Forward Guidance as a Monetary Policy Rule, Zero Lower Bound on Interest Rates and the Cost Channel

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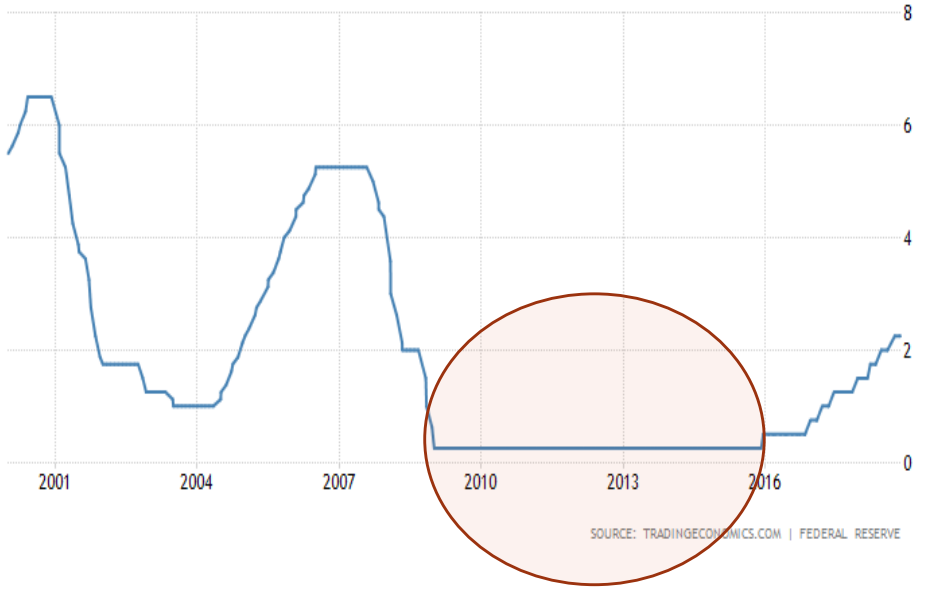
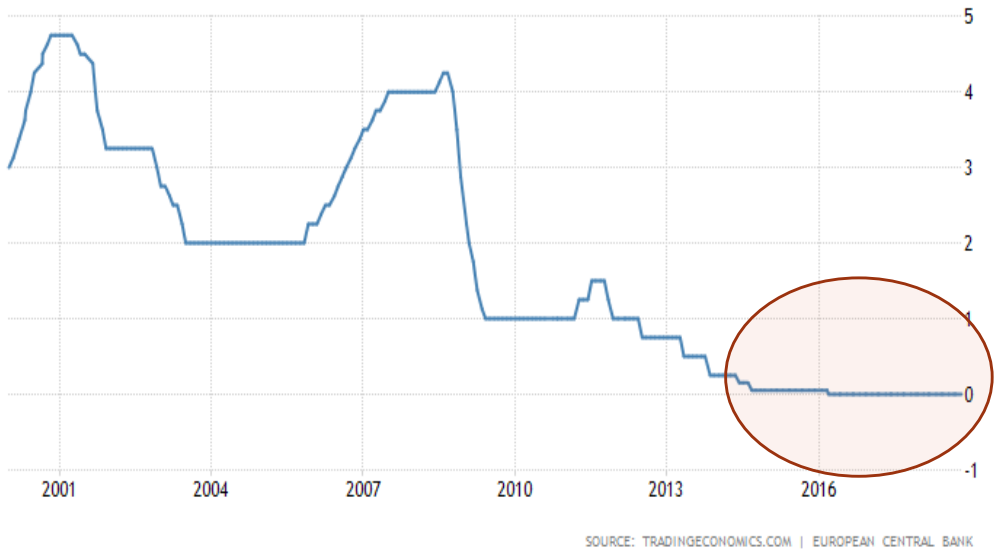
Zero Lower Bound on Nominal Interest Rates (ZLB) is no longer a theoretical concept…

- Short-term nominal interest rates were at zero levels in the recent past in many economies around the world

