Escaping the Great Recession[1]

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[1] The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Federal Reserve Bank of Chicago or any other person associated with the Federal Reserve System.

The Great Recession and policy uncertainty

The recent recession has induced:

1. Significant changes in the conduct of monetary policy, with interest rates stuck at the zero lower bound
   - Standard new-Keynesian model would predict deflation
2. Policy uncertainty: Debate on the best way to mitigate the consequences of a recession when at the zero-lower-bound:
   - Robust fiscal intervention combined with a reduction in the focus on inflation
   - Reluctance to explicitly abandon macroeconomic policies that have been successful in the past
3. Increase in macroeconomic uncertainty

Model setup

We model an economy in which:

1. recurrent large negative demand shocks can force the economy to the zero lower bound
2. two policy combinations characterize policy makers' behavior:
   - Monetary led policy mix: The fiscal authority strongly reacts to debt and the monetary policy rule satisfies the Taylor principle
   - Fiscally led policy mix: The fiscal authority disregards the level of debt and the Taylor principle does not hold

Agents are aware of the possibility of...

1. ...zero lower bound episodes,
2. ...changes in policy makers' behavior,
3. ...and the link between the two

Main results

1. Out of the zero lower bound the Monetary led regime leads to a stable macroeconomic environment
2. At the zero lower bound the policy trade-off arises...
   - switching to the Fiscally led policy mix would greatly mitigate the recession, but...
   - ...it would also imply an increase in macroeconomic volatility once out of the zero-lower-bound

   $\Longrightarrow$ High uncertainty is an inherent implication of entering the zero lower bound, whereas deflation is not
3. Policy makers could escape the Great Recession committing to inflate away only the amount of debt that results from the recession itself

Related literature

- Uncertainty: Baker et al. (2012), Fernández-Villaverde et al. (2012), Kitsul and Wright (2013), Jurado et al. (2013)
- Zero-Lower-Bound: Krugman (1998), Benhabib et al. (2001, 2002), Eggertsson and Woodford (2003), Eggertsson (2006), Christiano et al. (2011), Correia et al. (2012), Farhi and Werning (2012); ZLB in DSGE: Aruoba and Schorfheide (2013), Fernández-Villaverde et al. (2012), Gust et al. (2013), Del Negro et al. (2013).
- Monetary/fiscal policy interaction: Sargent and Wallace (1981), Leeper (1991), Sims (1994, 2011), Woodford (1994, 2001), Cochrane (1998, 2001), Schmitt-Grohe and Uribe (2000), Bianchi and Ilut (2012)
- Fiscal Multipliers: Blanchard and Perotti (2002), Romer and Romer (2010), Mertens and Ravn (2011, 2013)

A new-Keynesian model

Textbook new-Keynesian model augmented with a fiscal rule and a discrete preference shock that triggers the zero lower bound

- Representative household
  - derives utility from consumption and disutility from labor
  - holds government bonds and receives dividends from the firm
- Monopolistic competitive firms face
  - downward sloping demand curve
  - quadratic adjustment costs whenever they want to change price
  - a linear production function with labor being the only input

Linearization: Households and firms ▸ Details

- Expectation augmented Phillips curve:

$$\pi_t = \beta E_t(\pi_{t+1}) + \kappa(y_t - z_t) \tag{1}$$

- Linearized Euler Equation:

$$y_t = E_t\left(y_{t+1}\right) - \left(R_t - E_t\left(\pi_{t+1}\right)\right) + d_t - E_t\left(d_{t+1}\right) \tag{2}$$

- Stochastic processes of the shocks:

$$d_t = \overline{d}_{\zeta_t^d} \tag{3}$$

$$z_t = \rho_z z_{t-1} + \sigma_z \epsilon_{z,t},\ \epsilon_{z,t} \sim N\left(0,1\right) \tag{4}$$

where $\overline{d}_{\zeta_t^d}$ can assume two values, high or low ($\overline{d}_h$ and $\overline{d}_l$), and ζ_t^d evolves according to the transition matrix H^d:

$$H^d = \begin{bmatrix} p_{hh} & 1 - p_{ll} \\ 1 - p_{hh} & p_{ll} \end{bmatrix}$$

Linearization: Policy makers

▸ Details

- Monetary rule:
  1. Out of the zero lower bound ($Z_{\zeta_t^{zd}} = 0$):

$$R_t = \rho_R R_{t-1} + (1-\rho_R)\left(\psi_{\pi,\zeta_t^{zp}}\pi_t + \psi_y\left[y_t - z_t\right]\right) + \sigma_R \epsilon_{R,t}$$

  2. At the zero lower bound ($Z_{\zeta_t^{zd}} = 1$): $R_t = -\log(R)$
- Linearized government budget constraint:

$$b_t = \beta^{-1} b_{t-1} + b\beta^{-1}\left(R_{t-1} - \pi_t - \Delta y_t\right) - s_t$$

- Fiscal rule (net lump-sum taxes):

$$\begin{aligned} s_t &= \delta_{b,\zeta_t^{zp}} b_{t-1} + \delta_y\left(y_t - z_t\right) + \sigma_x x_t \\ x_t &= \rho_x x_{t-1} + \epsilon_{x,t},\ \ \epsilon_{x,t} \sim N(0,1) \end{aligned}$$

Monetary/Fiscal Policy Mix

When regimes are taken in isolation, the two policy rules and the linearized budget constraint are key to determine existence and uniqueness of a solution:

$$R_t = \rho_R R_{t-1} + (1-\rho_R)\,\psi_{\pi,\xi_t^p}\,\pi_t + ...$$

$$s_t = \delta_{b,\xi_t^p}\, b_{t-1} + ...$$

$$\begin{aligned} b_t &= \beta^{-1} b_{t-1} + ... - s_t \\ &\rightarrow \quad b_t = \left(\beta^{-1} - \delta_{b,\xi_t^p}\right) b_{t-1} + ... \end{aligned}$$

Monetary/Fiscal Policy Mix ▸ Four cases

Leeper (1991) shows that two determinacy regions exist:

	ψ_{π,ξ_t^p}	δ_{b,ξ_t^p}
Active Monetary, Passive Fiscal	> 1	$> \beta^{-1} - 1$
Passive Monetary, Active Fiscal	< 1	$< \beta^{-1} - 1$

- AM/PF $\longrightarrow$ Taylor principle is satisfied, fiscal police accommodates behavior of monetary authority
  $\longrightarrow$ Macroeconomy is insulated (Ricardian regime)
- PM/AF $\longrightarrow$ Taylor principle is not satisfied, inflation is free to move to keep debt on a stable path
  $\longrightarrow$ Macroeconomy is not insulated (non-Ricardian regime)

Allowing for regime changes ▸ All

- Monetary led policy mix (AM/PF, $Z_{\xi_t^d} = 0$):

$$\psi_\pi\left(\xi_t^p = M;\ \xi_t^d = h\right) = \psi_\pi^M = 2 > 1$$
$$\delta_b\left(\xi_t^p = M;\ \xi_t^d = h\right) = \delta_b^M = .03 > \beta^{-1} - 1$$

