Precautionary pricing: the disinflationary effects of ELB risk

Robert Amano[1] Thomas J. Carter[1] Sylvain Leduc[2]

[1]Bank of Canada
[2]Federal Reserve Bank of San Francisco

November 1, 2018

The views expressed in this presentation are those of the authors. No responsibility for them should be attributed to the Bank of Canada or the Federal Reserve system.

Motivation

Motivation

- pre-crisis view: ELB episodes few and far between
- post-crisis view: heightened ELB risk as a key feature of the economic landscape
    - Dorich, Labelle St-Pierre, Lepetyuk, and Mendes (2018): ELB risk in Canada has more than doubled to 8% since the mid-2000s

Motivation

- pre-crisis view: ELB episodes few and far between
- post-crisis view: heightened ELB risk as a key feature of the economic landscape
  - Dorich, Labelle St-Pierre, Lepetyuk, and Mendes (2018): ELB risk in Canada has more than doubled to 8% since the mid-2000s
- natural question: how will the economy operate with a higher amount of ELB risk looming in the background?

Motivation

- pre-crisis view: ELB episodes few and far between
- post-crisis view: heightened ELB risk as a key feature of the economic landscape
  - Dorich, Labelle St-Pierre, Lepetyuk, and Mendes (2018): ELB risk in Canada has more than doubled to 8% since the mid-2000s
- natural question: how will the economy operate with a higher amount of ELB risk looming in the background?
- growing literature (Adam and Billi, 2007; Nakov, 2008; Nakata and Schmidt, 2014, 2016a; Hills et al., 2016)...

Motivation

- pre-crisis view: ELB episodes few and far between
- post-crisis view: heightened ELB risk as a key feature of the economic landscape
  - Dorich, Labelle St-Pierre, Lepetyuk, and Mendes (2018): ELB risk in Canada has more than doubled to 8% since the mid-2000s
- natural question: how will the economy operate with a higher amount of ELB risk looming in the background?
- growing literature (Adam and Billi, 2007; Nakov, 2008; Nakata and Schmidt, 2014, 2016a; Hills et al., 2016)...
- ...but two potential shortcomings in models used to date:

Motivation

- pre-crisis view: ELB episodes few and far between
- post-crisis view: heightened ELB risk as a key feature of the economic landscape
  - Dorich, Labelle St-Pierre, Lepetyuk, and Mendes (2018): ELB risk in Canada has more than doubled to 8% since the mid-2000s
- natural question: how will the economy operate with a higher amount of ELB risk looming in the background?
- growing literature (Adam and Billi, 2007; Nakov, 2008; Nakata and Schmidt, 2014, 2016a; Hills et al., 2016)...
- ...but two potential shortcomings in models used to date:
  - missing link between ELB and potential output

Motivation

- pre-crisis view: ELB episodes few and far between
- post-crisis view: heightened ELB risk as a key feature of the economic landscape
  - Dorich, Labelle St-Pierre, Lepetyuk, and Mendes (2018): ELB risk in Canada has more than doubled to 8% since the mid-2000s
- natural question: how will the economy operate with a higher amount of ELB risk looming in the background?
- growing literature (Adam and Billi, 2007; Nakov, 2008; Nakata and Schmidt, 2014, 2016a; Hills et al., 2016)...
- ...but two potential shortcomings in models used to date:
  - missing link between ELB and potential output
  - implausibly low risk aversion

What we do

- augment standard New Keynesian model to include two key ingredients:

What we do

- augment standard New Keynesian model to include two key ingredients:
    1. simple endogenous growth mechanism

What we do

- augment standard New Keynesian model to include two key ingredients:
  1. simple endogenous growth mechanism
  2. recursive preferences

What we do

- augment standard New Keynesian model to include two key ingredients:
  1. simple endogenous growth mechanism
  2. recursive preferences
- globally solve, then compare behaviour in normal times against otherwise comparable model without ELB

What we find

- ELB risk leaves significant signature on aggregate outcomes in normal times:

What we find

- ELB risk leaves significant signature on aggregate outcomes in normal times:
    1. strong downward pressure on real rates

What we find

- ELB risk leaves significant signature on aggregate outcomes in normal times:
  1. strong downward pressure on real rates
  2. similar effect on inflation

What we find

- ELB risk leaves significant signature on aggregate outcomes in normal times:
  1. strong downward pressure on real rates
  2. similar effect on inflation
  3. sharp disconnect between inflation and real economic conditions

What we find

- ELB risk leaves significant signature on aggregate outcomes in normal times:
  1. strong downward pressure on real rates
  2. similar effect on inflation
  3. sharp disconnect between inflation and real economic conditions