US Interest Rates

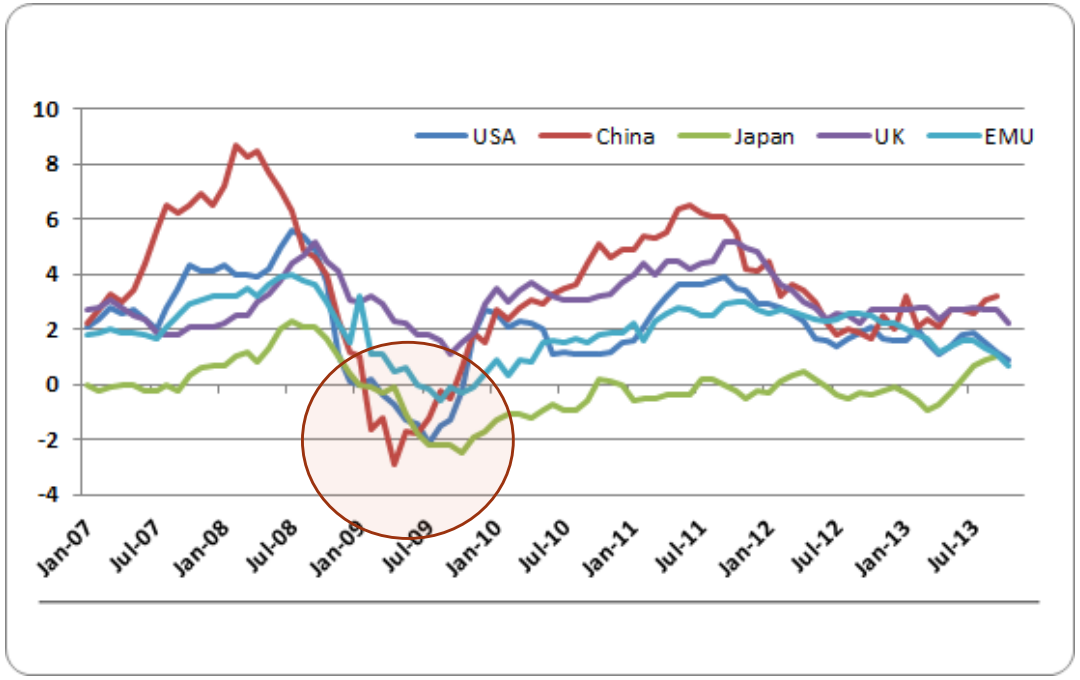


Euro Area Interest Rates



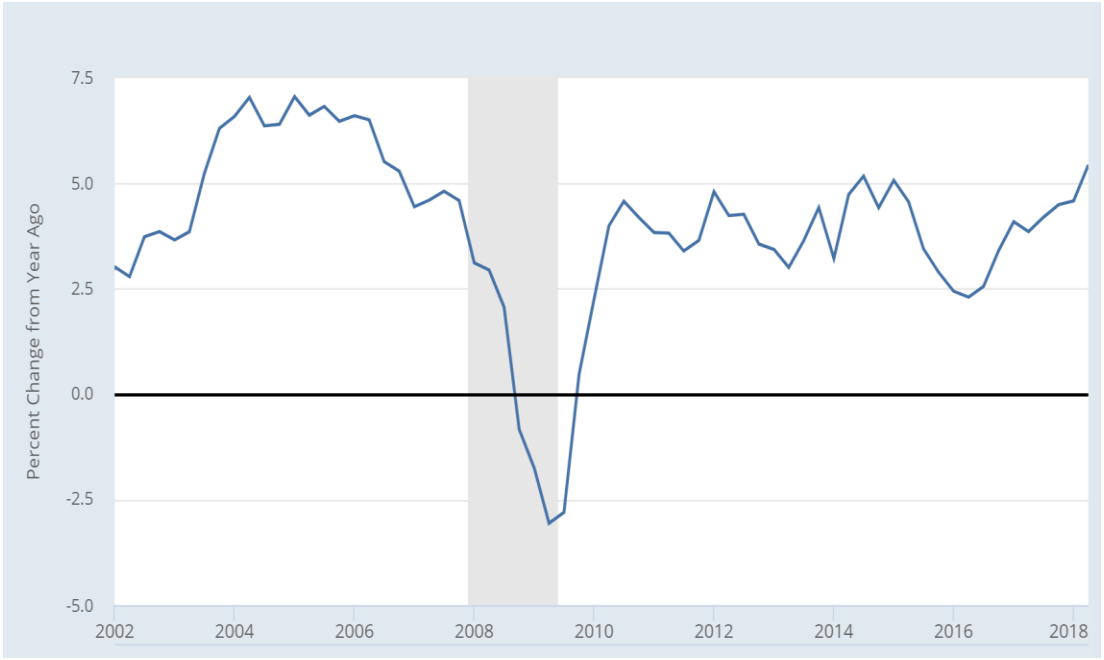
… and ZLB was accompanied by Deflation and Recession

Deflation: Selected Countries



Source: Orcam Financial Group, LLC

Recession: USA (GDP)



Source: FRED

- Monetary policy is restricted by the ZLB constraint and prompted unconventional monetary policies
  - **Forward guidance** and Balance sheet (quantitative easing - QE) policies

Forward Guidance is…

- Central bank's public announcement of its near future policy plan
  - Central bank provides information about its future monetary policy intentions, based on its assessment of the outlook for price stability
  - Odyssean and Delphic Forward Guidance
  - Threshold based and Calendar based Forward Guidance
- Exercised to shape inflationary expectations of economic agents

How does it work?

- Central bank clearly and credibly announces its near term policy path

  eg. keeping interest rate low for a specific time
  - Commercial banks set long term interest rates low, trusting central bank announcement
  - Businesses and households get cheaper loans stimulating investments and spending
  - Increases inflationary expectations and facilitates growth

A permanent Forward Guidance rule?

… and Cost Channel of Monetary Policy *is* …

- the transmission mechanism of the supply-side effect of monetary policy.
  - It is generally assumed that the supplied side effect is transmitted through the Cost Channel of Monetary Policy

- Economists agree monetary policy changes affect the real economy, at least in the short run
- Demand-side effects of monetary policy are well established

Wright Patman – A USA Congressman once said (1970):

… raising interest rates to fight inflation is similar to throwing gasoline on fire to put out the flames…

Wright Patman discussed an extreme case of supply-side effects of monetary policy, which is less examined

… and the Cost Channel received considerable attention since 1990s

- Scholars renewed interest of supply side effects with the emergence of *price puzzle* –*rise in price level due tight monetary policy*- in VAR analysis in 1990s

- A Cost Channel exists in an economy, if changes in nominal interest rates affect firms' costs of production directly -*by way of cost of working capital*- and thereby inflation and output
  - In this study, I consider firms borrow money to pay wage bill, within the period
- Cost Channel is empirically validated using:
  - aggregate/industrial data with VAR analysis: Barth & Ramey (2001), Kim & Lastrapes (2007).
  - single equation method (NKPC): Ravenna & Walsh (2006), Chowdhury, Hoffmann and Schabert (2006), Tillmann (2008, 2009).
  - firm-level data: Gaiotti & Secchi (2006).