- Fiscally led policy mix (PM/AF, $Z_{\xi_t^d} = 0$):

$$\psi_\pi\left(\xi_t^p = F;\ \xi_t^d = h\right) = \psi_\pi^F = .8 < 1$$
$$\delta_b\left(\xi_t^p = F;\ \xi_t^d = h\right) = \delta_b^F = 0 < \beta^{-1} - 1$$

- Zero lower bound policy mix ($Z_{\xi_t^d} = 1$):

$$Z_{\xi_t^d} = 1 \rightarrow \quad R_t = -\log(R)$$
$$\delta_b\left(\xi_t^p = Z;\ \xi_t^d = I\right) = \quad \delta_b^Z = 0 < \beta^{-1} - 1$$

In and out of the zero lower bound

- Out of the zero lower bound policy makers' behavior evolves according to a transition matrix H^p

$$H^p = \begin{bmatrix} p_{MM} & 1 - p_{FF} \\ 1 - p_{MM} & p_{FF} \end{bmatrix}$$

- The economy enters the zero lower bound as a result of a negative preference shock
- The matrices H^i, H^o, and H^z define policy makers' exit strategies

$$H = \begin{bmatrix} p_{hh} H^p & (1 - p_{ll}) H^o \\ (1 - p_{hh}) H^i & p_{ll} H^z \end{bmatrix}$$

$\Rightarrow$ Agents take into account the possibility of entering the zero lower bound and the consequent changes in policy makers' behavior

Parameters (Bianchi (2012))

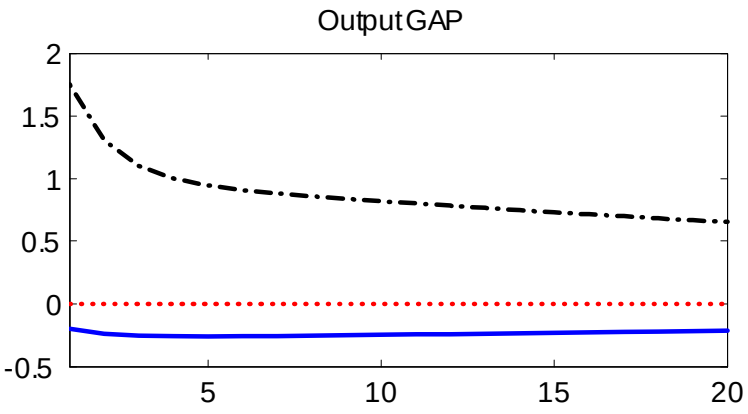
Parameter	Value	Parameter	Value	Parameter	Value
ψ_π^M	2.00	ψ_y	0.10	$100\sigma_R$	0.20
ψ_π^F	0.80	ρ_R	0.75	$100\sigma_x$	0.50
δ_b^M	0.03	δ_y	0.50	$100\sigma_z$	0.70
δ_b^F, δ_b^Z	0	ρ_z	0.90	$100\sigma_d$	0
Z_M, Z_F	0	ρ_x	0.90	$\overline{d}_h$	0
Z_Z	1	b	1.00	$\overline{d}_l$	$-.1$
p_{MM}	99%	κ	0.035	p_{hh}	98%
p_{FF}	99%	β	0.995	p_{ll}	80%

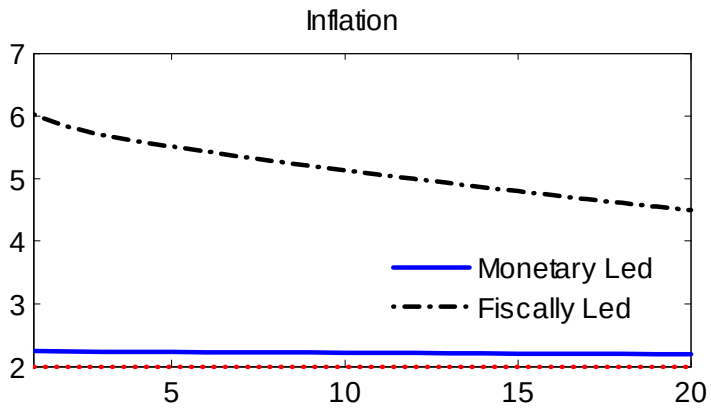
Road map

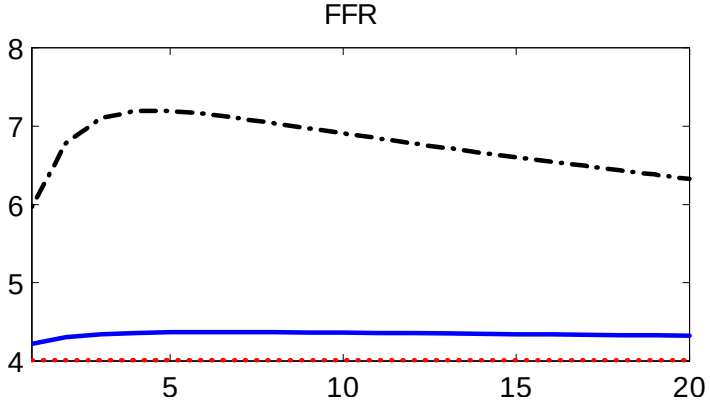
We will illustrate...

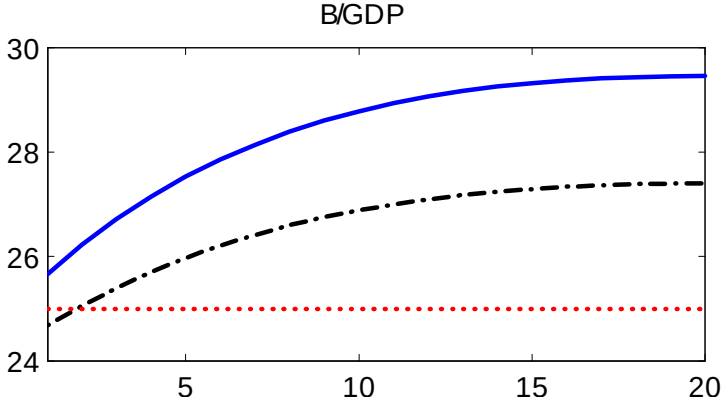
1. that the Monetary led regime leads to a stable macroeconomic environment out of the ZLB, but...
2. ...it can be detrimental at the ZLB
   - $\Rightarrow$ Policy trade-off
   - $\Rightarrow$ High uncertainty, no deflation
3. a shock specific policy to escape the Great recession

