Monetary Policy and Sovereign Risk in Emerging Economies (NK-Default)

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20th Jacques Polak Annual Research Conference
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Motivation for NK-Default

- Many emerging markets adopted inflation targeting in early 2000s
  - Monetary policy targets nominal rates to keep inflation in band
- New Keynesian theory toolkit for monetary policy implementation
  - Theory for developed countries, mainly perfect capital markets
  - Useful for transmission of monetary policy to inflation and output
- Silent on monetary policy interactions with sovereign risk
  - Emerging markets history of recurring sovereign debt crises
  - Both policies affect consumption, output, inflation

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New Keynesian model with sovereign default risk

New toolkit for central banks in emerging markets

Emerging Markets Inflation Targeters

	Means		Correlation with Spread		
	Inflation	Govt Spread	Inflation	Domestic Rate	Output
Brazil	5.9	2.6	59	59	-62
Chile	3.0	1.4	30	39	-49
Colombia	5.2	3.2	74	76	-60
Indonesia	6.6	2.8	17	75	-62
Korea	2.6	1.1	44	74	-30
Mexico	4.3	2.3	48	27	-54
Peru	2.8	3.0	50	55	-33
Philippines	3.9	2.9	17	82	-26
Poland	3.0	1.7	59	52	-11
South Africa	5.8	1.9	54	20	-49
Mean	**4.4**	**2.4**	**45**	**58**	**-38**

- Single digit inflation and $ govt bonds carry spread over US bonds
- Govt spread positively correlates with inflation and domestic rates
- Govt spread negatively correlates with output

Default Risk Matters for Monetary Policy

- New Keynesian model with default risk, NK-Default
  - Govt borrows foreign-currency debt with default risk
  - Monetary policy is a nominal interest rate rule to target inflation
- Default Amplification: Govt default risk increases monetary frictions
  - High default risk depresses domestic consumption demand
  - Price rigidities keep nominal rates high
  - $\Rightarrow$ Lower output and larger monetary frictions
- Monetary Discipline: Monetary frictions discourage borrowing
  - Govt internalizes the effects of its policy on domestic outcomes

Quantitative Tool

- Model predictions consistent with emerging market data
  - Positive co-movement of spreads, nominal rates, inflation
- Properties of NK-Default
  - More volatile inflation and nominal rates than without default
    default amplification
  - Lower spreads and debt accumulation than real version
    monetary discipline
- Rationalize Brazilian experience with 2015 monetary tightening
  - Counterfactual low rates $\rightarrow$ moderate recession but increase in inflation and spreads
- Evaluate alternative interest rate rules and debt denomination
  - Large weight on inflation and local currency debt is best

Literature

- New Keynesian models for small open economies: Gali-Monacelli (2005), Aoki-Benigno-Kyotaki (2016), Devereux-Young-Yu (2019)
- Sovereign default: Aguiar-Gopinath (2006), Arellano (2008), Reinhart-Rogoff (2009), Chatterjee-Eyigungor (2012)
- Default risk & dilution: Hatchondo-Martinez-Sosa Padilla (2016), Aguiar-Amador-Hopenhayn-Werning (2018), Hatchondo-Martinez-Roch (2018)
- Inflation as default for local currency debt: Calvo (1988), Aguiar-Amador-Farhi-Gopinath (2013), Corsetti-Dedola (2016), Hur-Kondo-Perri (2018)
- Downward rigid wages & default risk: Na-Schmitt-Grohe-Uribe-Yue (2018), Bianchi-Ottonello-Presno (2018), Bianchi-Mondragon (2018)

  Here optimal price setting (NKPC) + nominal rates to target inflation

NK-Default: Monetary policy targets inflation with sovereign default risk

Model

Small open economy: households, firms, monetary auth, fiscal govt

Households

- Values consumption of domestic C and foreign goods C^f, supply labor N

$$\frac{u_{C^f,t}}{u_{C,t}} = e_t, \qquad \frac{u_{N,t}}{u_{C,t}} = w_t, \qquad u_{C,t} = \beta i_t \mathbf{E}_t \left[\frac{u_{C,t+1}}{\pi_{t+1}} \right]$$

- Terms of trade e_t ($\uparrow$ depreciation), inflation π_{t+1}, nominal rate i_t

Monopolistic Intermediate Goods Firms

- Produce $y_{it} = z_t n_{it}$ and set prices subject to adjustment costs (Rotemberg)
- Dynamic choice of n_{it} and prices p_{it} (NKPC)

$$\frac{w_t}{z_t} = 1 + \frac{\varphi}{\eta - 1} \left(\pi_t - \bar{\pi} \right) \pi_t - \frac{\varphi}{\eta - 1} \mathbf{E}_t \left[\beta \frac{u_{c,t+1}}{u_{c,t}} \frac{Y_{t+1}}{Y_t} \left(\pi_{t+1} - \bar{\pi} \right) \pi_{t+1} \right]$$

- Monetary frictions hinder efficient production, reflected in inflation

$$1 + \text{monetary wedge} = \frac{z_t}{w_t} = \frac{z_t u_{C,t}}{u_{N,t}}, \qquad (> 0 \text{ depressed output})$$

Goods Market

- Domestic good used for consumption and exports

$$z_t N_t = C_t + X_t + \langle \text{price-setting costs} \rangle_t$$

- Elastic demand for export $X_t = e_t^{\rho} \xi$

Monetary Policy

- Interest rate rule targets inflation $\overline{\pi}$

$$i_t = \bar{i} \left(\frac{\pi_t}{\overline{\pi}} \right)^{\alpha_P}$$

Government

- Borrows abroad foreign-currency bonds (later long-term bonds)
- Finance imports net of exports with capital flows

$$C_t^f = X_t / e_t + q_t B_{t+1} - B_t$$

- Govt can default on its debt
  - Debt eliminated, productivity reduced $z_t^d \leq z_t$, temporary exclusion
- Bond price schedule $q(z_t, B_{t+1})$ compensates for default risk

Recursive Markov Equilibrium

- Government with state (z, B) chooses its fiscal policies

  Default D: $\quad V(z,B) = \max\left\{W(z,B),\ W^d(z^d)\right\}$

  Borrowing B': $\quad W(z,B) = \max_{B'}\left\{u(C,C^f,N) + \beta \mathbf{E} V(z',B')\right\}$

- Understands that its policies impact equilibrium

  Domestic Euler: $\quad u_C = \beta\, i\, \mathbf{E}\left[\dfrac{u'_C}{\pi'}\right]$

  Pricing condition: $\quad \dfrac{u_N}{z u_C} = 1 + \dfrac{\varphi}{\eta - 1}\left[(\pi - \overline{\pi})\,\pi - \beta \mathbf{E}\dfrac{z' N' u'_C}{z N u_C}\,(\pi' - \overline{\pi})\,\pi'\right]$

  Interest rate rule: $\quad i = \bar{i}\left(\dfrac{\pi}{\overline{\pi}}\right)^{\alpha_P}$