Outline for the Rest of the Presentation

- Motivation and Objective
- Literature Review
- The Model and Simulation
- Analysis and Results
- Conclusion

Motivation and Objective

Motivation

- Zero lower bound on nominal interest rates restricts monetary policy and worsens recession
- Can a **permanent** forward guidance rule help increase inflation expectations and revive the economy
- How different would be the impact on Cost Channel economies

Objective

- To examine an endogenous threshold-based forward guidance policy rule at ZLB in a Cost Channel economy

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Monetary Policy at ZLB

- **Optimal monetary policy with credible commitment (by managing expectations) improves conditions of recession (perfect foresight):**
  - Without Cost Channel: Eggerston & Woodford (2003) and Jung et al (2005)
  - With Cost Channel: Chattopadhyay and Ghosh (2016), Pathberiya (2016)
- **Occasionally binding ZLB constraint can affect even steady state values (stochastic setting):**
  - Deflation bias at (risky) steady state:
    - Optimal monetary policy [Adam and Billi (2006, 2007), Nakov (2008)]
    - Taylor type interest rate rules [Nakov (2008), Hills, Nakata and Schmidt (2016)]
    - No study with Cost Channel
- **Implications of Taylor type interest rate rules at ZLB:**

  Truncated Taylor rule (TTR)

  Multiple steady states [Benhabib, Schmitt-Grohé and Uribe (2001)]

Forward Guidance (FG)

- **Odyssean and Delphic Forward guidance** [Campbell, Evans, Fisher and Justiniano (2012)]
  - **Applications (Odyssean):**
    - **Exogenous extension to zero interest rate regime** [Chattopadhyay and Daniel (2015)]
    - **Transitory unanticipated endogenous rule** [Boneva, Harrison and Waldron (2015)]

Forward Guidance rule in this study is closest to latter one -transitory endogenous rule-, but the rule examine in this study is anticipated and permanent

Outline

- Concepts
- Introduction to the Study
- Literature Review
- The Model and Simulation
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The Model

- New Keynesian forward looking inter-temporal model
- Incorporate Cost Channel assuming firms borrow within the period to pay wage bill
- Model economy consists of four main agents: households, firms, monetary authority, financial intermediaries
- ZLB binds occasionally

The Model - Supply and Demand Side Blocks

- Dynamic IS Curve:

$$x_t = E_t x_{t+1} - \sigma^{-1}\left[\hat{R}_t - E_t \pi_{t+1} - \hat{r_t^n}\right]$$

- New Keynesian Phillips Curve adjusted for Cost Channel:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa(\sigma + \eta) x_t + \kappa J \hat{R}_t$$

where x_t is the output gap, π_t is the rate of inflation between time $t-1$ and t. $\hat{R}_t$ and $\hat{r_t^n}$ are the percentage point deviation of nominal interest rate and natural interest rate from their corresponding zero inflation steady state values, respectively. $\beta \in (0,1)$ is a subjective rate of discount, $\sigma > 0$ is the coefficient of relative risk aversion and $\eta > 0$ is the elasticity of labour supply. The slope parameter of the NKPC: $\kappa = \frac{(1-\omega)(1-\omega\beta)}{\omega}$, where ω is share of firms that cannot adjust prices optimally

The parameter $J \in [0,1]$ in the NKPC represents the cost channel of monetary policy.

- Economy is prone to hit by a stochastic shock to natural interest rate

$$\hat{r_t^n} = \rho \hat{r}_{t-1}^n + \epsilon_t$$

where ϵ_t is i.i.d. $N(0, \sigma_\epsilon^2)$, σ_ϵ^2 is the variance of the shock and $\rho \in (0,1)$ is the persistence parameter

The Model – Monetary Policy Block

- Baseline: Truncated Taylor Rule (CTTR):

$$R_t = max[1, r^* + \pi^* + \phi_\pi(\pi_t - \pi^*) + \phi_x x_t]$$

where R_t is the gross nominal interest rate, r^* is the equilibrium real gross interest rate, π^* is the target inflation rate, ϕ_π is the inflation response coefficient and ϕ_x is the output gap response coefficient.

The Model – Monetary Policy Block

- Forward Guidance Rule: Central bank credibly announces a permanent Forward guidance rule at time zero:

  "We will not increase interest rates until output gap recovers to X in a liquidity trapped recession"

$$R_t = 1 \quad \text{if} \quad \left[R_t^{Taylor} \leq 1\right] \quad \text{or} \quad [R_{t-1} = 1 \text{ and } x_{t-1} < a]$$

$$R_t = R_t^{Taylor} \quad \text{otherwise}$$

where $a < 0$ is a value chosen by the central bank. If the central bank chooses a large value for a, that is considered as *strict forward guidance,* while if the central bank chooses a small value for a, that is considered as *weak forward guidance*.

Solution Method

- Since the non-linear rational expectation model is stochastic in nature and ZLB binds occasionally, no analytical solution is p[possible
- A numerical approximation method: *the collocation method*
- Widely used to solve models with occasionally binding ZLB constraint:

  Adam and Billi (2006,2007), Nakov (2008), Gavin, Keen, Richter and Throckmorton (2013), Boneva, Harrison and Waldron (2015)

Advantages:

– A global solution technique

– Flexible and numerically efficient [Miranda and Fackler (2003)]

Disadvantages:

– Non-convergence in certain regions in parameter space

– Curse of dimensionality

Baseline Calibration

- Calibrated to the US economy. Time period: Quarterly

Parameter	Description	Baseline Value
β	Discount rate in the utility function	0.993
σ	Coefficient of relative risk aversion	4
J	Share of working capital to be financed externally	$[0, 1]$
Net Natural rate of interest	Mean (per annum)	$\frac{1}{\beta} - 1 = 3\%$
	Max. depth of the large negative shock (per annum)	-6%
	Standard deviation [per annum, $\sigma(r^n)$]	3
	Shock persistence (ρ)	0.65
Taylor Rule	Inflation Target (per annum)	0%
	Coefficient on Inflation (ϕ_π)	1.5
	Coefficient on Output (ϕ_x)	1

- Simulations: 20,000 simulations in each case examined with 4,000 periods per simulation