Model
Firms

Model
Firms

- intermediate good producer *i* sets prices à la Rotemberg (1982) and operates technology
$$y_{it} = k_{it}^{1-\alpha_\ell} \left(A_t \ell_{it}\right)^{\alpha_\ell}$$
- simple learning-by-doing externality:

$$A_t = k_t \implies y_t = k_t \ell_t^{\alpha_\ell}$$

Model

Households

Model
Households

- HH preferences à la Rudebusch and Swanson (2012):

$$V_t = \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\chi A_t^{1-\sigma} \ell_t^{1+\nu}}{1+\nu} - \beta \left[\mathbb{E}_t \left\{ (-V_{t+1})^{1-\gamma} \right\} \right]^{\frac{1}{1-\gamma}}$$

- SDF incorporates HHs' future prospects:

$$SDF_{t,t+1} = \beta \left(\frac{c_{t+1}}{c_t} \right)^{-\sigma} \left[\frac{-V_{t+1}}{\left[\mathbb{E}_t \left\{ (-V_{t+1})^{1-\gamma} \right\} \right]^{\frac{1}{1-\gamma}}} \right]^{-\gamma}$$

Model
Households

- HH preferences à la Rudebusch and Swanson (2012):

$$V_t = \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\chi A_t^{1-\sigma} \ell_t^{1+\nu}}{1+\nu} - \beta \left[\mathbb{E}_t \left\{ \left(-V_{t+1} \right)^{1-\gamma} \right\} \right]^{\frac{1}{1-\gamma}}$$

- SDF incorporates HHs' future prospects:

$$SDF_{t,t+1} = \beta \left(\frac{c_{t+1}}{c_t} \right)^{-\sigma} \left[\frac{-V_{t+1}}{\left[\mathbb{E}_t \left\{ \left(-V_{t+1} \right)^{1-\gamma} \right\} \right]^{\frac{1}{1-\gamma}}} \right]^{-\gamma}$$

- γ set such that CRRA $\approx$ 80
  - c.f. Rudebusch and Swanson (2012), Nakata and Tanaka (2016), Swanson (2016), Gourio and Ngo (2017), and other previous literature on recursive preferences in NK models

- HH preferences à la Rudebusch and Swanson (2012):

$$V_t = \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\chi A_t^{1-\sigma}\ell_t^{1+\nu}}{1+\nu} - \beta\left[\mathbb{E}_t\left\{(-V_{t+1})^{1-\gamma}\right\}\right]^{\frac{1}{1-\gamma}}$$

- SDF incorporates HHs' future prospects:

$$SDF_{t,t+1} = \beta\left(\frac{c_{t+1}}{c_t}\right)^{-\sigma}\left[\frac{-V_{t+1}}{\left[\mathbb{E}_t\left\{(-V_{t+1})^{1-\gamma}\right\}\right]^{\frac{1}{1-\gamma}}}\right]^{-\gamma}$$

- γ set such that CRRA $\approx$ 80
  - c.f. Rudebusch and Swanson (2012), Nakata and Tanaka (2016), Swanson (2016), Gourio and Ngo (2017), and other previous literature on recursive preferences in NK models

Model
ELB episodes

- “flight to safety”-style demand shock:

$$1 = \mathbb{E}_t \left(SDF_{t,t+1} \cdot \frac{1}{\xi_t} \cdot \frac{R_t}{\Pi_{t+1}} \right)$$

Model
ELB episodes

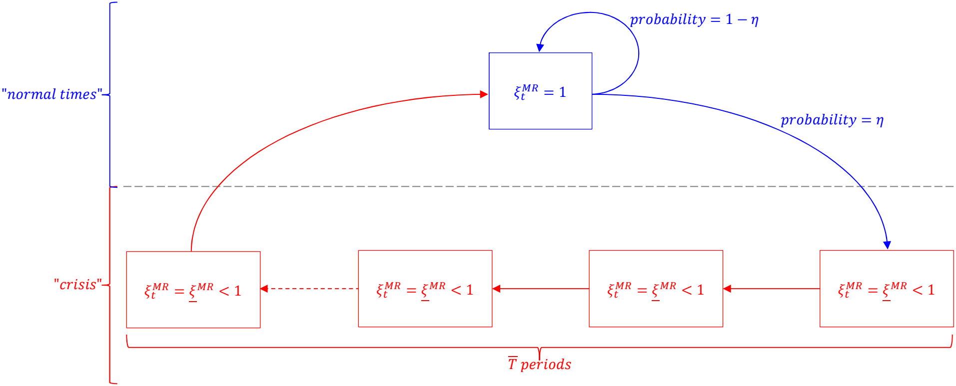
- “flight to safety”-style demand shock:

$$1 = \mathbb{E}_t \left(SDF_{t,t+1} \cdot \frac{1}{\xi_t} \cdot \frac{R_t}{\Pi_{t+1}} \right)$$