  Relative consumption: $\quad u_{C^f} / u_C = e$

  Balance of payments: $\quad X/e = e^{\rho-1}\xi = C^f + B - q(z,B')B'$

  Resource constraint: $\quad C + X = \left[1 - \dfrac{\varphi}{2}\,(\pi - \overline{\pi})^2\right] zN$

- Bond price schedule that reflects default

$$q(z,B') = \frac{1}{1+r^*}\mathbf{E}\left[1 - D(z',B')\right]$$

Default Amplification

(With rigid prices and log separable preferences)

Large borrowing B' and high default risk D' affect monetary friction

Domestic Euler:	$\frac{1}{C} = \beta \bar{i} \left(\mathbf{E}_{D'(B')=0} \frac{1}{C'(B')} + \mathbf{E}_{D'(B')=1} \frac{1}{C'_d} \right)$
Relative consumption:	$\frac{C}{C^f} \propto e$
Balance of payments:	$X/e = e^{\rho-1}\xi = C^f + B - q(B')B'$
Resource constraint:	$C + X = zN$

Proposition. A higher B' increases default risk D' and increases the monetary wedge

- Consumption: Lower expected consumption, more likely low C'_d and lower $C(B')$
  - Domestic Euler calls for decline in current domestic consumption C
- Export-Import: More capital inflows appreciate e, lower exports
- Lower $(C + X)$ lowers labor $N \rightarrow$ increases monetary wedge

Large borrowing and default risk increase monetary frictions

Monetary Discipline

- Govt borrowing smooths consumption, responds to default risk

$$u_{C_f}\left[q + q_{B'}B'\right] = \beta \mathbf{E}(1 - D')u'_{C_f}$$

Monetary Discipline

- Govt borrowing smooths consumption, responds to default risk

$$u_{C_f}\left[q + q_{B'}B'\right](1-\tau_m^X) - \tau_m^C = \beta \mathbf{E}(1-D')u'_{C_f}(1-\tau_m^{X'})$$

- With borrowing wedges τ_m^C and τ_m^X from monetary frictions

$$\tau_m^C \propto \text{monetary wedge} \times \frac{\partial \mathbf{E} u_C(s', B')}{\partial B'} \frac{\beta i}{G} \qquad \text{[consumption channel]}$$

$$\tau_m^X \propto \text{monetary wedge} \times u_C G^X \qquad \text{[exports-imports channel]}$$

- Reduce B' to improve monetary wedge (from proposition)
  - τ_m^C: to reduce default risk and boost domestic consumption
  - τ_m^X: to depreciate terms of trade and boost exports

Monetary frictions reduce govt's incentive to borrow

Quantitative Analysis

- Parameterize model to Brazil (output, inflation, nominal rates, spreads)
- Compare NK-Default to two reference models
  - *NK-Reference model*: similar as Gali-Monacelli (2005)

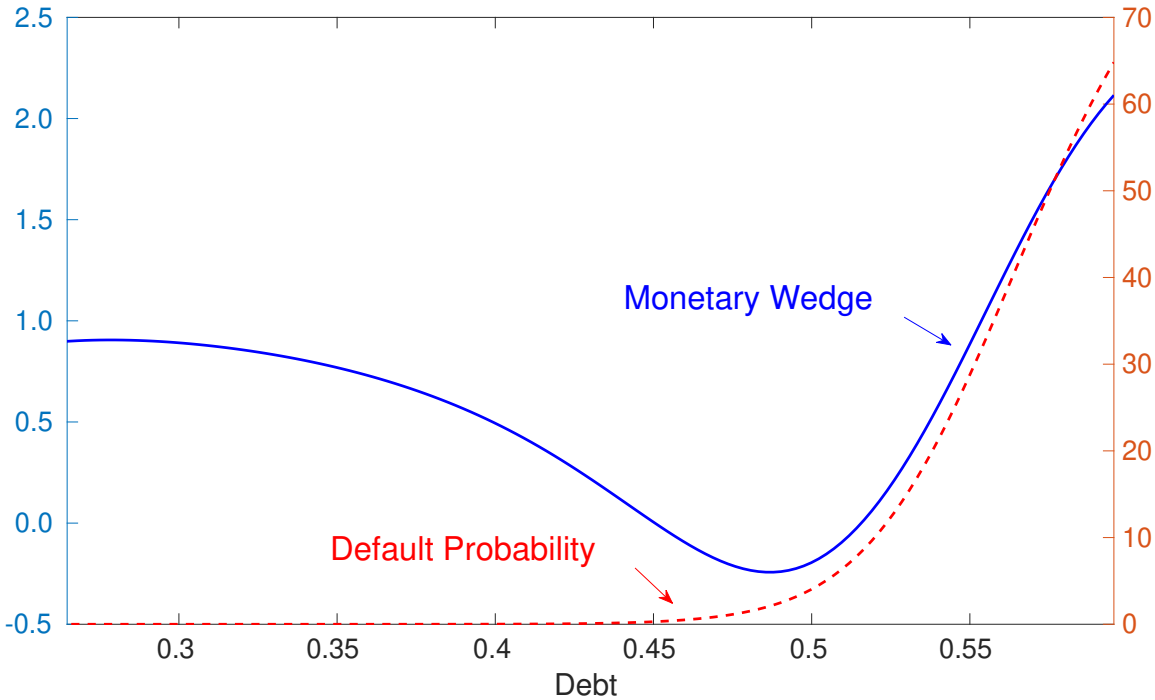
    $$u_{C_f} q = \beta \mathbf{E} u'_{C_f}$$

