Self-fulfilling Recessions at the ZLB

Charles Brendon (Cambridge)
Matthias Paustian (Board of Governors)
Tony Yates (Birmingham)

Amsterdam, 7th September 2016

Introduction

- This paper has one central message:
  Endogenous propagation mechanisms can open the door to self-fulfilling recessions at the ZLB
- We:
  1. Explain why this is so (partial eqm)
  2. Analyse resulting episodes, effects of policy (computed non-linear NK)
  3. Test for relevance (medium-scale DSGE)

Introduction

The basic mechanism

- Suppose some link from current outcomes to (perceived) marginal benefits of saving
  - **Mechanistic**: e.g. unemployment persistence
  - **Policy-induced**: e.g. growth feedback, ZLB
- **Recession** $\Rightarrow$ **saving more desirable**
- So **recession** $\Rightarrow$ **demand** $\downarrow$ $\Rightarrow$ **recession**
- Our paper explores this dynamic

Introduction

Findings

1. **Theory**:
   - Possible across wide range of settings, but parameter-specific
   - Distinct from known multiplicity problems at ZLB (esp. BSU, 2001)
   - Supportable in RE eqm with iid sunspot
2. **Empirics**:
   - Investigate size of multiplicity region in two popular DSGE models: Smets & Wouters (2007), Iacoviello & Neri (2010)
   - Posterior likelihoods: 99.8%, 69% respectively
   - Policy-sensitive

Literature

- 'Fundamental' liquidity traps – falls in the natural rate:
  - Eggertsson & Woodford (2003), Christiano et al. (2011), ...
- Self-fulfilling liquidity traps:
  - Benhabib, Schmitt-Grohe & Uribe (2001)
  - Mertens & Ravn (2014), Aruoba, Cuba-Borda & Schorfheide (2016)
- Our paper: in second tradition, but with a twist

Motivating example

- Start with partial eqm example
- Closed economy, rep. consumer only source of demand
- Production demand-determined, no labour supply choice
- Eqm at t requires , $C_t = Y_t$
- Euler condition:

$$C_t^{-\sigma} = \beta \left(1 + i_t\right) \tilde{\mathbb{E}}_t \Pi_{t+1}^{-1} C_{t+1}^{-\sigma}$$

- $\tilde{\mathbb{E}}_t$: expectations mapping (more later)

Motivating example

- **Monetary policy** follows feedback rule with ZLB:

$$(1 + i_t) = \max\left\{\bar{R}\Pi^* \left(\frac{Y_t}{\bar{Y}}\right)^{\alpha}, 1\right\}$$

- Feedback on Π_t would not change arguments
- Implies threshold for Y_t where $i_t = 0$, say $\tilde{Y}$

Motivating example

- Let consumers believe future outcomes given by lognormal model:

$$\begin{bmatrix} Y_{t+1} \\ \Pi_{t+1} \end{bmatrix} \sim \log N \left(\begin{bmatrix} \bar{y} + \rho \log \left(\frac{Y_t}{\bar{Y}} \right) \\ \pi^* + \delta \log \left(\frac{Y_t}{\bar{Y}} \right) \end{bmatrix}, \Sigma \right)$$

- Implies simple mapping:

$$\tilde{\mathbb{E}}_t \Pi_{t+1}^{-1} Y_{t+1}^{-\sigma} = \Xi Y_t^{-(\sigma\rho+\delta)}$$

- [Ξ a composite constant]

Motivating example

- Subbing into Euler eqn, two possibilities for eqm:

$$\Gamma Y_t^{-\sigma(1-\rho)+\delta-\alpha} = 1 \qquad \& \qquad Y_t \geq \tilde{Y}$$
$$\bar{\Gamma} Y_t^{-\sigma(1-\rho)+\delta} = 1 \qquad \& \qquad Y_t < \tilde{Y}$$

  - Γ, $\bar{\Gamma}$ constants
- 'MRS between consumption & savings should equal 1'
- Three effects on MRS from lower eqm Y_t:
  1. Increase in marginal value of C_t
  2. Cut to i_t so long as $Y_t > \tilde{Y}$
  3. Change in expected Y_{t+1}, Π_{t+1}

