Fiscal Multipliers in a Nonlinear World

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November 28, 2016

Motivation

- Literature suggests that fiscal spending multiplier can be very large at the zero lower bound (ZLB):
  - Eggertsson (2010), Davig and Leeper (2011), Christiano, Eichenbaum and Rebelo (2011), Woodford (2011), Coenen et al. (2012)...
  - Erceg and Lindé (2014) show that spending hikes can be self-financing ("fiscal free lunch") in a long-lived liquidity trap.
- Conversly, literature suggests that – at the ZLB – it is hard to reduce government debt in the short-run through aggressive spending cuts.
  - Fiscal consolidation can be self-defeating.

Motivation

- One elephant in the room: bulk of existing literature analyzed fiscal multipliers in models that are linearized around the steady state.
  - Implicit assumption: linearized solution accurate even far away from steady state.
- Braun, Körber and Waki (2016) suggest linearization might produce misleading results at the ZLB.
- Open question: can fiscal stimulus be self-financing in a liquidity trap in a fully nonlinear model economy?
  - Similarly, can fiscal consolidations be self-defeating?

What we do

- *Positive* analysis of the effects of spending-based fiscal stimulus / consolidation on *output* and *government debt* in nonlinear model.
- Benchmark environment: variant of simple New Keynesian model of Woodford (2003).
  - Monopolistic competition and Calvo sticky prices.
  - ZLB constraint on nominal interest rate.
  - Focus on positive inflation steady state.
- Robustness in workhorse Christiano-Eichenbaum-Evans (2005) model with endogenous capital and BGG/CMR financial frictions.

What we do

- Compare fiscal multipliers for output and government debt in nonlinear and linearized solutions of the model.
  - Pin down key features that account for differences between both solutions.
- Use model with real rigidities: allows to match *macroevidence* of a low Phillips curve slope (0.01) and *microevidence* of frequent price re-optimization (3-4 quarters).

Outline

- Benchmark model
- Parameterization
- Spending multipliers: nonlinear vs. linearized model
- Robustness in model with endogenous capital
- Conclusion

Model

Households

- Variant of simple NK model in Woodford (2003).
- Household preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \log\left(C_t - C\nu_t\right) - \frac{N_t^{1+\chi}}{1+\chi} \right\}$$

  - ν_t consumption demand shock as in Erceg and Linde (2014). Akin to discount factor shock.

- Household budget constraint:

$$P_t C_t + B_t = (1-\tau) W_t N_t + R_{t-1} B_{t-1} - T_t + \Gamma_t$$

Model

Final Good Firms

- Competitive firms aggregate intermediate goods $Y_t(f)$ into final good Y_t using technology $\int_0^1 G\left(Y_t\left(f\right)/Y_t\right) df = 1$.

- Following Dotsey-King (2005) and Levin-Lopez-Salido-Yun (2007):

