INFREQUENT BUT LONG-LIVED ZERO-BOUND EPISODES AND THE OPTIMAL RATE OF INFLATION

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UC San Diego & NBER

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- Central banks in the majority of developed countries use implicit or explicit inflation target of 1 to 3 percent per year.
- Recent interest is reignited by hitting the zero lower bound on nominal interest rates

"The crisis has shown that interest rates can actually hit the zero level, and when this happens it is a severe constraint on monetary policy that ties your hands during times of trouble. As a matter of logic, higher average inflation and thus higher average nominal interest rates before the crisis would have given more room for monetary policy to be eased during the crisis and would have resulted in less deterioration of fiscal positions. What we need to think about now is whether this could justify setting a higher inflation target in the future."

Olivier Blanchard, February 12th, 2010

WHY IS BINDING ZLB BAD?

- The Fed can't stimulate the economy using conventional tools.

- Policy rate unresponsive to developments in the economy raises the possibility of indeterminate ("sunspot") equilibria.

- As a result:
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  b. deflation spirals
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BUT THE COST DEPENDS ON THE **DURATION** OF A BINDING ZLB EPISODE.

ZLB DURATIONS IN DSGE MODELS

- Reifschneider and Williams (2000), Chung et al. (2012):
  - The frequency of ZLB for three popular DSGE models estimated on the post-WWII, pre-2007 data is typically less than 5 percent.
  - ZLB episodes longer than 8 quarters can be observed less than 1 percent of the time.
  - For the Great Moderation period, ZLB episodes are even shorter and less frequent.

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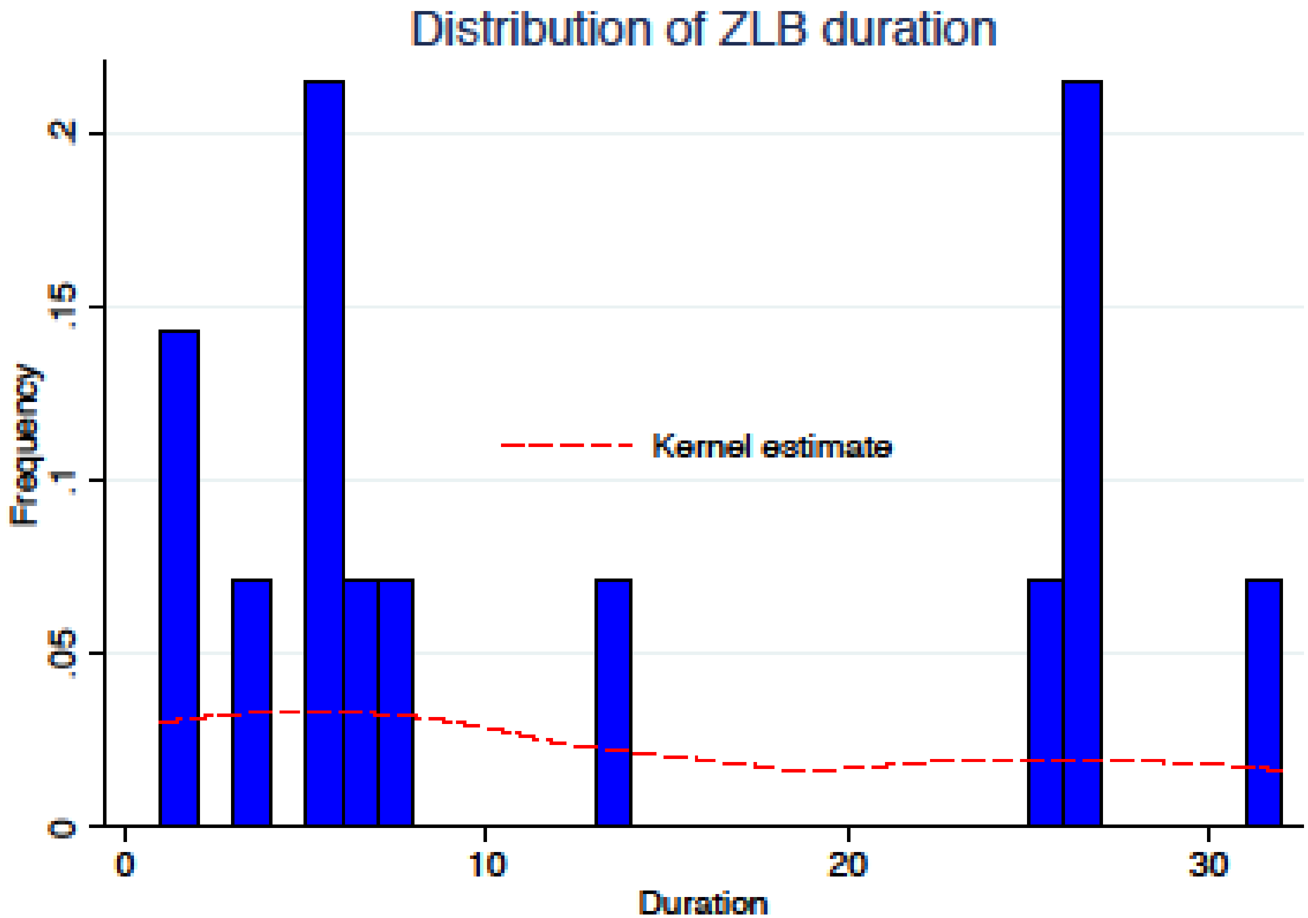
- Coibion, Gorodnichenko, and Wieland (2012)
  - Unconditional probability of hitting ZLB is 5%.

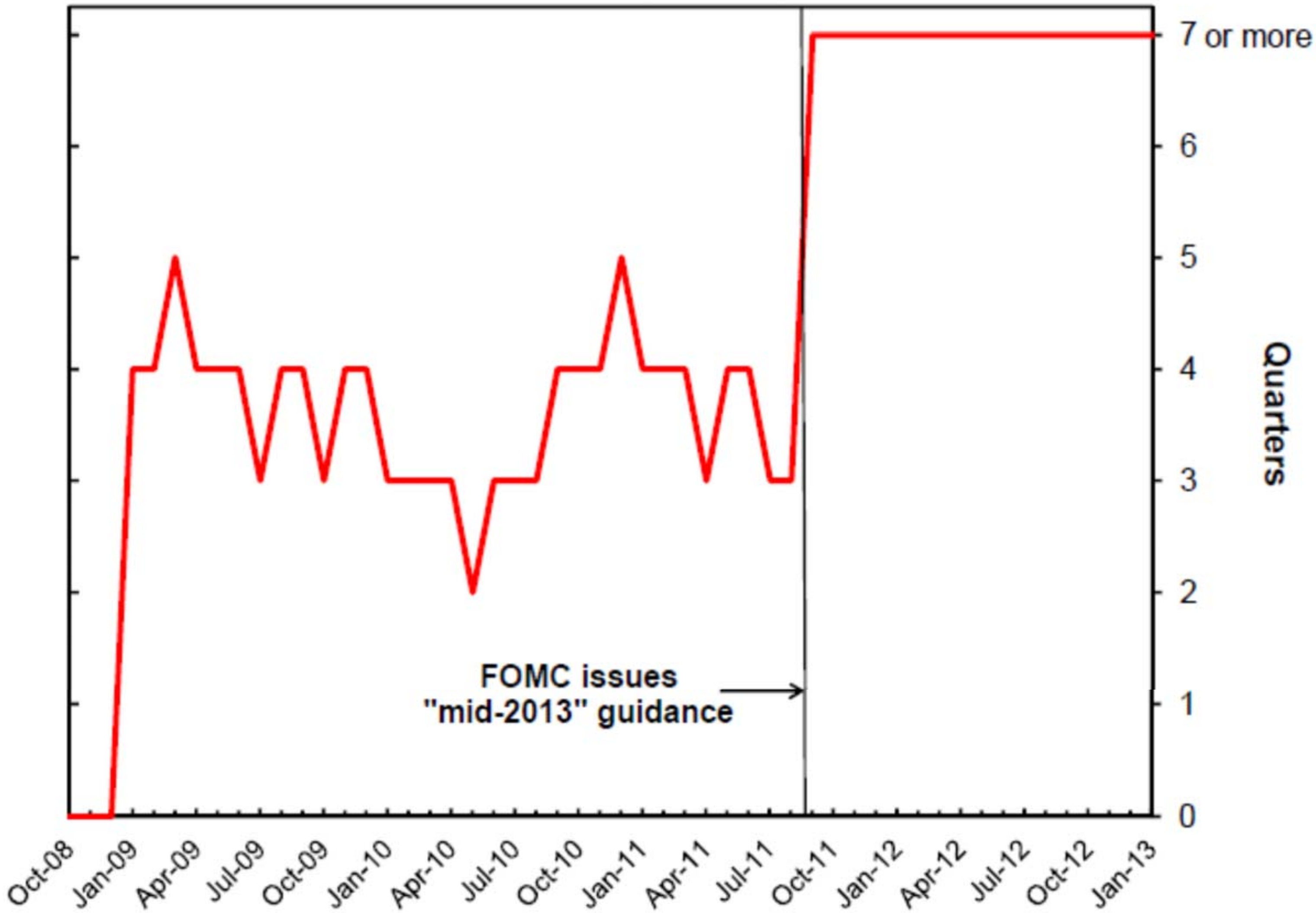
POST-WAR EXPERIENCES WITH THE ZLB

	Duration (quarters)	Duration (years)	Unconditional Frequency of ZLB
Average:	14.2	3.6	0.075
Average with all Euro countries:	12.3	3.1	0.085
Average w/o Japan:	11.5	2.9	0.058
Average w/o Norway, Australia & NZ:	14.2	3.6	0.108

DISTRIBUTION OF HISTORICAL ZLB DURATIONS



HOW LONG WOULD ZLB BIND IN THE U.S.?



Source: Swanson and Williams (AER 2014)

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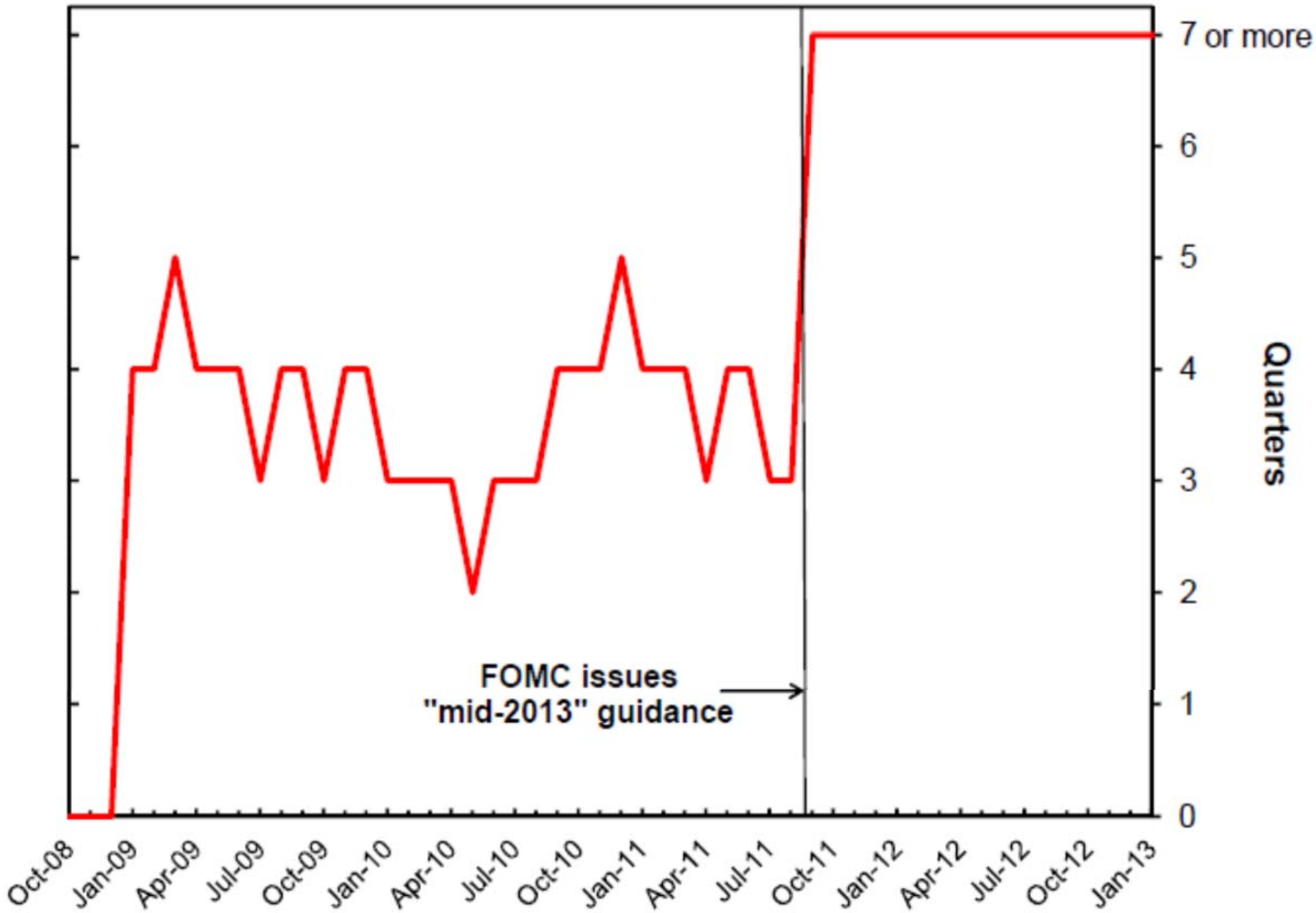

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ZLBs in models used by researchers and policymakers may be too short and too rare to matter.