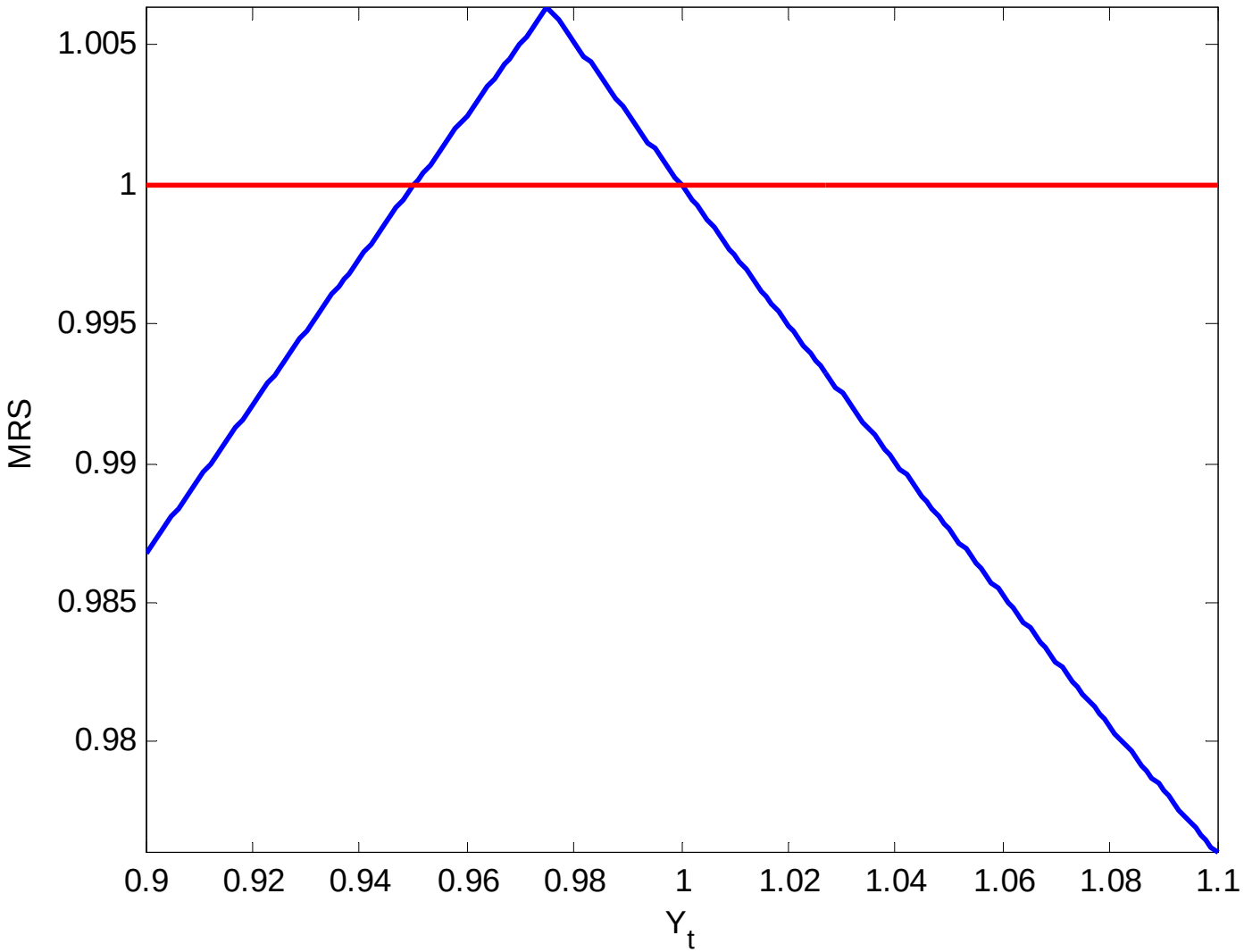
Motivating example

- Four parameters determine qualitative outcomes here: σ, α, ρ and δ
- Some numbers to work with:

σ	2	EIS = 0.5
α	0.5	Taylor feedback
ρ	0.91	Stock & Watson
δ	0.43	Stock & Watson

- Graph up MRS schedule for this case...