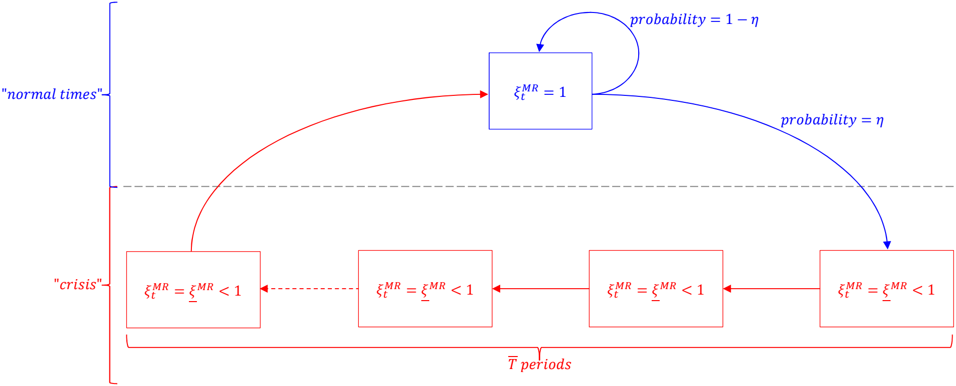
- distinct short- and medium-run components:

$$\xi_t = \xi_t^{SR} \xi_t^{MR},$$

with $\log(\xi_t^{SR}) \sim AR(1)$, while ξ_t^{MR} follows a regime-switching process à la Coibion, Dordal-i-Carreras, Gorodnichenko, and Wieland (2016)...



probability = 1 − η
"normal times"
$\xi_t^{MR} = 1$
probability = η
"crisis"
$\xi_t^{MR} = \underline{\xi}^{MR} < 1$
$\xi_t^{MR} = \underline{\xi}^{MR} < 1$
$\xi_t^{MR} = \underline{\xi}^{MR} < 1$
$\xi_t^{MR} = \underline{\xi}^{MR} < 1$
$\overline{T}$ periods



	Data	Model
International post-war sample: ELB frequency (%, Coibion et al., 2016)	6-11	7.1
Canada, 2009-10: peak-to-trough drop in GDP per capita (%)	5.3	5.4 (mean)
Canada, 2009-10: ELB duration (quarters)	5	5.1 (mean)

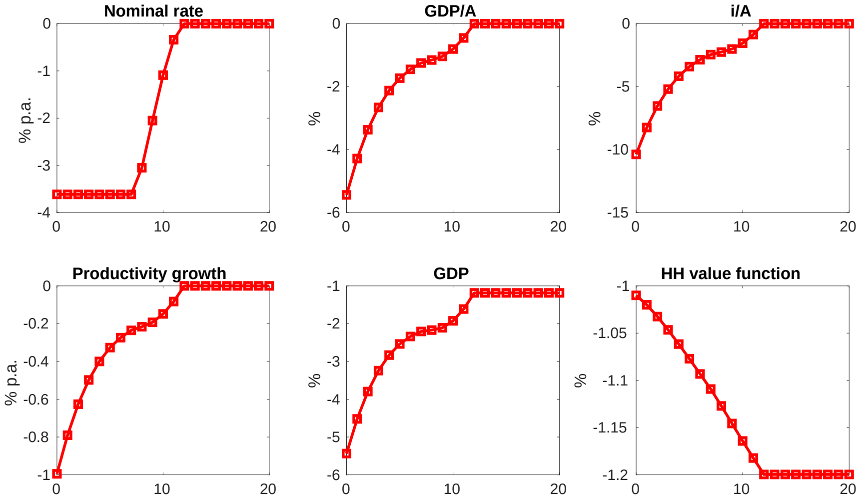
Model
Monetary policy

- truncated Taylor rule:

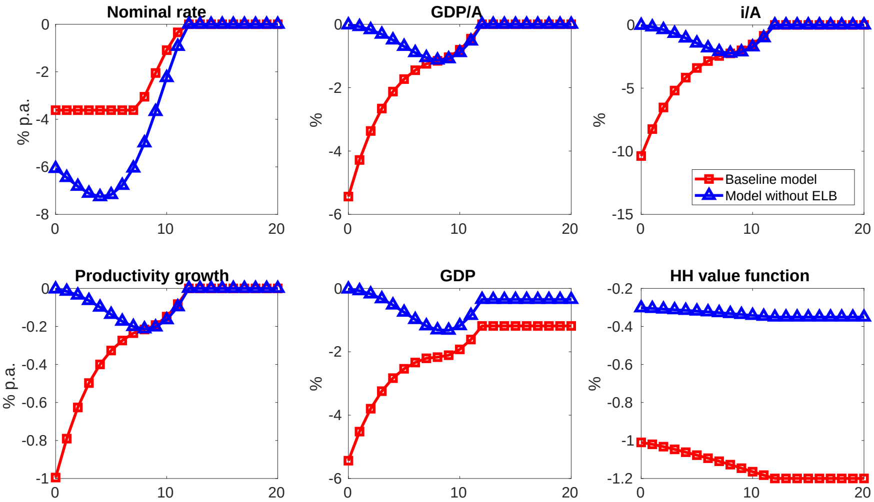
$$R_t = \max\left\{1, R_{SS}\left(\frac{\Pi_t}{\Pi_{SS}}\right)^{\phi_\pi}\left[\frac{GDP_t/A_t}{(GDP/A)_{SS}}\right]^{\phi_{GDP}}\right\}$$

Crises and long-run risk

Crises and long-run risk



Crises and long-run risk



Results
Effect of ELB risk on real rates and inflation

Results
Effect of ELB risk on real rates and inflation

	Deterministic steady state	No ELB	Low risk aversion	Baseline (ELB plus high risk aversion)
Conditional averages in "normal times" ($\xi_t^{MR} = 1$)...				
Real rate (%)	3.06	3.04	2.80	2.32
Inflation (%)	2.00	1.96	1.79	1.42

Results
Disconnect between inflation and real conditions

	Deterministic steady state	No ELB	Low risk aversion	Baseline (ELB plus high risk aversion)
Conditional averages in "normal times" ($\xi_t^{MR} = 1$)...				
Real rate (%)	3.06	3.04	2.80	2.32
Inflation (%)	2.00	1.96	1.79	1.42
Real marginal costs (normalized)	100.00	100.26	100.61	101.70
GDP growth (%)	1.50	1.53	1.55	1.60

Results
Disconnect between inflation and real conditions

	Deterministic steady state	No ELB	Low risk aversion	Baseline (ELB plus high risk aversion)
Conditional averages in "normal times" ($\xi_t^{MR} = 1$)...				
Real rate (%)	3.06	3.04	2.80	2.32
Inflation (%)	2.00	1.96	1.79	1.42
Real marginal costs (normalized)	100.00	100.26	100.61	101.70
GDP growth (%)	1.50	1.53	1.55	1.60

- Phillips curve under Rotemberg pricing:

$$\varphi(\Pi_t - \Pi_{SS})\Pi_t = (1-\theta) + \theta RMC_t + \mathbb{E}_t\left[SDF_{t,t+1} \cdot (y_{t+1}/y_t) \cdot \varphi(\Pi_{t+1} - \Pi_{SS})\Pi_{t+1}\right]$$

Results
Disconnect between inflation and real conditions

	Deterministic steady state	No ELB	Low risk aversion	Baseline (ELB plus high risk aversion)
Conditional averages in "normal times" ($\xi_t^{MR} = 1$)...				
Real rate (%)	3.06	3.04	2.80	2.32
Inflation (%)	2.00	1.96	1.79	1.42
Real marginal costs (normalized)	100.00	100.26	100.61	101.70
GDP growth (%)	1.50	1.53	1.55	1.60

- Phillips curve under Rotemberg pricing:

$$\varphi(\Pi_t - \Pi_{SS})\Pi_t = (1-\theta) + \theta RMC_t + \mathbb{E}_t\left[SDF_{t,t+1} \cdot (y_{t+1}/y_t) \cdot \varphi(\Pi_{t+1} - \Pi_{SS})\Pi_{t+1}\right]$$

Conclusion

- “anxious” economy in which concerns about the ELB leave a significant signature on agents’ behaviour in “normal times”

Conclusion

- “anxious” economy in which concerns about the ELB leave a significant signature on agents’ behaviour in “normal times”
- especially important that agents be aware (and convinced!) of monetary policy’s plans for mitigating ELB episodes ex-ante

Conclusion

- “anxious” economy in which concerns about the ELB leave a significant signature on agents’ behaviour in “normal times”
- especially important that agents be aware (and convinced!) of monetary policy’s plans for mitigating ELB episodes ex-ante
- potential avenues for future research: incorporate alternate monetary-policy regimes and/or unconventional tools

Adam, K. and Billi, R. (2007). Discretionary monetary policy and the zero lower bound on nominal interest rates. *Journal of Monetary Economics*, 3:728–752.