NO ZLB: Primary deficit shock ▸ Hs

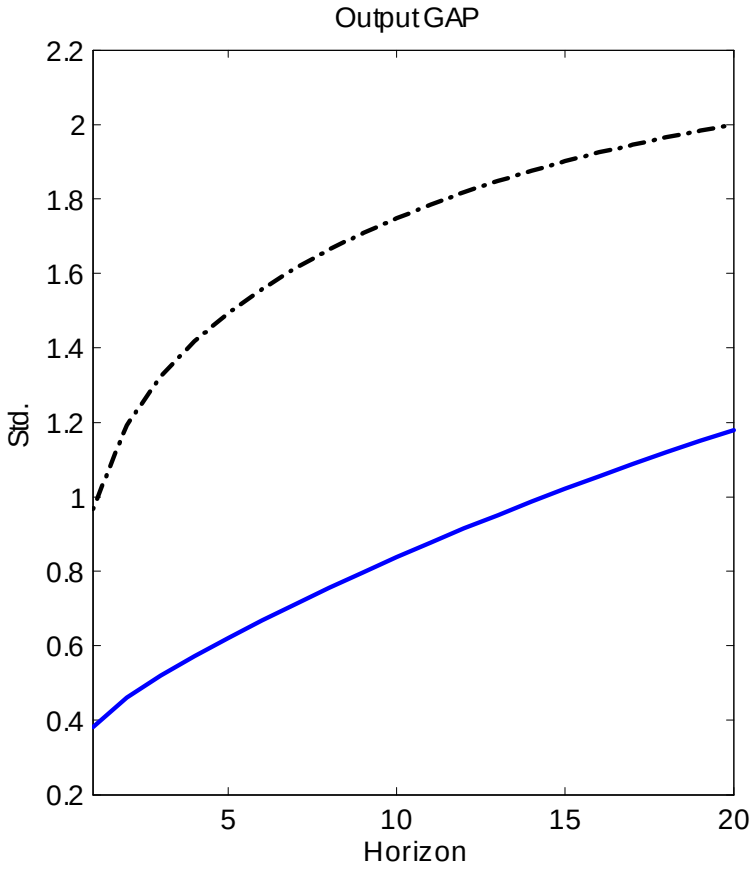


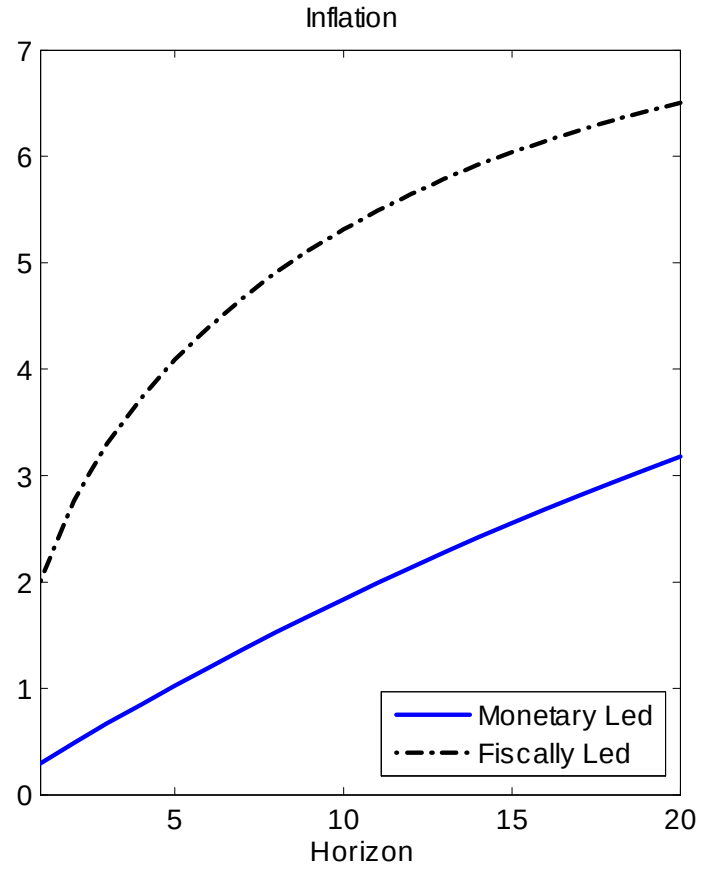






No ZLB: Evolution of uncertainty





The ZLB and policy uncertainty

We now allow for the possibility of entering the zero lower bound:

- At the ZLB, policy makers' behavior is not informative

  $\Longrightarrow$ *Uncertainty and announcements about future policy makers' behavior are key to determine behavior of the economy at the zero lower bound*

- Announcements and agents' beliefs captured by zero lower bound regimes that differ in terms of the exit strategy