    (only monetary frictions)
  - *Default-Reference model*: real model with default

    $$u_{C_f} \left[q + q_{B'} B' \right] = \beta \mathbf{E} (1 - D') u'_{C_f}$$

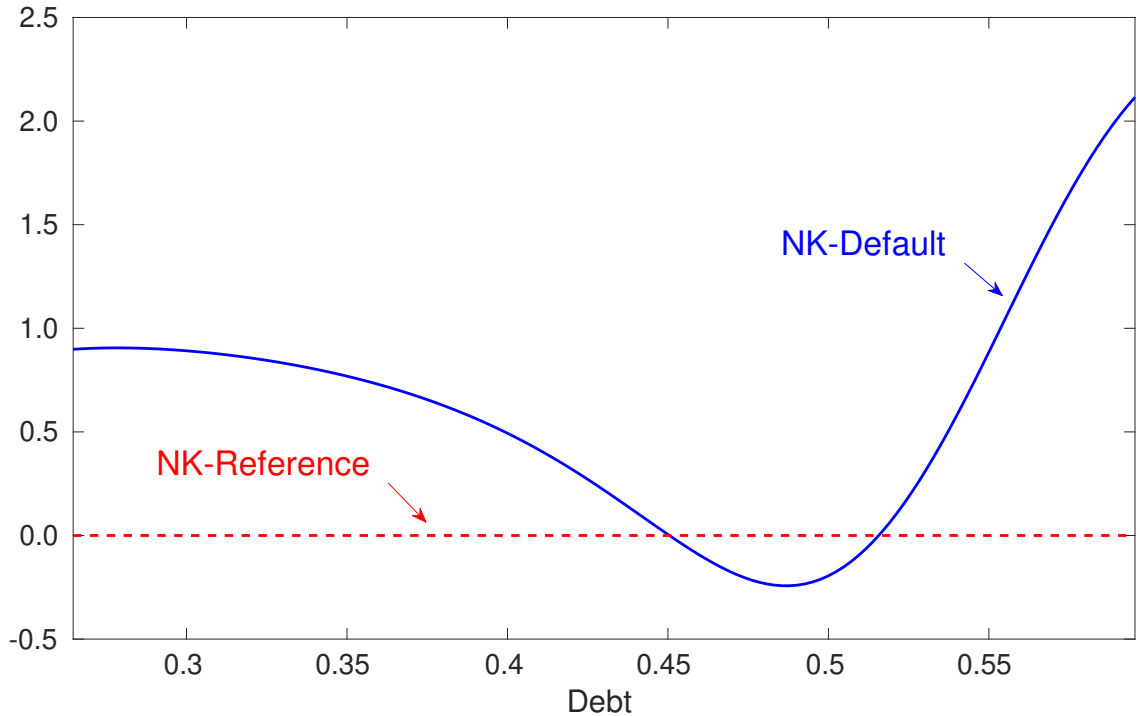
    (only default risk frictions)

Default Amplification on Monetary Wedge



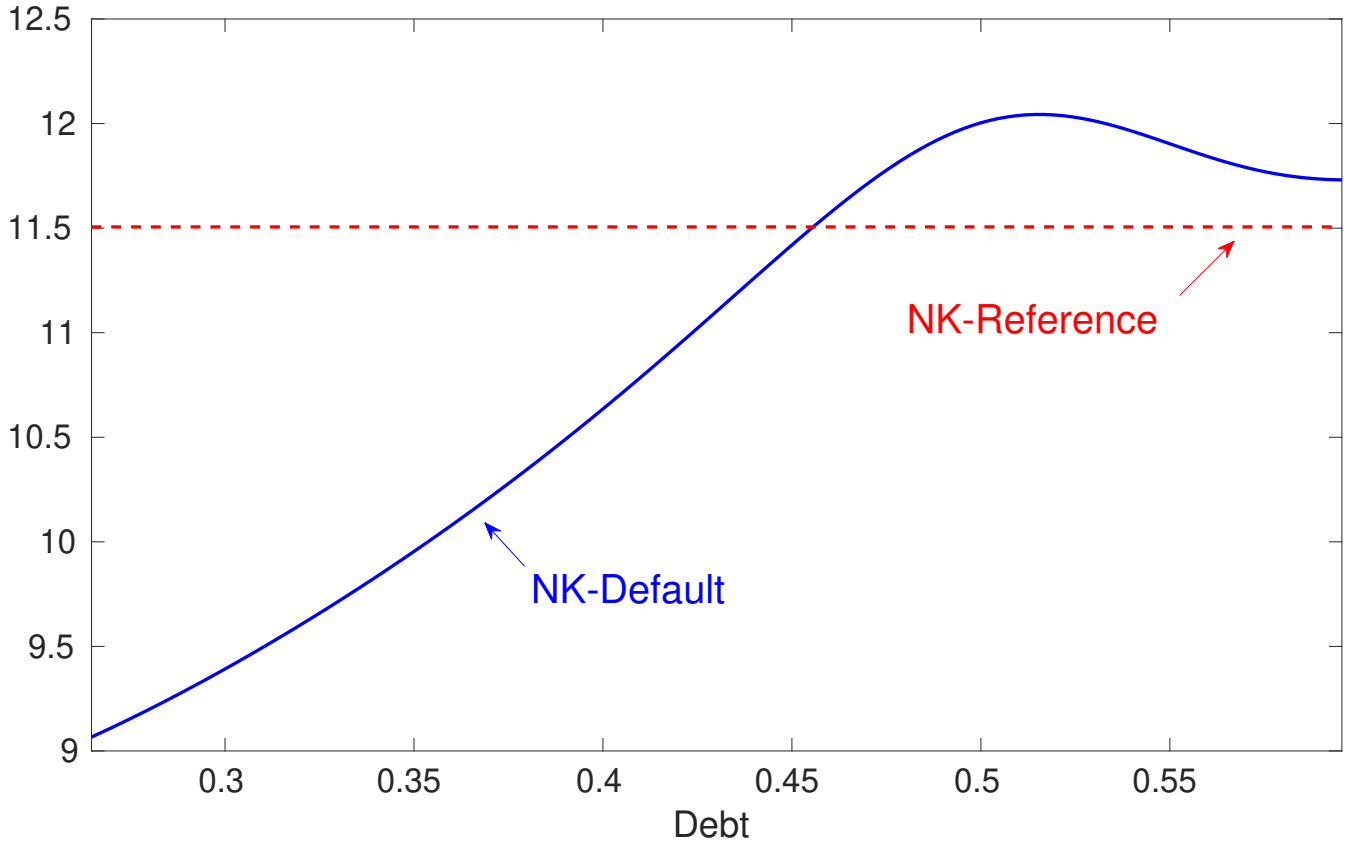
- High default zone: increasing monetary wedge
  - Default tomorrow associated with low C' and high $\pi' \rightarrow$ depresses C
- Low default zone: decreasing monetary wedge
  - Labor increases to export, pay debt, avoid default

Default Amplification on Monetary Wedge



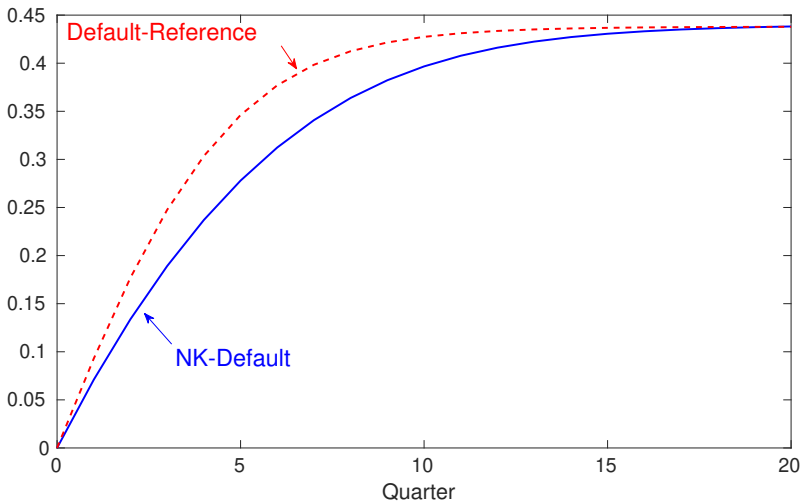
- NK-Reference: Monetary friction and nominal rates not responsive to debt (lax borrowing)