Coibion, O., Dordal-i-Carreras, M., Gorodnichenko, Y., and Wieland, J. (2016). Infrequent but long-lived zero lower bound episodes and the optimal rate of inflation. *Annual Review of Economics*, 8:497–520.

Gourio, F. and Ngo, P. (2017). Risk premia at the ZLB: a macroeconomic interpretation. Mimeo. Available at `https://dornsife.usc.edu/assets/sites/524/docs/draftJan2017.pdf`.

Hills, T., Nakata, T., and Schmidt, S. (2016). The risky steady state and the interest rate lower bound. Finance and economics discussion series, divisions of research & statistics and monetary affairs, Federal Reserve Board 2016-009.

Nakata, T. and Schmidt, S. (2014). Conservatism and liquidity traps. Finance and economics discussion series, divisions of research & statistics and monetary affairs, Federal Reserve Board 2014-105.

Nakata, T. and Schmidt, S. (2016a). Gradualism and liquidity traps. Finance and economics discussion series, divisions of research & statistics and monetary affairs, Federal Reserve Board 2016-092.

Nakata, T. and Schmidt, S. (2016b). The risk-adjusted monetary policy rule. Finance and economics discussion series, divisions of research & statistics and monetary affairs, Federal Reserve Board 2016-061.

Nakata, T. and Tanaka, H. (2016). Equilibrium yield curves and the interest rate lower bound. Finance and economics discussion series, divisions of research & statistics and monetary affairs, Federal Reserve Board 2016-085.

Nakov, A. (2008). Optimal and simple monetary policy rules with zero floor on the nominal interest rate. *International Journal of Central Banking*, 4.

Rudebusch, G. and Swanson, E. (2012). The bond premium in a DSGE model with long-run real and nominal risk. *American Economic Journal: Macroeconomics*, 4(1):105–143.

Swanson, E. (2016). A macroeconomic model of equities and real, nominal, and defaultable debt. Mimeo. Available at `http://www.ericswanson.us/papers/ezap.pdf`.

Model
Monetary policy

- risk-adjusted Taylor rule truncated Taylor rule à la Nakata and Schmidt (2016b)

$$R_t = \max\left\{1, R_{\text{risk-adj}} \left(\frac{\Pi_t}{\Pi_{\text{SS}}}\right)^{\phi_\pi} \left[\frac{GDP_t/A_t}{(GDP/A)_{\text{SS}}}\right]^{\phi_{GDP}}\right\},$$

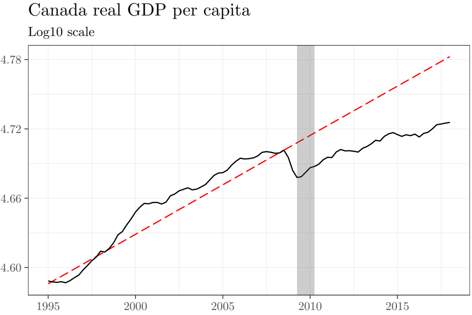
where $R_{\text{risk-adj}}$ set such that $\Pi_t = \Pi_{\text{SS}}$ when $(\xi_t^{SR}, \xi_t^{MR}) = (1, 1)$

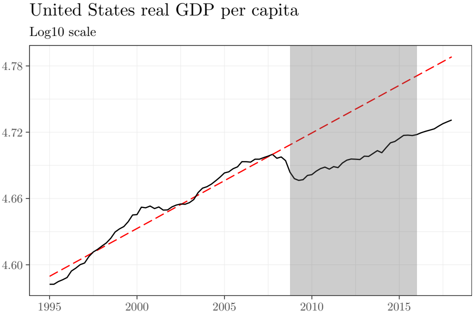
	Deterministic steady state	No ELB	Low risk aversion	Baseline (ELB plus high risk aversion)
Risk-adjusted Taylor intercept	5.12	5.06	4.65	4.15

Results

Average inflation during “crises” and “normal times”

	Deterministic steady state	No ELB	Low risk aversion	Baseline (ELB plus high risk aversion)
Conditional averages in “normal times” ($\xi_t^{MR} = 1$)...				
Inflation (%)	2.00	1.96	1.79	1.42
Conditional averages in “crises” ($\xi_t^{MR} < 1$)...				
Inflation (%)	—	—	-1.15	-0.89


Canada real GDP per capita
Log10 scale
4.78
4.72
4.66
4.60
1995
2000
2005
2010
2015


United States real GDP per capita
Log10 scale
4.78
4.72
4.66
4.60
1995
2000
2005
2010
2015