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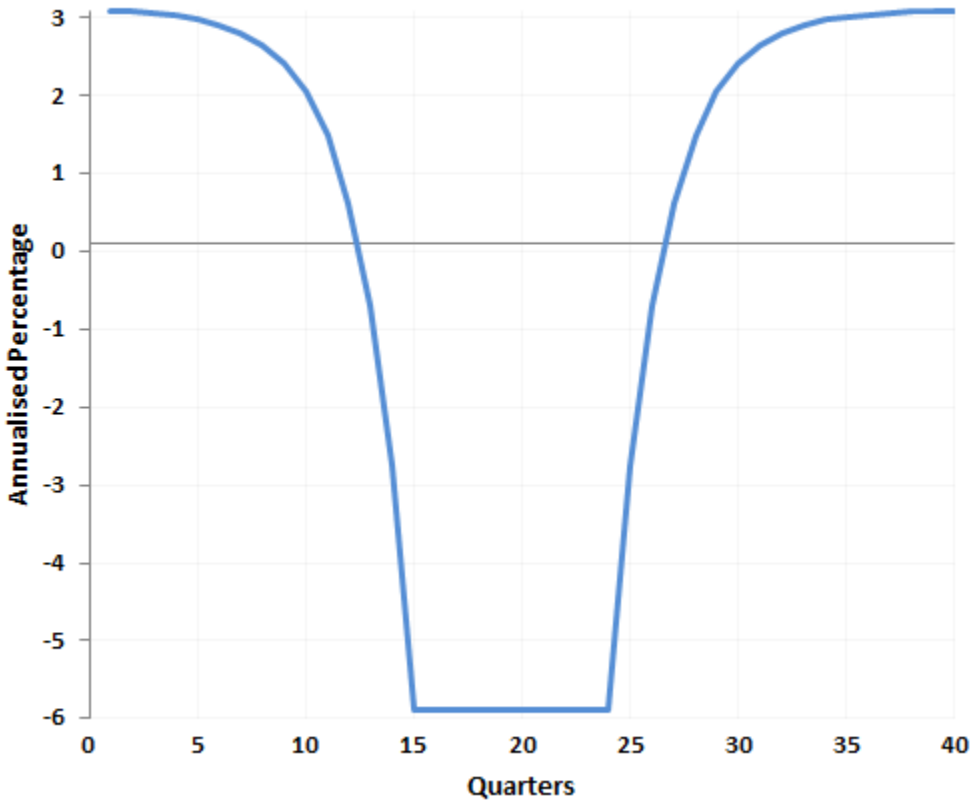
Baseline Analysis with Truncated Taylor Rule

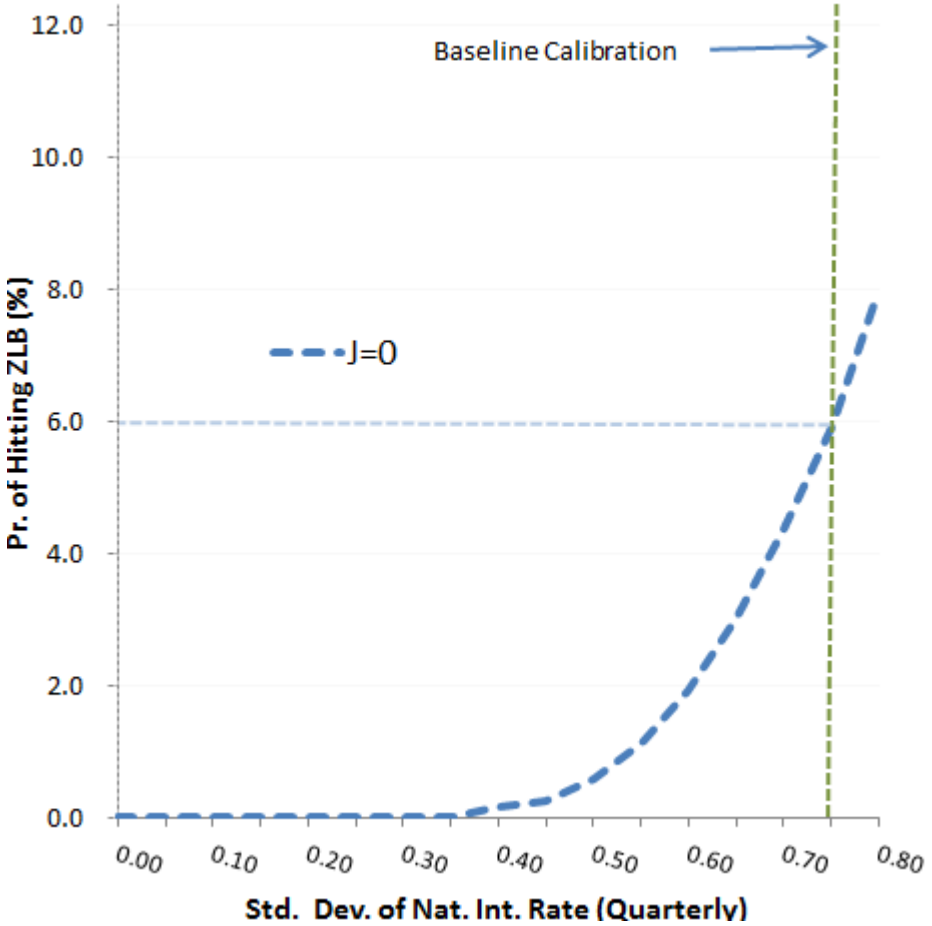
- Compare and contrast implications of Cost channel and no-Cost Channel economies with ZLB constraint
  - Relationship between std. deviation of shock and pr. of hitting ZLB
  - Dynamic paths of variables
  - Probability of persistence of Zero interest rate regimes

