The macroeconomic consequences of private debt

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The 2008 crisis according to freshwater DGSE macro

- Nobody could possibly see it coming: "*It's fun to say we didnt see the crisis coming, but the central empirical prediction of the efficient markets hypothesis is precisely that nobody can tell where markets are going*" (John Cochrane 2009).
- Financial markets victim of the real economy just as likely as the other way around: "I can tell a story very easily in which the financial markets were a casualty of the recession, not a cause of it." (Eugena Fama, New Yorker 2010)
- Bubbles are exceptional: "*With notably rare exceptions (2008, for example), the global 'invisible hand' has created relatively stable exchange rates, interest rates, prices, and wage rates.*" (Alan Greenspan 2011)

The 2008 crisis according to saltwater DSGE macro

- Some people saw it coming: "*Some economists, notably Robert Shiller, did identify the bubble and warn of painful consequences if it were to burst*" (Krugman 2009).
- Frictions identified in financial economics (e.g limits of arbitrage, heterogeneous beliefs, noise traders) can lead to large and persistent price distortions from "fundamental values".
- Because of similar frictions (e.g borrowing constraints, market liquidity for collateral), small initial shocks can be amplified and made persistent by the financial sector.

The aftermath according to freshwater DSGE macro

1. Increases government borrowing would lead to higher interest rates on government debt because of "crowding out".
2. Increases in the money supply would lead to inflation.
3. Fiscal stimulus has zero effect in an ideal world and negative effect in practice (because of decreased confidence).

Wrong prediction number 1

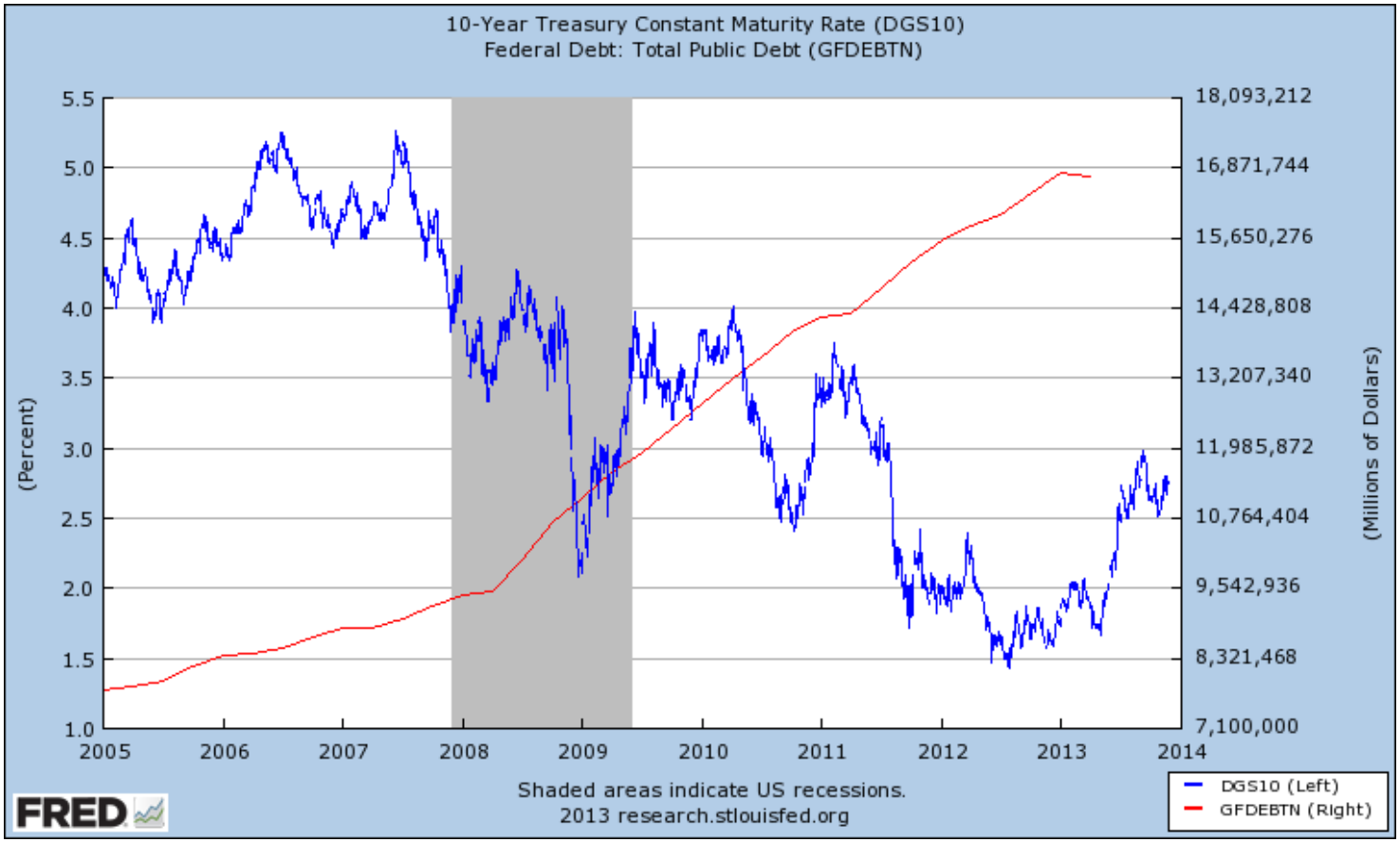


Figure: Government borrowing and interest rates.

Wrong prediction number 2

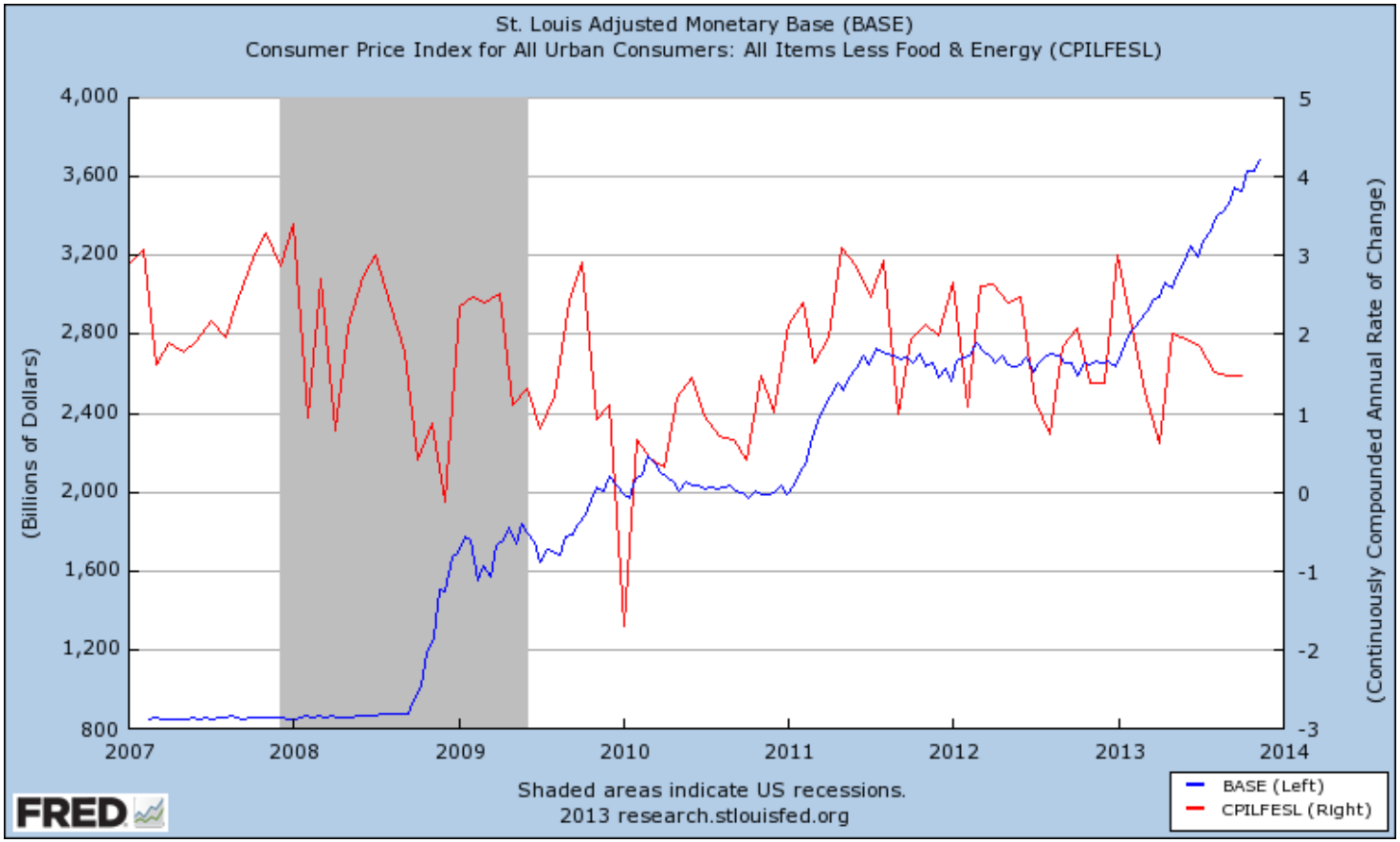


Figure: Monetary base and inflation.