PREVIEW OF THE PAPER

- Allow for positive steady state inflation rate in the basic New Keynesian model.
- Use second-order approximation to the consumer's utility for welfare calculations.
- Explicitly incorporate zero-lower bound on nominal interest rates.
- Consider alternative assumptions on how to model ZLB episodes.
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- Simulate the model to assess the optimal rate of inflation.

The optimal inflation rate is low (between 1% and 3%) but the magnitude can strongly vary depending on assumptions about ZLB duration.

CONTRIBUTION TO PREVIOUS WORK

- Optimal inflation in "modern" macroeconomic models
  - Billi (2009) and Walsh (2009): linearize around zero steady state inflation
  - Williams (2009): use FRB model (neither model nor welfare function are microfounded)
  - Schmidt-Grohe and Uribe (2007), Aruoba and Schorfheide (2009):
    - Incorporate motives to hold real money balances;
    - Focus on steady-state effects and introduce extensive indexation.
    - "No" zero lower bound.
  - Coibion, Gorodnichenko, and Wieland (2012): short-lived ZLB episodes
- Main difference from previous work
  - Consider long-lived ZLB

MODEL SUMMARY

Representative Consumer

- Labor Supply
- Consumption
- Saving/Borrowing

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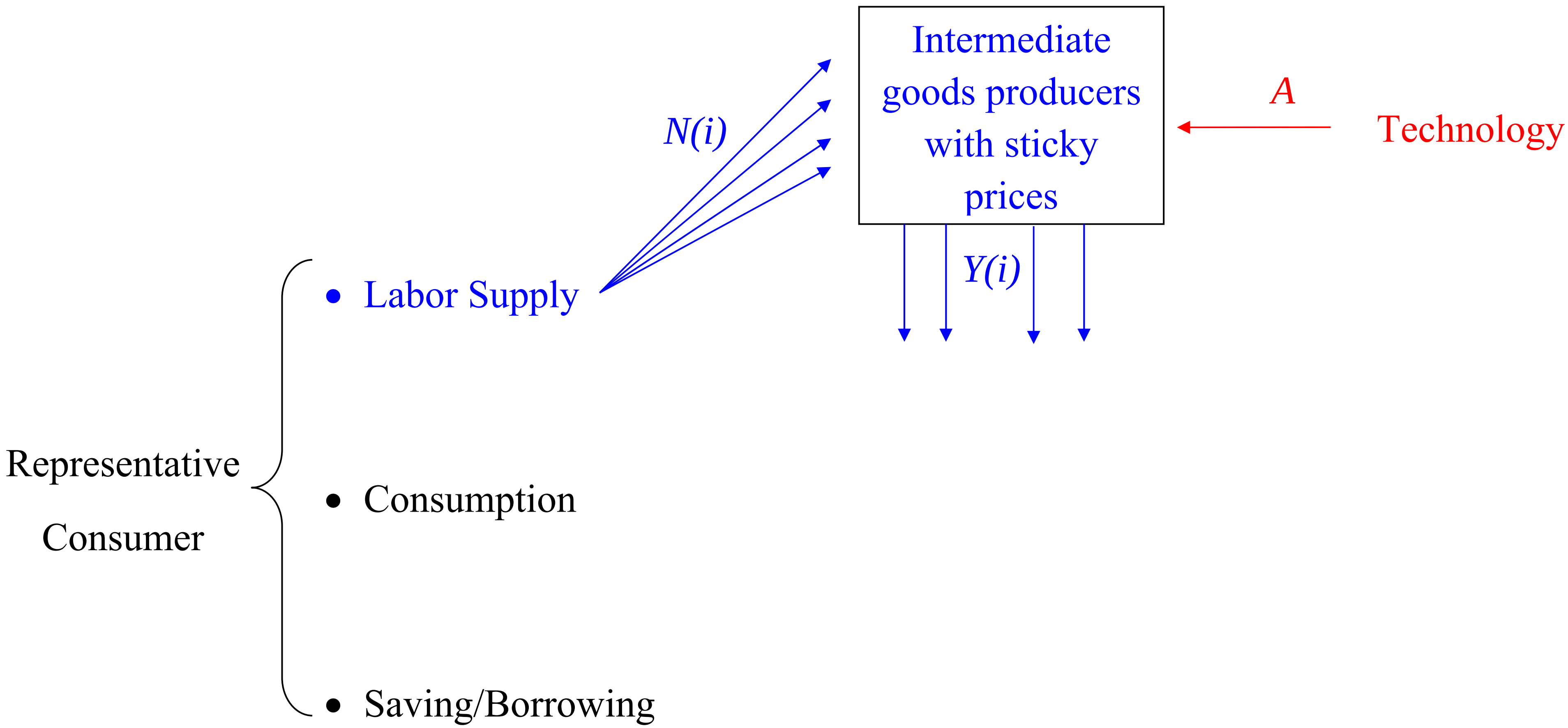

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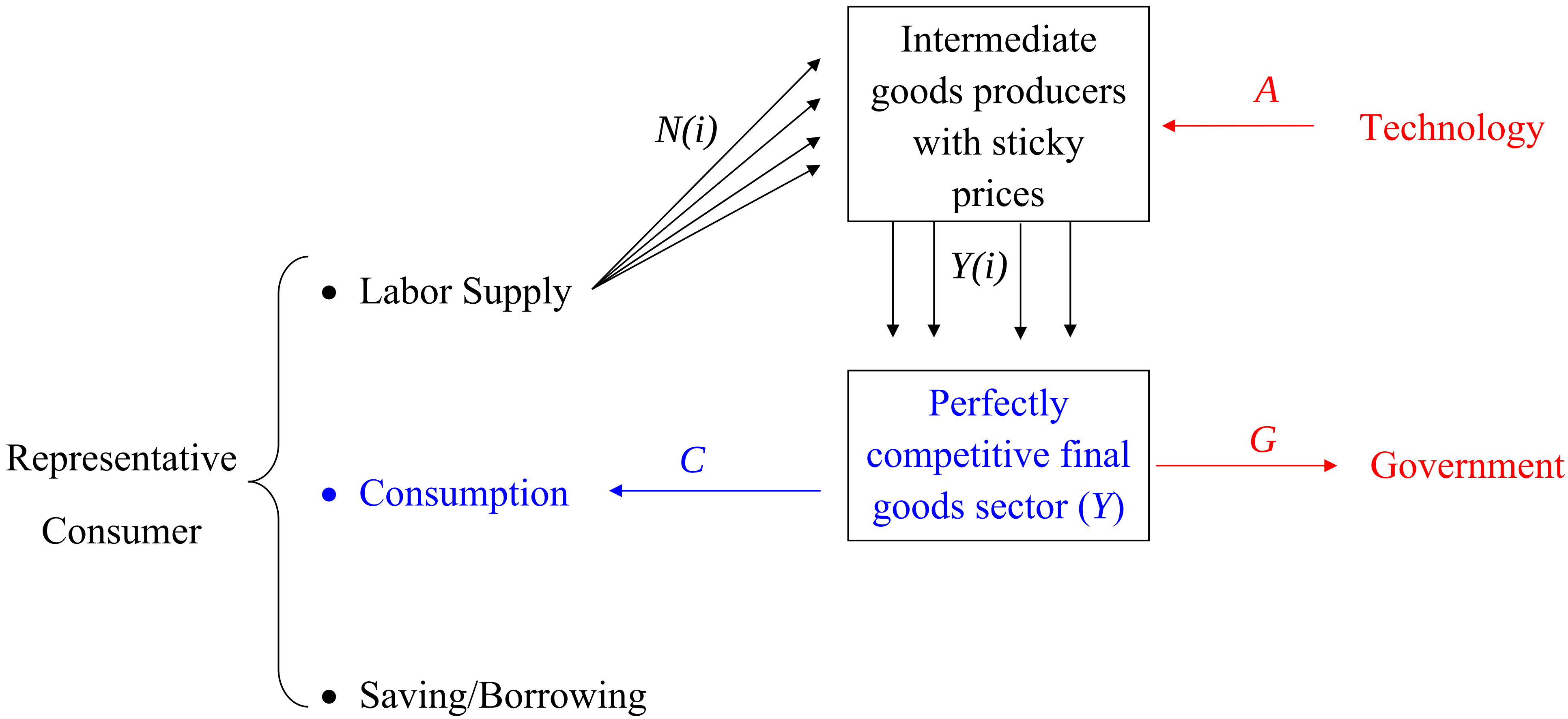

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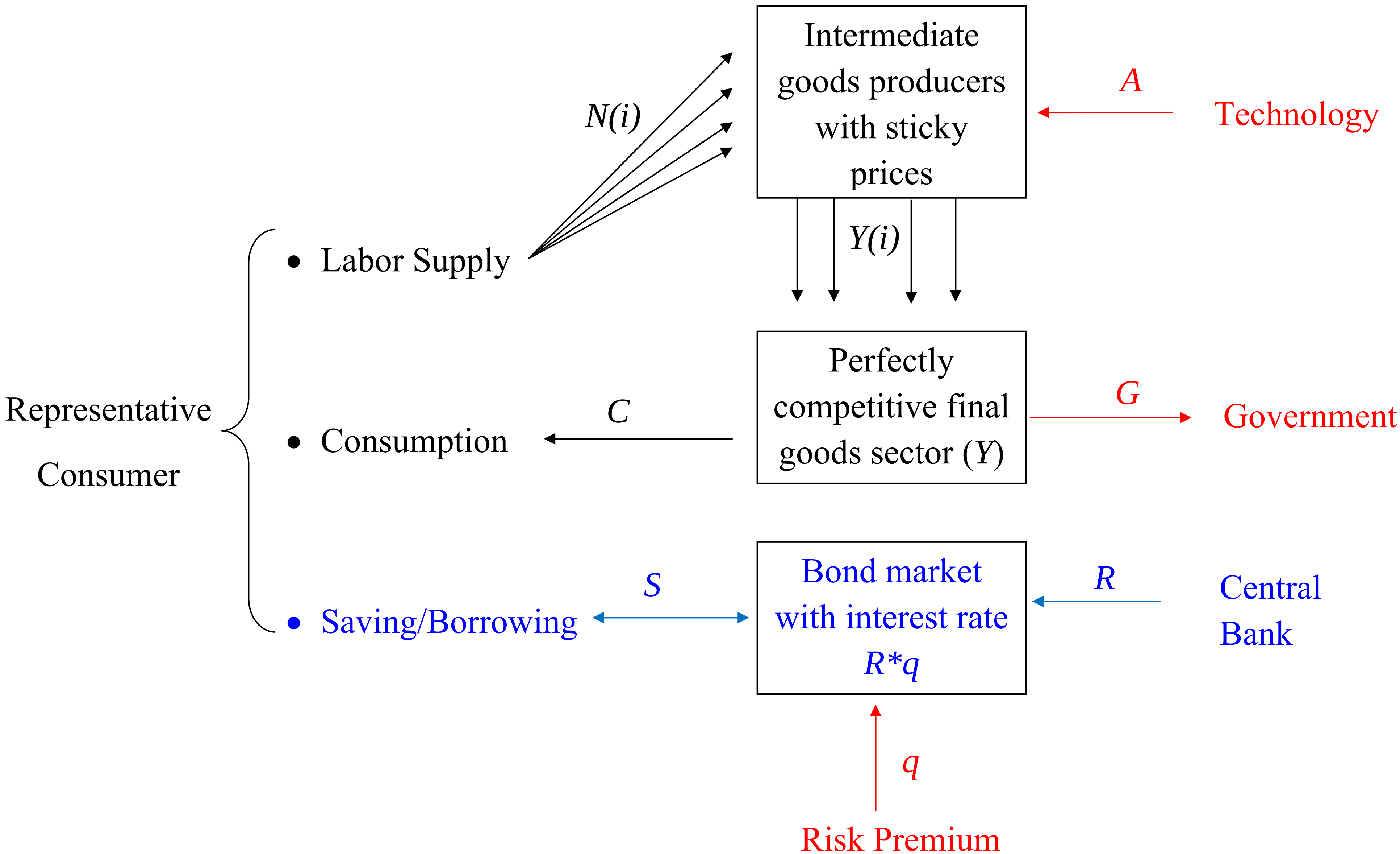