Dynamic Path of Natural Interest Rate



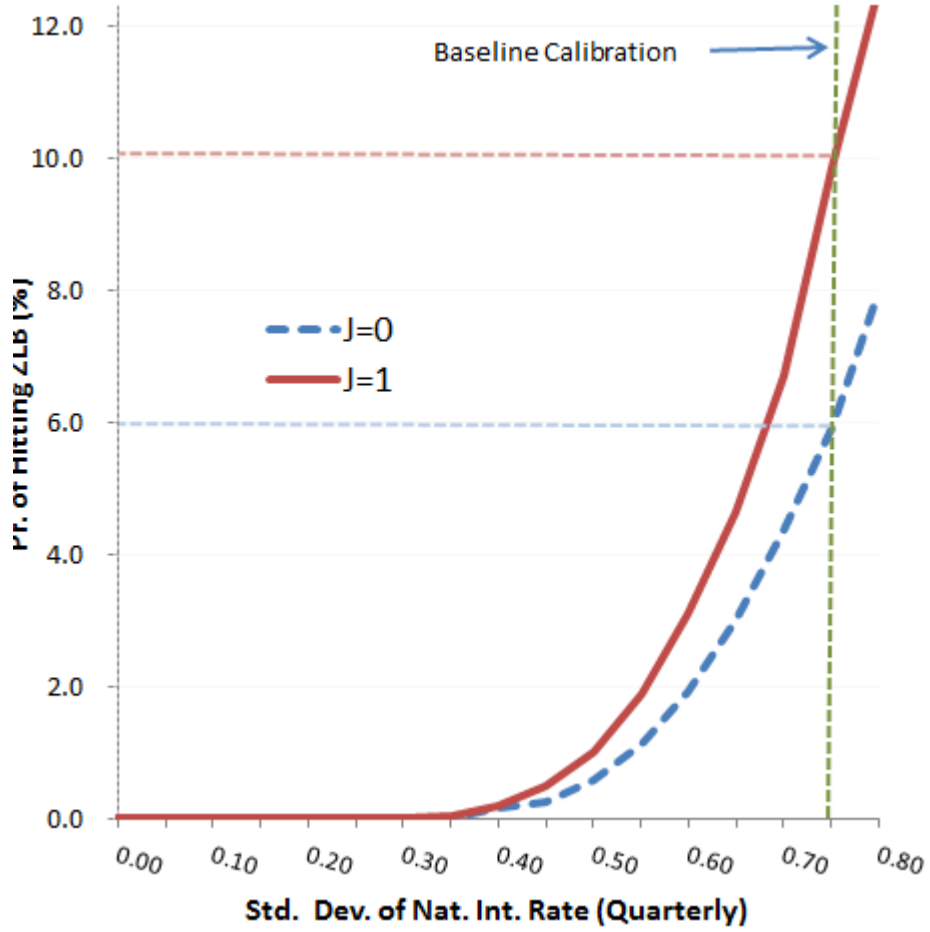
- Natural interest rate remain 10 quarters at the minimum value due to the shock.

Relationship between Std. Deviation of Shock and Probability of Hitting ZLB



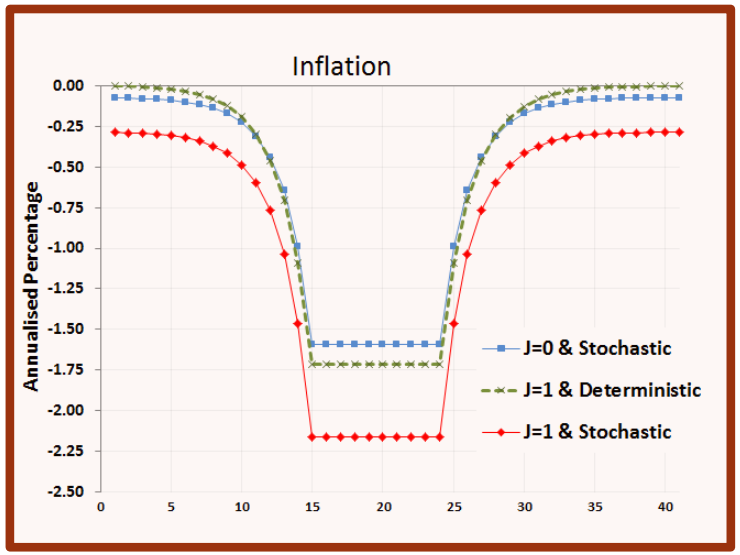
- The higher the uncertainty, the higher the pr. of hitting ZLB

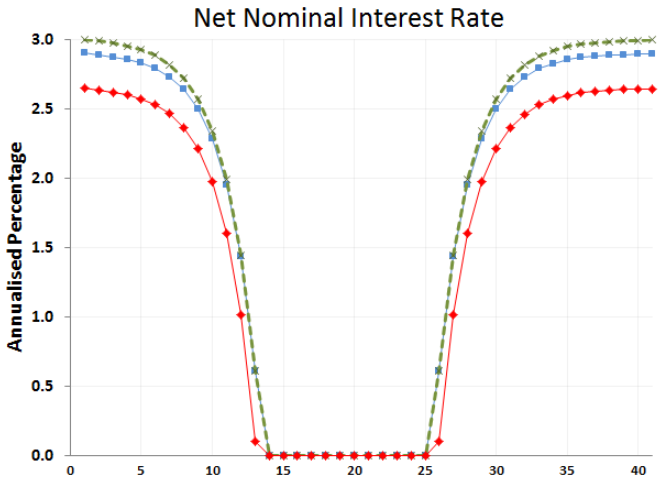
Relationship between Std. Deviation of Shock and Probability of Hitting ZLB ctd.