Motivating example



Motivating example

- Normalisation $\Rightarrow$ $Y_t = \bar{Y} = 1$ is an eqm – 'normal times'
- There is also a second, low-income eqm
- Logic as follows:
  - As Y_t falls, i_t initially cut $\Rightarrow$ relative benefits from current consumption $\uparrow$
  - But once ZLB binds, lower Y_t $\Rightarrow$ relative benefits from saving $\uparrow$
  - Expectations channel dominates

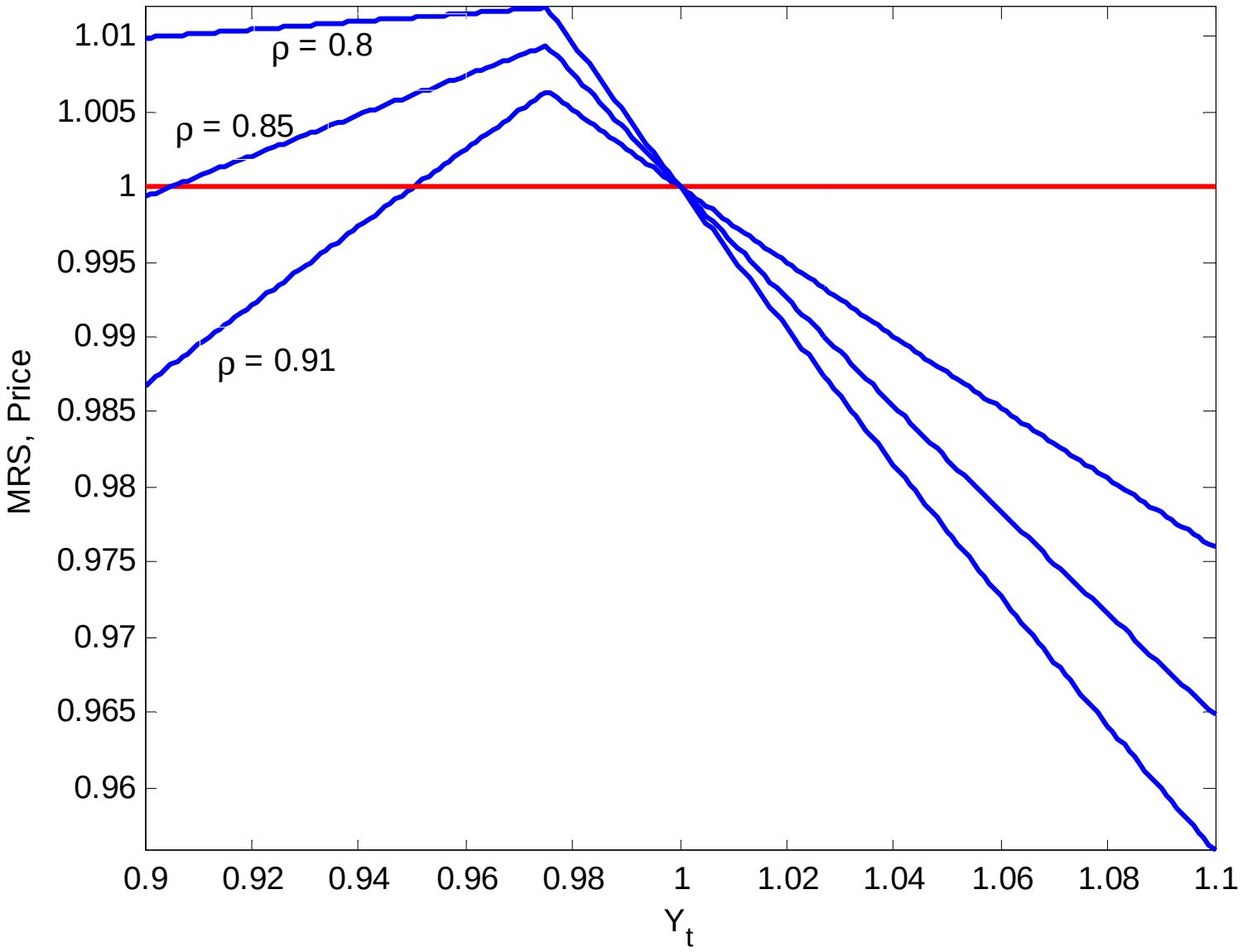
Motivating example

- For expectations effect to dominate at ZLB, need to satisfy parameter restriction:

$$1 < \rho + \frac{\delta}{\sigma}$$

- Multiplicity likely with:
  1. More **persistent output**
  2. Greater link to **future inflation**
  3. Higher **EIS** (lower σ)
- Low-output eqm very severe near this threshold...

Motivating example



What to take from this?

- *Holding constant the expectations mapping*, ZLB *may* imply more than one eqm
- Problem seems quite general: whenever recession raises relative benefits from saving
- Outstanding questions:
  - *(Why) Is this different from BSU (2001)?*
  - *What does mechanism look like in full RE model?*
  - *What policy responses are possible/desirable?*
  - *What is likelihood of parameter restriction being satisfied?*

Comparison with BSU

- ZLB known to cause multiplicity problems: BSU (2001)
- Is our story anything new?
- BSU works in pure Walrasian setting, fixed output:

$$1 = \beta \left(1 + i_t\right) \mathbb{E}_t \Pi_{t+1}^{-1}$$

  - $(1 + i_t)$ constrained by ZLB
- BSU: ZLB $\Rightarrow$ steady-state with $i_t = 0$, $\Pi_t = \beta$ all t
- Basis for 'pessimism' shocks, multiple regimes:
  - Mertens & Ravn (2014), Aruoba, Cuba-Borda & Schorfheide (2016)

Comparison with BSU

- BSU problem is of **multiple expectations mappings**
- State vector empty in endowment economy, so MSV mapping equivalent to $\mathbb{E}_t \Pi_{t+1}^{-1} = \tilde{\Pi}^{-1}$
- Single nominal interest rate consistent with eqm:

$$1 = \beta \left(1 + i_t\right) \tilde{\Pi}^{-1}$$

- *Fixing an expectations mapping resolves the indeterminacy!*

Comparison with BSU

'Conditional' multiplicity

- In our paper, multiplicity is 'static'
- Fix the expectations mapping ... more than one outcome remains
- [May *additionally* be more than one RE mapping]
- **Structural propagation is what matters**

Comparison with BSU

Learning and multiplicity

- Contrast matters because most popular way to 'refine' BSU indeterminacy is through learning
- Common finding that least-squares rules do not converge to deflationary ss
  - E.g. Evans & Honkapohja (2005)
- Learning *is* the process of fixing an expectations mapping
- Will not rule out our multiplicity

A New Keynesian model

Persistence in the NK model

- Embed same mechanism in a plain vanilla NK model to analyse properties
- Calvo pricing, government spending c. 20% of GDP
  - Focus on non-linear solution
- Need some link from Y_t (or Π_t, or ...) to $\tilde{\mathbb{E}}_t \Pi_{t+1}^{-1} Y_{t+1}^{-\sigma}$
- Problem: basic model has (essentially) no persistence!
- But with a policy rule...

$$(1 + i_t) = \max\left\{\beta^{-1}\Pi^* \left(\frac{\Pi_t}{\Pi^*}\right)^{\alpha_\pi} \left(\frac{Y_t}{Y_{t-1}}\right)^{\alpha_y}, 1\right\}$$

A New Keynesian model

Multiplicity logic

- Collapse in Y_t will $\Rightarrow$ expected reversion at $t+1 \Rightarrow \frac{Y_{t+1}}{Y_t} > 0$
- High growth feedback keeps Y_{t+1}, Π_{t+1} restrained
- This provides link from low Y_t to low $Y_{t+1}, \Pi_{t+1} \Rightarrow$ multiplicity