NEW KEYNESIAN MODEL

Taylor rule:

$$\hat{r}_t = \max\{\hat{r}_t^*, -\bar{r}\},$$

$$\hat{r}_t^* = \rho_1 \hat{r}_{t-1}^* + \rho_2 \hat{r}_{t-2}^* + (1-\rho_1-\rho_2)\left[\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + \phi_{gy} \widehat{gy}_t\right] + \varepsilon_t^r \,,$$

IS curve (consumption Euler equation):

$$\hat{\xi}_t = E_t\left[\hat{\xi}_{t+1} + \hat{r}_t - \hat{\pi}_{t+1} + \hat{u}_t^q\right],$$

where $\hat{\xi}_t = \frac{h}{(1-h)(1-\beta h)}\hat{c}_{t-1} - \frac{1+\beta h^2}{(1-h)(1-\beta h)}\hat{c}_t + \frac{\beta h}{(1-h)(1-\beta h)}E_t\hat{c}_{t+1}$ is the MU of consumption,

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Phillips curve:

$$\left(1+\frac{\theta}{\eta}\right)\left(\frac{\lambda\overline{\Pi}^{(\theta-1)}}{1-\lambda\overline{\Pi}^{(\theta-1)}}\right)\hat{\pi}_t = \sum_{j=0}^{\infty}\left[\gamma_2^j(1-\gamma_2) - \gamma_1^j(1-\gamma_1)\right]\left[\hat{y}_{t+j} + \hat{\xi}_{t+j}\right]$$
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where $\gamma_1 = \lambda\beta\overline{\Pi}^{(\theta-1)}$ and $\gamma_2 = \gamma_1\overline{\Pi}^{(1+\theta/\eta)}$, $\overline{\Pi}$ is the level of (gross) trend inflation, $\hat{u}_t^m$ is the cost-push shock.

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Welfare:

$$\Theta_0 + \Theta_1 var(\hat{y}_t) + \Theta_2 var(\hat{\pi}_t) + \Theta_3 var(\hat{c}_t)$$

Risk Premium Shock

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Alternative assumption: Regime-switching

$\hat{u}_t^q$ takes two values: 0 and $\Delta > 0$

Probability of switching from 0 to Δ is i.i.d. and equal to p_{12}

Once switched to Δ, $\hat{u}_t^q$ stays at the elevated level for T_q period and then returns to 0.

BASELINE PARAMETERS

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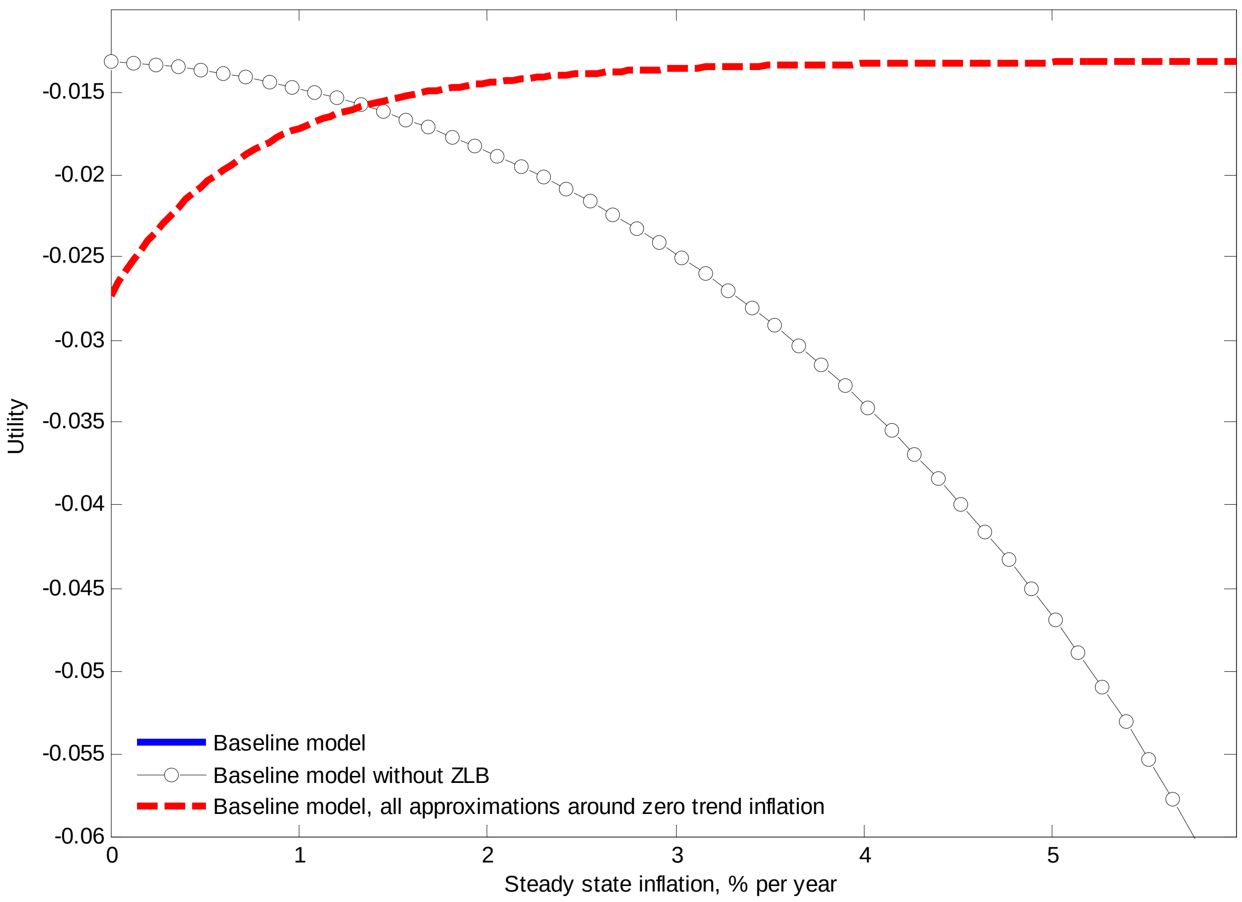
- Persistence and variance of shocks from Smets and Wouters (AER 2007).
- Persistence of risk-premium shocks: consider a range of possibilities.

THE OPTIMAL INFLATION RATE IN THE BASELINE CALVO MODEL



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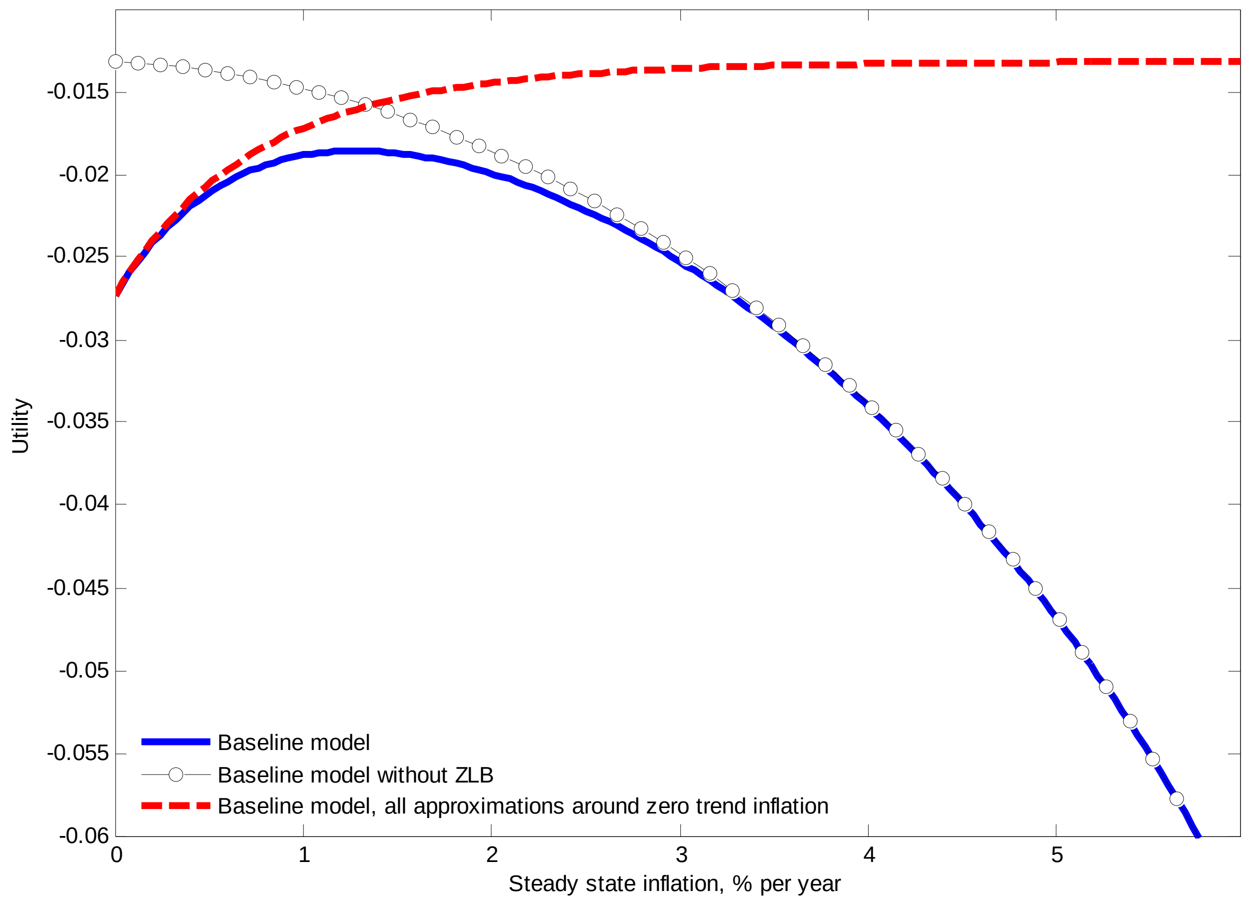
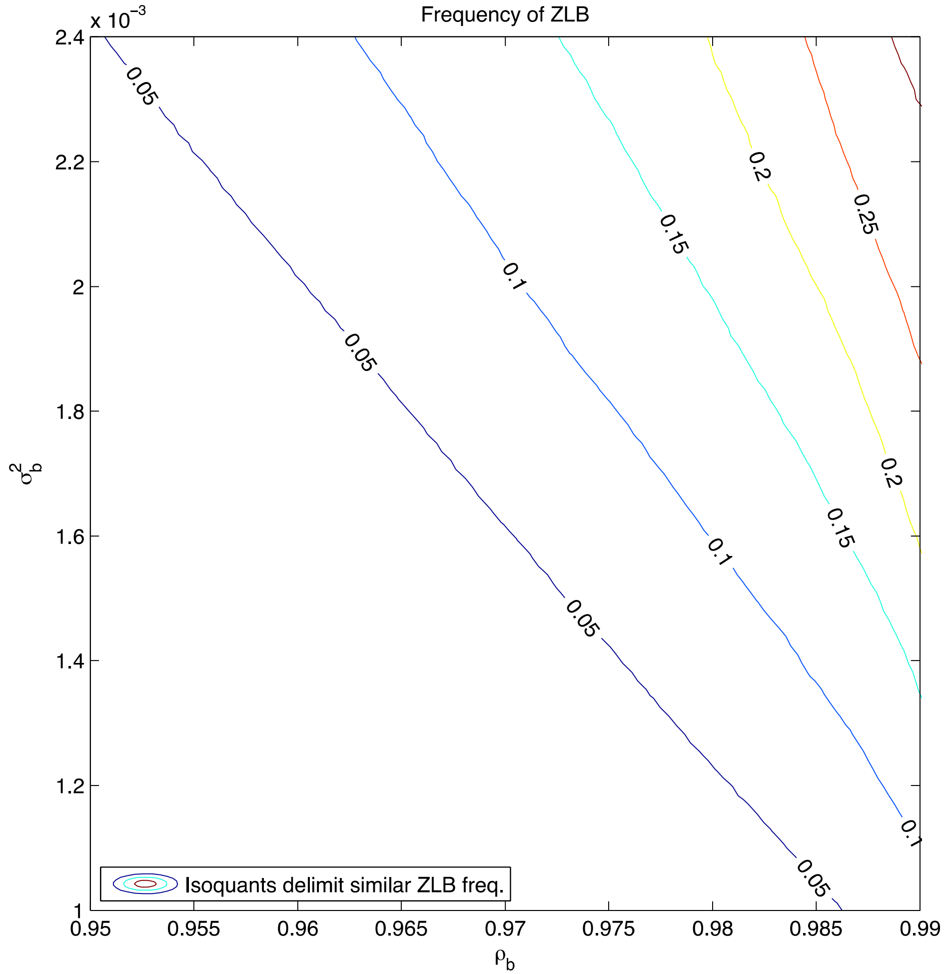