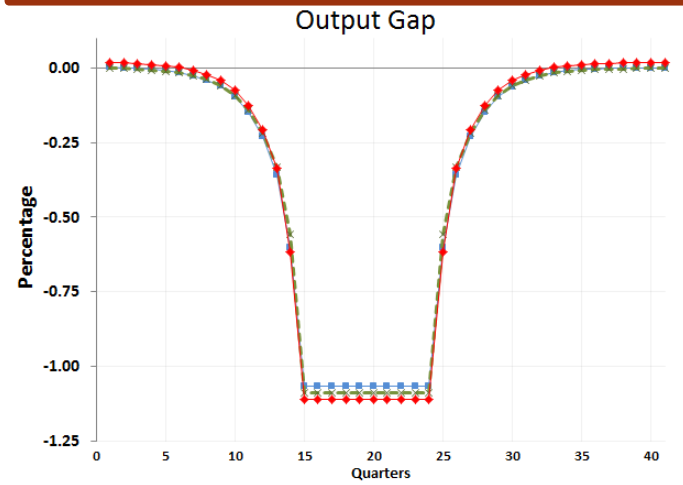


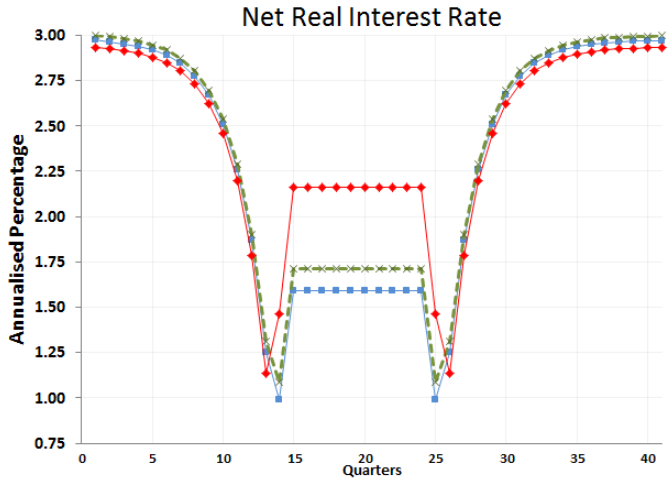
- The higher the uncertainty, the higher the pr. of hitting ZLB
- Pr. of hitting ZLB is higher in Cost Channel economies

Dynamic paths of variables - Baseline





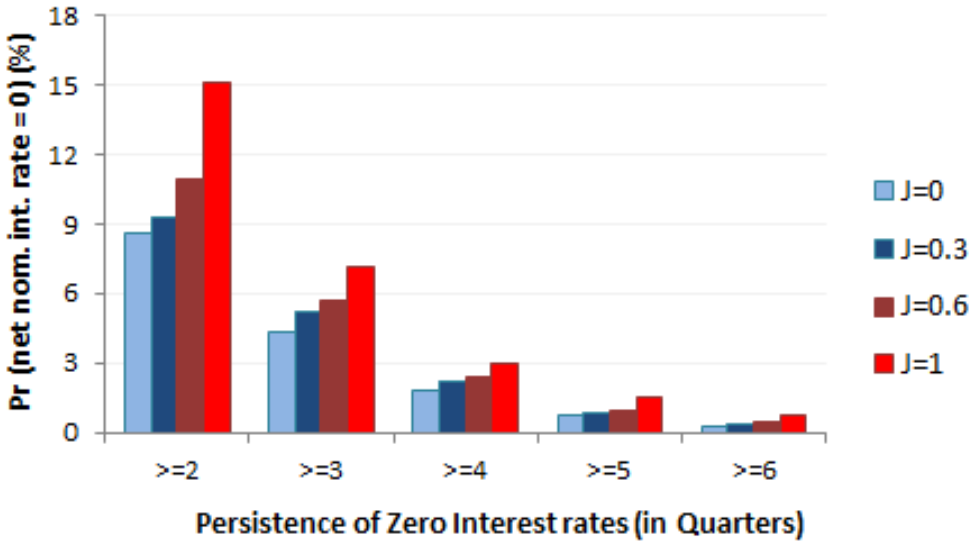




Note: Baseline calibration. In the deterministic setting, standard deviation of the natural interest rate has been set to zero.

- No deflation bias at deterministic case
- Deflation bias at stochastic steady state in both Cost Channel and no- Cost Channel economies
  - Asymmetry in expected production costs at risky steady state
- Cost Channel economy is more deflationary and recession is deeper
- Higher deflation bias in Cost Channel economies
  - Cost Channel amplifies asymmetry of expected production costs – Agents expect more recessions in Cost Channel economies

Probability of Persistence of the Zero Interest Rate Regime



Note: Highest persistence for J=1 is 21 quarters while for J=0 is 16 quarters.

- Persistent ZLB regimes in Cost Channel economies
- The stronger the Cost Channel, the higher the persistence of ZLB

Note: Persistence of ZLB regimes Conditional on Int. Rates Being Binding in Q1

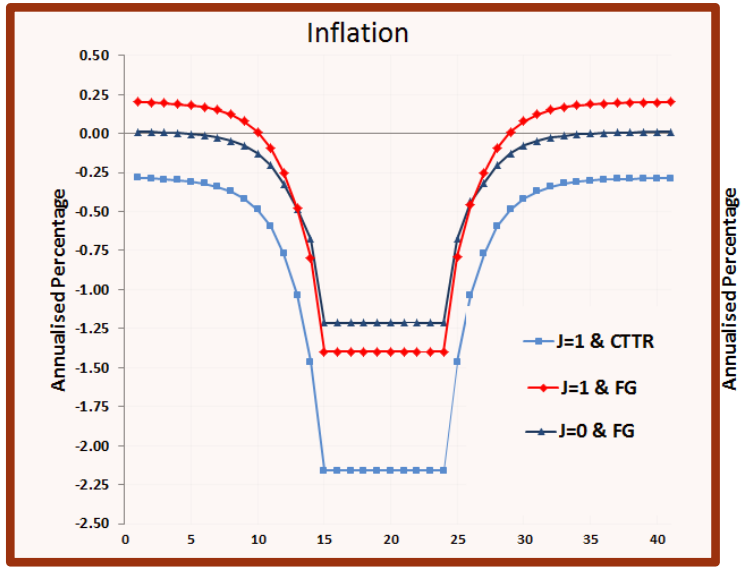
Paths of Variables under Forward Guidance rule