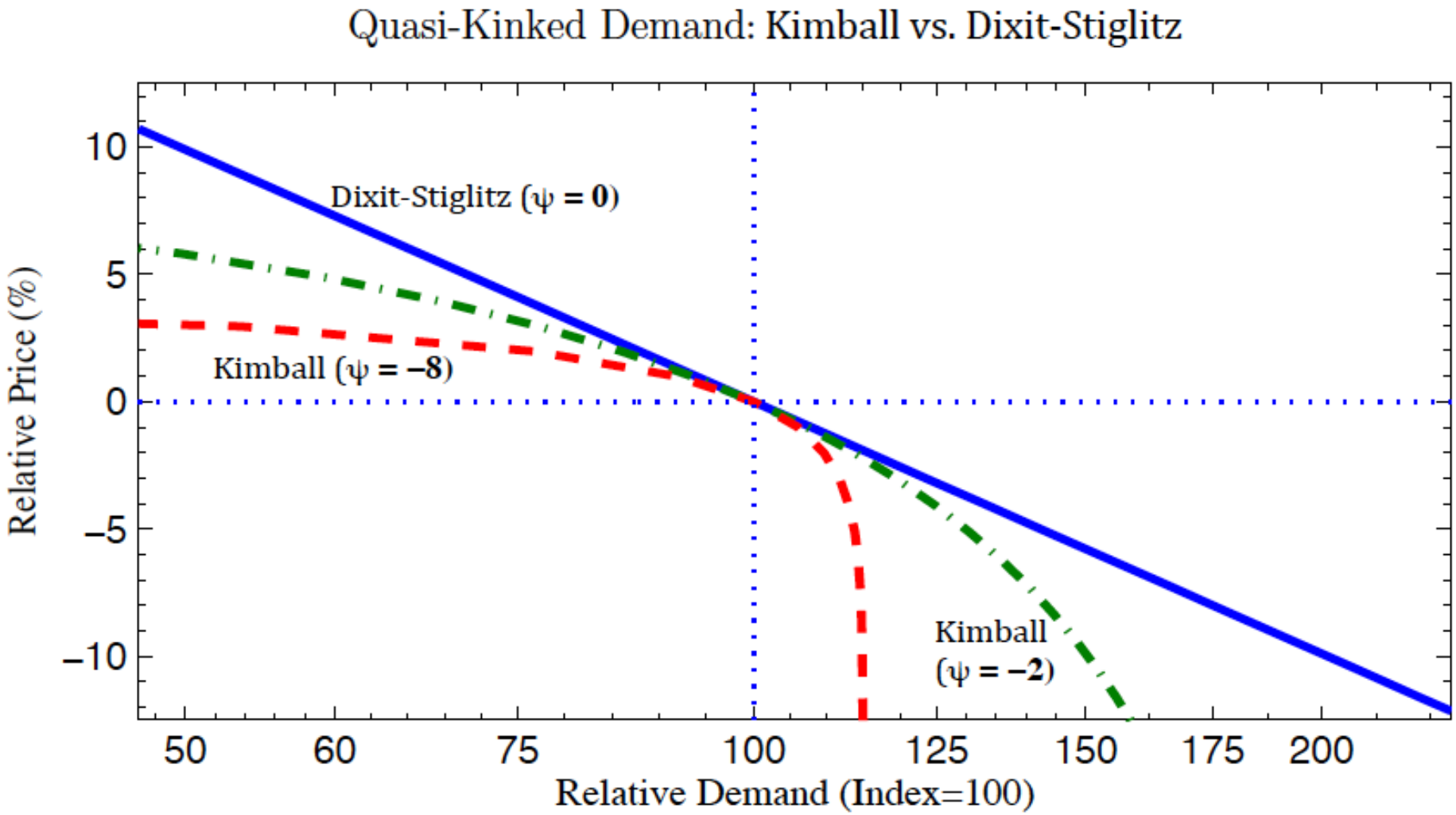
$$G\left(\frac{Y_t\left(f\right)}{Y_t}\right) = \frac{\omega}{1+\psi}\left[\left(1+\psi\right)\left(\frac{Y_t\left(f\right)}{Y_t}\right) - \psi\right]^{\frac{1}{\omega}} + 1 - \frac{\omega}{1+\psi}$$

- $\psi = 0$: Dixit-Stiglitz. $\psi < 0$: Kimball (1995).

- Kimball aggregator: demand elasticity for intermediate goods increasing function of relative price.
  - Dampens firms' price response to changes in marginal costs.

Levin, Lopez-Salido and Yun (2007)

Kimball vs. Dixit-Stiglitz Demand Schedules



Model

Intermediate Goods Firms

- Continuum of monopolistically competitive firms f :
  - Hire workers and rent capital.
  - Calvo sticky prices: price re-optimization with probability $1 - \xi_p$.
  - Non-optimizers set price $\tilde{P}_t = \pi P_{t-1}$ where π is steady state inflation.
- Fixed aggregate capital stock. Flexible wages.

Model

Aggregate Resource Constraint

- Output Y_t divided into private and government consumption:

$$Y_t = C_t + G_t$$

- Aggregate resource constraint:

$$\underbrace{C_t + G_t}_{\equiv Y_t} \leq (p_t^*)^{-1} \underbrace{K^{\alpha} {N_t}^{1-\alpha}}_{\equiv Y_t^*}$$

- where $Y_t^* = \int_0^1 Y_t(f)df$ and p_t^* is Yun's (1996) aggregate price dispersion.

- Government budget:

$$B_t = R_{t-1} B_{t-1} + P_t G_t - \tau W_t N_t - T_t$$

Lump-sum tax rule: $\frac{T_t}{P_t Y} = \varphi \left(\frac{B_t}{P_t Y} - \frac{B}{PY} \right)$.

- Monetary policy rule:

$$R_t = \max \left\{ 1, R \left(\pi_t / \pi \right)^{\gamma_\pi} \left(Y_t / Y_t^{pot} \right)^{\gamma_x} \right\}$$

where Y_t^{pot} is flex-price equilibrium output.

Solving the Model

- Solve linearized and nonlinear model using Fair and Taylor (1983, ECMA) method:
  - Two-point boundary value problem.
  - Solution of nonlinear model imposes certainty equivalence (just as linearized model solution does by definition).
  - Use Dynare for computations: 'perfect foresight solution' / 'deterministic simulation'.
- In other words, solution algorithm traces out implications of not linearizing equilibrium equations for resulting multiplier.