The optimal rate of inflation is 1.5%

UNCONDITIONAL FREQUENCY OF ZLB EPISODES

Panel A: AR(1) model



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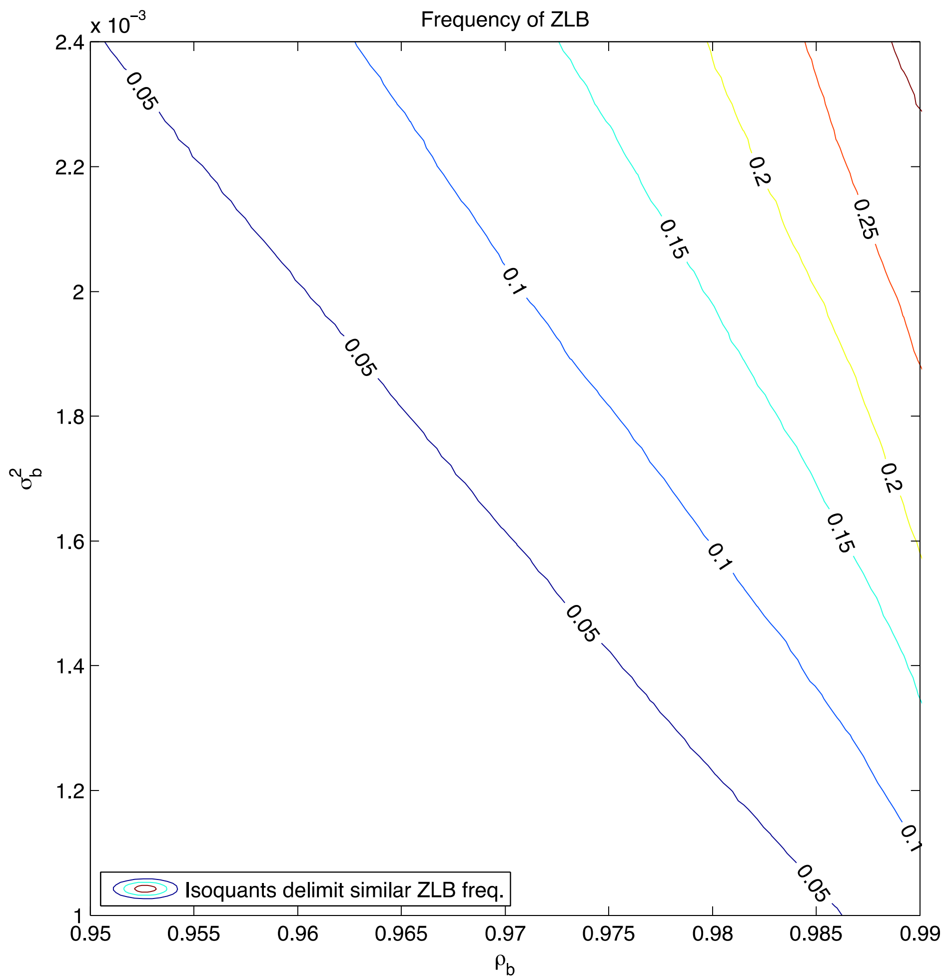
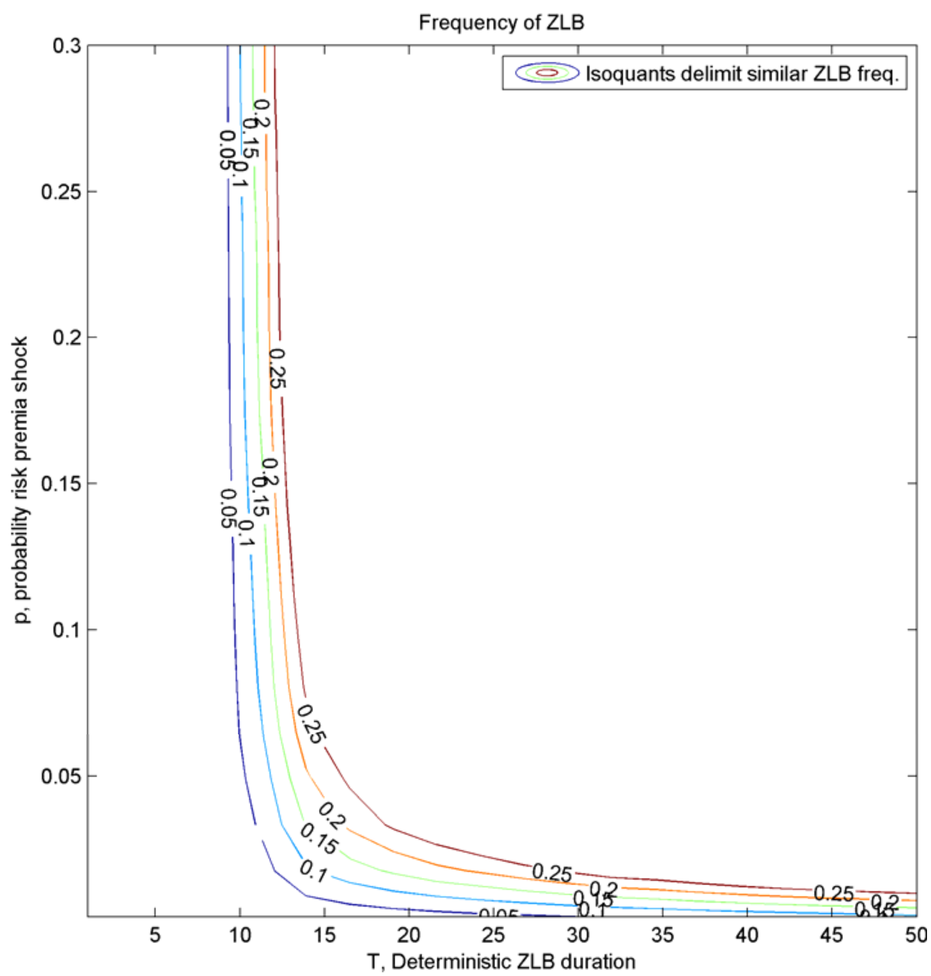


Panel B: Regime-switching model



Duration of ZLB episodes

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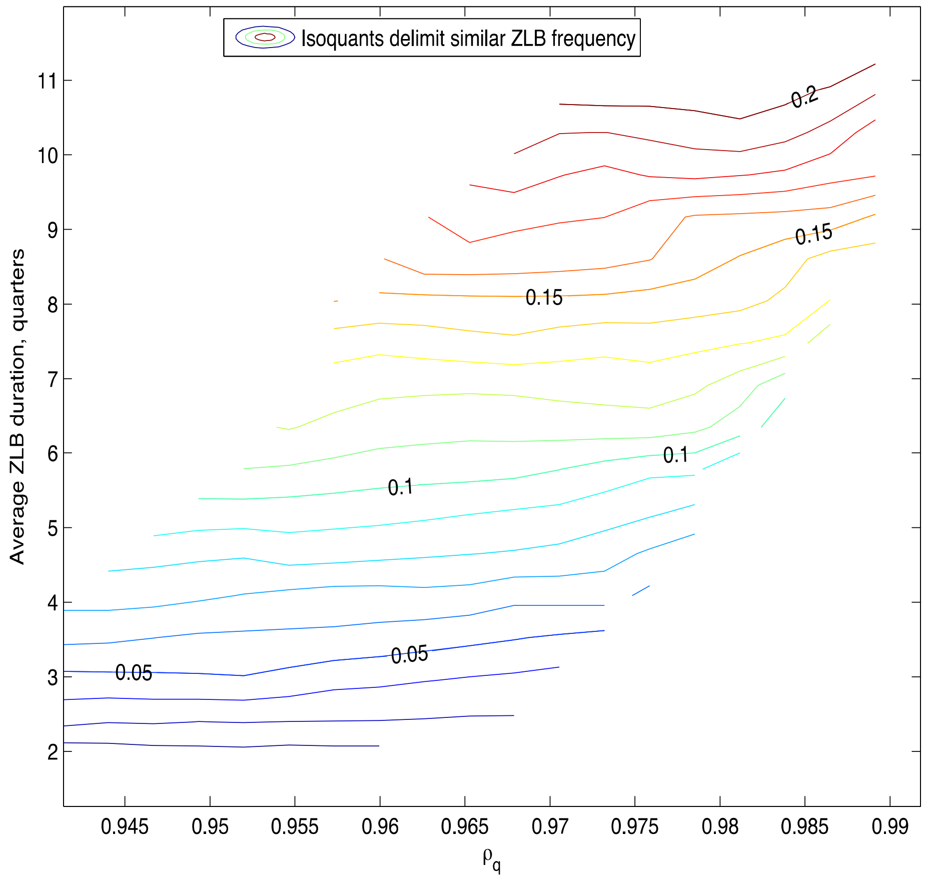

DURATION OF ZLB EPISODES

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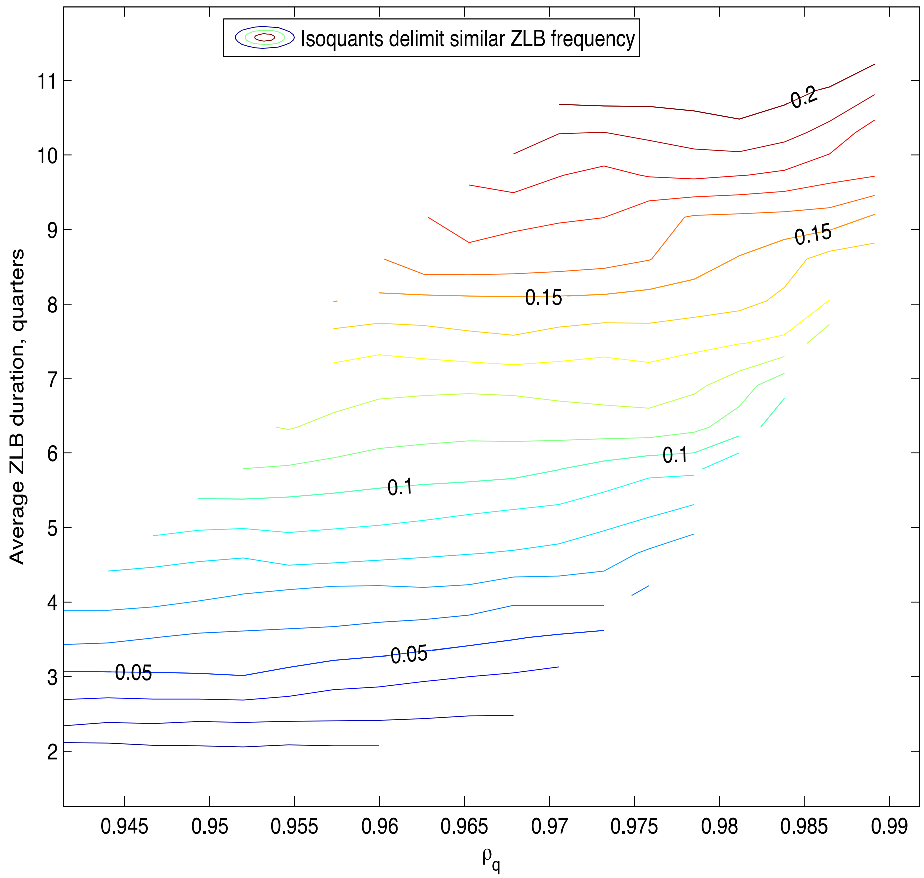