Policy uncertainty and coordinated announcements

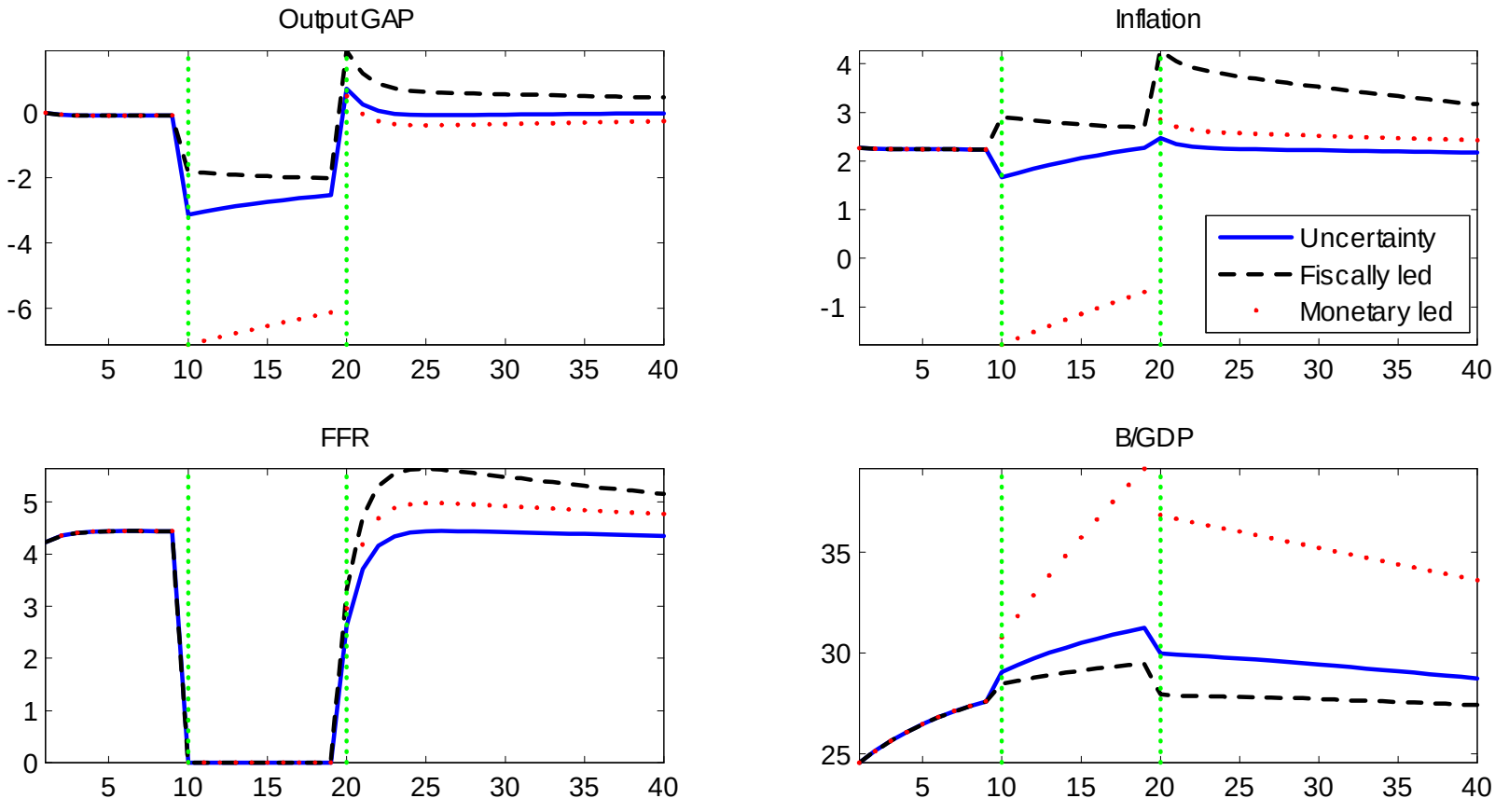
▸ Hs

Agents receive coordinated policy makers' announcements

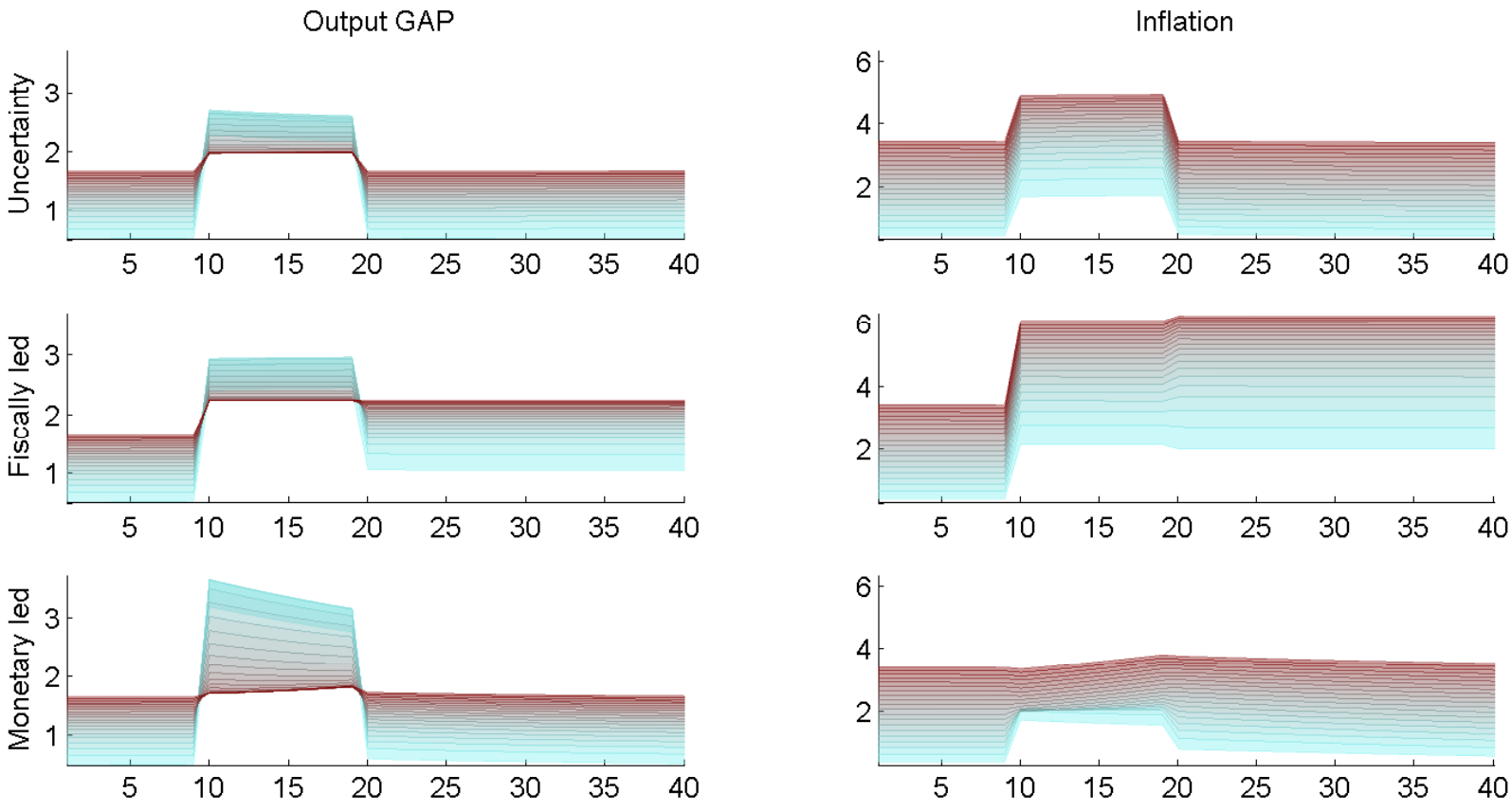
We assume that the economy enters the ZLB with an above steady state stock of debt and we consider three different scenarios:

1. Announcement that the Monetary led regime will be abandoned
2. Announcement that the Monetary led regime will be preserved
3. No announcement is made and agents attach equal probabilities to the two exit strategies outlined above