Parameterization I

Key Parameters

- Price mark-up $\theta_p = 0.2$, 3 quarter price contracts ($\xi_p = 0.667$). Kimball parameter then determined residually so that κ_{mc} in

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa_{mc} \widehat{mc}_t$$

  equals 0.012 (Gertler-Gali 1999, ACEL 2011).

- Government spending share $g_y = 0.2$, financed by labor income taxes in steady state.

- All shocks AR(1) with persistence 0.95.

Parameterization II

Key Parameters

- Log consumption utility ($\sigma = 1$), Frisch elasticity $= 0.4$ ($\chi = 2.5$), Labor share $= 0.7$ ($\alpha = 0.3$).
- Steady state inflation 2 percent, nominal interest rate 4 percent ($\beta = 0.995$, $\pi = 1.005 => R = 1.01$).
- Taylor rule coefficients ($\gamma_\pi = 1.5$, $\gamma_x = 0.125$).
- Lump sum tax rule: $t_t = 0.01\left(b_{t-1} - b\right)$, $b = 0.6$.
- Steady state labor tax: $\tau = \frac{1+\theta_p}{1-\alpha}\left(g_y + 4r \times b\right)$.

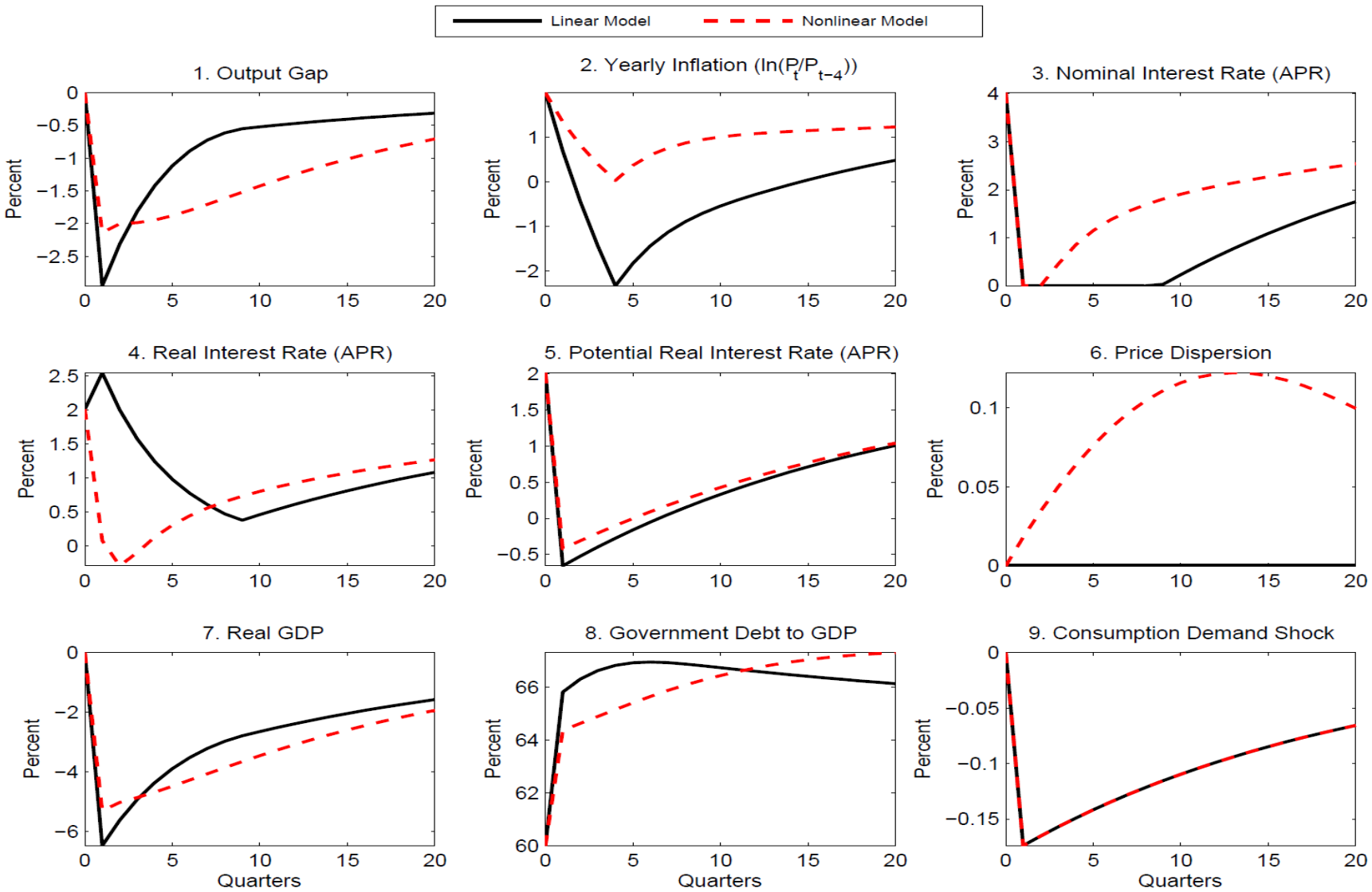
Analysis

- Two steps:
  1. Baseline: fall in ν_t triggers deep recession with binding ZLB.
  2. Scenario: increase G_t relative to baseline. Compute 'marginal' multipliers.

Baseline

- Follow Erceg and Lindé (2014): assume negative consumption demand shock ν_t hits the economy.
  - Shock pushes the economy into a 1,2,...,12 quarter liquidity trap.

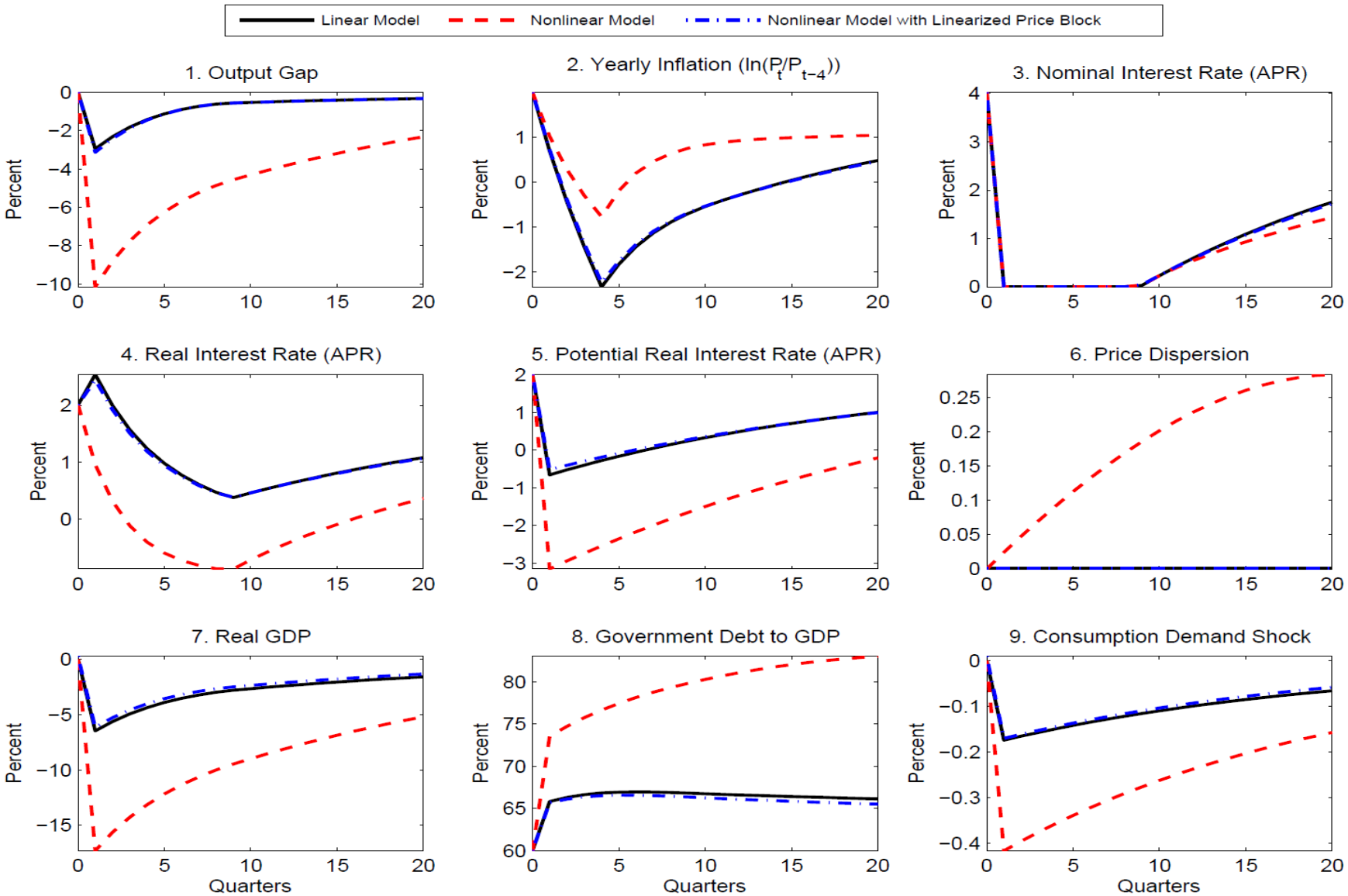
Effects of Same-sized Shock



Baseline

- Alternatively, set shock ν_t such that liquidity trap duration identical in linearized and nonlinear model.