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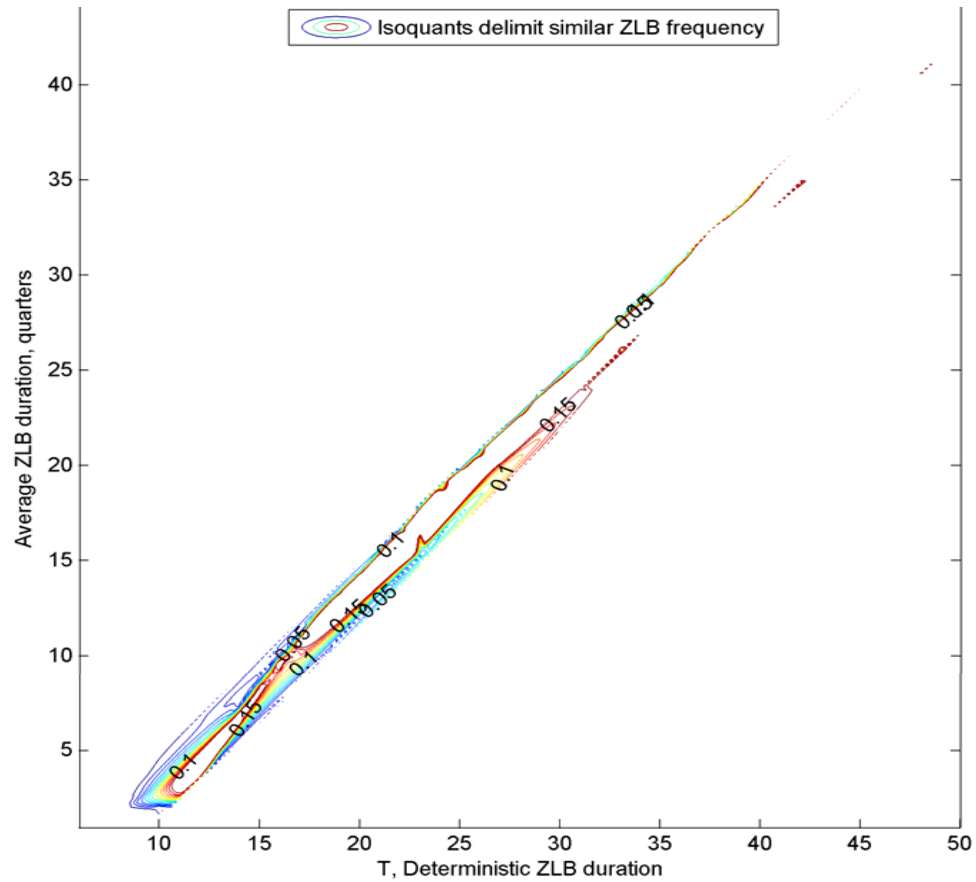
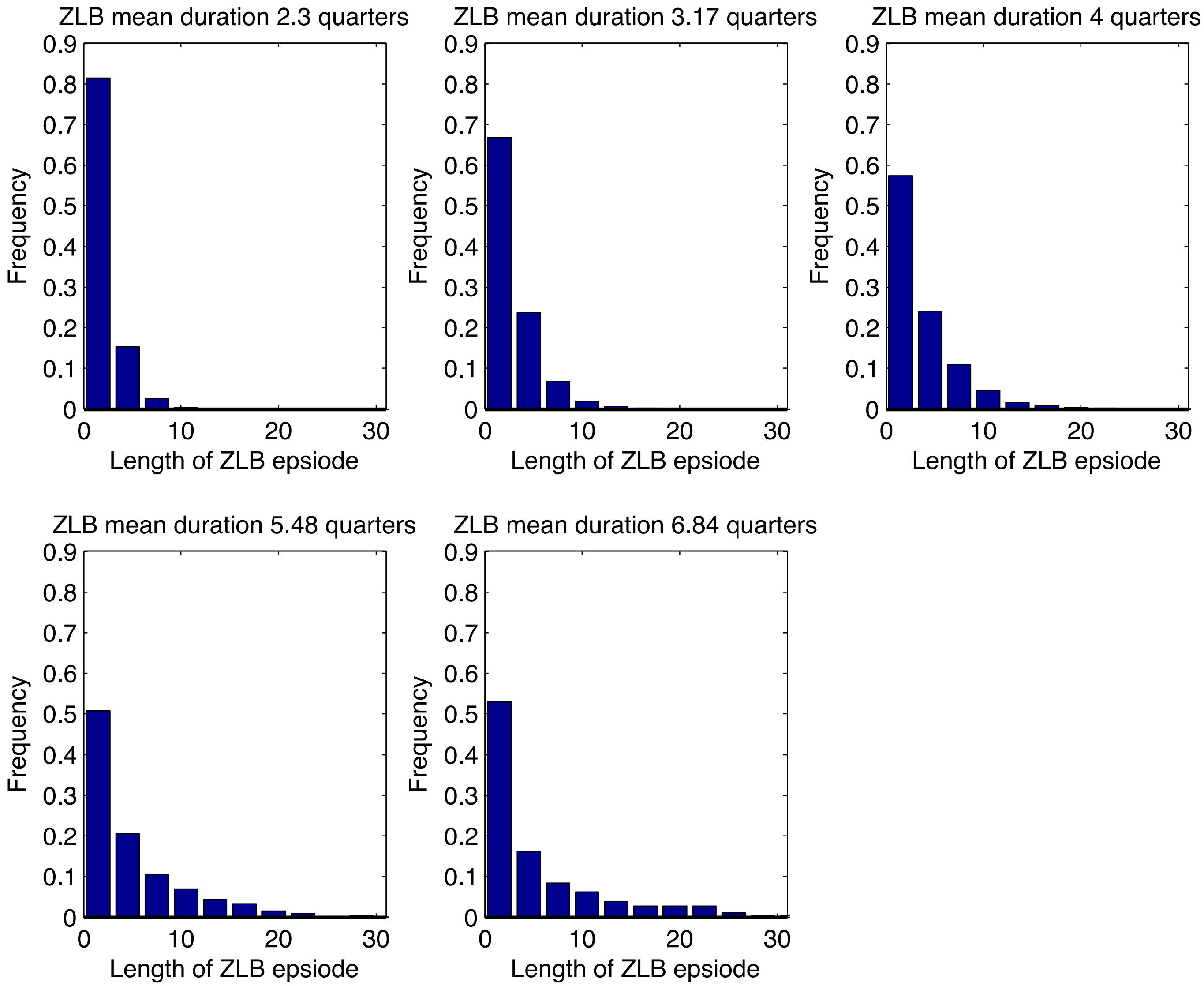


DURATION OF ZLB EPISODES WITH AR(1) SHOCKS



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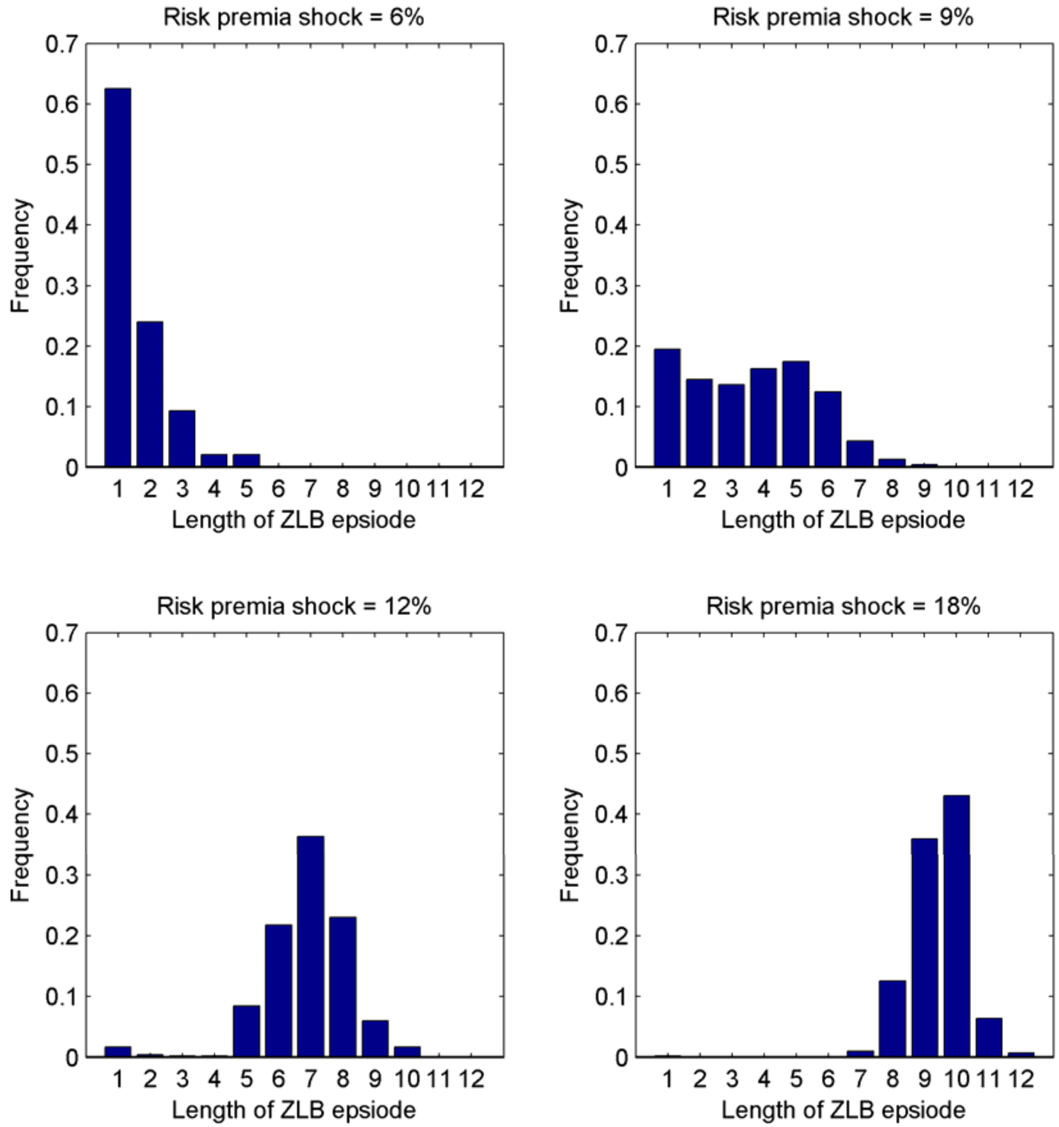

Regime-switching approach appears to be a better way to approximate the distribution of ZLBs in the data.

WELFARE LOSSES AT FIXED FREQUENCY OF ZLB

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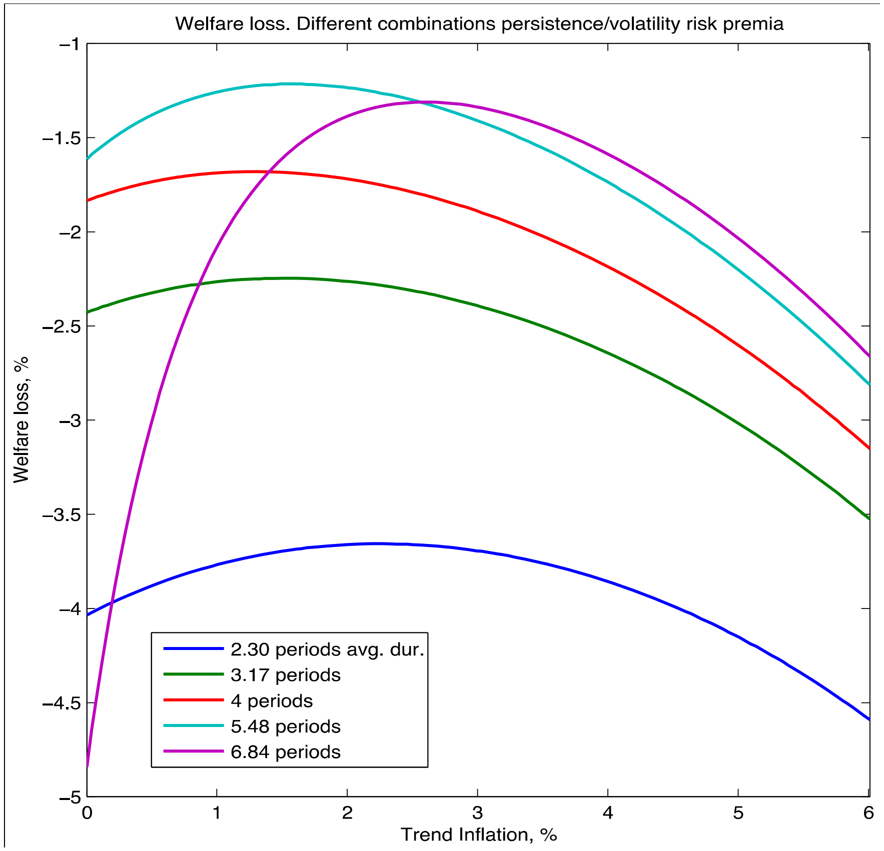