Wrong prediction number 3

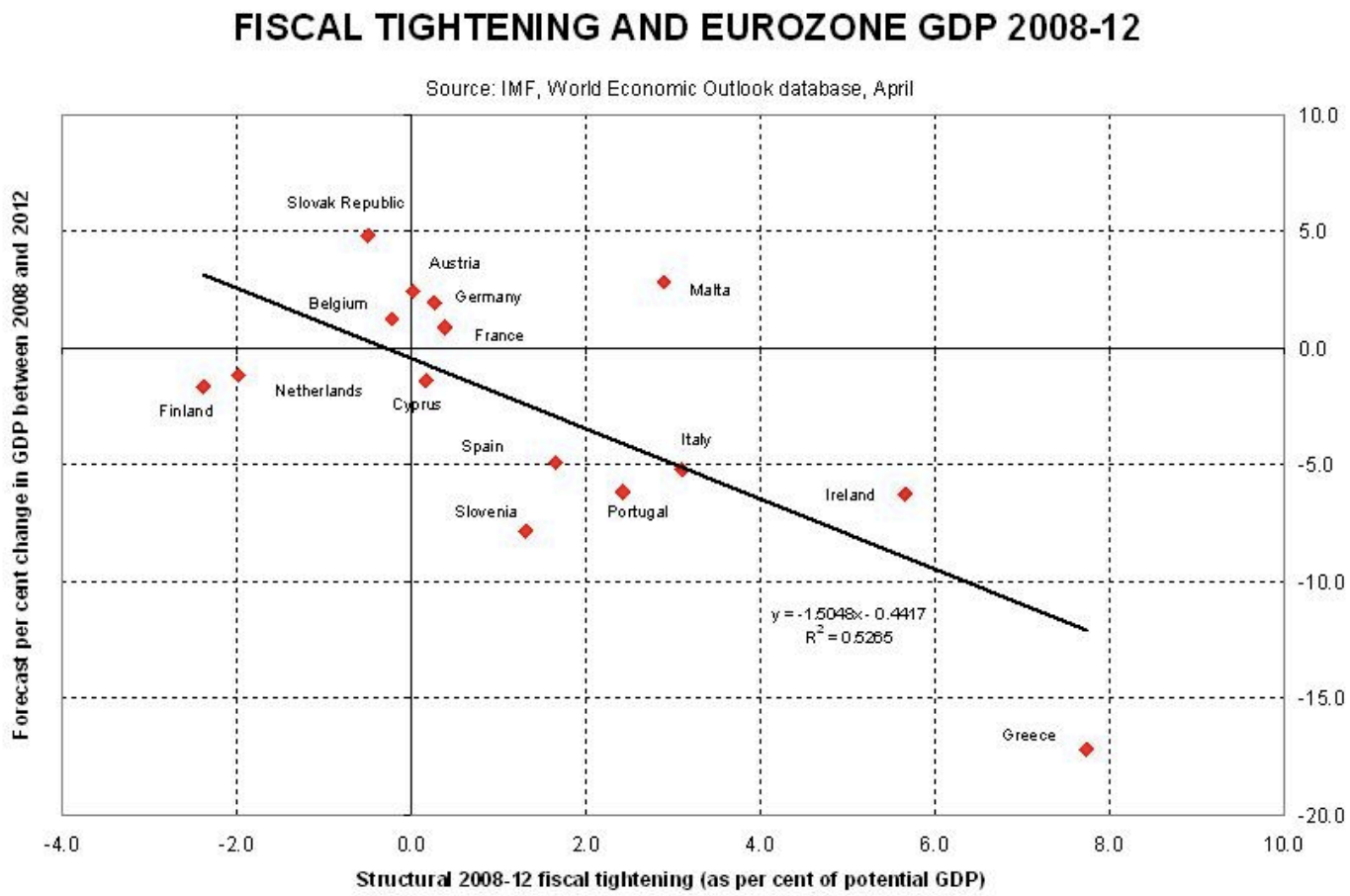
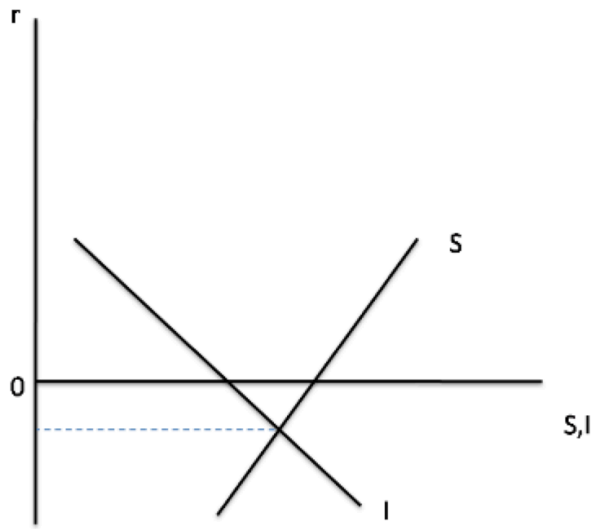
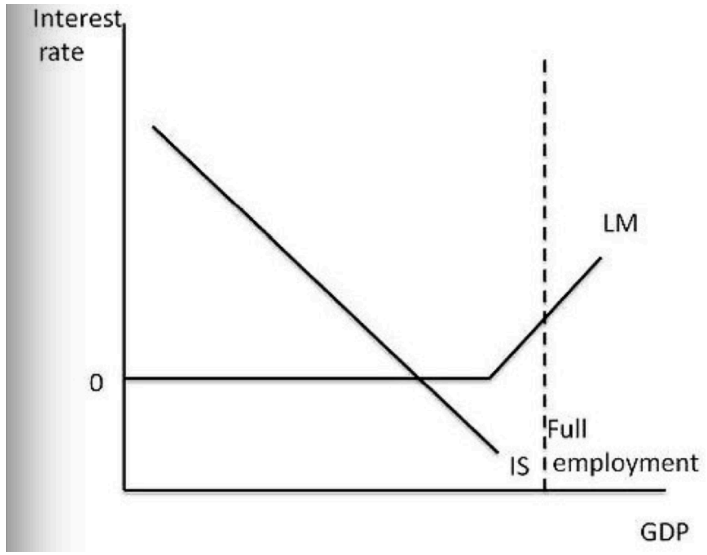


Figure: Fiscal tightening and GDP.

The aftermath according to saltwater DSGE macro

- The severity of the financial crisis put the economy in a "liquidity trap", in which case (1) government borrowing does not lead to higher interest rates (because of excess supply savings), (2) printing money does not cause inflation (because of excess capacity), and (3) fiscal stimulus has positive effect (because it mobilizes idle resources).





And what about private debt?

- Private debt never matters in freshwater macro: financial sector (both banks and markets) merely serve as intermediaries channeling savings (e.g from households) to investment (e.g business).
- "*People who get credit have to get it from some- where. Does a credit bubble mean that people save too much during that period? I dont know what a credit bubble means. I dont even know what a bubble means.*" (Eugene Fama, New Yorker, 2010).
- Money is neutral in its effect on real variables.
- Only matters in saltwater macro during a liquidity trap because of the zero lower bound in interest rates.
- "*Ignoring the foreign component, or looking at the world as a whole, the overall level of debt makes no difference to aggregate net worth – one person's liability is another person's asset.*" (Krugman and Eggertsson, 2010)

Then we can safely ignore this...

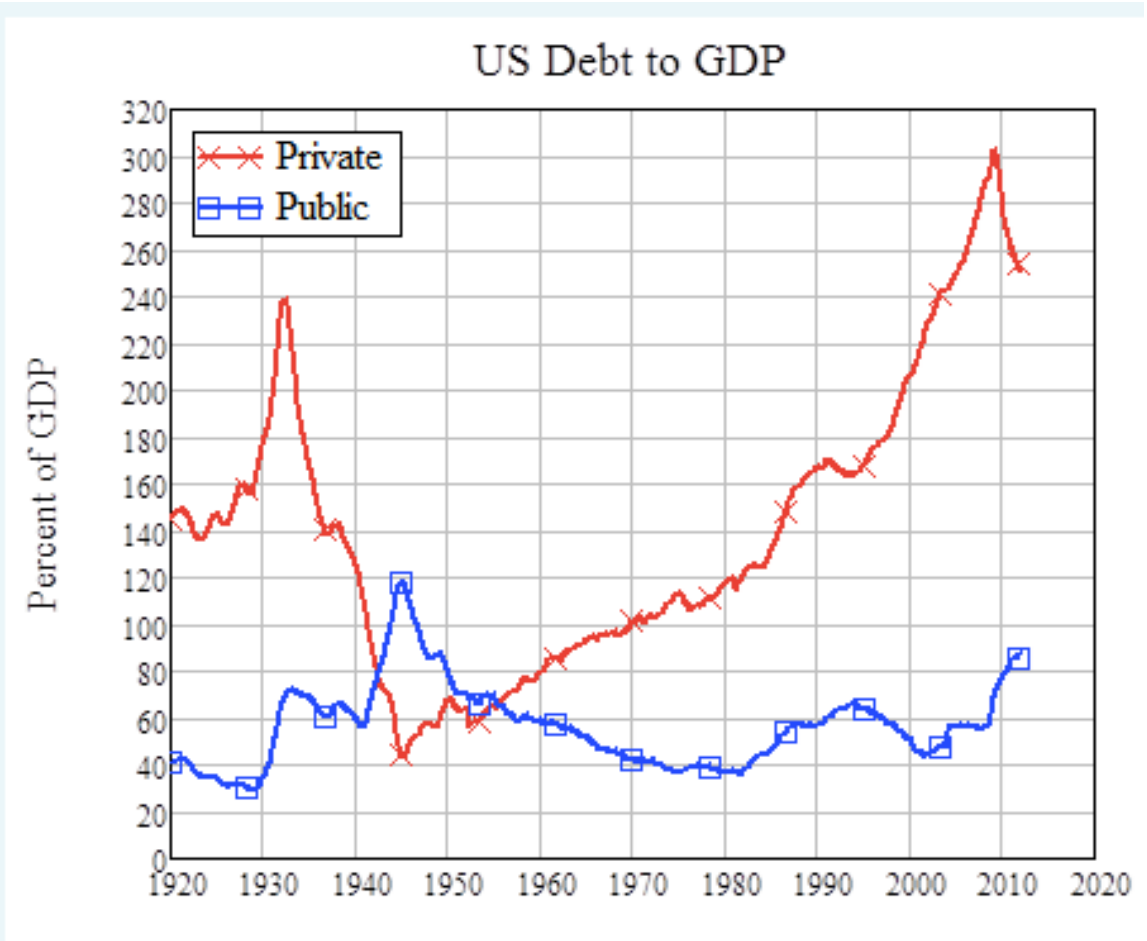


Figure: Private and public debt ratios.

Larry Summers and the Secular Stagnation Hypothesis

- Right now, the "natural" rate of interest is negative (liquidity trap).
- We may be an economy that needs bubbles just to achieve something near full employment, and have been there at least since the 1980s.
- Secular stagnation: permanently low investment demand (demographics? slowdown in innovation?)
- Even improved financial regulation is not necessarily a good thing that it may discourage irresponsible lending and borrowing at a time when more spending of any kind is good for the economy.

A tale of two Krugmans

- Krugman on March 27, 2012: "*If I decide to cut back on my spending and stash the funds in a bank, which lends them out to someone else, this doesnt have to represent a net increase in demand. Yes, in some (many) cases lending is associated with higher demand, because resources are being transferred to people with a higher propensity to spend.*"
- Krugman on December 07, 2013: "$\cdots$ *underneath the apparent stability of the Great Moderation lurked a rapid rise in debt that is now being unwound. Debt was rising by around 2 percent of GDP annually; thats not going to happen in future, which a naive calculation suggests means a reduction in demand, other things equal, of around 2 percent of GDP.*"

Minsky's Financial Instability Hypothesis

- Start when the economy is doing well but firms and banks are conservative.
- Most projects succeed - "Existing debt is easily validated: it pays to lever".
- Revised valuation of cash flows, exponential growth in credit, investment and asset prices.
- Beginning of "euphoric economy": increased debt to equity ratios, development of Ponzi financier.
- Viability of business activity is eventually compromised.
- Ponzi financiers have to sell assets, liquidity dries out, asset market is flooded.
- Euphoria becomes a panic.
- "Stability - or tranquility - in a world with a cyclical past and capitalist financial institutions is destabilizing".

Key insight 1: money is not neutral

- Money is hierarchical: currency is a promise to pay gold (or extinguish taxes); deposits are promises to pay currency; securities are promises to pay deposits.
- Financial institutions are market-makers straddling two levels in the hierarchy: CB, banks, security dealers.
- The hierarchy is dynamic:

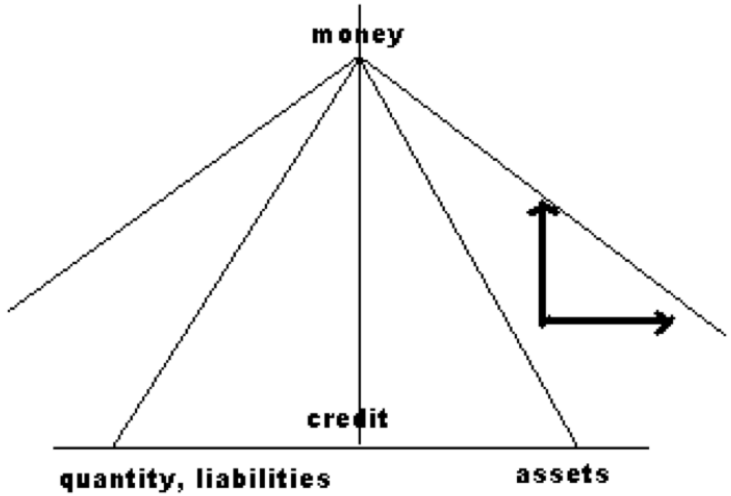


Figure: Mehrling (2013)

Key insight 2: money is endogenous

- Banks create money, credit, and purchasing power.
- Reserve requirements are never binding.