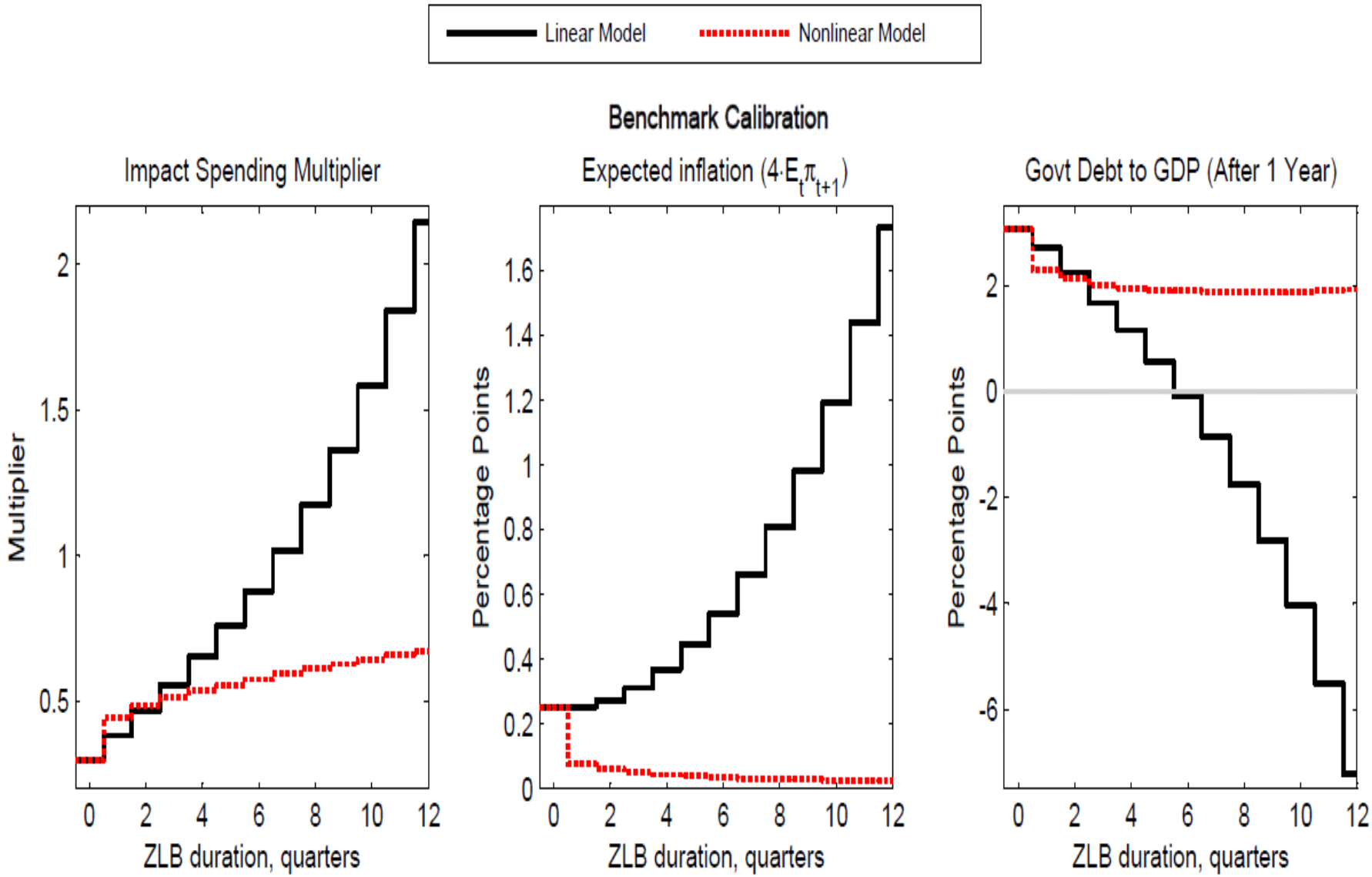
Baseline: 8-Quarter Liquidity Trap



Scenario

- For each baseline simulation, add small government spending shock in the period when ZLB starts binding.
  - Size of g_t shock small such that ZLB duration unchanged $\Rightarrow$ "marginal effects".
- Compute output and debt multipliers as difference between scenario (both ν_t and G_t shock) and baseline (only ν_t shock).

