency costs, risk management, and capital structure. *Journal of Finance 53*, 1213–1243.

References III

Martin, P. and T. Philippon (2014). Inspecting the mechanism: Leverage and the great recession in the eurozone. Working Paper NYU.

Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics 5*, 147–175.

Myers, S. C. and N. S. Majluf (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics 13*, 187–221.

Nachman, D. and T. Noe (1994). Optimal design of securities under asymmetric information. *Review of Financial Studies 7*, 1–44.

Philippon, T. (2009). The bond market's q. *The Quarterly Journal of Economics 124*(3), 1011–1056.

References IV

Philippon, T. (2015). Has the us finance industry become less efficient? on the theory and measurement of financial intermediation. *The American Economic Review 105*(4), 1408–38.