Inflation and the zero lower bound



Uncertainty and the zero lower bound



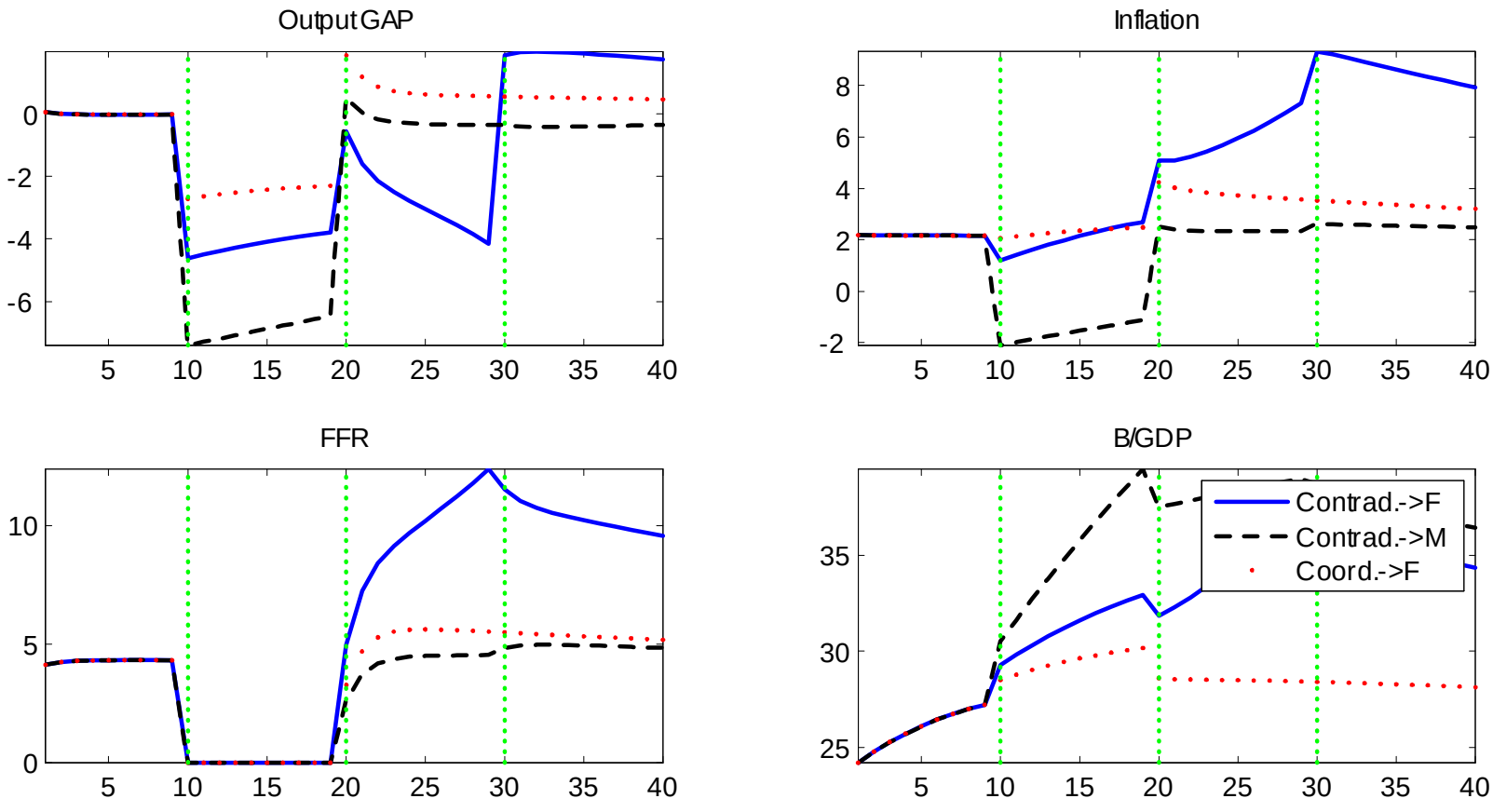
Contradictory announcements ▸ Hs

Policy makers' announcements can be contradictory

We assume that the economy enters the ZLB with an above steady state stock of debt and we consider three different scenarios:

1. Policy makers announce that the Monetary led regime will be abandoned
2. Fiscal authority $\longrightarrow$ fiscal discipline will be abandoned
   Monetary authority $\longrightarrow$ inflation stability will be preserved
   1. Conflict and agents expect fiscal authority to prevail
   2. Conflict and agents expect monetary authority to prevail

Contradictory announcements



Escaping the Great Recession ▸ Details

Suppose policy makers commit to inflate away *only* the amount of debt resulting from the recession itself

- We model a shadow economy to keep track of the debt deriving from the discrete preference shock
- Policy makers do not react to debt and inflation caused by the discrete preference shock, while...
- ...they follow the Monetary led policy mix in response to all other shocks

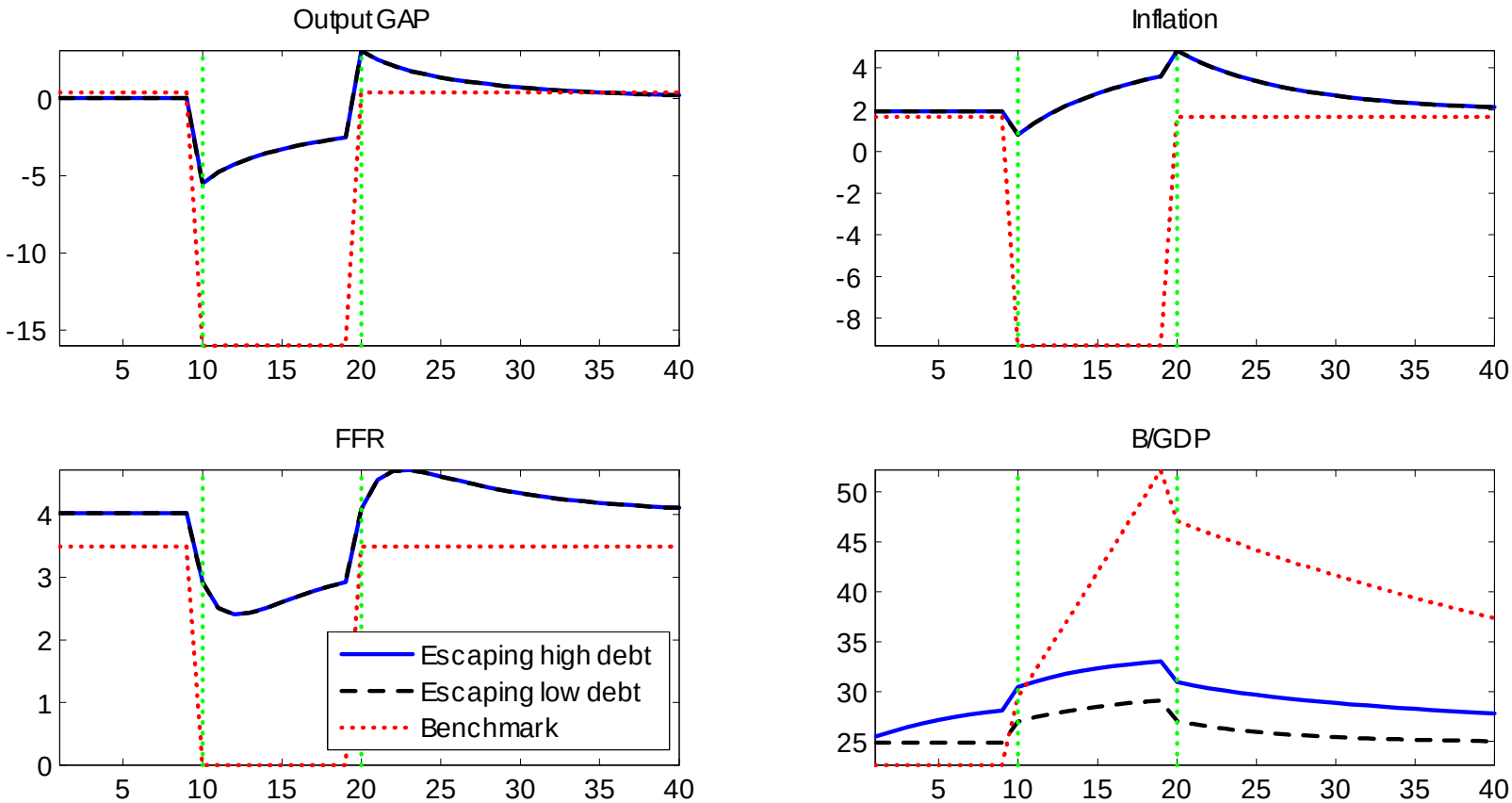
Shock-Specific Policy Rules

- Denote debt and inflation of a shadow economy in which demand shocks are shut down as b_t^{nd} and π_t^{nd}
- Write the policy rules as