Spending Multipliers in Linearized and Nonlinear Model



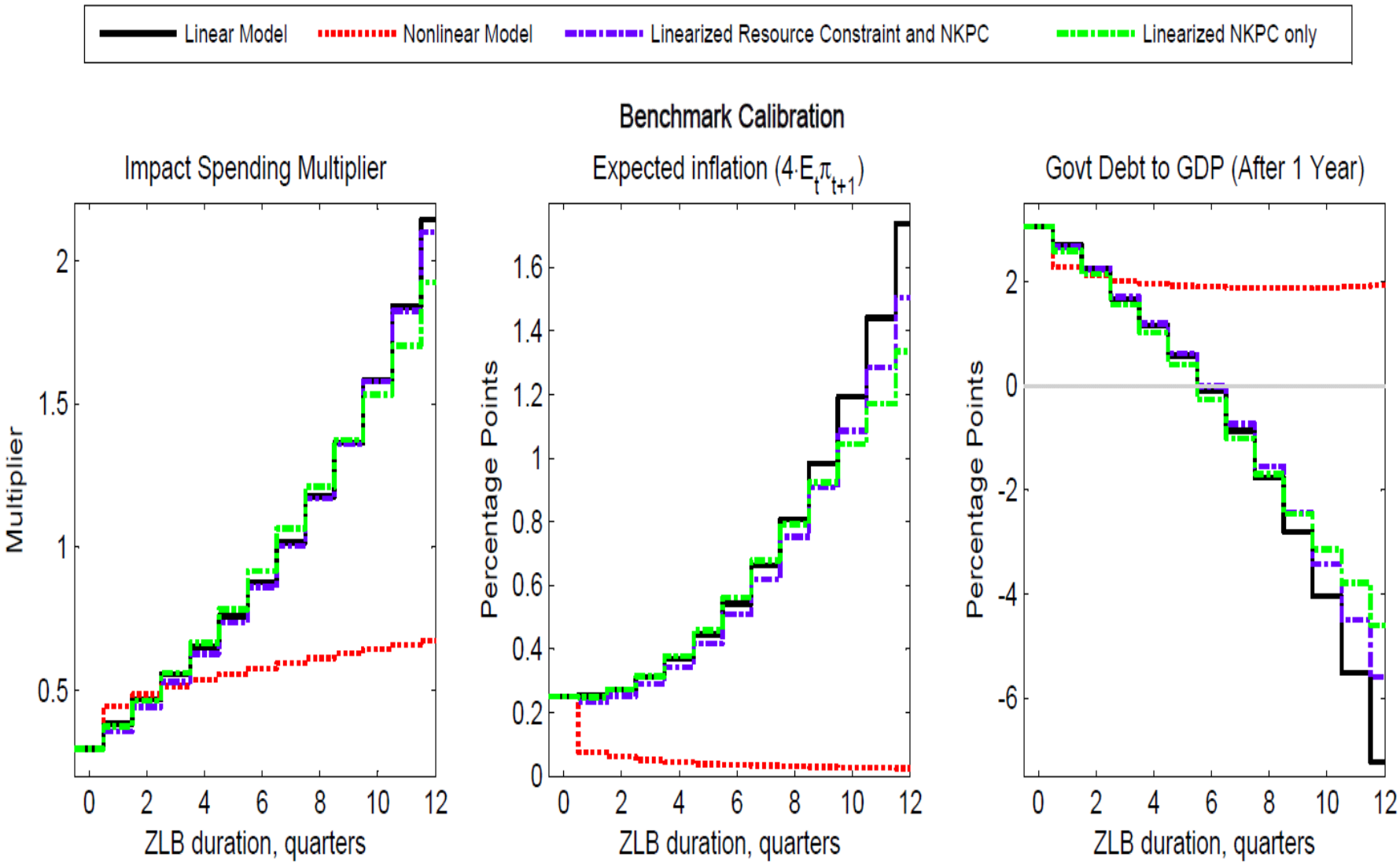
Spending Multipliers in Linearized and Nonlinear Model

Why do Multipliers Differ?

- What accounts for the differences between the nonlinear and linearized solution?
- Examine two variants of the nonlinear model:
  - First, linearize the New Keynesian Phillips curve (NKPC); keep all other equations in nonlinear form.
  - Second, linearize NKPC *and* the resource constraint, keep all other equations in nonlinear form.

Spending Multipliers in Linearized and Nonlinear Model

Why do Multipliers Differ?