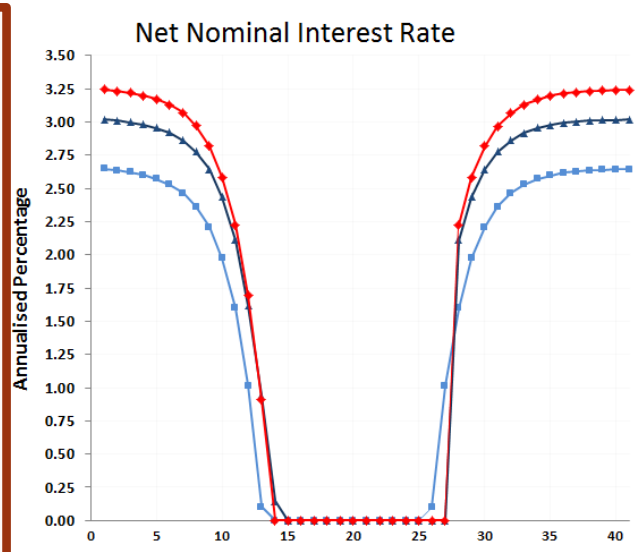
Recall the forward guidance rule…

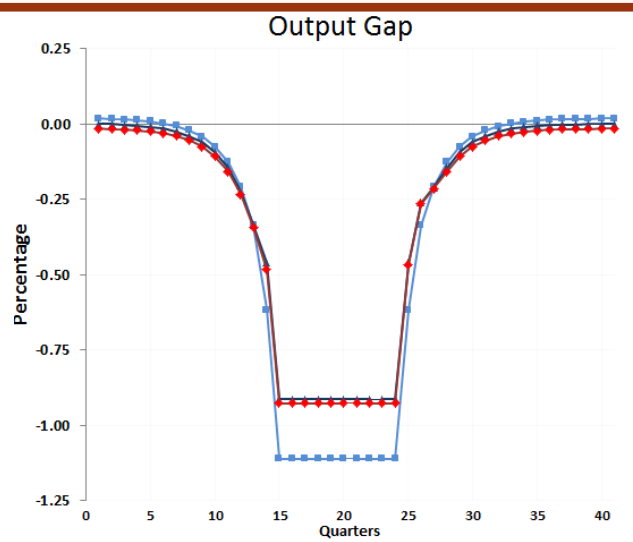
$$R_t = 1 \quad \text{if} \quad \left[R_t^{Taylor} \leq 1\right] \quad \text{or} \quad [R_{t-1} = 1 \text{ and } x_{t-1} < a]$$

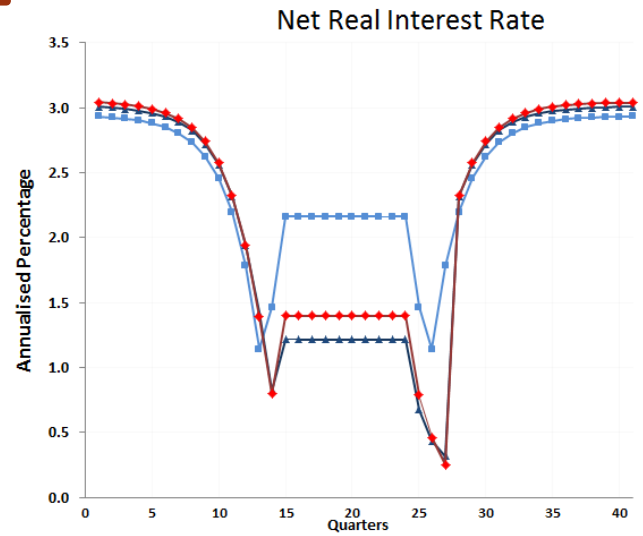
$$R_t = R_t^{Taylor} \quad \text{otherwise}$$

Paths of Variables under Forward Guidance









Note: Forward guidance: a=-0.25.

- Inflation bias under FG due to management of expectations
  - Higher inflation expectations at ZLB
  - Lower real int. rates at ZLB.
  - Ultimately, increases exp. prod. Costs (asymmetric) at steady state
- Cost Channel amplifies inflation bias
- Recession is milder under FG, irrespective of Cost Channel

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Conclusion

- Liquidity trapped recession due to a large demand shock is milder and welfare increasing under Forward Guidance Rule
- An appropriate Forward Guidance Rule can avoid deflation bias
- Cost Channel economy:
  - Is more likely to hit ZLB and remain longer
  - Has amplified inflation bias under Forward guidance

Policy implications:

An endogenous Forward guidance rule increases welfare

Central banks should pay careful attention on Cost Channel when they set policies at the ZLB