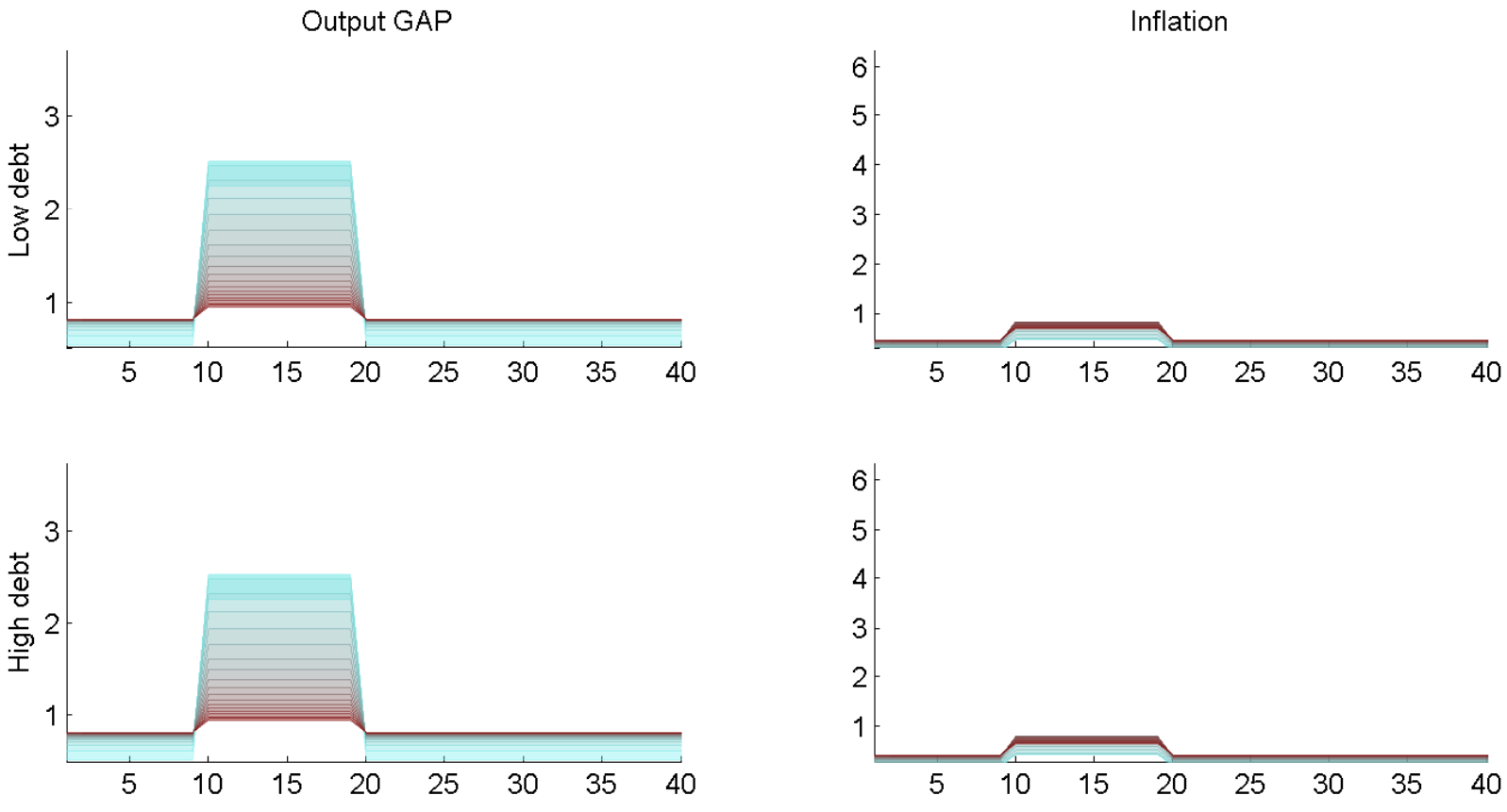
$$\begin{aligned} s_t &= \delta_b^M b_{t-1}^{nd} + \delta_b^F \left(b_{t-1} - b_{t-1}^{nd} \right) + ... \\ R_t &= (1-\rho_R) \left(\psi_\pi^M \pi_t^{nd} + \psi_\pi^F \left(\pi_t - \pi_t^{nd} \right) \right) + ... \end{aligned}$$

- Future fiscal adjustments are not enough to cover the entire debt b_{t-1}: The amount $\left(b_{t-1} - b_{t-1}^{nd} \right)$ is going to be inflated away

Escaping the Great Recession



Escaping the Great Recession



Why does this approach work?

- Policy makers are influencing agents' beliefs about their long run behavior in response to a specific shock
  - *Automatic stabilizer*: This behavior determines an increase in short run expected inflation exactly when necessary
- Policy makers are still committed to cover the preexisting amount of debt and neutralize all other future fiscal imbalances
  - *Macroeconomic stability is retained* after the recession

Summary of the results

1. Recurrent ZLB events in a standard DSGE model
2. The model highlights why policy makers...
   - are reluctant to abandon fiscal discipline
   - might be tempted to do so to escape the Great Recession
   - should avoid sending contradictory signals
3. Uncertainty is an inherent implication of entering the ZLB, while deflation is not
4. Escaping the Great Recession: Inflate away only amount of debt accumulated *because* of the recession

Details about linearization

▸ Back

Markov switching process for d_t represents a non-Gaussian shock

1. Compute its ergodic steady state d_{ss} and rescale the shock
2. Verify that the ZLB is not binding at d_{ss}
3. Linearize/loglinearize around the steady state
4. Use a VAR and a vector of dummy variables to model the Markov-switching process:

$$\begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix} = \begin{bmatrix} p_{hh} & 1-p_{ll} \\ 1-p_{hh} & p_{ll} \end{bmatrix} \begin{bmatrix} e_{1,t-1} \\ e_{2,t-1} \end{bmatrix} + \begin{bmatrix} v_{1,t} \\ v_{2,t} \end{bmatrix}$$

where

$$e_t \in \{[1;0],[0;1]\}$$

$$v_t \in \{[1-p_{hh};p_{hh}-1],[-p_{hh};p_{hh}],[p_{ll};-p_{ll}],[p_{ll}-1;1-p_{ll}]\}$$

No ZLB and benchmark New-Keynesian

▸ Back ▸ Back

- When no ZLB:

$$H^p = \begin{bmatrix} .99 & .01 \\ .01 & .99 \end{bmatrix}$$

  with $d_t = d_{ss}$ for each t.

- In benchmark New-Keynesian model policy makers always follow the Monetary led regime:

$$H^p = H^i = H^z = H^o = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \; H^d = \begin{bmatrix} p_{hh} & 1 - p_{ll} \\ 1 - p_{hh} & p_{ll} \end{bmatrix}$$

Coordinated announcements

▸ Back

At zero lower bound three cases: Uncertainty, Announced Fiscally led regime, and Announced Monetary led regime

$$H^p = \begin{bmatrix} .99 & .01 \\ .01 & .99 \end{bmatrix}, \; H^o = \begin{bmatrix} .5 & 1 & 0 \\ .5 & 0 & 1 \end{bmatrix}$$

$$H^i = \begin{bmatrix} .33 & .33 \\ .33 & .33 \\ .33 & .33 \end{bmatrix}, \; H^z = \begin{bmatrix} .99 & .005 & .005 \\ .005 & .99 & .005 \\ .005 & .005 & .99 \end{bmatrix}$$

$$H^d = \begin{bmatrix} p_{hh} & 1 - p_{ll} \\ 1 - p_{hh} & p_{ll} \end{bmatrix}$$