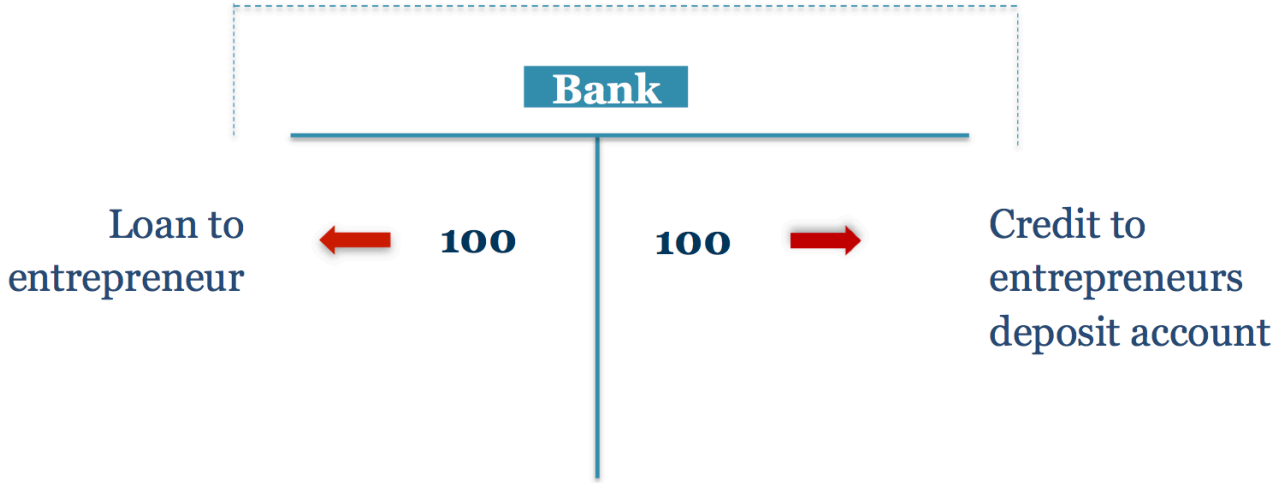


Figure: Turner (2013)

Key insight 3: private debt matters

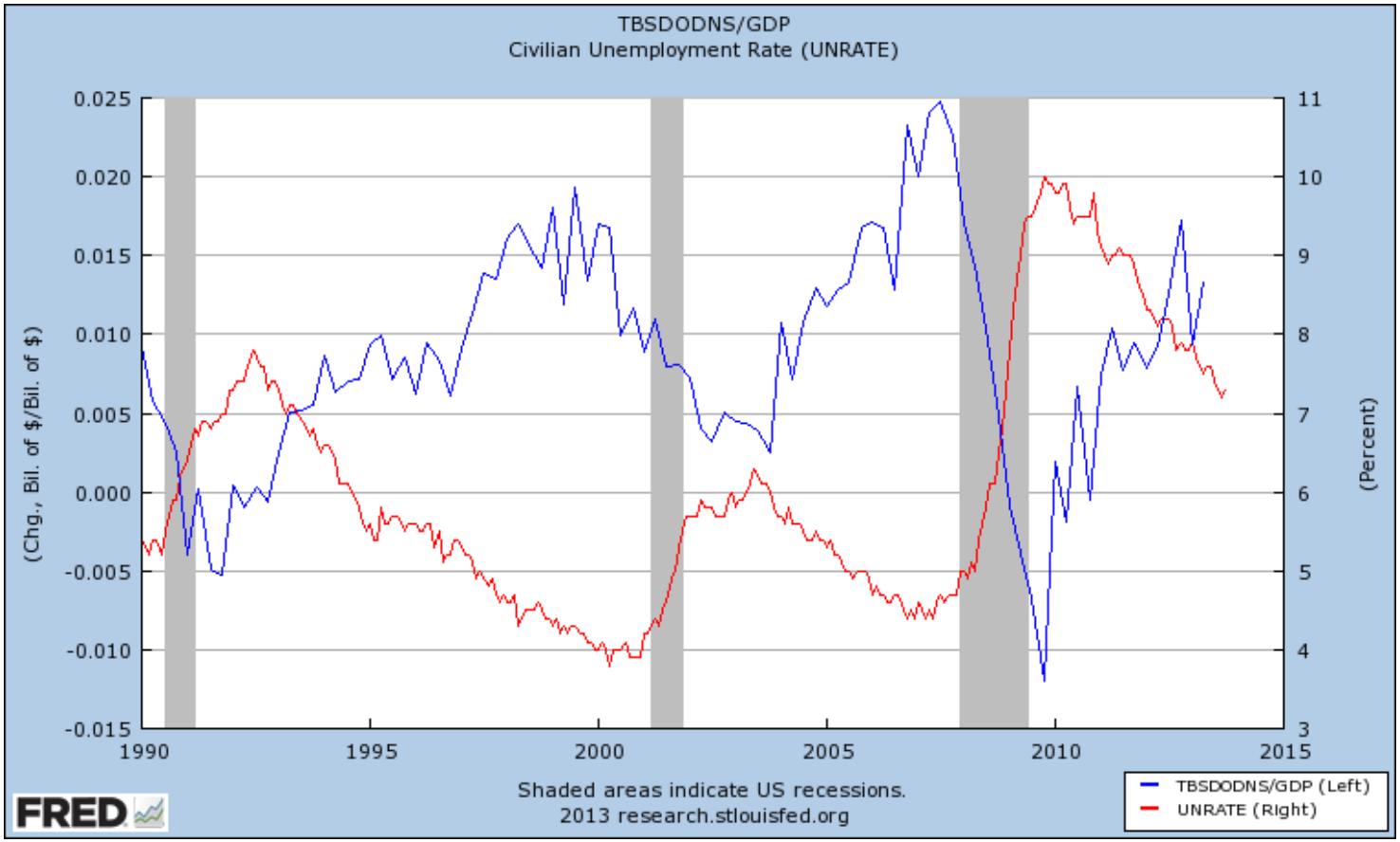


Figure: Change in debt and unemployment.

Key insight 4: finance is not just intermediation

- Market never clear in all states: set of events is larger than what can be contracted.
- The financial sector absorbs the risk of unfulfilled promises.
- The cone of acceptable losses defines the size of the real economy.

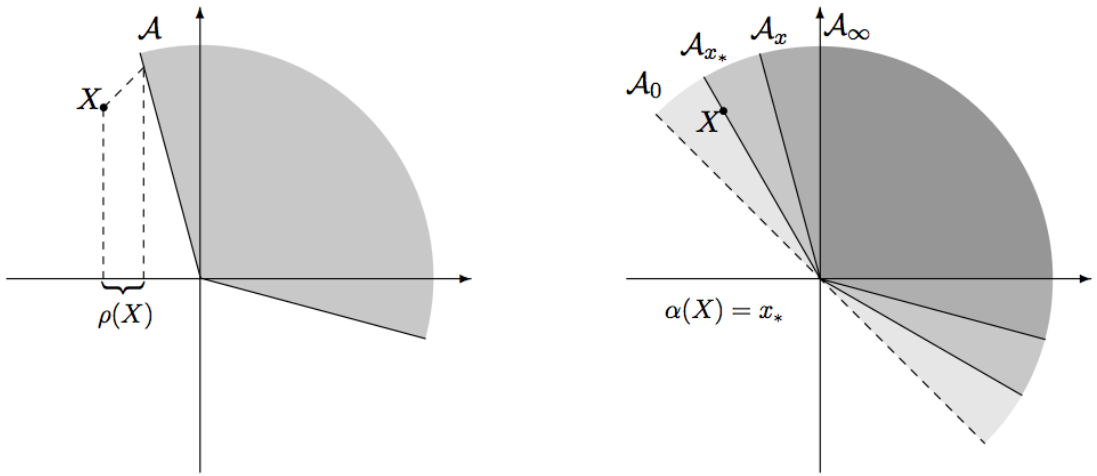


Figure: Cherny and Madan (2009)

Much better economics: SFC models

- Stock-flow consistent models emerged in the last decade as a common language for many heterodox schools of thought in economics.
- Consider both real and monetary factors from the start
- Specify the balance sheet and transactions between sectors
- Accommodate a number of behavioural assumptions in a way that is consistent with the underlying accounting structure.
- Reject silly (and mathematically unsound!) hypotheses such as the RARE individual (representative agent with rational expectations).
- See Godley and Lavoie (2007) for the full framework.

Balance Sheets

Balance Sheet	Households	Firms		Banks	Central Bank	Government	Sum
		current	capital				
Cash	$+H_h$			$+H_b$	$-H$		0
Deposits	$+M_h$		$+M_f$	$-M$			0
Loans			$-L$	$+L$			0
Bills	$+B_h$			$+B_b$	$+B_c$	$-B$	0
Equities	$+p_f E_f + p_b E_b$		$-p_f E_f$	$-p_b E_b$			0
Advances				$-A$	$+A$		0
Capital			$+pK$				pK
Sum (net worth)	V_h	0	V_f	V_b	0	$-B$	pK

Table: Balance sheet in an example of a general SFC model.

Transactions

Transactions	Households	Firms		Banks	Central Bank	Government	Sum
		current	capital				
Consumption	$-pC_h$	$+pC$		$-pC_b$			0
Investment		$+pI$	$-pI$				0
Gov spending		$+pG$				$-pG$	0
Acct memo [GDP]		$[pY]$					
Wages	$+W$	$-W$					0
Taxes	$-T_h$	$-T_f$				$+T$	0
Interest on deposits	$+r_M.M_h$	$+r_M.M_f$		$-r_M.M$			0
Interest on loans		$-r_L.L$		$+r_L.L$			0
Interest on bills	$+r_B.B_h$			$+r_B.B_b$	$+r_B.B_c$	$-r_B.B$	0
Profits	$+\Pi_d+\Pi_b$	$-\Pi$	$+\Pi_u$	$-\Pi_b$	$-\Pi_c$	$+\Pi_c$	0
Sum	S_h	0	S_f-pI	S_b	0	S_g	0

Table: Transactions in an example of a general SFC model.

Flow of Funds

Flow of Funds	Households	Firms		Banks	Central Bank	Government	Sum
		current	capital				
Cash	$+\dot{H}_h$			$+\dot{H}_b$	$-\dot{H}$		0
Deposits	$+\dot{M}_h$		$+\dot{M}_f$	$-\dot{M}$			0
Loans			$-\dot{L}$	$+\dot{L}$			0
Bills	$+\dot{B}_h$			$+\dot{B}_b$	$+\dot{B}_c$	$-\dot{B}$	0
Equities	$+p_f\dot{E}_f + p_b\dot{E}_b$		$-p_f\dot{E}_f$	$-p_b\dot{E}_b$			0
Advances				$-\dot{A}$	$+\dot{A}$		0
Capital			$+pI$				pI
Sum	S_h	0	S_f	S_b	0	S_g	pI
Change in Net Worth	$(S_h + \dot{p}_f E_f + \dot{p}_b E_b)$	$(S_f - \dot{p}_f E_f + \dot{p}K - p\delta K)$		$(S_b - \dot{p}_b E_b)$		S_g	$\dot{p}K + p\dot{K}$

Table: Flow of funds in an example of a general SFC model.