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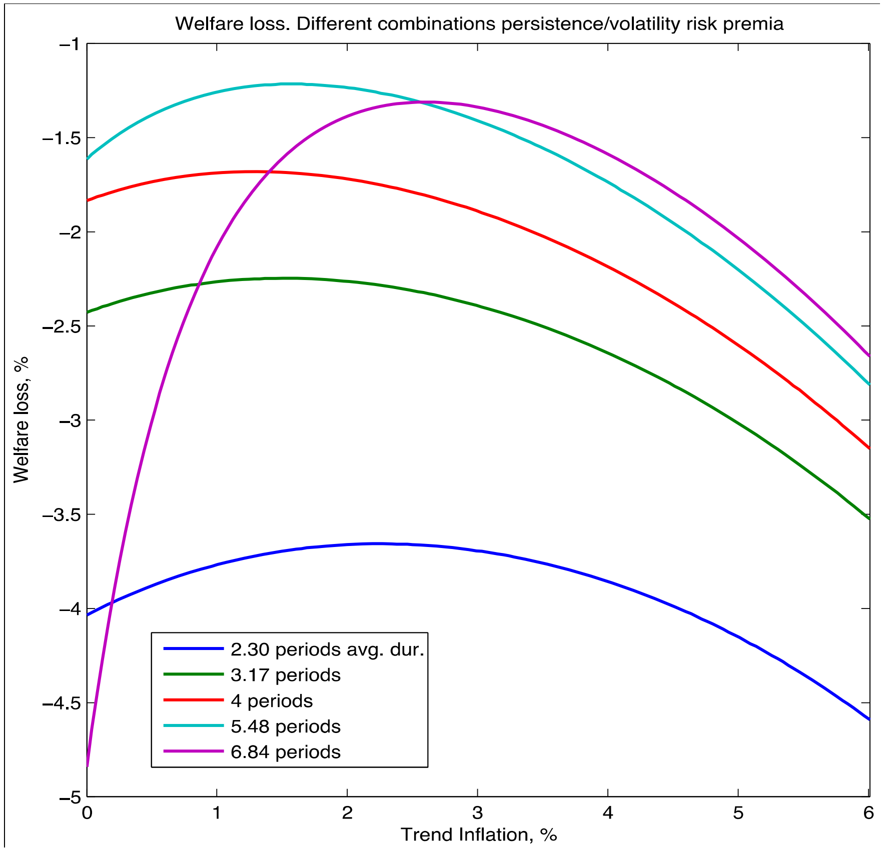

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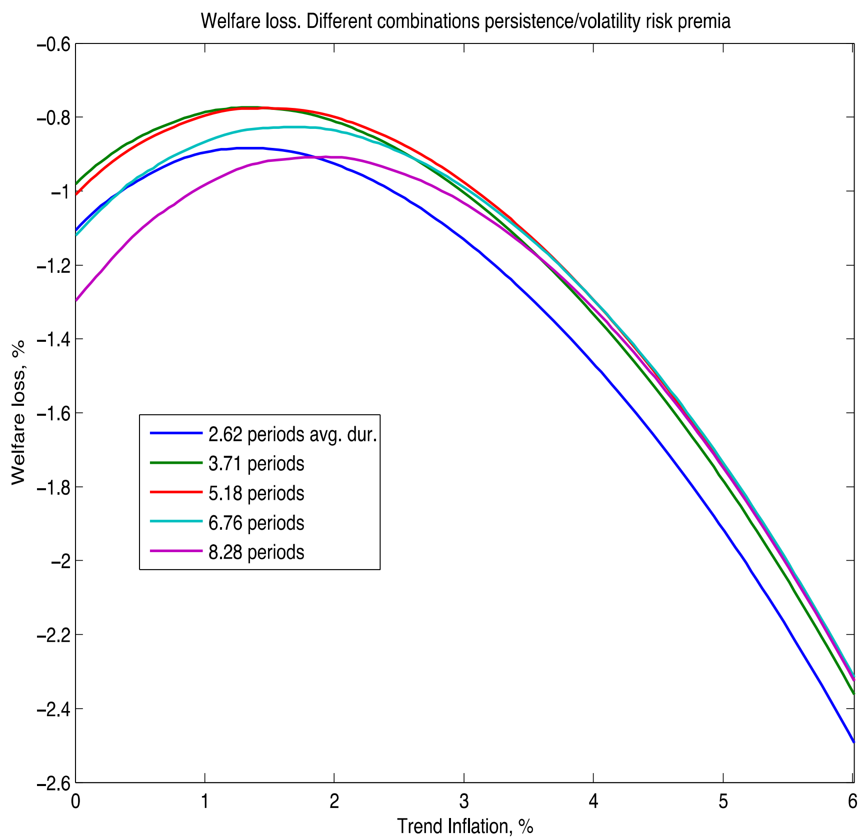

COST OF ZLB PER HIT

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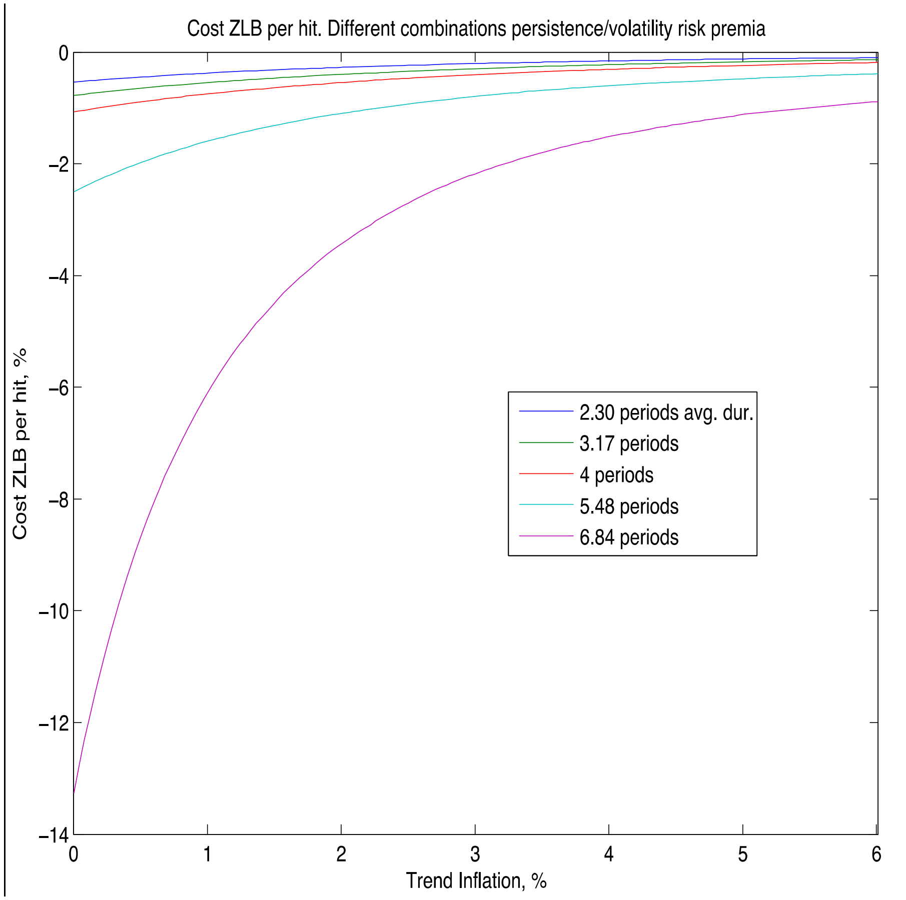

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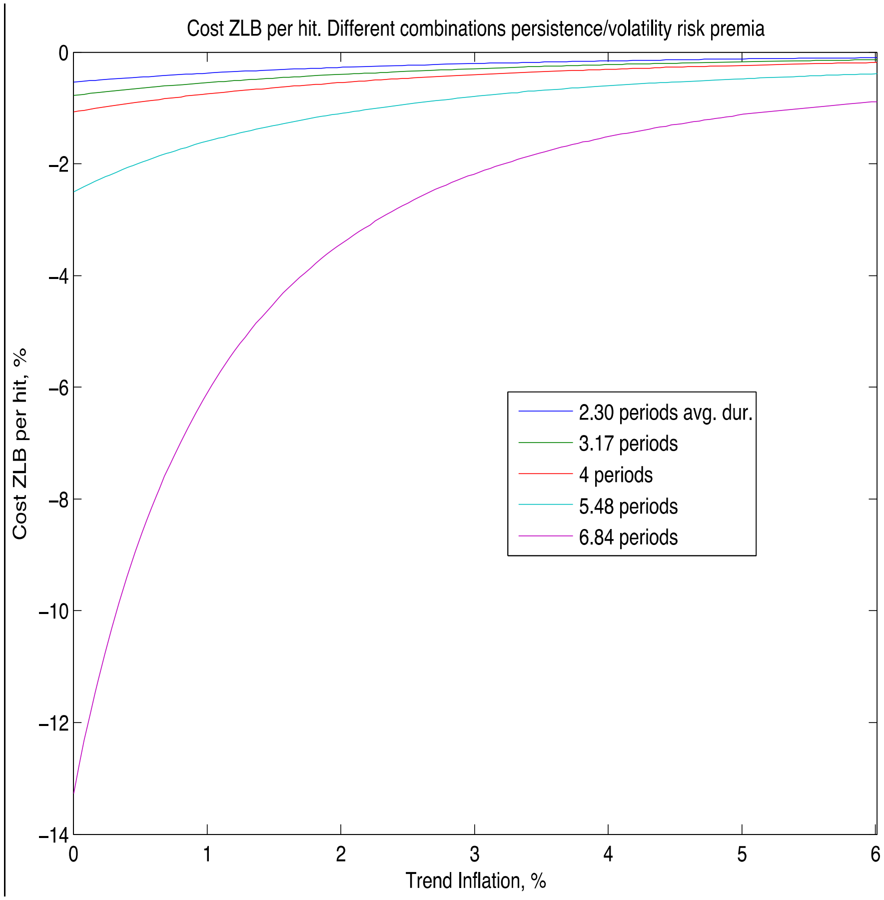

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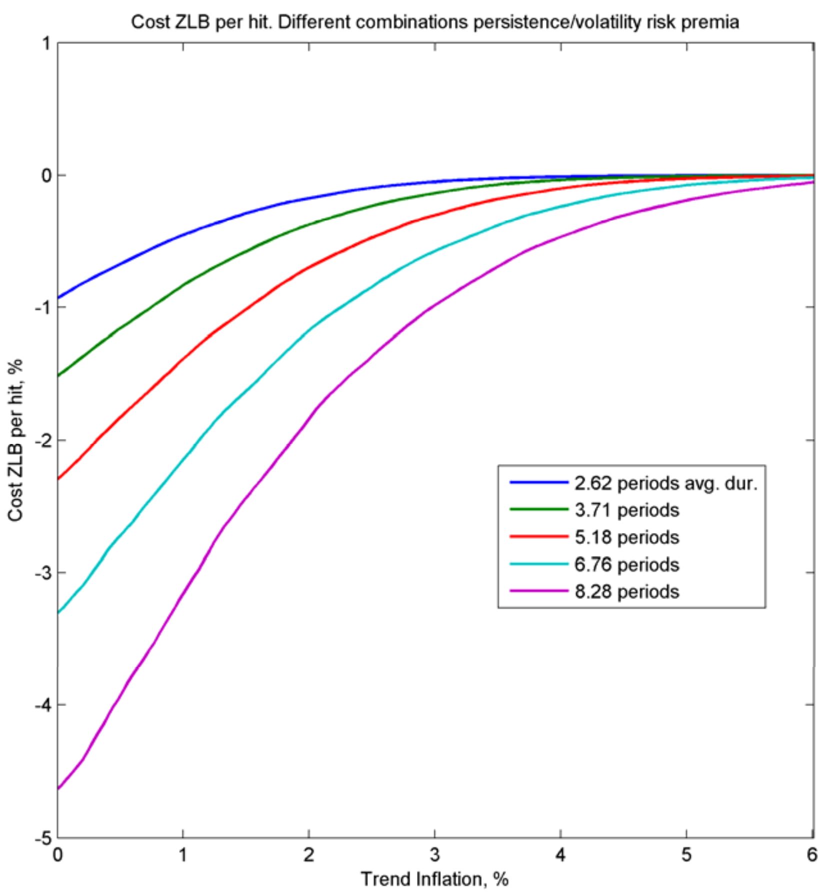