Contradictory announcements

Back

At zero lower bound five cases: Uncertainty, Announced Fiscally led regime, Announced Monetary led regime, contradictory announcement leading to Fiscally led regime, contradictory announcement leading to Monetary led regime.

$$H^p = \begin{bmatrix} .99 & .01 & .14 & \\ .01 & .99 & & .14 \\ & & .86 & \\ & & & .86 \end{bmatrix}, \quad H^o = \begin{bmatrix} .25 & 1 & & \\ .25 & & 1 & \\ .25 & & & 1 \\ .25 & & & \end{bmatrix}$$

$$H^i = \begin{bmatrix} .20 & .20 \\ .20 & .20 \\ .20 & .20 \\ .20 & .20 \\ .20 & .20 \end{bmatrix}, \quad H^z = \begin{bmatrix} .98 & .005 & .005 & .005 & .005 \\ .005 & .98 & .005 & .005 & .005 \\ .005 & .005 & .98 & .005 & .005 \\ .005 & .005 & .005 & .98 & .005 \\ .005 & .005 & .005 & .005 & .98 \end{bmatrix}$$

where the third and fourth out-of-the-ZLB regimes are both characterized by AM/AF and only differ in terms of the authority that will eventually prevail.

Monetary/Fiscal Policy Mix

▸ Back

Following Leeper (1991) we can distinguish four cases:

	Active Fiscal (AF)	Passive Fiscal (PF)
Active Monetary (AM)	No Solution	Determinacy
Passive Monetary (PM)	Determinacy	Indeterminacy

- Active Monetary Policy: Taylor principle is satisfied $(\psi_{\pi,\xi_t^p} > 1)$
- Passive Fiscal Policy: Taxes react strongly to debt $(\delta_{b,\xi_t^p} > \beta^{-1} - 1 \;\rightarrow\; \beta^{-1} - \delta_{b,\xi_t^p} < 1)$

Shock specific policies

Back

- Denote the debt and inflation of a shadow economy in which only discrete demand shocks occur as b_t^d and π_t^d
- Write the policy rules as

$$s_t = \left(\delta_b^F - \delta_b^M\right) b_{t-1}^d + \delta_b^M b_{t-1} + ...$$

$$R_t = (1-\rho_R)\left(\left(\psi_\pi^F - \psi_\pi^M\right)\pi_t^d + \psi_\pi^M \pi_t\right) + ...$$

- Compare with outcomes when policymakers always behave according to the monetary-led regime out of the ZLB

Household ▸ Linearized Model

- The representative household maximizes:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \exp\left(\overline{d}_{\xi_t^d} \right) \left[\log\left(C_t \right) - h_t \right] \right]$$

subject to the budget constraint:

$$P_t C_t + B_t + P_t T_t = P_t W_t h_t + R_{t-1} B_{t-1} + D_t$$

- The preference shock $\overline{d}_{\xi_t^d}$ can assume two values, high or low ($\overline{d}_h$ and $\overline{d}_l$). The variable ξ_t^d evolves according to the transition matrix H^d:

$$H^d = \begin{bmatrix} p_{hh} & 1 - p_{ll} \\ 1 - p_{hh} & p_{ll} \end{bmatrix}$$

Firms ▸ Linearized Model

- The monopolistically competitive firms face a downward sloping demand curve:

$$Y_t(j) = \left(P_t(j)/P_t\right)^{-1/v} Y_t$$

where $1/v$ is the elasticity of substitution between two differentiated goods

- Whenever a firm wants to change its price, it faces quadratic adjustment costs represented by an output loss:

$$AC_t(j) = \frac{\varphi}{2}\left(\frac{P_t(j)}{P_{t-1}(j)} - \Pi\right)^2 Y_t(j)\frac{P_t(j)}{P_t}$$

Technology ▸ Linearized Model

Labor is the only input in a linear production function:

$$Y_t(j) = A_t h_t(j)$$

where total factor productivity A_t evolves according to:

$$\begin{aligned} \ln A_t &= \ln \overline{A} + z_t \\ z_t &= \rho_z z_{t-1} + \sigma_z \epsilon_{z,t} \end{aligned}$$

Monetary authority ▸ Linearized Model

The Central Bank moves the FFR according to the rule:

$$\frac{R_t}{R} = \left(1 - Z_{\xi_t^p}\right)\left(\frac{R_{t-1}}{R}\right)^{\rho_R}\left[\left(\frac{\Pi_t}{\Pi}\right)^{\psi_{\pi,\xi_t^p}}\left(\frac{Y_t}{Y_t^n}\right)^{\psi_y}\right]^{(1-\rho_R)} e^{\sigma_R \epsilon_{R,t}}$$

where:

- The variable ξ_t^p captures the monetary/fiscal policy combination that is in place at time t
- $Z^{\xi_t^p}$ is a dummy variable controlling if the economy is in or out of the zero lower bound

Fiscal authority ▸ Linearized Model

- The Government budget constraint is given by:

$$b_t = b_{t-1} \left(Y_t \Pi_t / Y_{t-1} \right)^{-1} R_{t-1} - s_t$$

where $b_t = B_t / \left(P_t Y_t \right)$ and $s_t = S_t / \left(P_t Y_t \right)$

- The government moves primary surpluses according to the rule:

$$\begin{aligned} \left(s_t - s \right) &= \delta_{b,\xi_t^p} \left(b_{t-1} - b \right) + \delta_y \left(y_t - y_t^n \right) + x_t \quad (5) \\ x_t &= \rho_x x_{t-1} + \sigma_x \epsilon_{x,t}, \ \epsilon_{x,t} \sim N(0,1) \quad (6) \end{aligned}$$

- In order to completely isolate the effects of fiscal discipline, we assume that the government only provides a subsidy or raises taxes ($T_t = S_t$).