General Notation

- Employed labor force: ℓ
- Production function: $Y = f(K, \ell)$
- Labour productivity: $a = \frac{Y}{\ell}$
- Capital-to-output ratio: $\nu = \frac{K}{Y}$
- Employment rate: $\lambda = \frac{\ell}{N}$
- Change in capital: $\dot{K} = I - \delta K$
- Inflation rate: $i = \frac{\dot{p}}{p}$

Goodwin Model - SFC matrix

Balance Sheet	Households	Firms		Sum
		current	capital	
Capital			$+pK$	pK
Sum (net worth)	0	0	V_f	pK
Transactions				
Consumption	$-pC$	$+pC$		0
Investment		$+pI$	$-pI$	0
Acct memo [GDP]		$[pY]$		
Wages	$+W$	$-W$		0
Profits		$-\Pi$	$+\Pi_u$	0
Sum	0	0	0	0
Flow of Funds				
Capital			$+pI$	pI
Sum	0	0	Π_u	pI
Change in Net Worth	0	$pI + \dot{p}K - p\delta K$		$\dot{p}K + p\dot{K}$

Table: SFC table for the Goodwin model.

Goodwin Model - Differential equations

- Define

$$\omega = \frac{\mathrm{w}L}{pY} = \frac{\mathrm{w}}{pa} \quad \text{(wage share)}$$

$$\lambda = \frac{L}{N} = \frac{Y}{aN} \quad \text{(employment rate)}$$

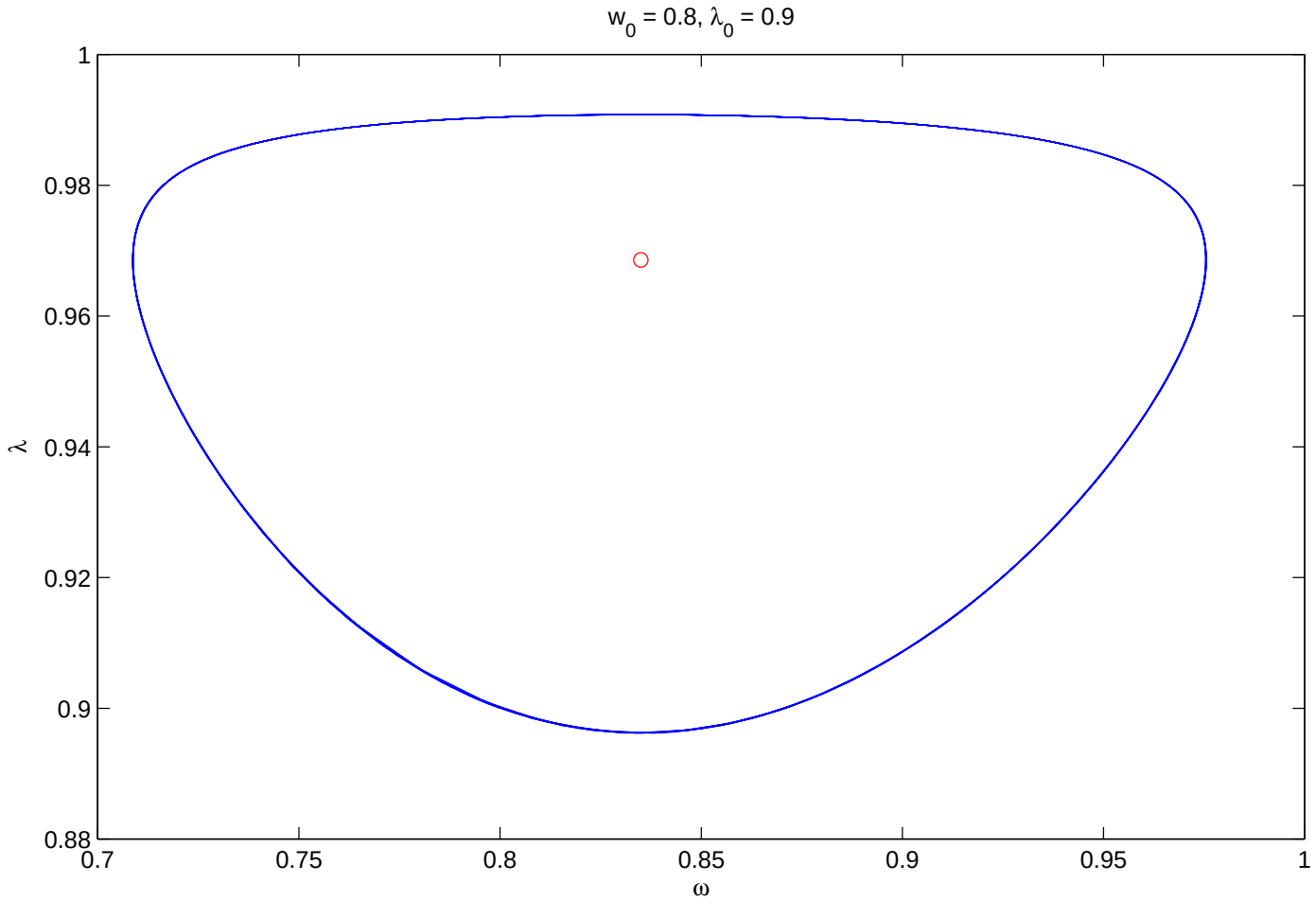
- It then follows that

$$\frac{\dot{\omega}}{\omega} = \frac{\dot{\mathrm{w}}}{\mathrm{w}} - \frac{\dot{p}}{p} - \frac{\dot{a}}{a} = \Phi(\lambda, i, i^e) - i - \alpha$$

$$\frac{\dot{\lambda}}{\lambda} = \frac{1-\omega}{\nu} - \alpha - \beta - \delta$$

- In the original model, all quantities were real (i.e divided by p), which is equivalent to setting $i = i^e = 0$.

Example 1: Goodwin model



Testing Goodwin on OECD countries

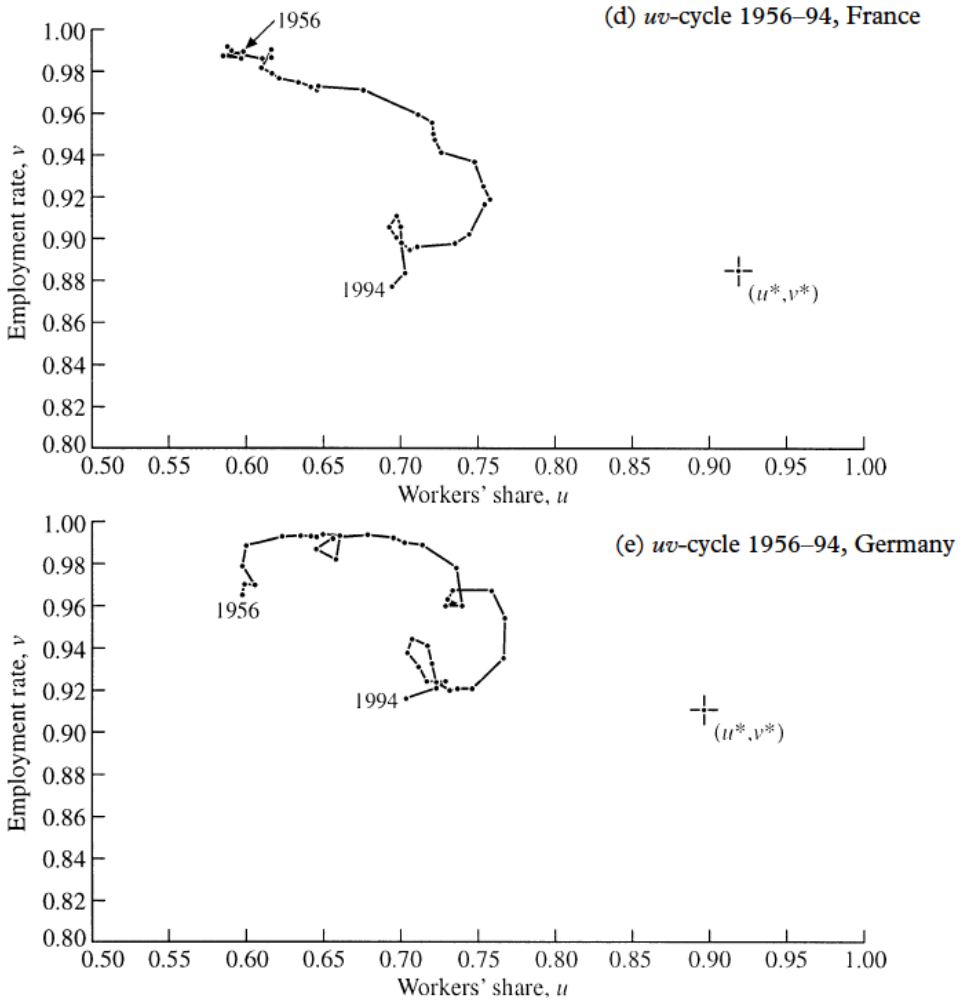


Figure: Harvie (2000)

Correcting Harvie

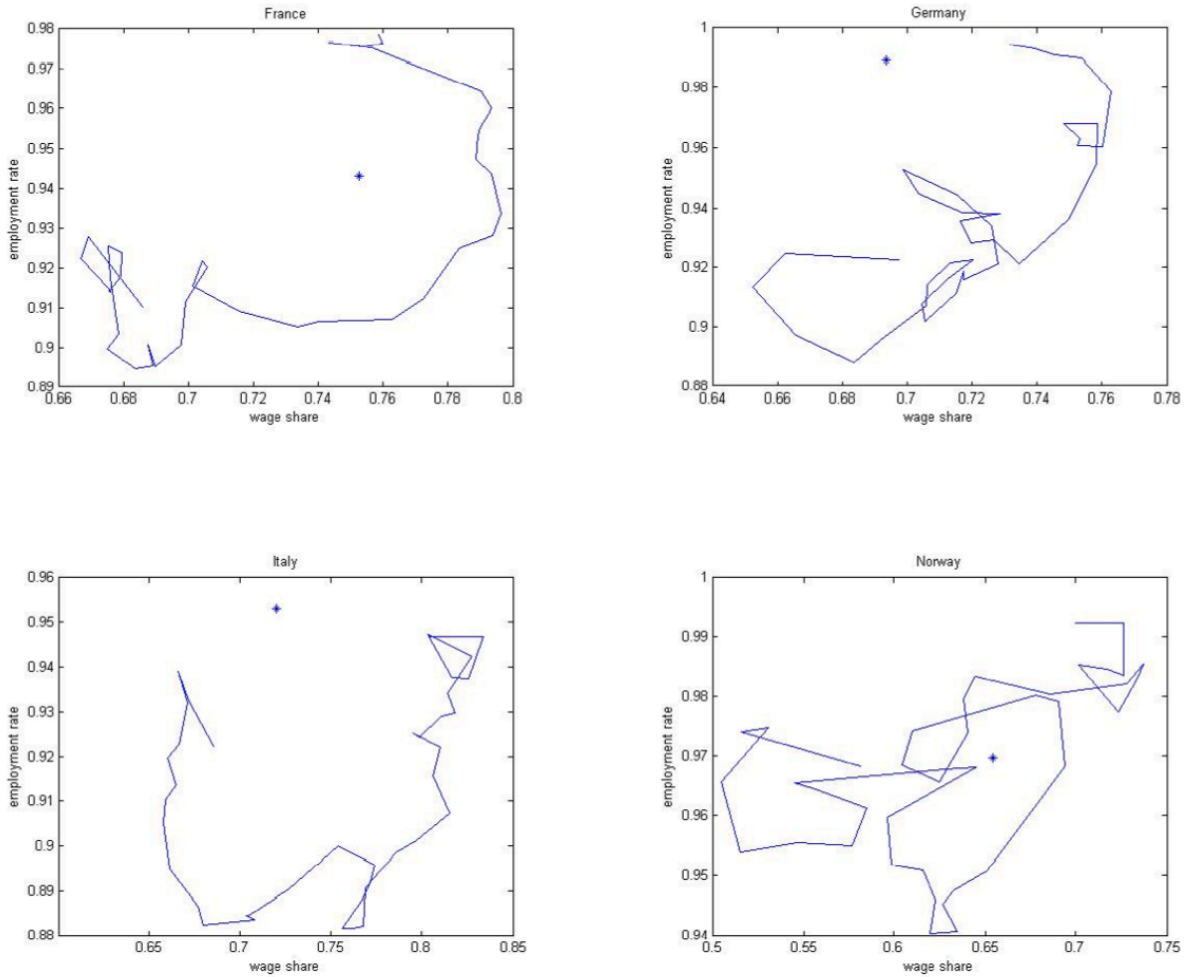


Figure: Grasselli and Maheshwari (2012)