Default Amplification on Nominal Rates

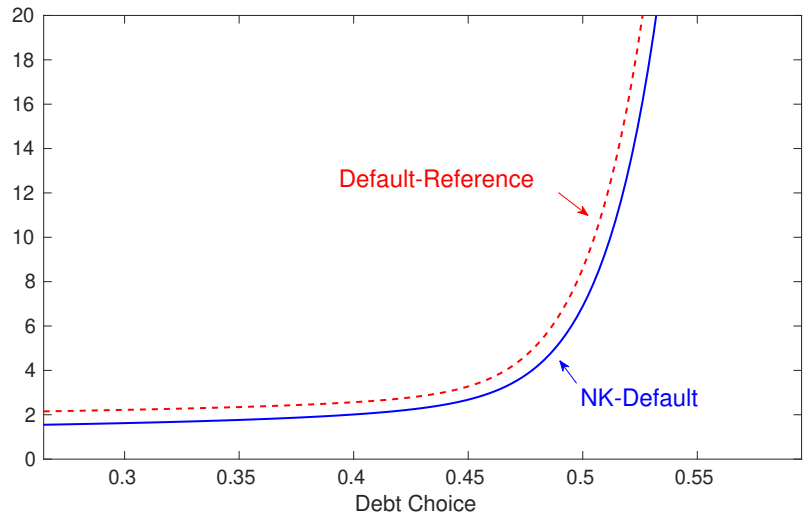


- NK-Default: High nominal rates with high default risk
- Default risk induces variability in inflation and nominal rates

Monetary Discipline on Borrowing



(a) Debt Accumulation



(b) Spread Schedule

- Debt accumulates more slowly in NK-Default model relative to real
- Lower borrowing makes spread schedules looser in NK-Default

Business Cycle Moments

Mean	Data (%)	NK-Default	NK-Reference	Default-Reference
Spread	2.6	2.6	—	3.2
Standard Deviation				
Inflation	1.8	1.8	1.0	0.6
Domestic Rate	2.2	2.5	1.3	1.8
Spread	0.9	0.9	—	0.8
Trade Balance	0.9	0.3	1.9	0.5
Correlation with Spread				
Inflation	59	60	—	−1
Domestic Rate	59	64	—	18
Trade Balance	61	35	—	33

- NK-Default: positive co-movement of inflation, nominal rates, and spreads
- NK-Reference: silent on spread and volatile trade balance
  - Less volatile inflation & nominal rates
- Default-Reference: higher spreads without disciplining monetary friction

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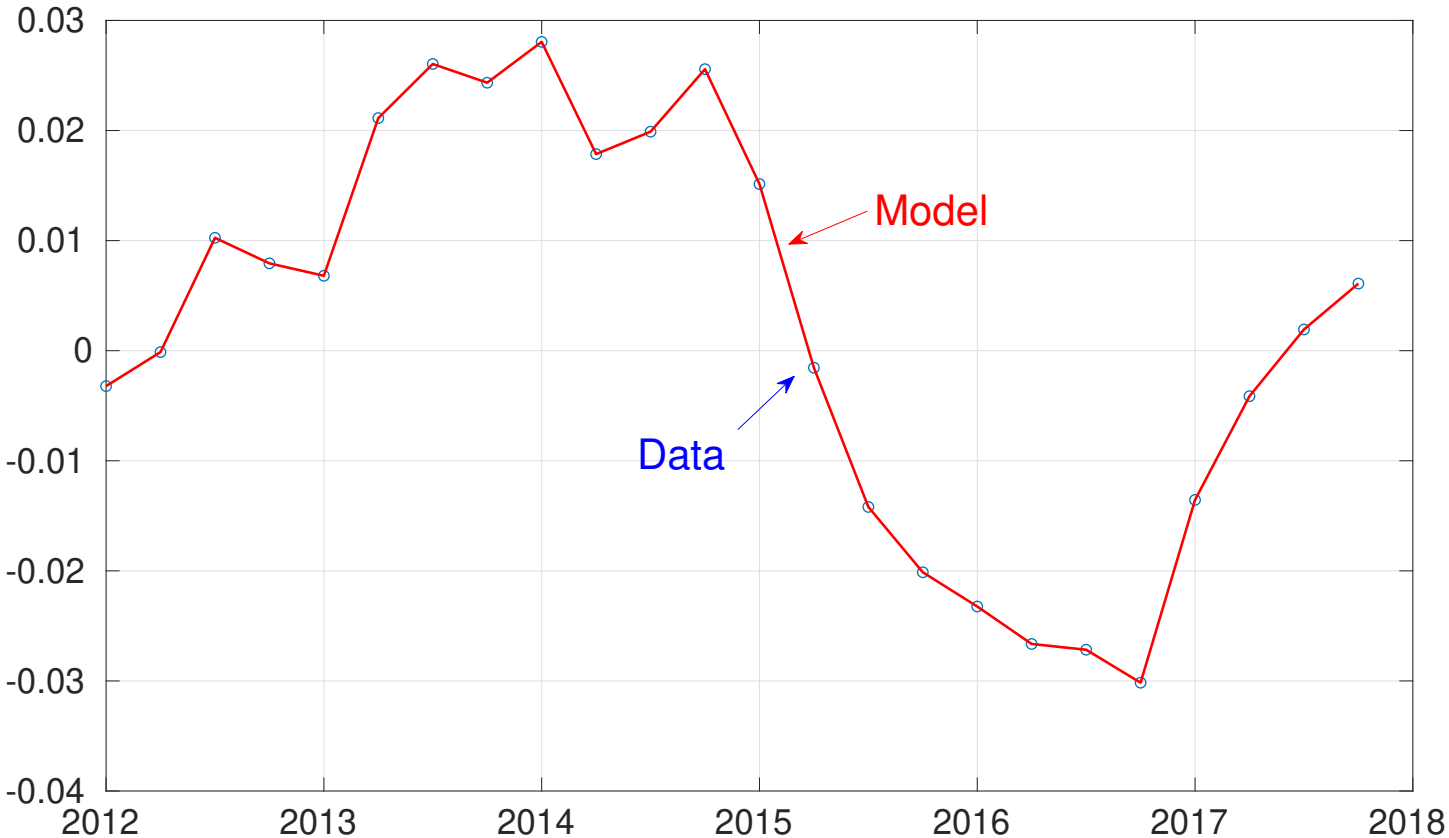
Event Study