A New Keynesian model

Equilibrium definition

- Look for recursive REE, defined by reference to a **policy function** $g(S)$ and **expectations mapping** $\phi(S)$
  - $S := [Y, \Delta]'$ is state vector
- Two (main) requirements:
  1. $g(S)$ satisfies all eqm conditions, given $\tilde{\mathbb{E}}x' := \phi(S)$
  2. $\phi(S)$ is consistent with $g(S)$ being implemented in all periods

A New Keynesian model

Solution approach

- Solve model by iterating on expectations mapping:
  1. Input initial $\phi_0(S)$
  2. Given ϕ_0, solve for (multiple) eqm outcomes on grid for S
  3. Infer $\phi_1(S)$, *given some weighting over eqm possibilities*
  4. Iterate to convergence
- The resulting $\phi(S)$ function is an RE equivalent of the 'naive' expectations mapping conjectured earlier

A New Keynesian model

Coordinating sunspots

- Assume a binary coordinating sunspot
- $p(S)$ is prob of ZLB binding when state is S
- State dependence to allow for non-multiplicity in some regions
- $p(S)$ indeterminate, choice will affect steady state
- For simulations, fix $p(S) = \bar{p} = 0.02$
- **No persistence in sunspot process** – c.f. Mertens & Ravn (2014)

A New Keynesian model

Parameter restriction

- For multiplicity, need large enough feedback on growth $\Rightarrow$ sufficient propagation
- Possible to prove necessary & sufficient condition in linearised model w/out govt spending:

$$\alpha_y > \sigma \alpha_\pi$$

- Numerically also appears threshold here
- Strong requirement here, but very little persistence to be had from elsewhere...