SFC table for Keen (1995) model

Balance Sheet	Households	Firms		Banks	Sum
		current	capital		
Deposits	$+D$			$-D$	0
Loans			$-L$	$+L$	0
Capital			$+pK$		pK
Sum (net worth)	V_h	0	V_f	0	pK
Transactions					
Consumption	$-pC$	$+pC$			0
Investment		$+pI$	$-pI$		0
Acct memo [GDP]		$[pY]$			
Wages	$+W$	$-W$			0
Interest on deposits	$+rD$			$-rD$	0
Interest on loans		$-rL$		$+rL$	0
Profits		$-\Pi$	$+\Pi_u$		0
Sum	S_h	0	$S_f - pI$	0	0
Flow of Funds					
Deposits	$+\dot{D}$			$-\dot{D}$	0
Loans			$-\dot{L}$	$+\dot{L}$	0
Capital			$+pI$		pI
Sum	S_h	0	Π_u	0	pI
Change in Net Worth	S_h	$(S_f + \dot{p}K - p\delta K)$			$\dot{p}K + p\dot{K}$

Table: SFC table for the Keen model.

Keen model - Investment function

- Assume now that new investment is given by

$$\dot{K} = \kappa(1 - \omega - rd)Y - \delta K$$

where $\kappa(\cdot)$ is a nonlinear increasing function of profits $\pi = 1 - \omega - rd$.

- This leads to external financing through debt evolving according to

$$\dot{D} = \kappa(1 - \omega - rd)Y - (1 - \omega - rd)Y$$

Keen model - Differential Equations

Denote the debt ratio in the economy by $d = D/Y$, the model can now be described by the following system

$$\begin{aligned}
\dot{\omega} &= \omega\left[\Phi(\lambda) - \alpha\right] \\
\dot{\lambda} &= \lambda\left[\frac{\kappa(1-\omega-rd)}{\nu} - \alpha - \beta - \delta\right] \\
\dot{d} &= d\left[r - \frac{\kappa(1-\omega-rd)}{\nu} + \delta\right] + \kappa(1-\omega-rd) - (1-\omega)
\end{aligned} \tag{1}$$

Example 2: convergence to the good equilibrium in a Keen model

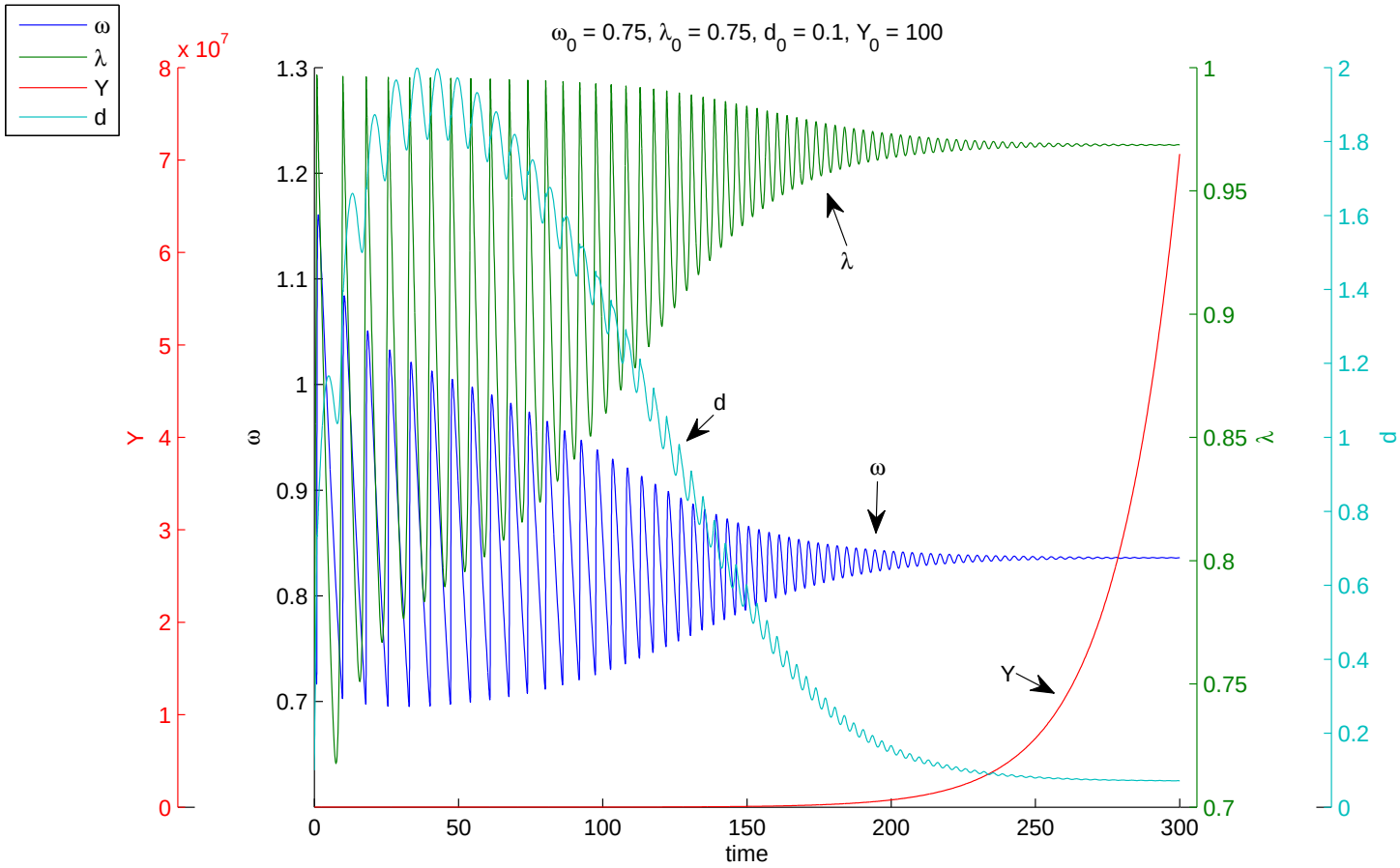


Figure: Grasselli and Costa Lima (2012)

Example 3: explosive debt in a Keen model

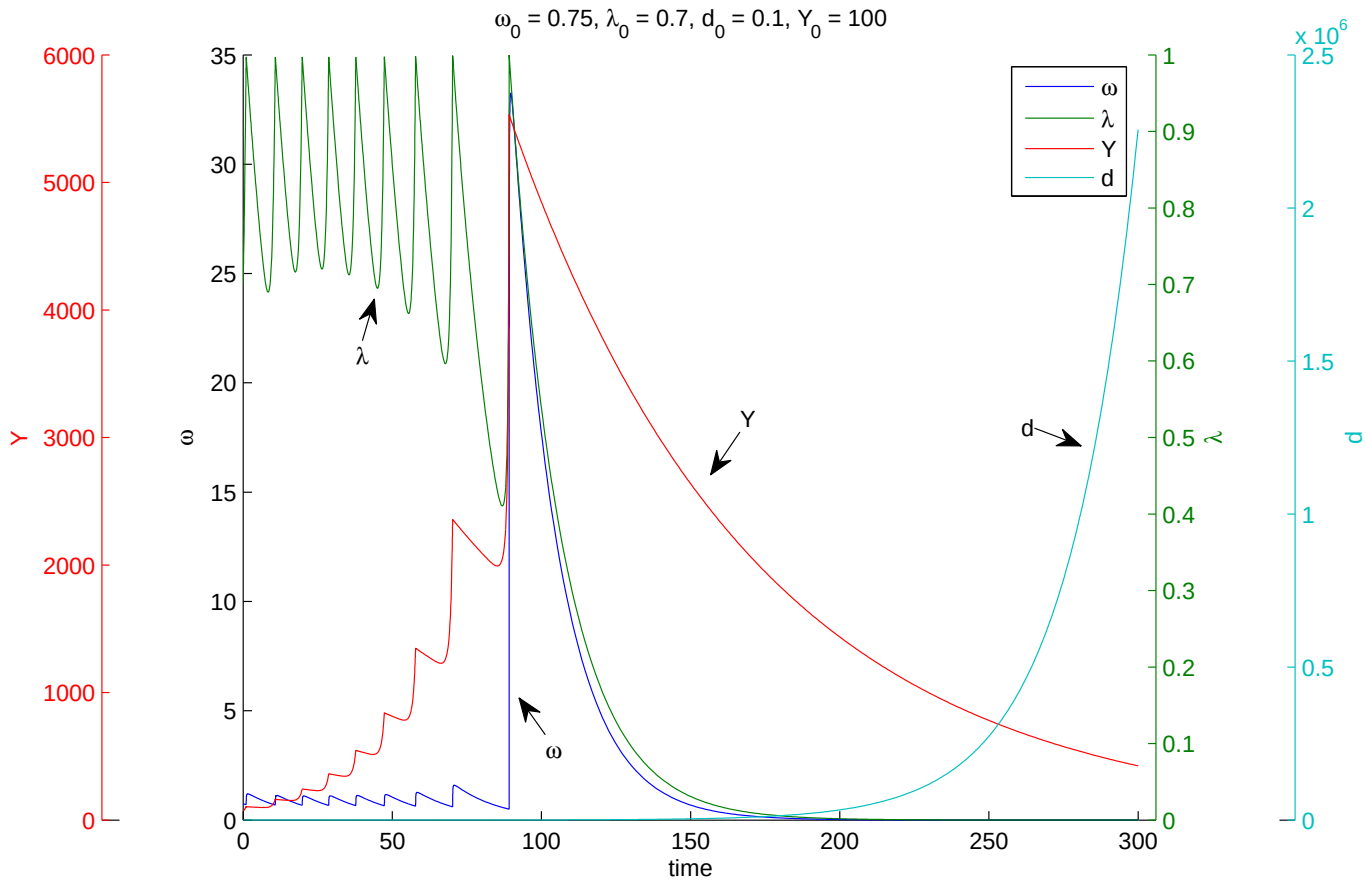


Figure: Grasselli and Costa Lima (2012)