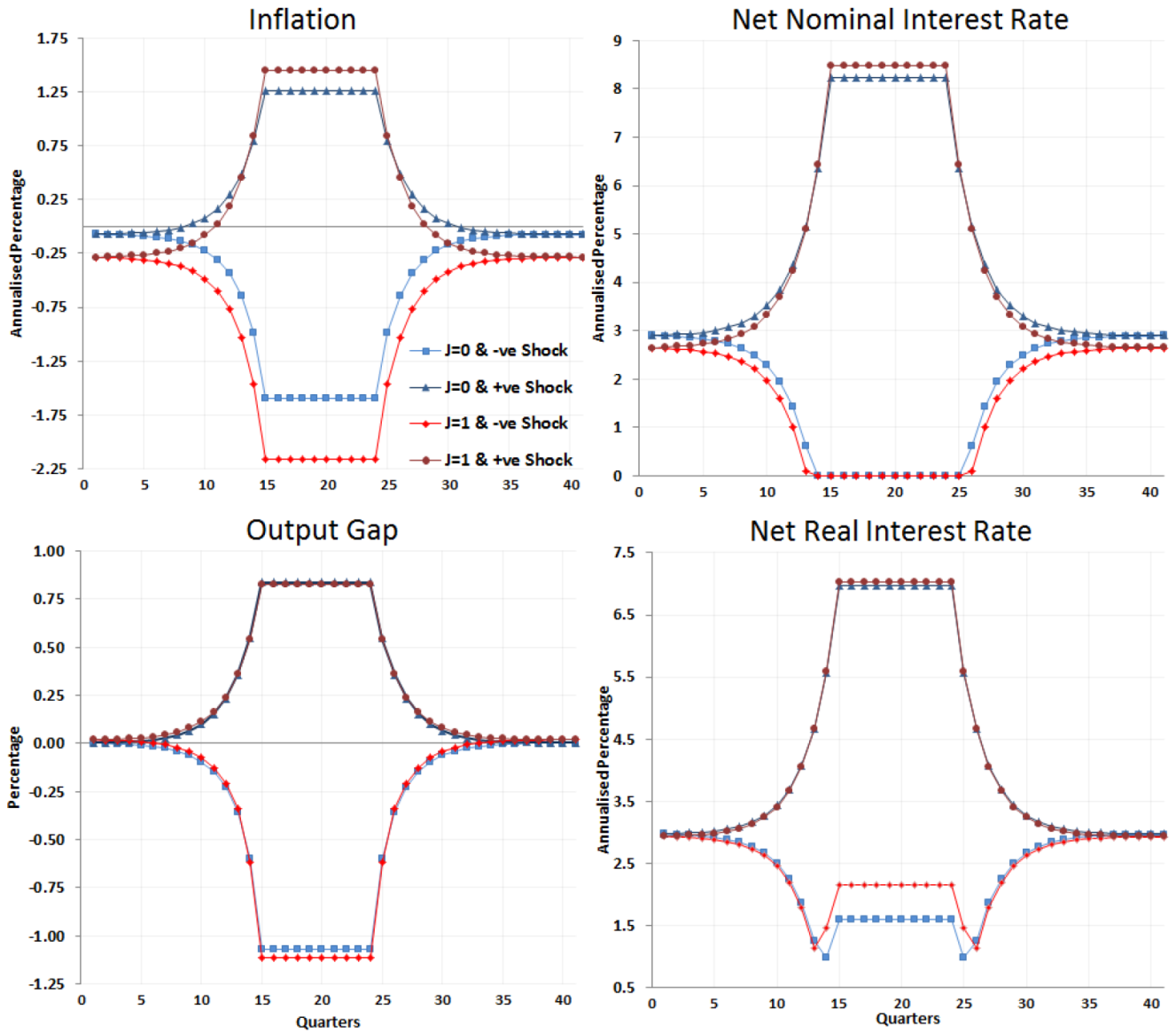
Thank you

Annex

Deflation Bias

- If Inflation is lower than the target rate in the steady state, we call that a Deflation bias “risky” steady state
- The risky steady state is the point where economic agents choose to stay at a given date if they expect future risk (asymmetry)
- Lower inflation observed in many countries including the USA following the Great Recession can be explained by deflation bias risky steady state

Figure 5.8: Paths of Variables to a Large Positive Shock to the Economy under CTTR



Note: Path of the natural interest rate to a positive shock is symmetric to the negative shock. Accordingly, the maximum value of the net natural interest rate during the liquidity trap is 12%.

3.4 Welfare Calculation

The welfare calculation is based on the procedure used by Adam and Billi (2007, p.748). Accordingly, the utility equivalent percentage loss of consumption in the steady state is given by, $p = 100 * \frac{1}{\sigma}\left(-1+\sqrt{1+\frac{2(1-\beta)L'}{1/\sigma}}\right)$. Here, $L' = \frac{1}{2}\frac{\omega\theta(1+\zeta\theta)}{(1-\omega)(1-\omega\beta)}\sum_{i=0}^{\infty}\beta^i(\pi_{t+i}^2+\lambda x_{t+i}^2)$, where, λ is the weight assigned to the output gap in the monetary authority's objective function,[11] ζ is elasticity of a firm's real marginal cost and θ is the elasticity of substitution among production varieties.[12]

Macroeconomic Performance under Forward Guidance

Measure	J=0						J=1					
	CTTR	Value of FG Parameter: a					CTTR	Value of FG Parameter: a				
		-0.25	-0.5	-0.75	-1	-10		-0.25	-0.5	-0.75	-1	-10
% of time nominal Interest rate bounded by Zero[1/]	5.92	2.29	4.56	5.76	5.91	5.92	9.86	3.06	7.76	9.52	9.83	9.86
Additional periods i binding	0	3	2	1	1	1	0	3	2	1	1	1
Lowest value (%):												
Net Nom. Interest Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inflation	-1.59	-1.21	-1.37	-1.54	-1.57	-1.59	-2.16	-1.40	-1.91	-2.11	-2.14	-2.16
Output Gap	-1.07	-0.91	-0.98	-1.04	-1.05	-1.07	-1.11	-0.93	-1.03	-1.09	-1.09	-1.11
Steady state value (%) of:												
Net Nom. Interest Rate	2.87	3.04	3.02	2.90	2.88	2.87	2.60	3.27	2.81	2.64	2.60	2.60
Inflation	-0.08	0.01	0.01	-0.06	-0.08	-0.08	-0.29	0.21	-0.14	-0.26	-0.29	-0.29
Output Gap	-0.003	0.005	-0.001	-0.002	-0.003	-0.003	0.009	-0.009	0.005	0.008	0.009	0.009
Standard Deviation[1/] of:												
Net Nom. Interest Rate	1.706	x 0.93	x 0.99	x 1.00	x 1.00	x 1.00	1.810	x 0.98	x 1.00	x 1.00	x 1.00	x 1.00
Inflation	0.453	x 0.85	x 0.96	x 0.99	x 1.00	x 1.00	0.590	x 0.90	x 0.97	x 0.99	x 1.00	x 1.00
Output Gap	0.290	x 0.91	x 0.97	x 0.99	x 1.00	x 1.00	0.290	x 0.89	x 0.96	x 0.99	x 1.00	x 1.00
Welfare Loss[1/]	0.0156	x 0.46	x 0.59	x 0.89	x 0.97	x 1.00	0.0600	x 0.41	x 0.47	x 0.88	x 1.00	x 1.01

1/ Relative to the value of CTTR.