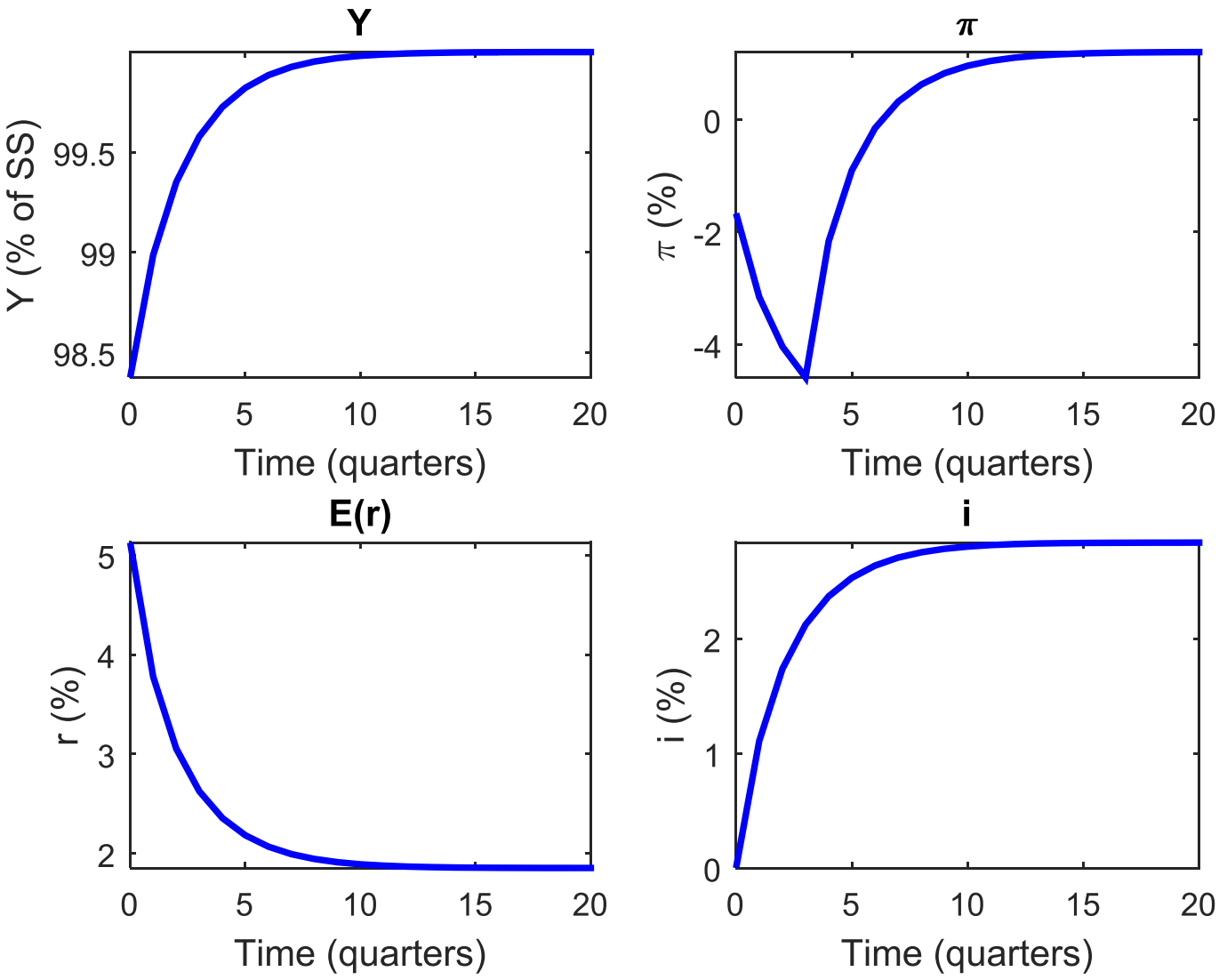
A New Keynesian model

Calibration

Parameter	Role	Value
β	Discount factor	0.995
ϕ	Inverse Frisch	2
σ	Inverse EIS	1
θ	Calvo rate	0.65
ε	Elasticity of substitution	10
α_π	Inflation feedback	1.5
α_y	Growth feedback	3