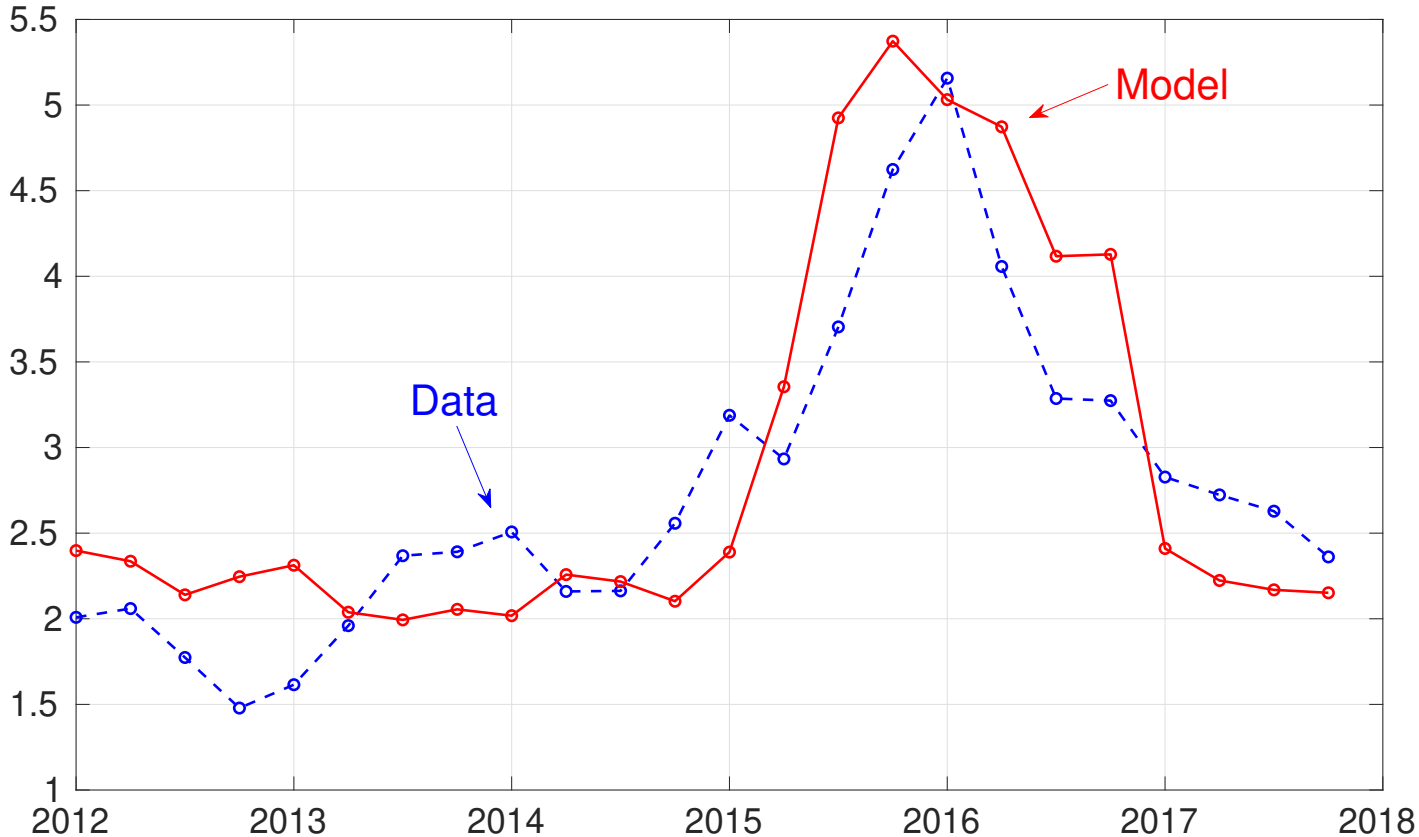
- Use Brazil data from 2012 to 2017
- Feed in a sequence of productivity shocks to replicate output path
- Model implications on inflation, spreads, and nominal rates
- Simulate counterfactual:
  loose monetary policy with low nominal rates throughout

Event: Output



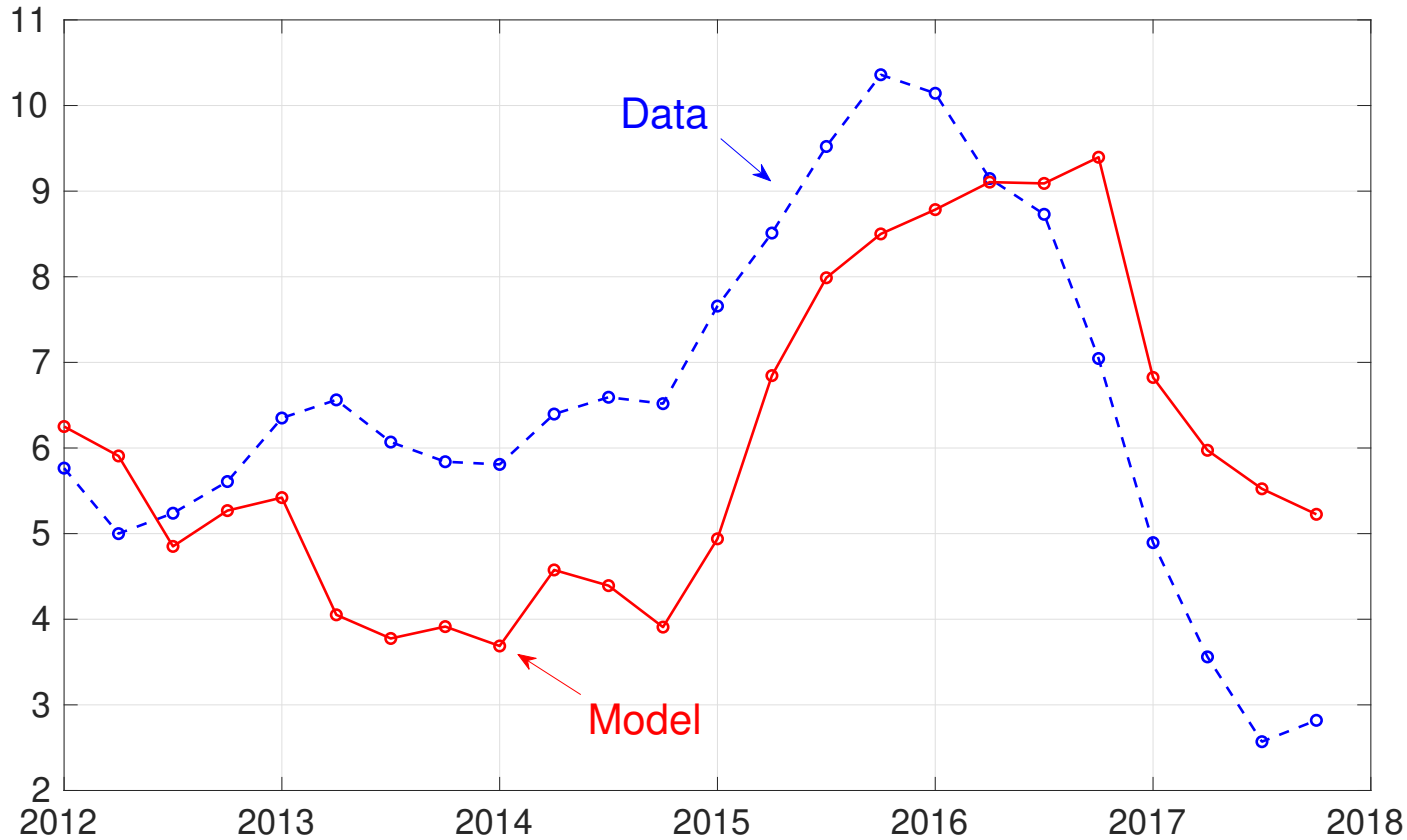
- Sequence of productivity shocks such that model matches output