Optimal Inflation for Different Freq. and Durations of ZLB Episodes

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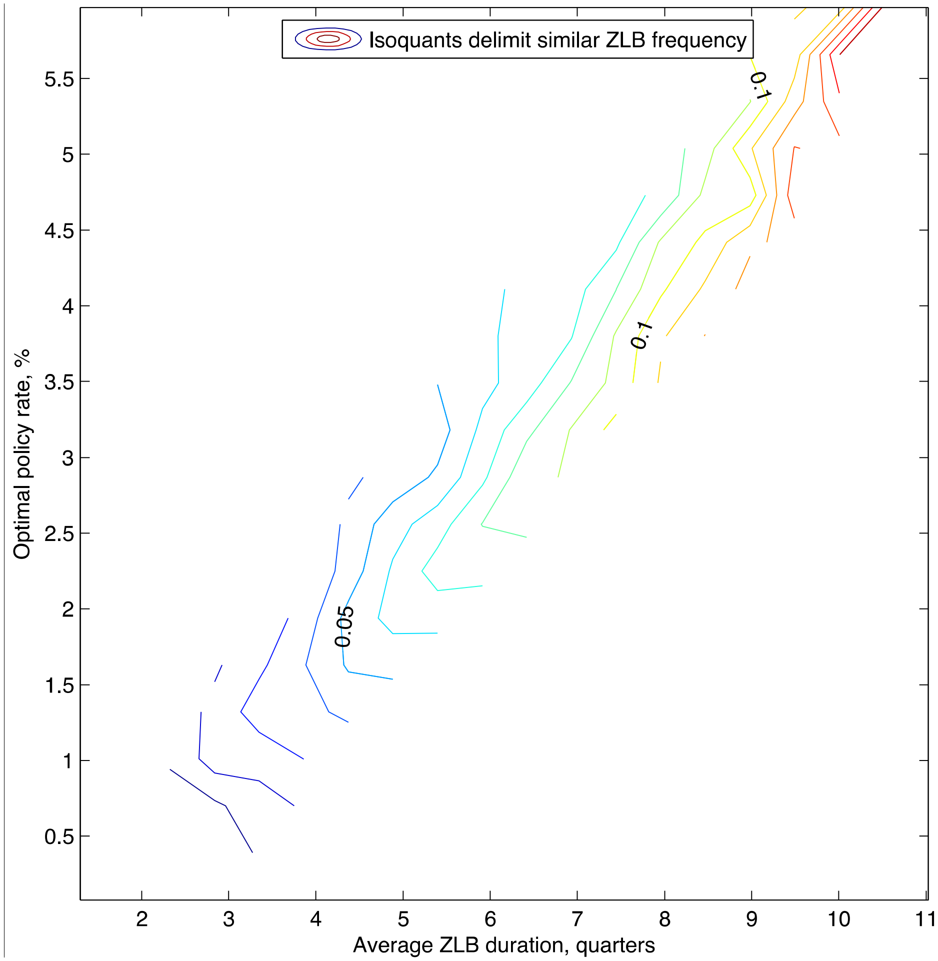

OPTIMAL INFLATION FOR DIFFERENT FREQ. AND DURATIONS OF ZLB EPISODES

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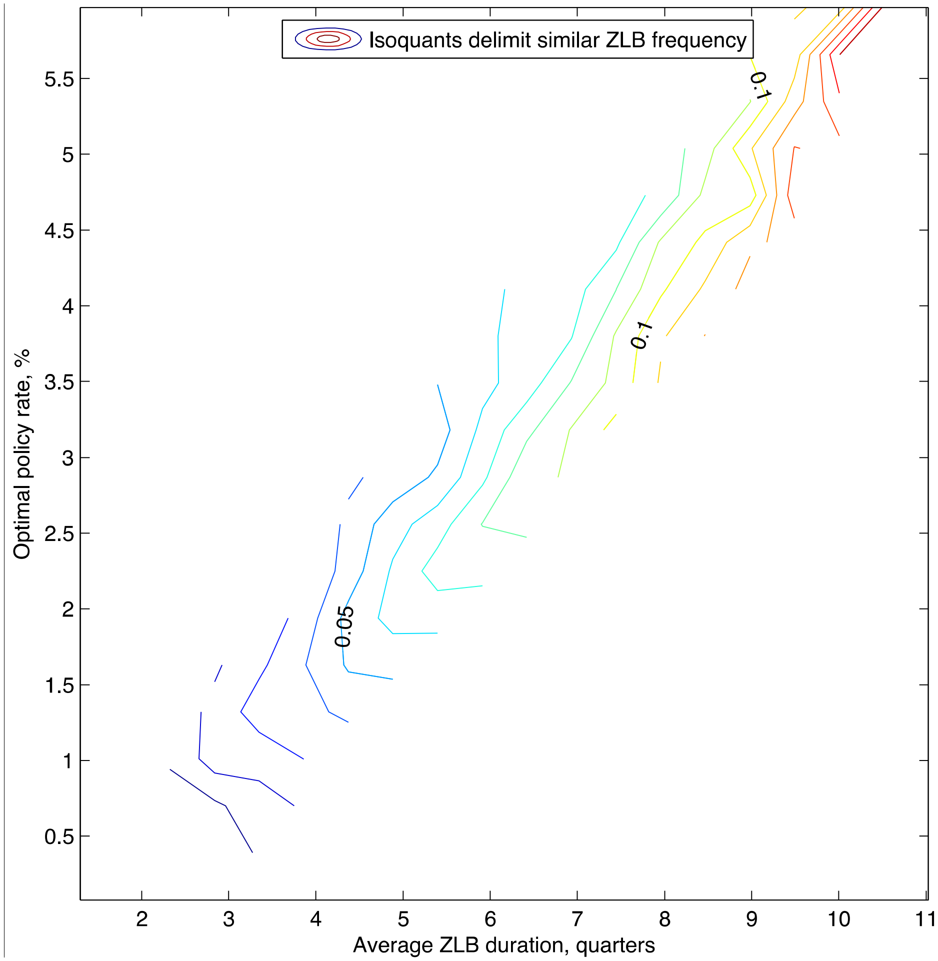

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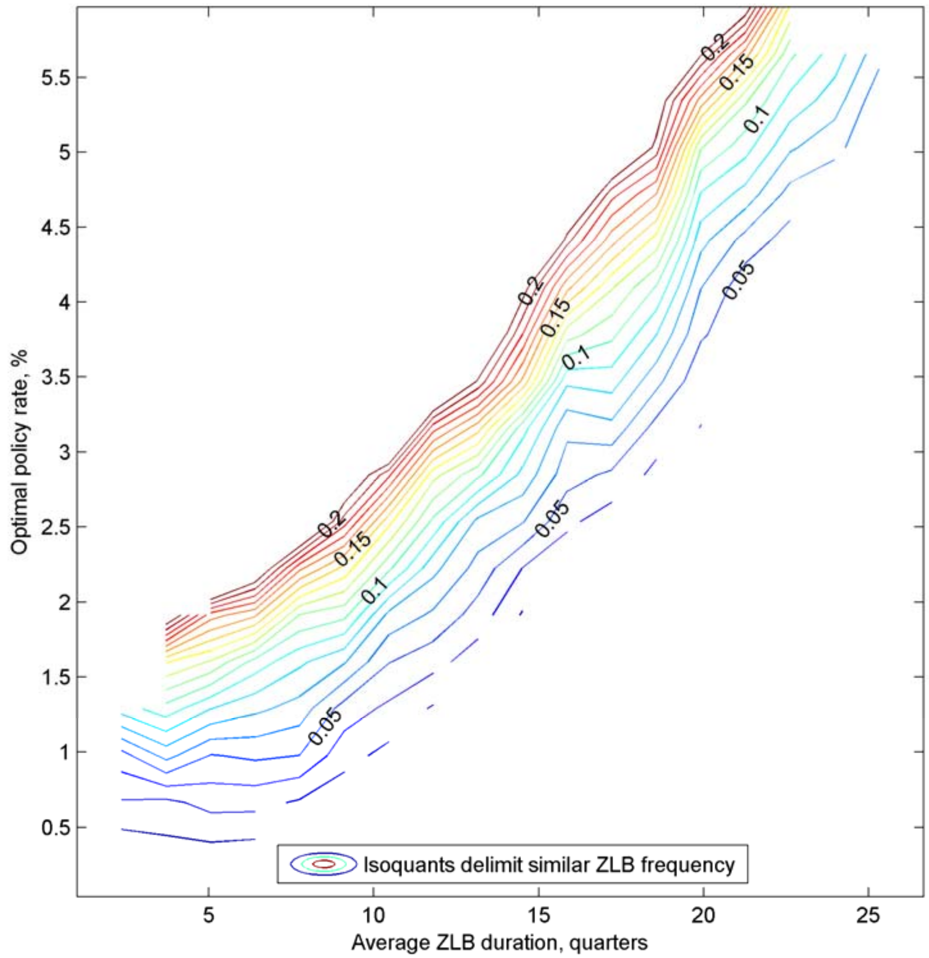

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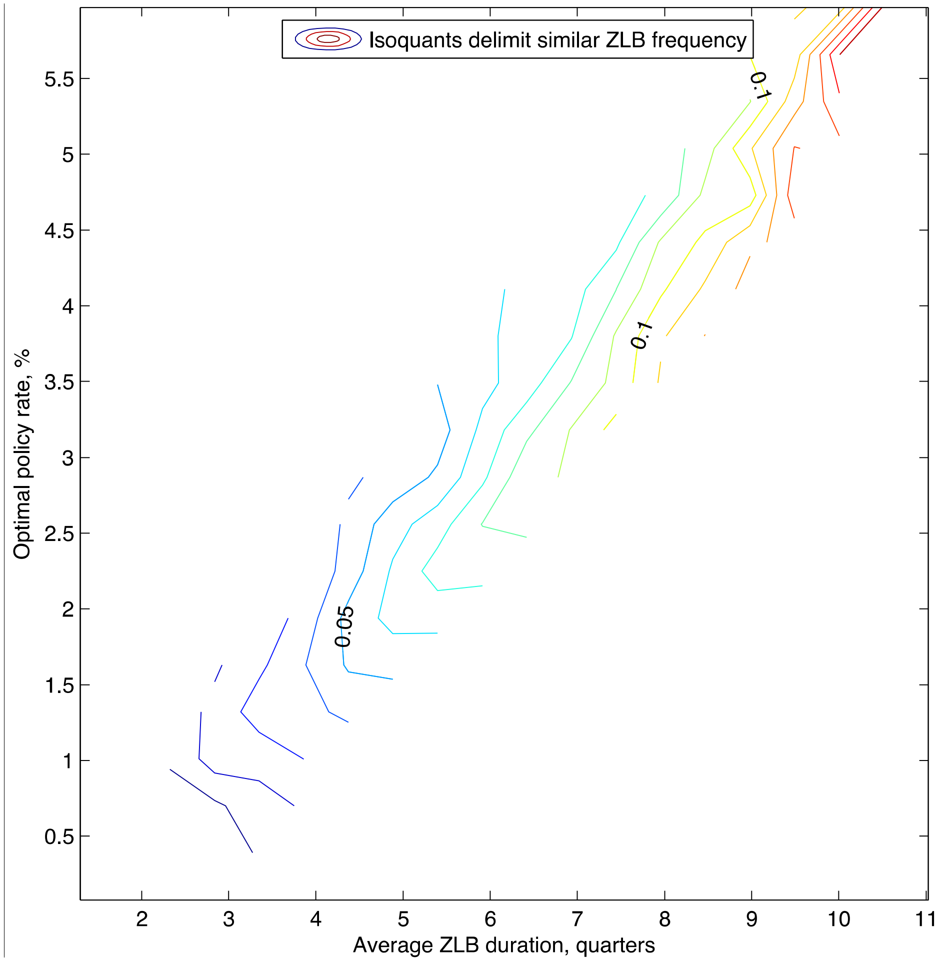
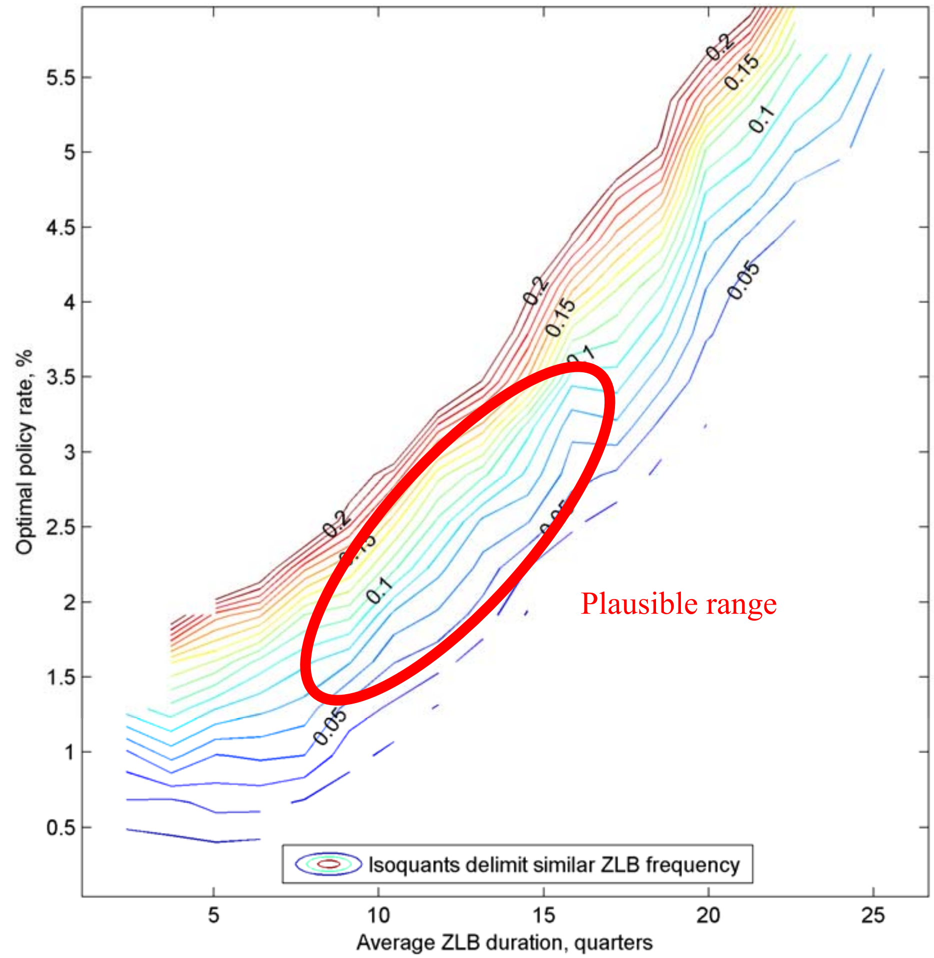