Basin of convergence for Keen model

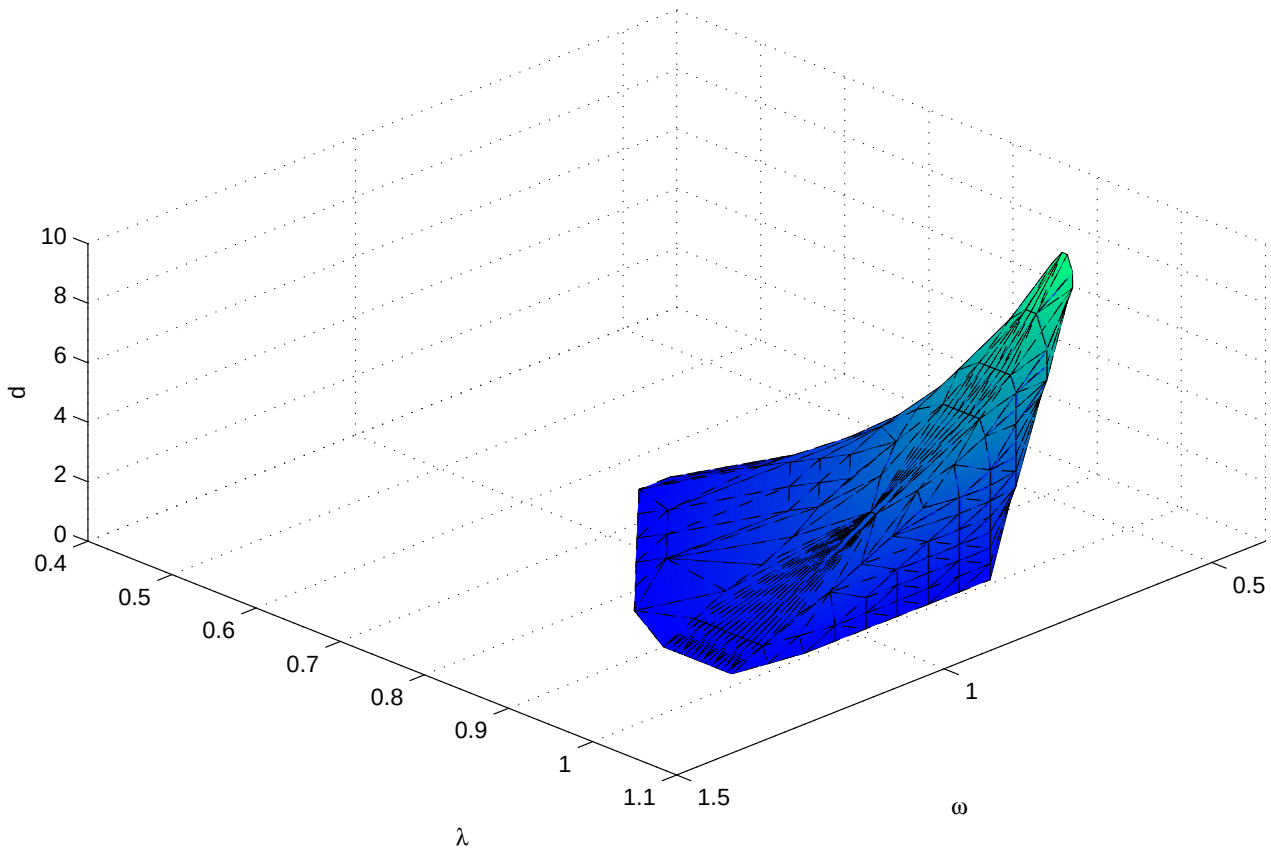


Figure: Grasselli and Costa Lima (2012)

Ponzi financing

To introduce the destabilizing effect of purely speculative investment, we consider a modified version of the previous model with

$$\dot{D} = \kappa(1 - \omega - rd)Y - (1 - \omega - rd)Y + P$$
$$\dot{P} = \Psi(g(\omega, d)P$$

where $\Psi(\cdot)$ is an increasing function of the growth rate of economic output

$$g = \frac{\kappa(1 - \omega - rd)}{\nu} - \delta.$$

Example 4: effect of Ponzi financing

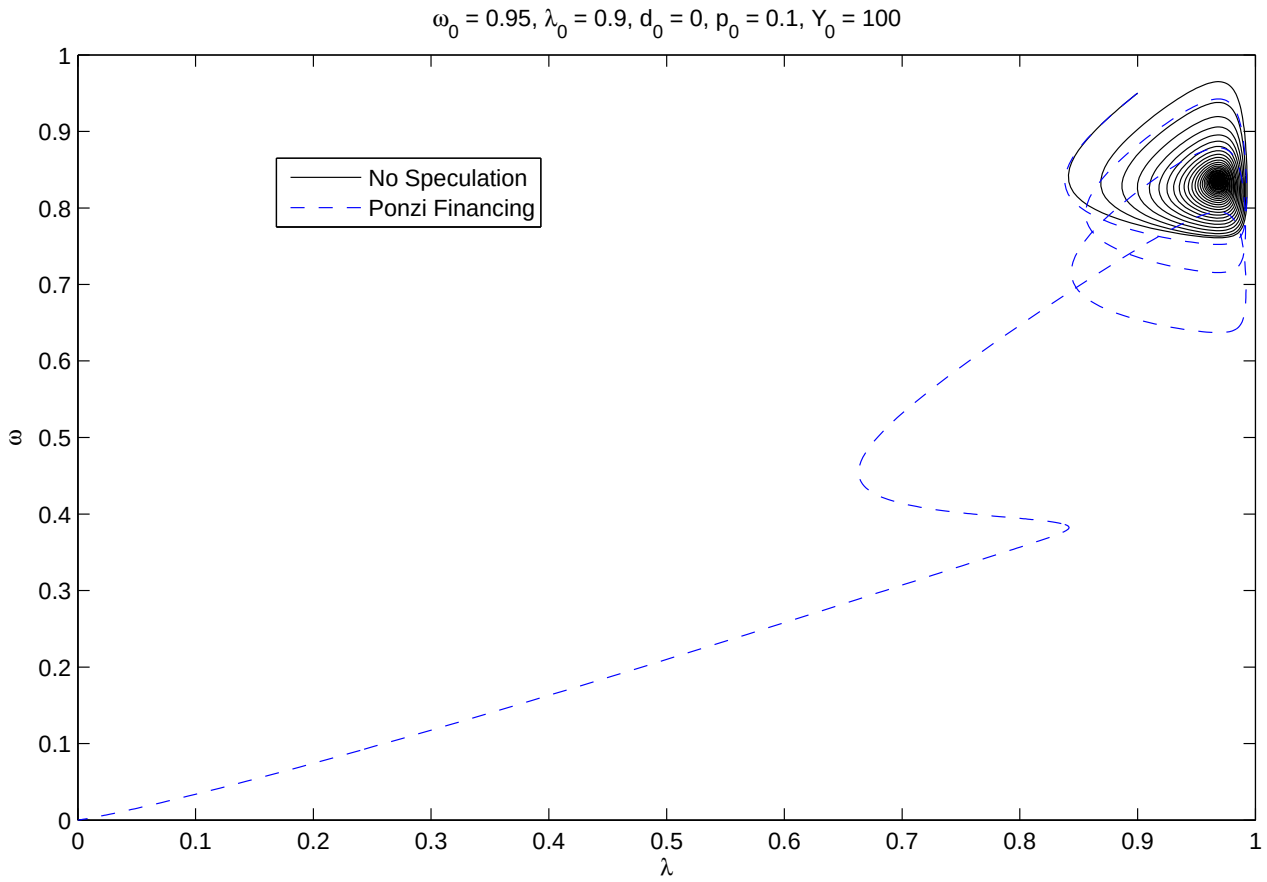


Figure: Grasselli and Costa Lima (2012)

Stock prices

- Consider a stock price process of the form

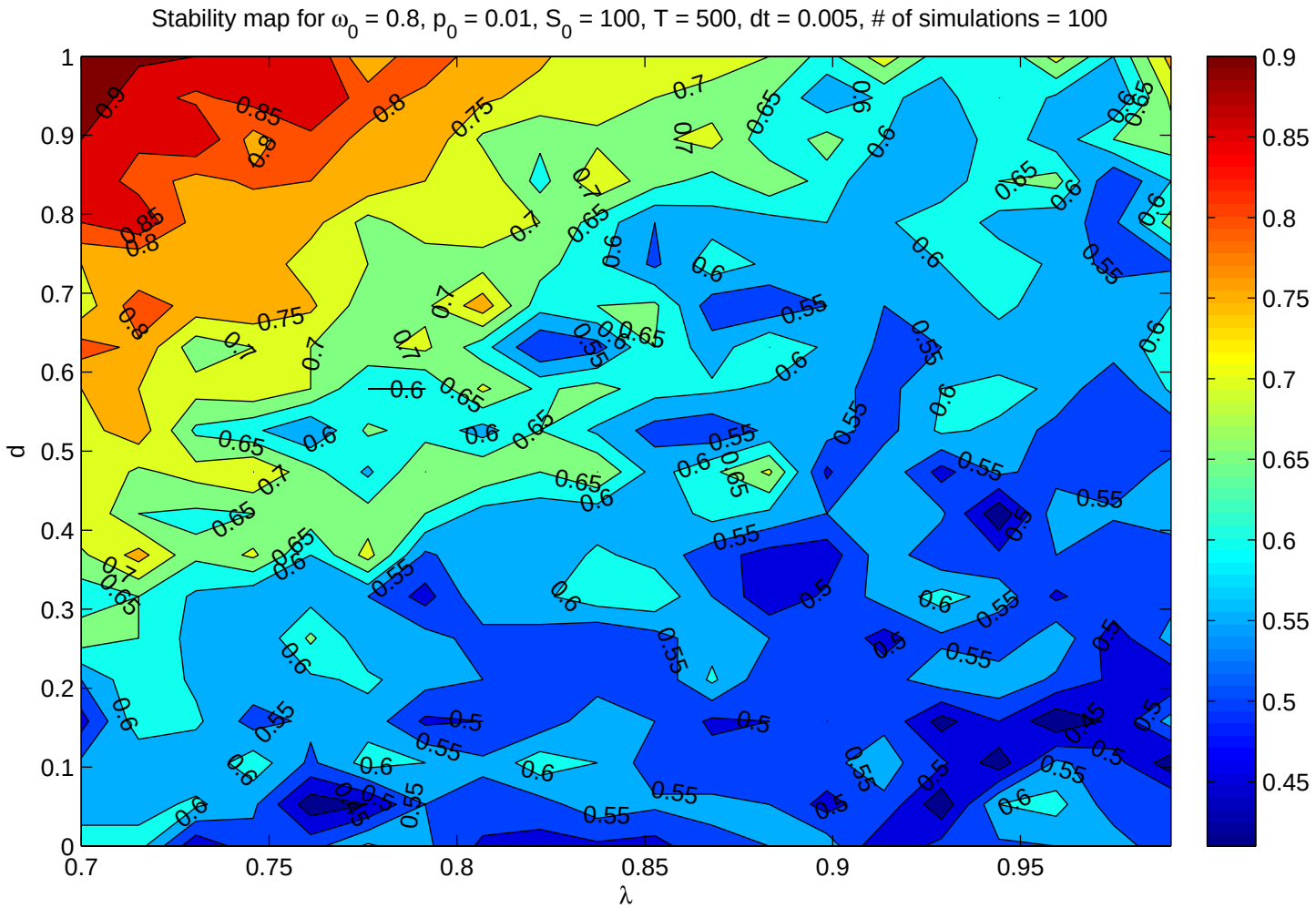
$$\frac{dS_t}{S_t} = r_b dt + \sigma dW_t + \gamma \mu_t dt - \gamma dN^{(\mu_t)}$$

where N_t is a Cox process with stochastic intensity $\mu_t = M(p(t))$.