Event: Spread



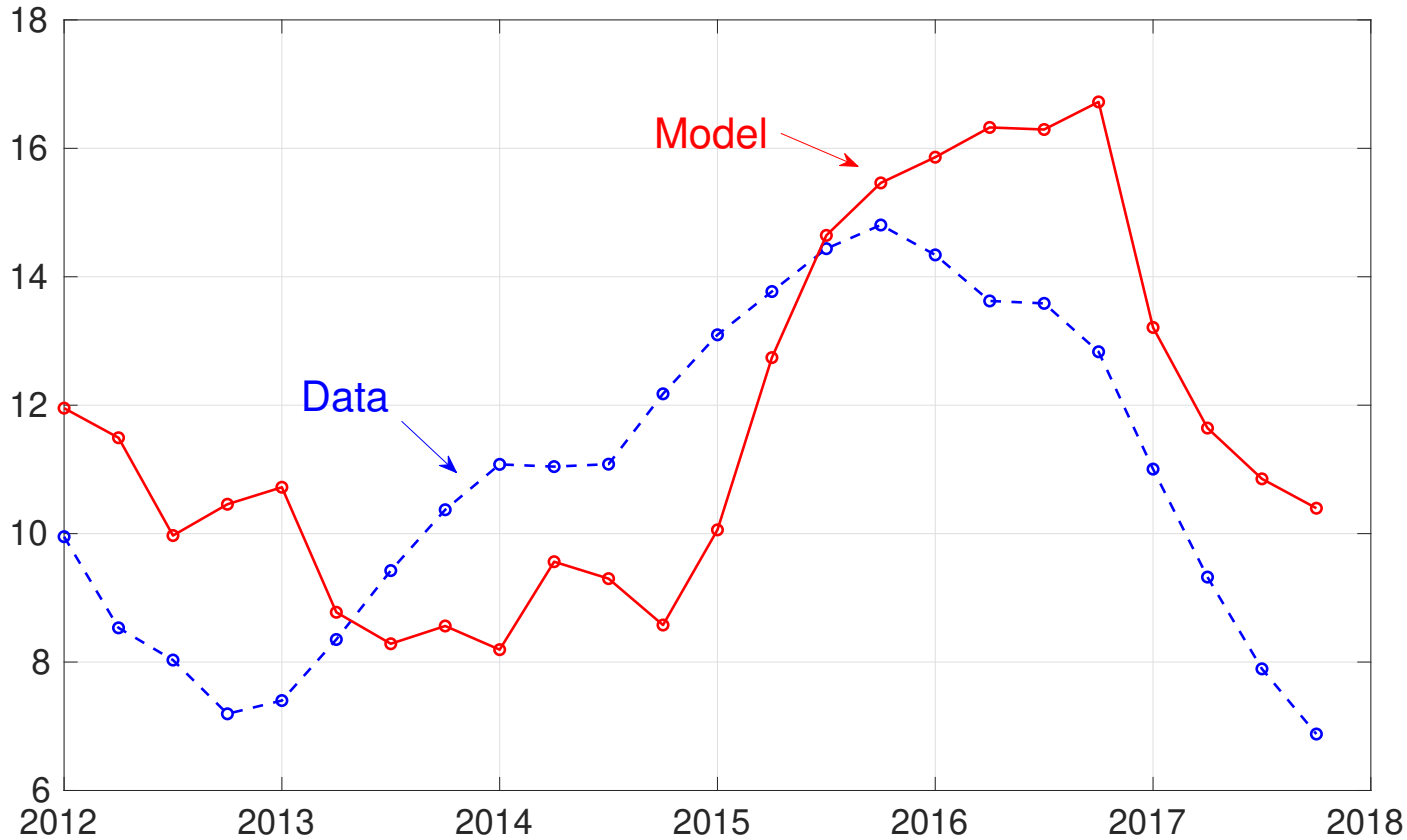
- Model generates similar increase in spreads

Event: Inflation



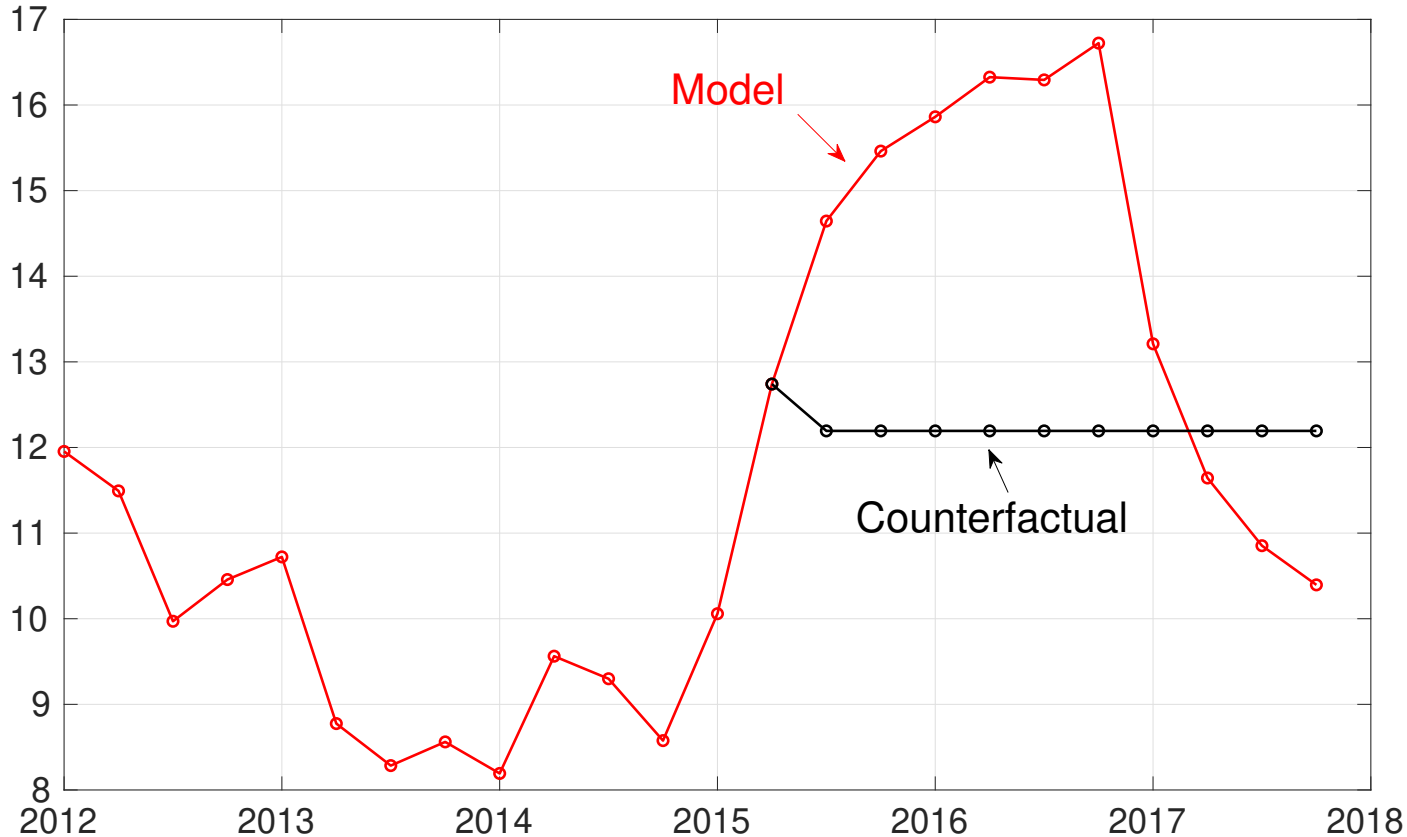
- Model generates similar increase in inflation as in the data (higher than without default)