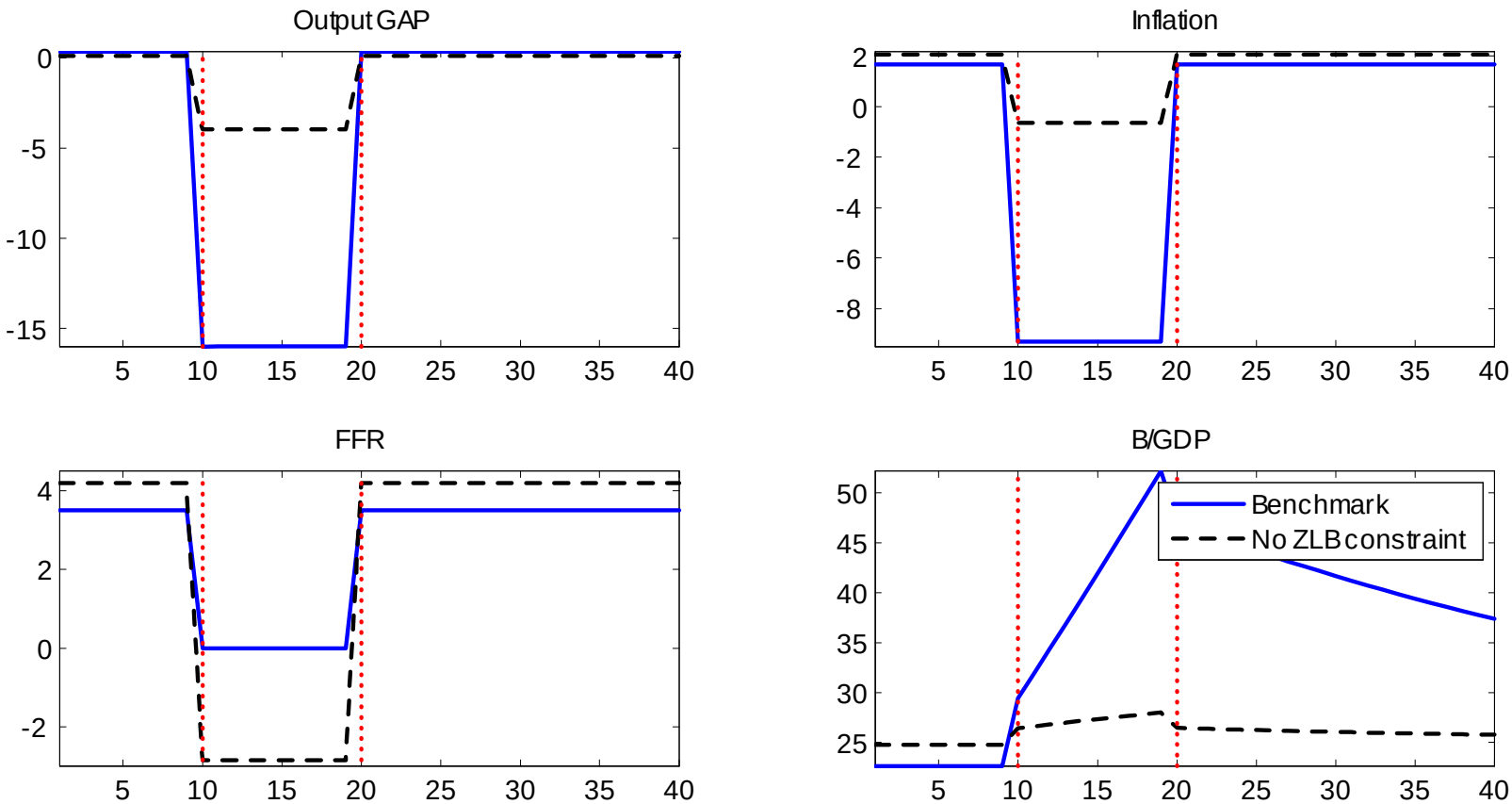
The ZLB: The Standard new-Keynesian model ▸ Hs

Assume that...

- ...policy makers always behave according to the Monetary led regime and...
- ...the economy is hit by an adverse preference shock

  $\longrightarrow$ Agents want to save more, consumption declines, the central bank cannot set a negative nominal interest rate
  $\longrightarrow$ zero lower bound binds
  $\longrightarrow$ Economy enters a deep recession and deflation

The ZLB: The Standard new-Keynesian model



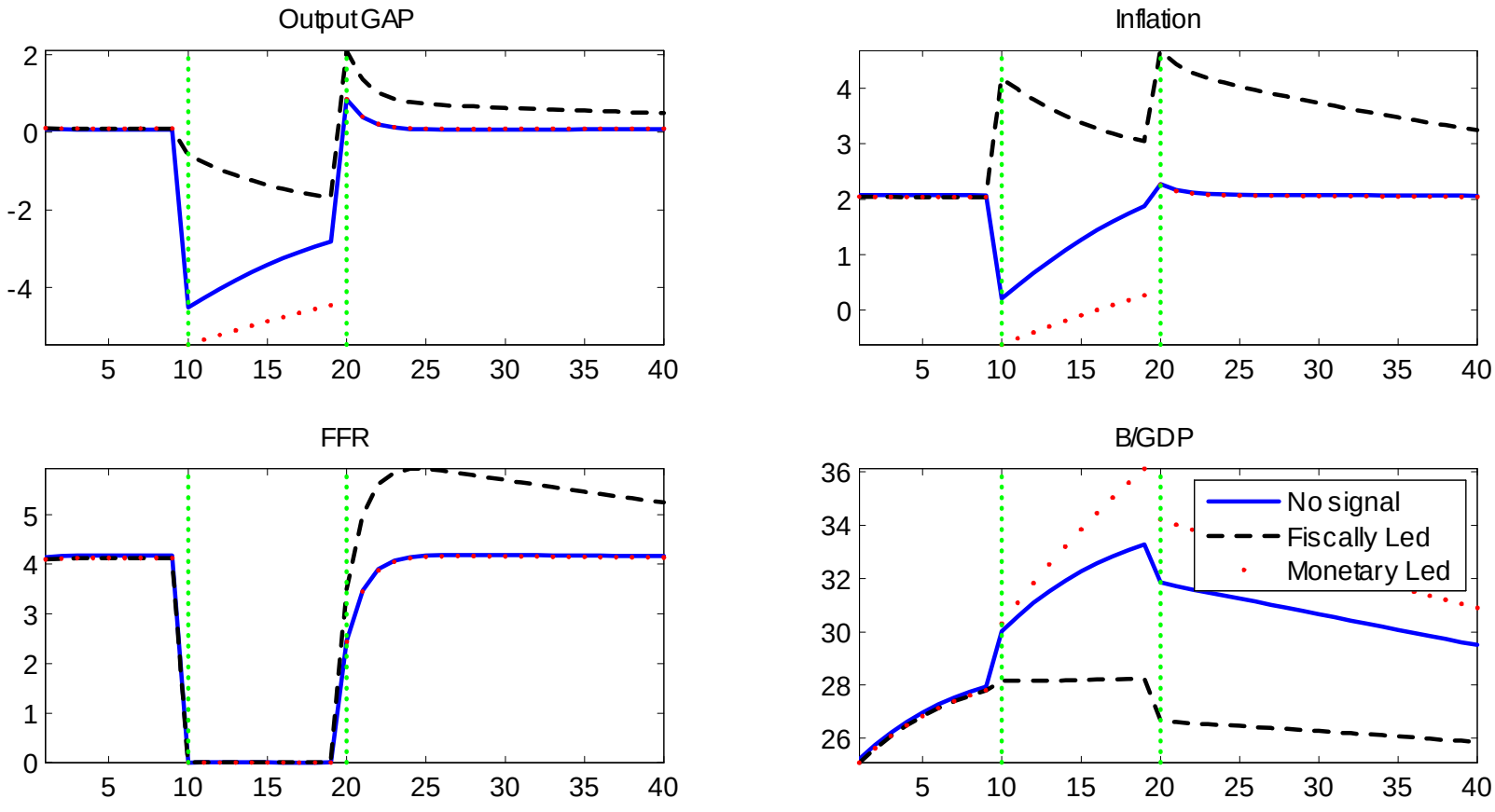
Robustness check: Deterioration of reputation

In absence of signals, Agents update their beliefs based on the probability of moving across regimes

Even if out of the ZLB policy makers are committed to the Monetary led regime, entering the ZLB might make their hands tremble

$\Rightarrow$ The more time is spent under the zero lower bound regime, the more likely it is that policy makers will switch to the Fiscally led regime

No announcements



Contradictory announcements