- The interest rate for private debt is modelled as $r_t = r_b + r_p(t)$ where

$$r_p(t) = \rho_1 (S_t + \rho_2)^{\rho_3}$$

Stability map



Introducing a government sector

- Following Keen (and echoing Minsky) we add discretionary government subsidied and taxation into the original system in the form

$$G = G_1 + G_2$$
$$T = T_1 + T_2$$

where

$$\dot{G}_1 = \eta_1(\lambda)Y \qquad \dot{G}_2 = \eta_2(\lambda)G_2$$
$$\dot{T}_1 = \Theta_1(\pi)Y \qquad \dot{T}_2 = \Theta_2(\pi)T_2$$

- Defining $g = G/Y$ and $\tau = T/Y$, the net profit share is now

$$\pi = 1 - \omega - rd + g - \tau,$$

and government debt evolves according to

$$\dot{B} = rB + G - T.$$

Persistence results

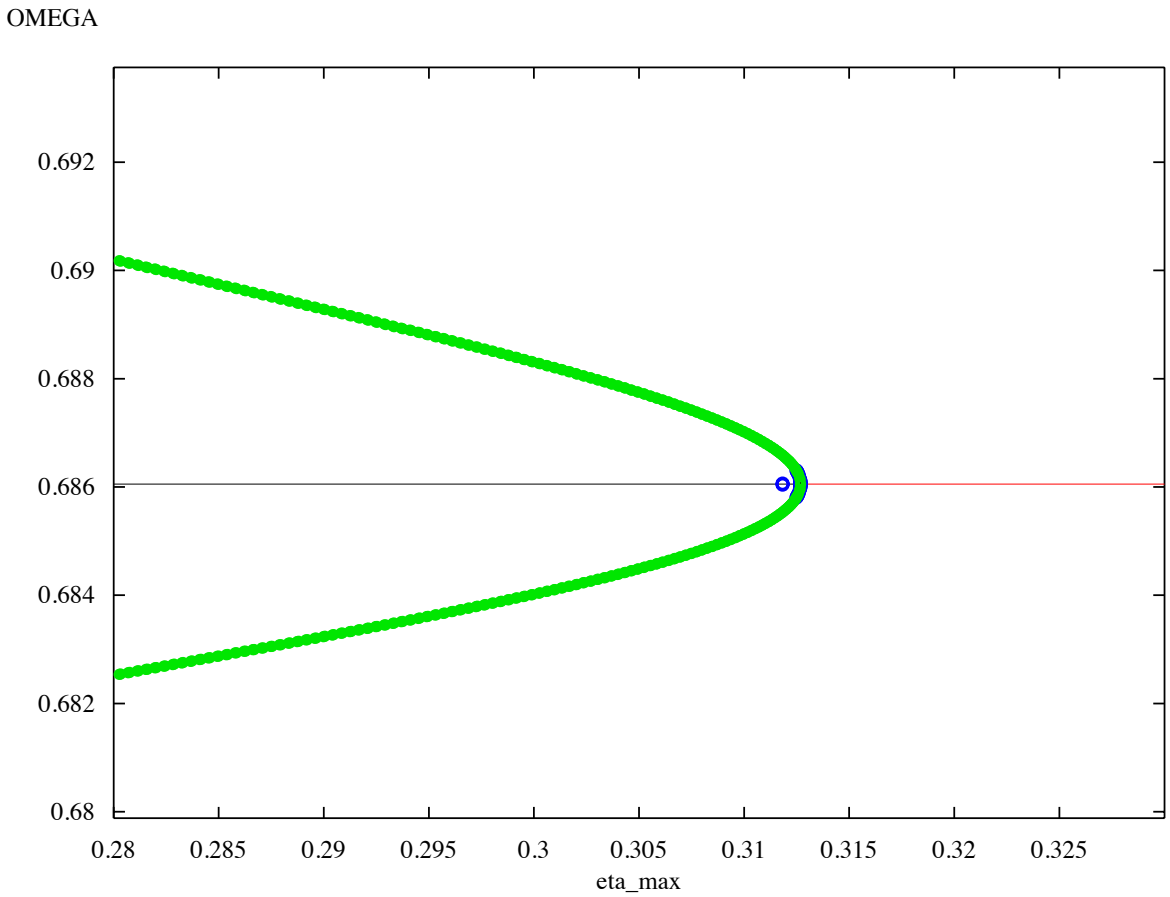
Proposition 1: Assume $g_2(0) > 0$, then the model is e^π-UWP if either

1. $\lambda\eta_1(\lambda)$ is bounded below as $\lambda \to 0$, or
2. $\eta_2(0) > r$.

Proposition 2: Assume $g_2(0) > 0$ and $\tau_2(0) = 0$, then the model is λ-UWP if either of the following three conditions is satisfied:

1. $\lambda\eta_1(\lambda)$ is bounded below as $\lambda \to 0$, or
2. $\eta_2(0) > \max\{r, \alpha + \beta\}$, or
3. $r < \eta_2(0) \leq \alpha + \beta$ and $-r(\kappa(x) - x) + (1 - x)\gamma(x) + \eta_1(0) - \Theta_1(x) > 0$ for $\gamma(x) \in [\eta_2(0), \alpha + \beta]$.

Hopft bifurcation with respect to government spending.



The Great Moderation in the U.S. - 1984 to 2007

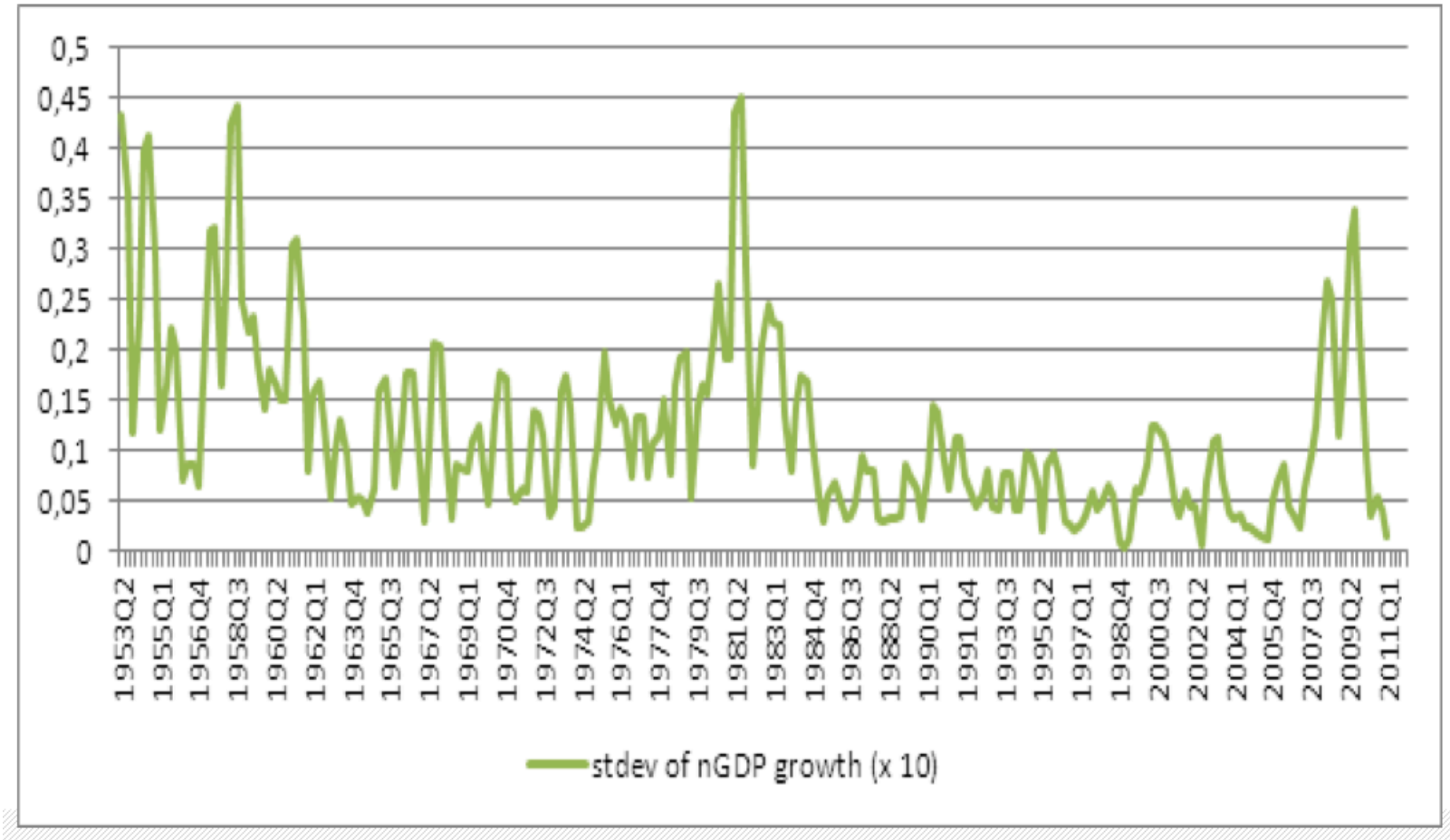


Figure: Grydaki and Bezemer (2013)

Possible explanations

- Real-sector causes: inventory management, labour market changes, responses to oil shocks, external balances , etc.
- Financial-sector causes: credit accelerator models, financial innovation, deregulation, better monetary policy, etc.
- Grydaki and Bezemer (2013): growth of debt in the real sector.