Event: Nominal Rate



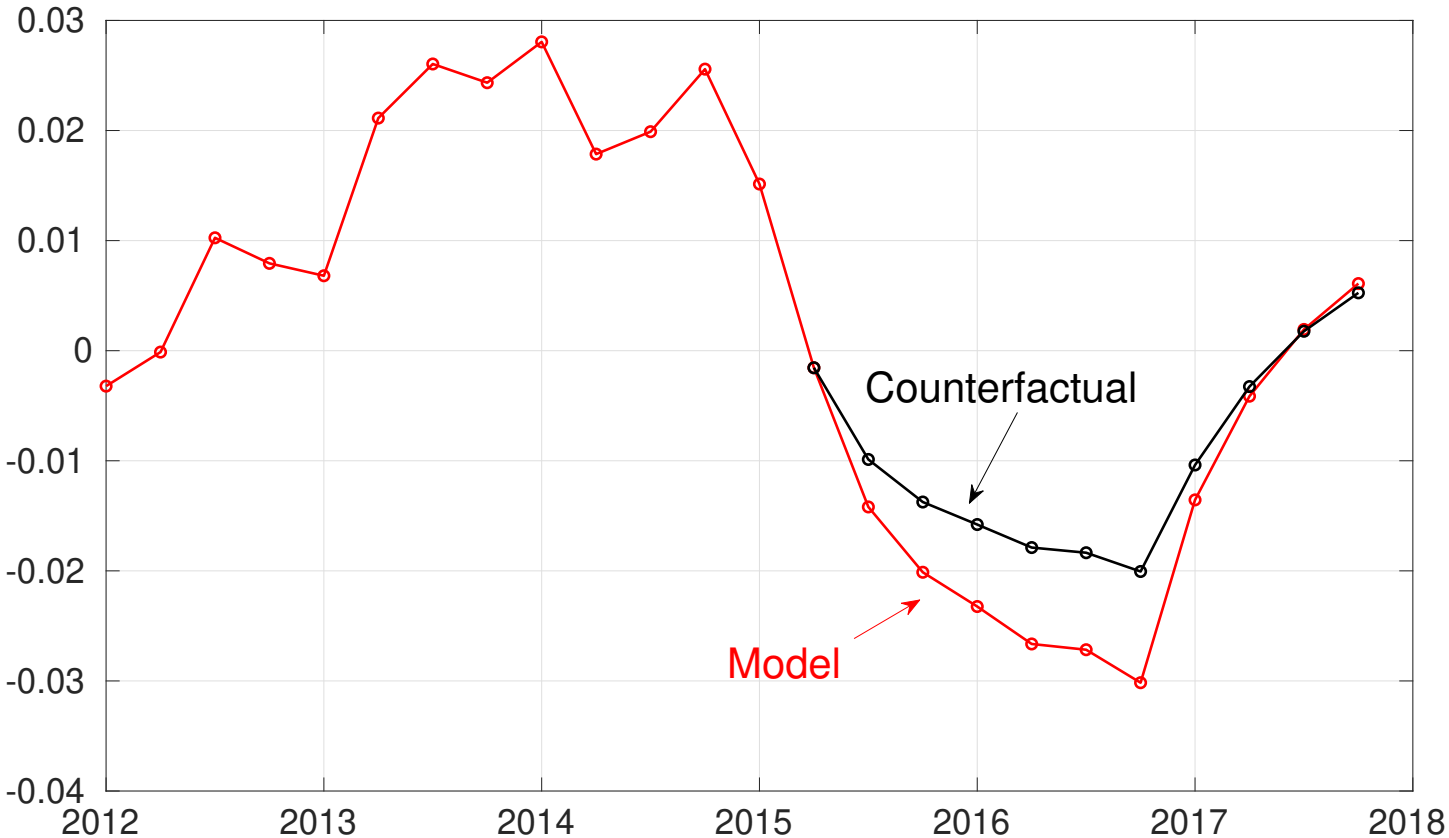
- Nominal rate increases to fight inflation
  (more aggressive than without default)