Spending Multipliers in Nonlinear and Linearized Model

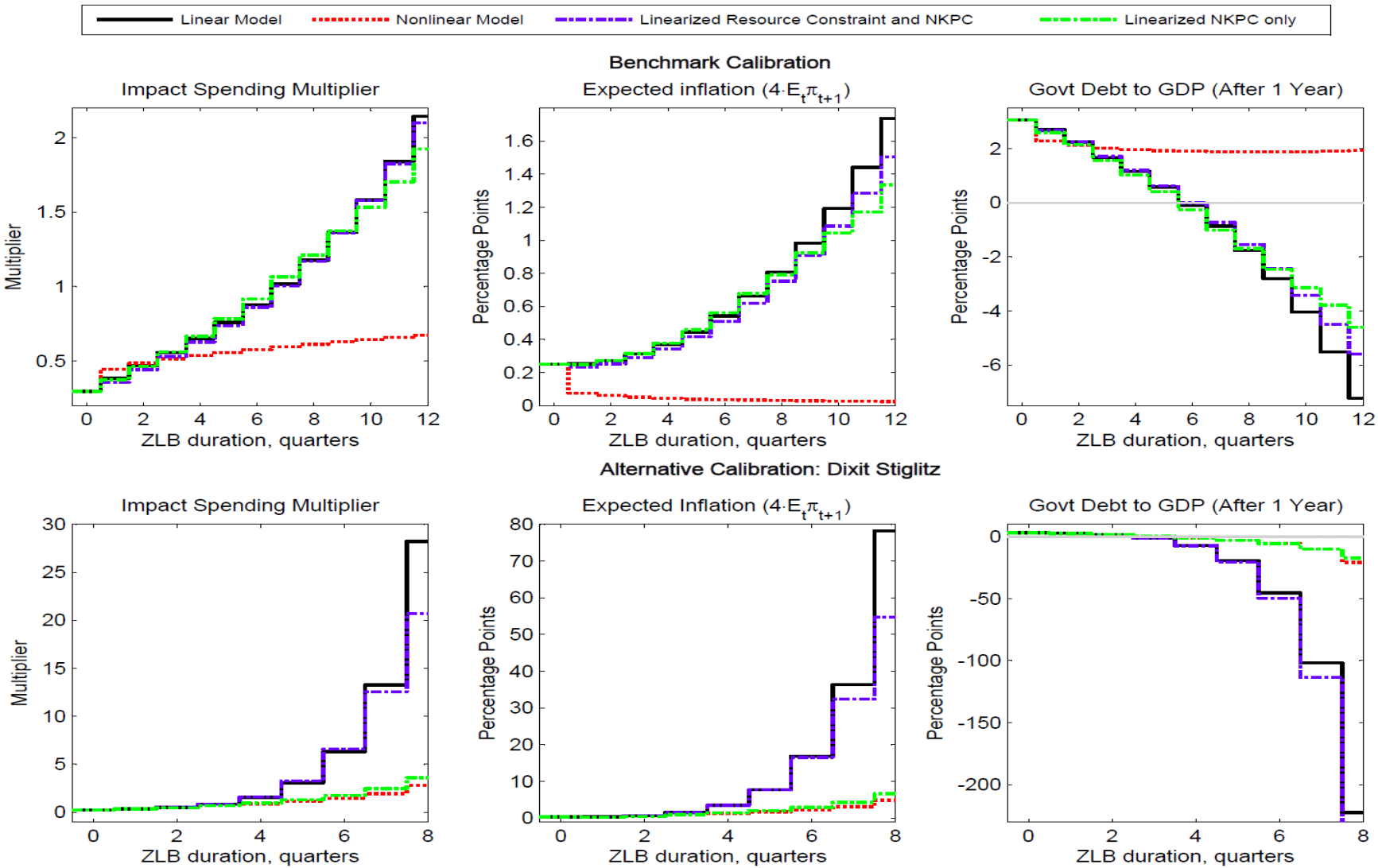
Comparison to Dixit-Stiglitz

- Examine role of Kimball aggregator.
- Re-calculate results for standard Dixit-Stiglitz aggregator:
  - Keeping ξ_p unchanged at 0.667 implies a higher slope of Phillips curve (κ_{mc}) and stronger sensitivity of expected inflation.