Bank credit-to-GDP ratio in the U.S

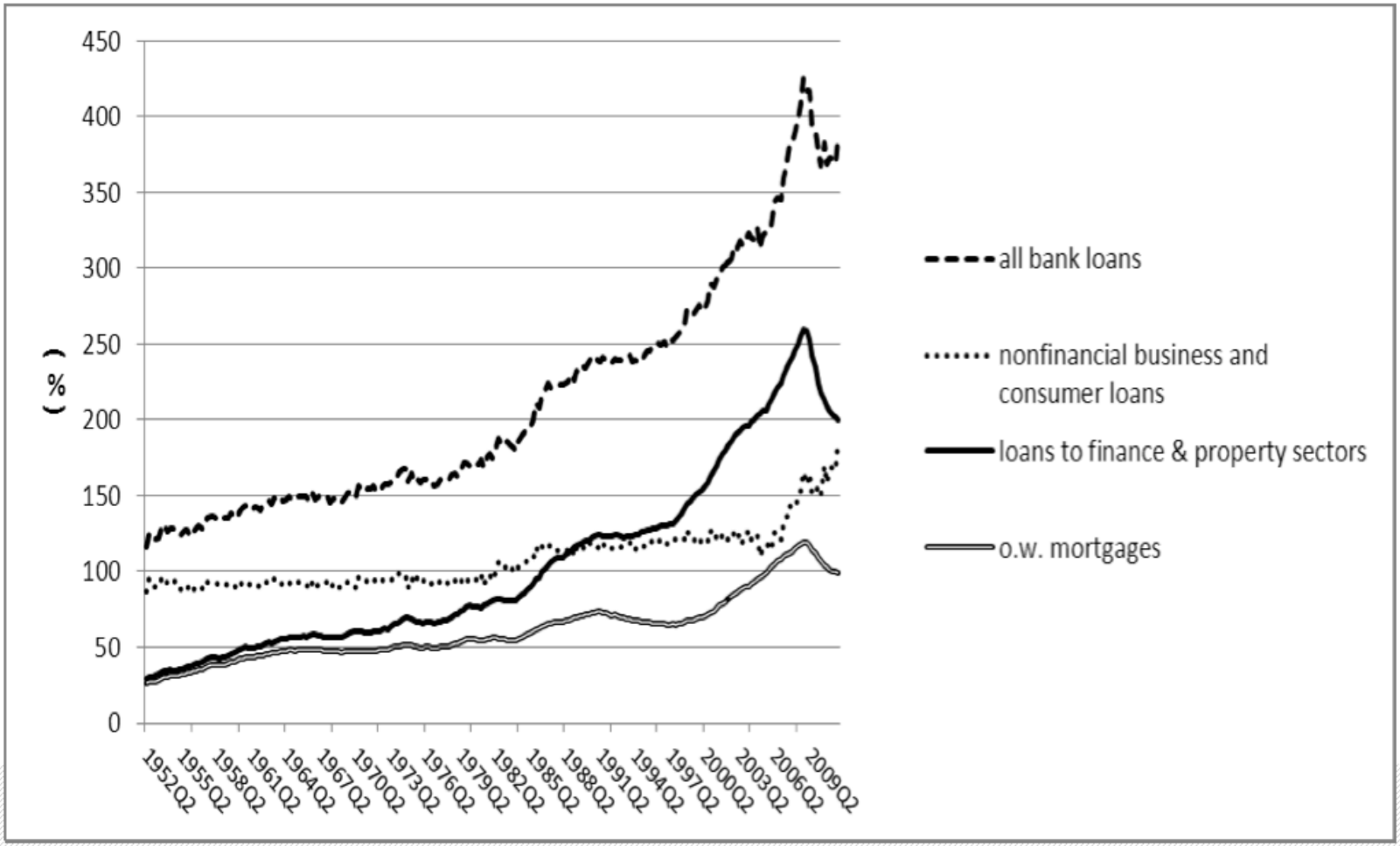


Figure: Grydaki and Bezemer (2013)

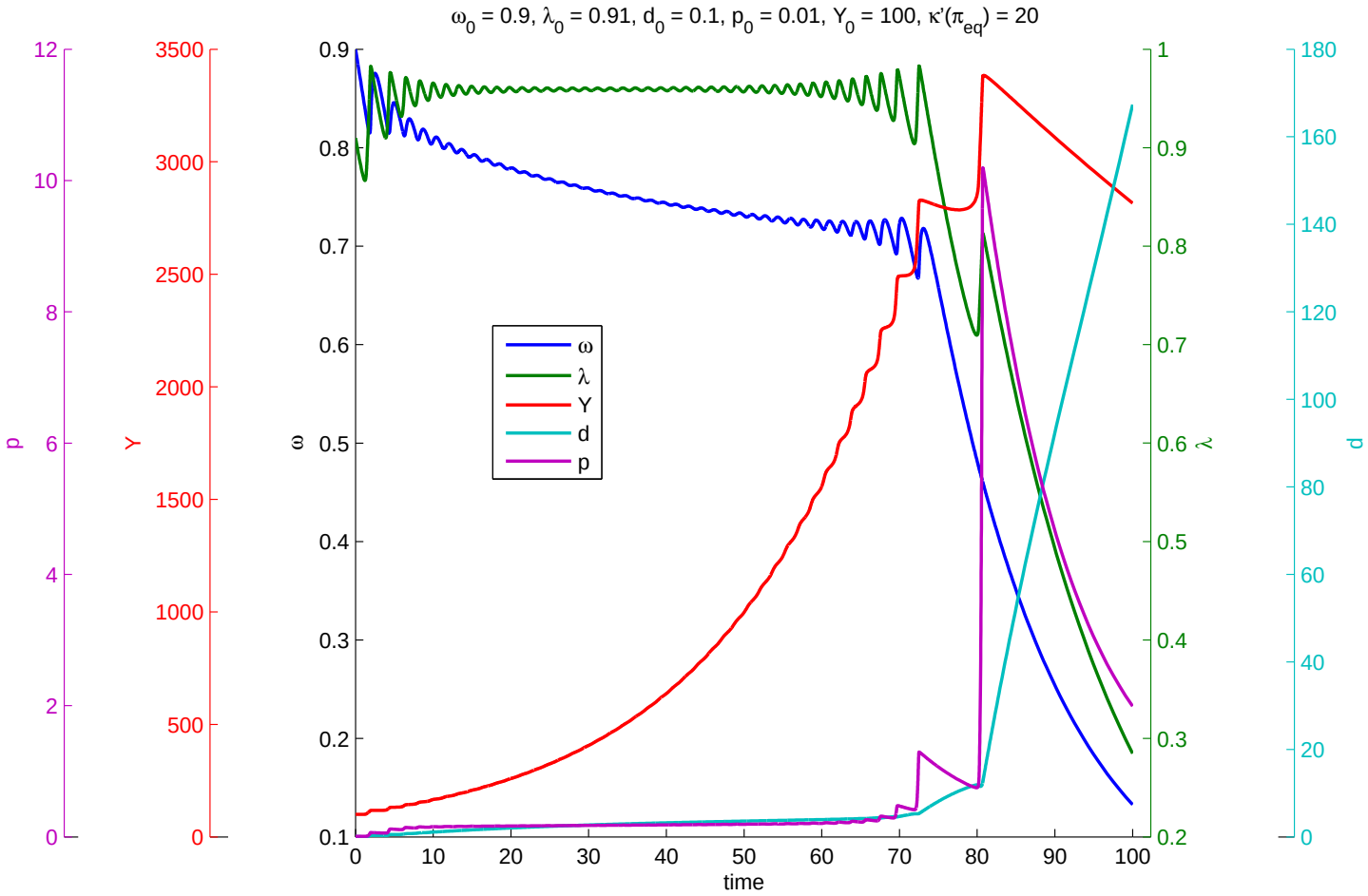
Excess credit growth moderated output volatility during, but not before the Great Moderation

Before the Great Moderation	*During the Great Moderation*
change in interest rate (-) => output volatility	excess credit growth (-) => output volatility
change in interest rate (+) => inflation	output volatility (+) => excess credit growth
excess credit growth (+) => change in interest rate	output volatility (-) => change in interest rate
	excess credit growth (+) => change in interest rate
	inflation (+) => change in interest rate

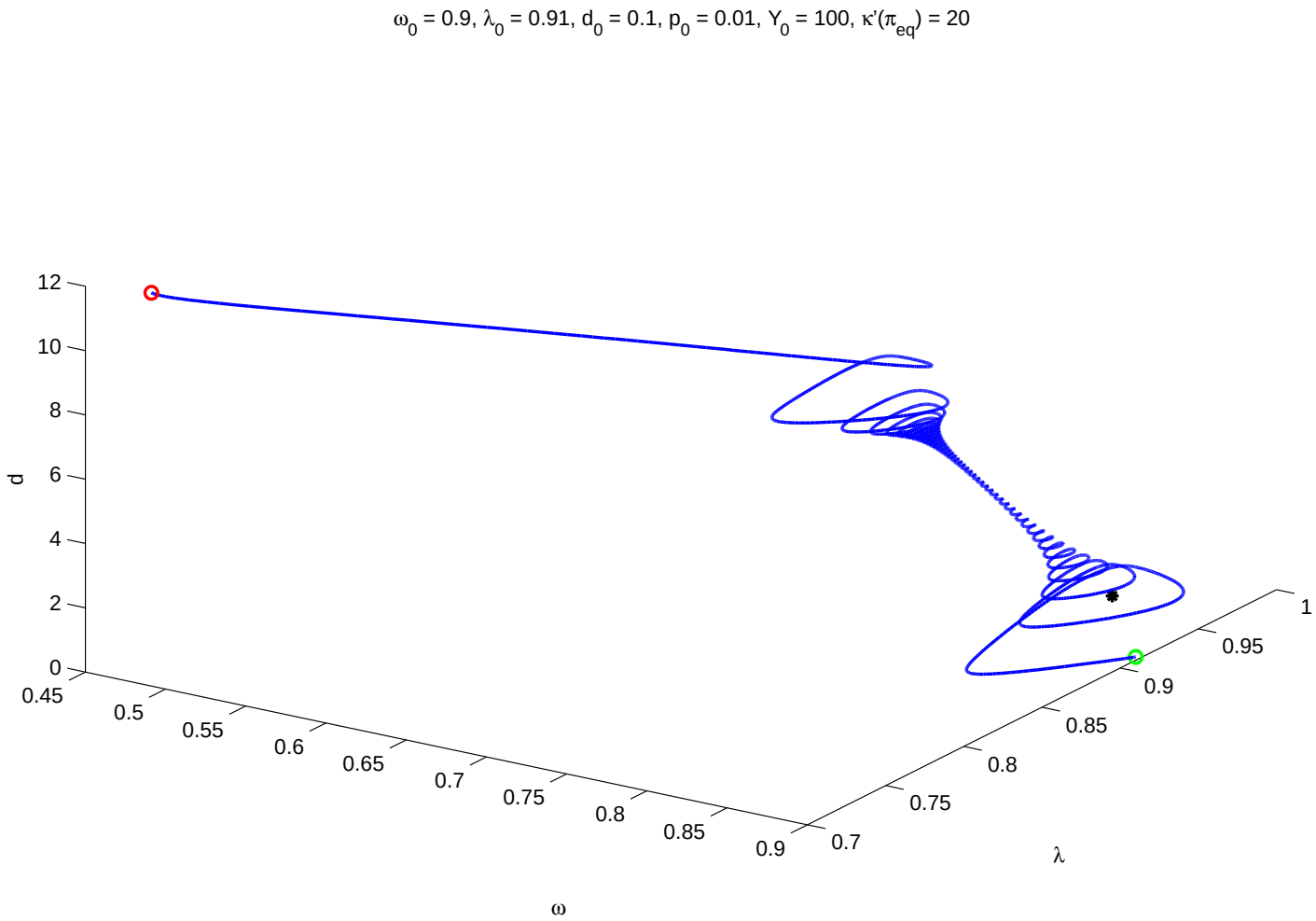
Note: In the table, x (-) => y denotes that a one-standard deviation shock in variable x impacts negatively on the change of variable y. Similarly, x (+) => y indicates a positive impact.

Figure: Grydaki and Bezemer (2013)

Example 5: strongly moderated oscillations



Example 5 (cont): Shilnikov bifurcation



Shortcomings of Goodwin and Keen models

- No independent specification of consumption (and therefore savings) for households:

$$C = W, \quad S_h = 0 \qquad \text{(Goodwin)}$$

$$C = (1 - \kappa(\pi))Y, \quad S_h = \dot{D} = \Pi_u - I \qquad \text{(Keen)}$$

- Full capacity utilization.
- Everything that is produced is sold.
- No active market for equities.
- Skott (1989) uses prices as an accommodating variable in the short run.
- Chiarella, Flaschel and Franke (2005) propose a dynamics for inventory and expected sales.
- Grasselli and Nguyen (2013) provide a synthesis, including equities and Tobin's portfolio choices.

Concluding remarks

- Macroeconomics is too important to be left to macroeconomists.
- Since Keynes's death it has developed in two radically different approaches:
  1. The dominant one has the appearance of mathematical rigour (the SMD theorems notwithstanding), but is based on implausible assumptions, has poor fit to data in general, and is disastrously wrong during crises. Finance plays a negligible role
  2. The heterodox approach is grounded in history and institutional understanding, takes empirical work much more seriously, but is generally averse to mathematics. Finance plays a major role.
- It's clear which approach should be embraced by mathematical finance "to boldly go where no man has gone before" $\cdots$

Merci!