A New Keynesian model

IRFs for a self-fulfilling recession



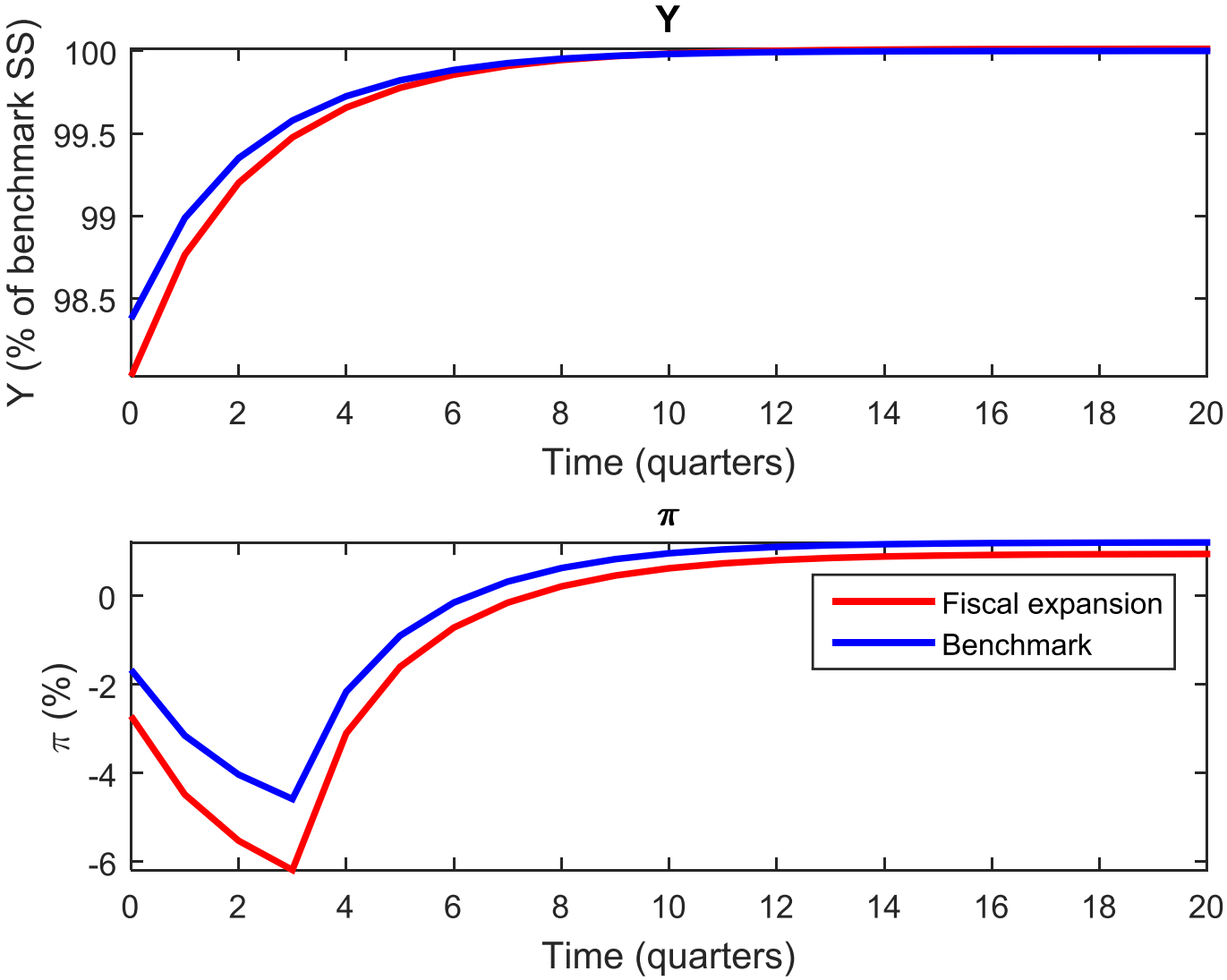
A New Keynesian model

What scope for fiscal policy?

- This is a deep, inefficient recession
- Note ZLB only binds for one period – c.f. pessimism shocks
- Well-known literature explores scope for fiscal policy to offset
- We run a CER (2011) exercise: raise spending so long as ZLB binds
- G increased by 1% of its value (c. 0.2% of GDP)

A New Keynesian model

What scope for fiscal policy?



A New Keynesian model

What scope for fiscal policy?

- A very large, negative fiscal multiplier: -1.9 (impact)
- Qualitatively similar to reducing ρ in initial example
- Intuition as follows:
  - Holding Y_t constant, raising G_t lowers C_t
  - Can only be supported with higher real rate
  - Requires bigger initial fall in Y_t
- BUT, a larger spending commitment can rule out multiplicity

How likely is multiplicity?

- Earlier examples very stylised: unclear if parameter thresholds would be met
- Test this by investigating off-the-shelf medium-scale DSGE models
- Two popular versions:
  1. Smets & Wouters (2007)
  2. Iacoviello & Neri (2010)
     - [SW, with housing sector à la Iacoviello (2005)]

How likely is multiplicity?

Methodology

- Replicate main parameter estimates from both models on **pre-2008 US data**
  - No concern about ZLB episodes
- Draw from estimated posterior on parameters, check for multiplicity given ZLB
- ZLB imposed as quasi-linearity:

$$\hat{i}_t \geq \beta - 1$$

- [Solution assumes reversion to 'normal times' in long run, expectations consistent with this]

How likely is multiplicity?

Headline results

Model	Benchmark	Augmented rule
Smets-Wouters	0.998	0.613
Iacoviello-Neri	0.686	0.056

- Both models assume (linearised) Taylor rule with growth rate terms:

$$i_t = \rho i_{t-1} + (1-\rho)\left[\bar{i} + \alpha_\pi \pi_t + \alpha_{\Delta y}\left(y_t - y_{t-1}\right)\right] + \varepsilon_t$$