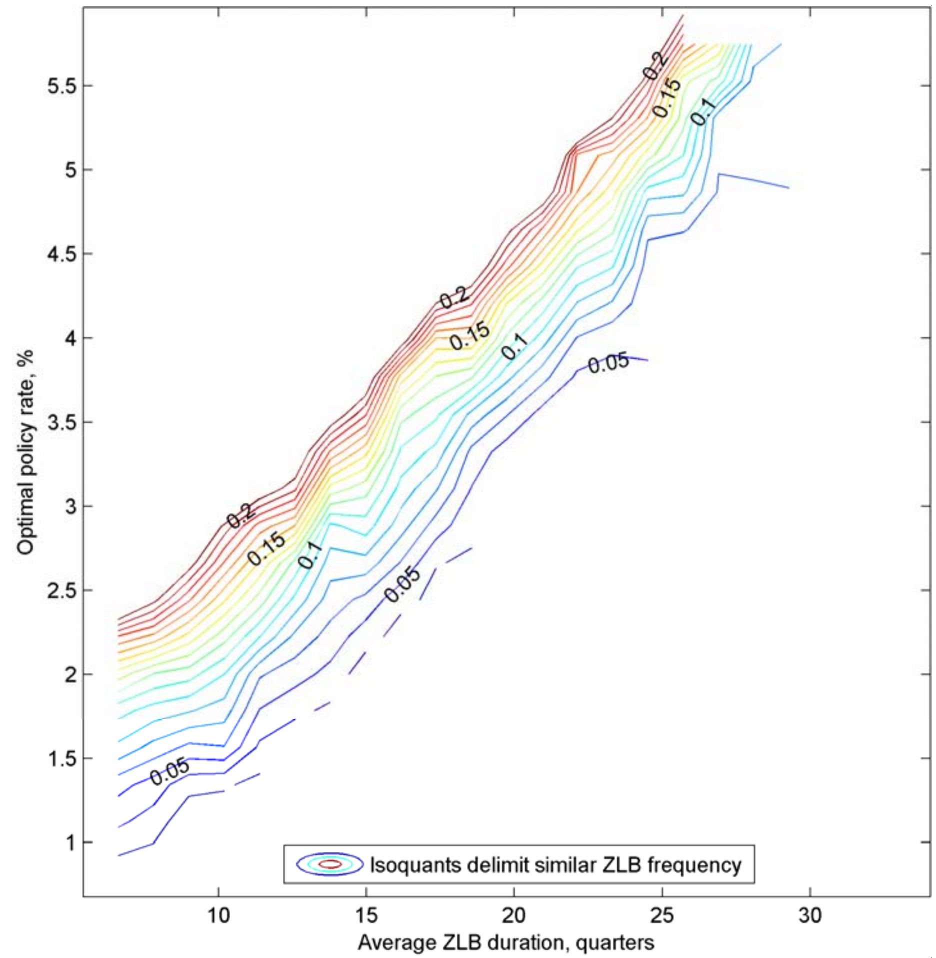
Panel B: Regime-switching model



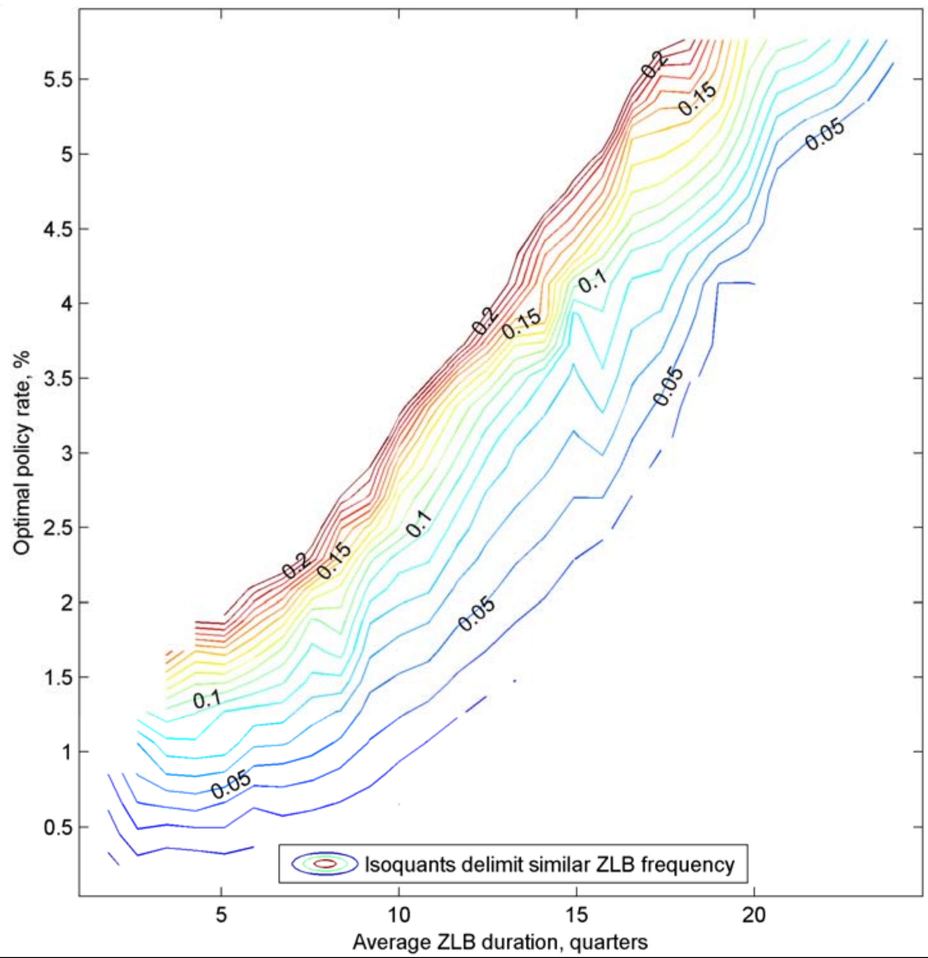
Optimal Inflation with Different Sizes of Shocks to Risk Premium

Regime-switching model

Panel A: Δ = 6%



Panel B: Δ = 12%



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Regime-switching model

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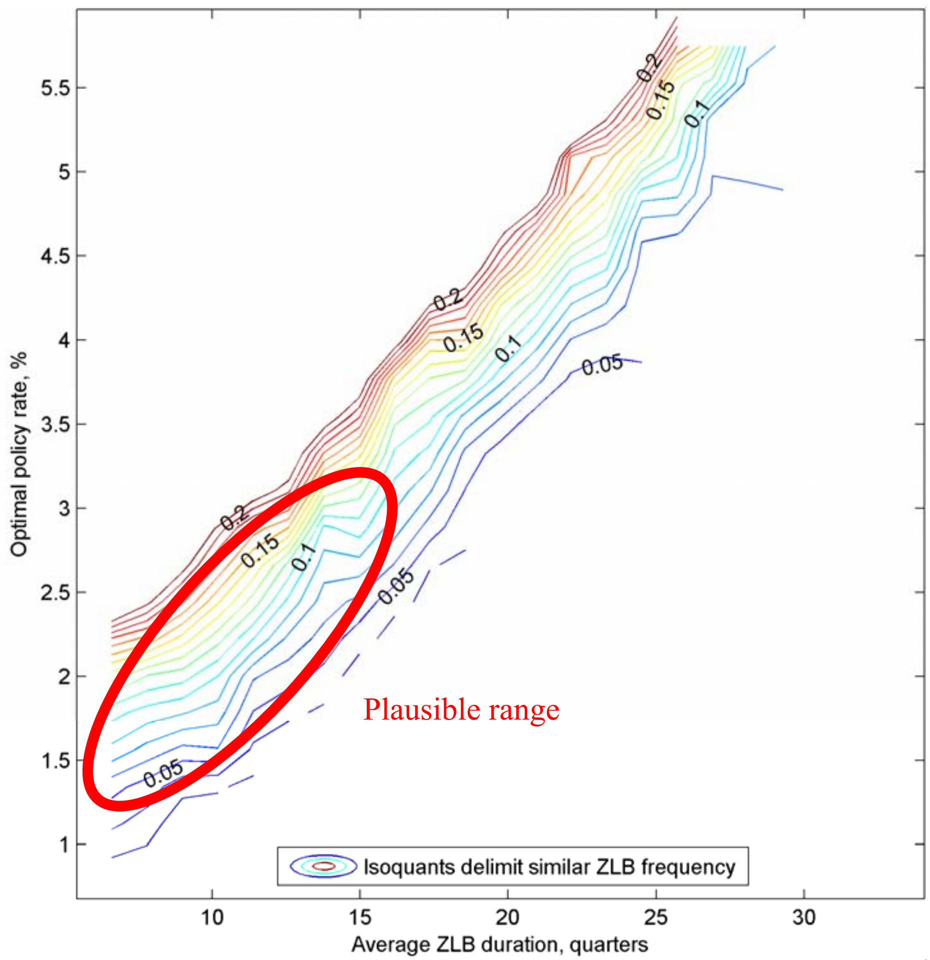
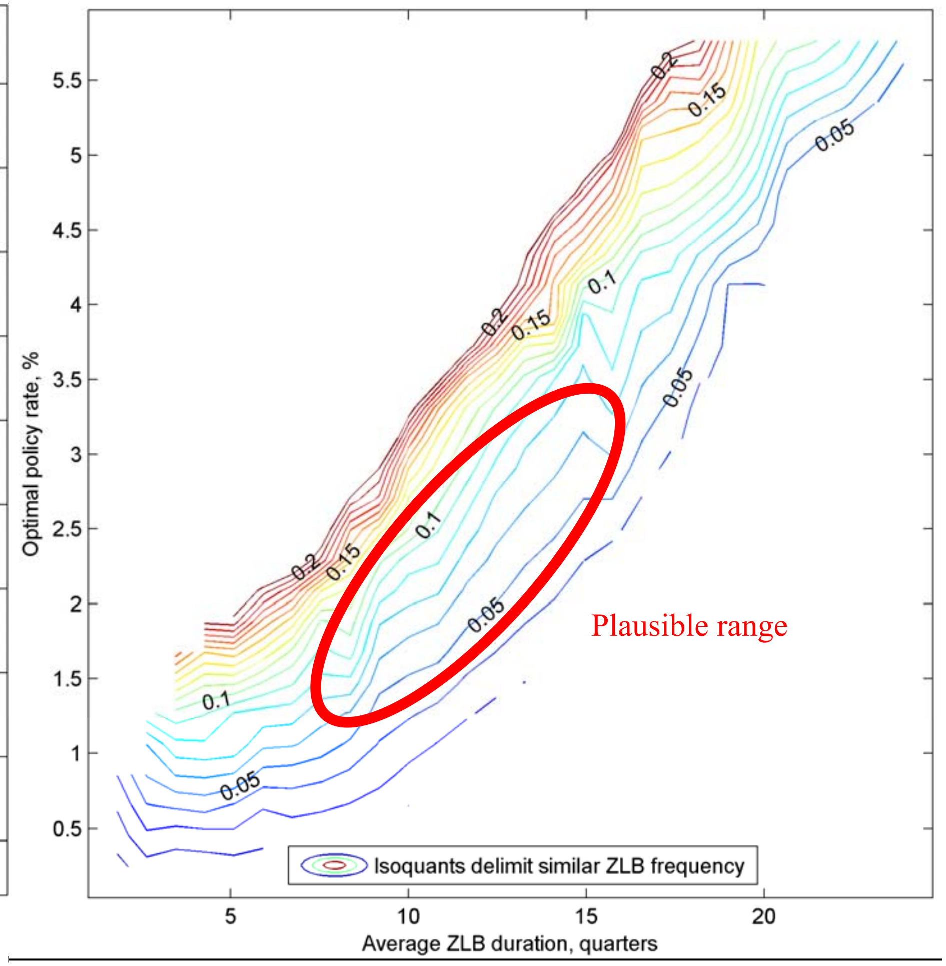


Panel B: Δ = 12%



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