Spending Multipliers in Nonlinear and Linearized Model

Multipliers: Kimball vs. Dixit-Stiglitz

Figure 4: Marginal Multipliers



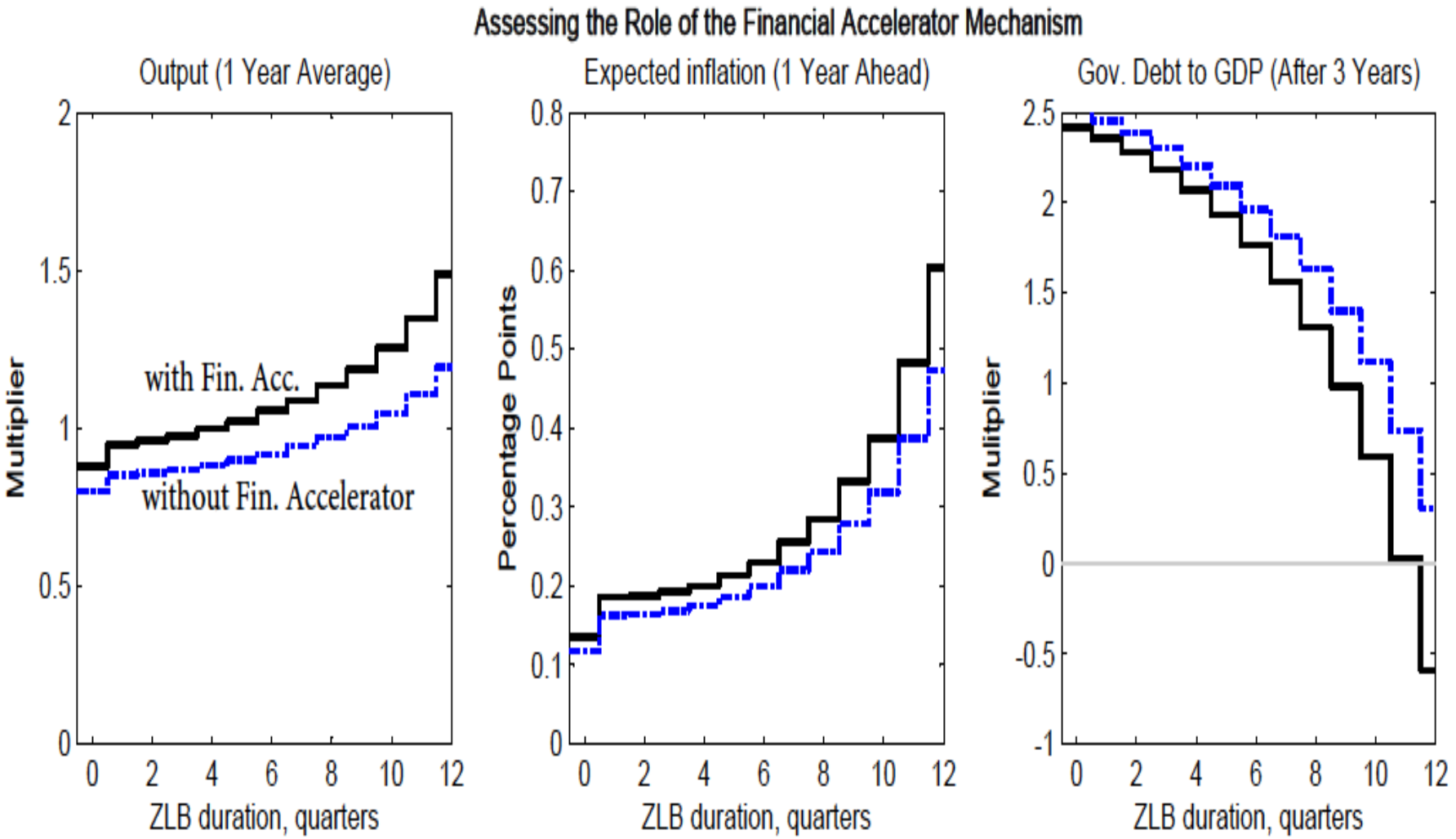
Robustness in Model with Endog. Capital (CEE)

Key Model Features

- Assess multipliers in a workhorse model with endogenous capital.
- Key model features:
  - Nominal price stickiness
  - Nominal wage stickiness
  - Habit persistence and investment adjustment costs
  - Financial accelerator: CMR (2014) variant of BGG (1999)
  - Fiscal block (gov. consumption, lump sum transfers, labor income taxes)

Robustness in Model with Endog. Capital (CEE)

Multipliers: Nonlinear CEE with and without Financial Accelerator



Summary and Policy Implications

- Simple NK model suggests important quantitative differences for output and debt multipliers in linearized and nonlinear variants:
  - In fully nonlinear model, spending multiplier moderate even in a long-lived liquidity trap -> no fiscal free lunch; consolidations unlikely to be self-defeating
- Workhorse model (CEE) highlights importance of financial frictions for resulting multiplier:
  - With financial frictions -> free lunch/self-defeating consolidations possible – but only in very long-lived liquidity traps