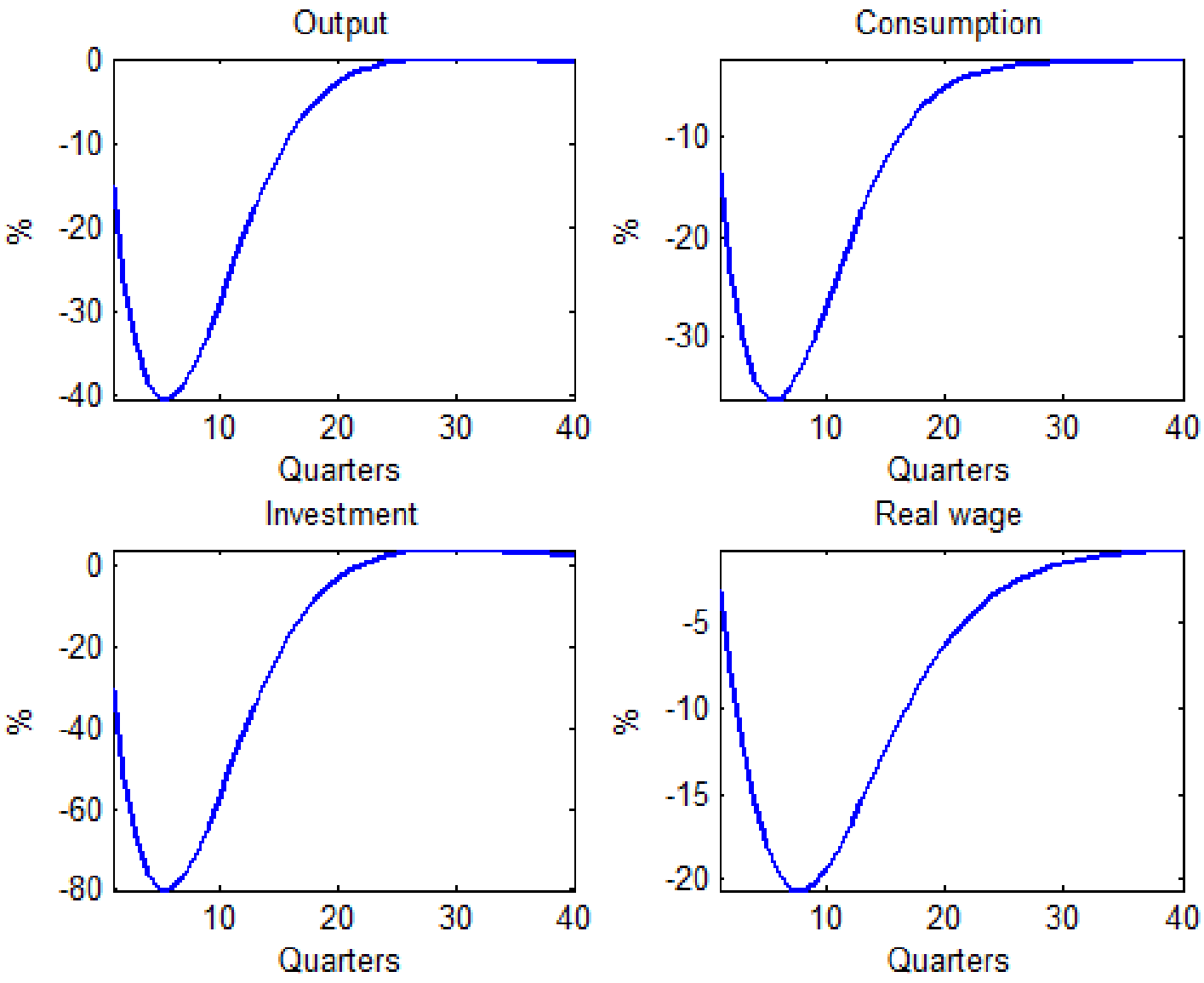
- Augmented rule assumes level feedback instead

How likely is multiplicity?

A qualification

- Important qualification: associated recessions are **very** large
  - [Great Depression magnitude]
- Seems to be related to sheer amount of persistence hard-wired in
- *[IRFs do not scale with the ZLB, unless d.f. changes...]*

SW recession episode



Concluding points

- Alternative mechanisms ... ?
- Frictional labour market seems a useful way to go
- Is this sort of dynamic behind some 'amplification' mechanisms at the ZLB?
  - Small shocks $\Rightarrow$ large outcomes when no shocks would do the same