Counterfactual: Nominal Rate



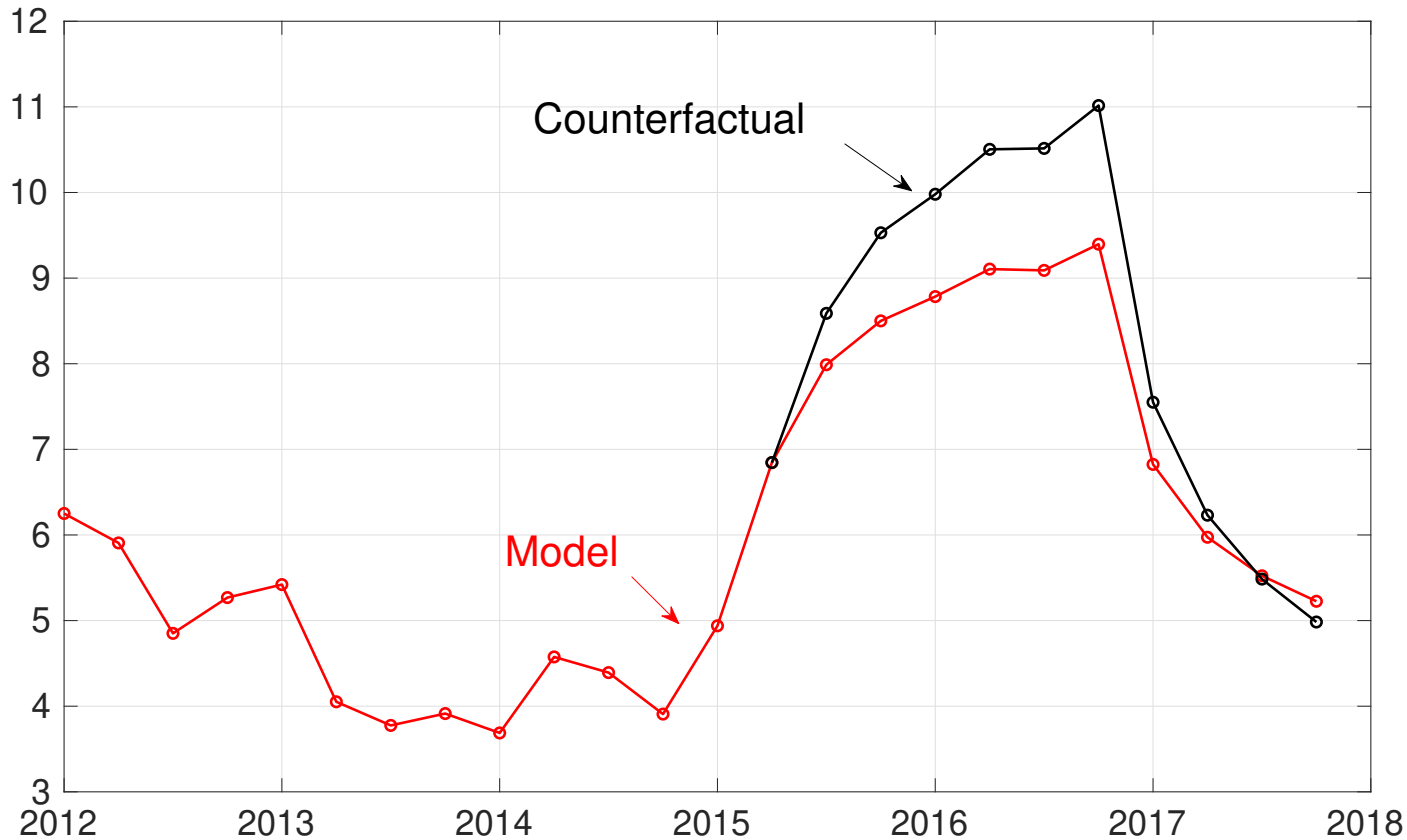
- Feed in same productivity sequence
- Keep nominal rates low

Counterfactual: Output



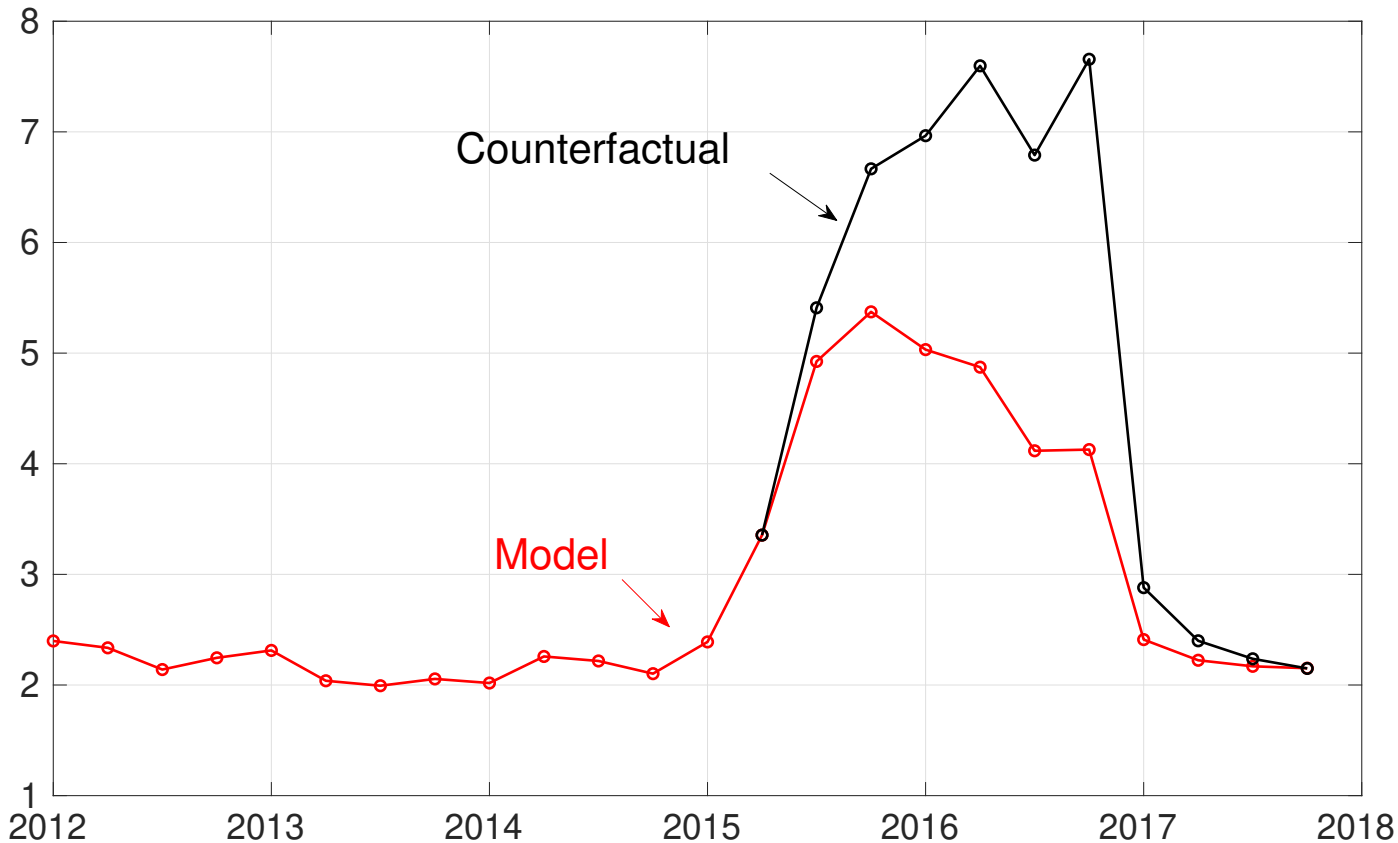
- Output falls by less with expansionary monetary policy

Counterfactual: Inflation



- Inflation increases by more with expansionary monetary policy

Counterfactual: Spread



- Expansionary monetary policy worsens the debt crisis
- Brazil's tight monetary policy helped with inflation and debt crisis

Robustness: Extended Rules and Local Currency

Mean	Benchmark	Local currency	Rule with larger α_P	Rule with output gap
Spread	2.6	1.9	2.9	2.7
Standard Deviation				
Inflation	1.8	1.9	1.0	1.5
Domestic Rate	2.5	2.5	1.7	2.2
Spread	0.9	0.4	0.9	0.9
Correlation with Spread				
Inflation	60	57	54	72
Domestic Rate	64	61	66	76
Welfare rel to no monetary frictions				
	$-.02$	$+.02$	$+.01$	$-.01$

Robust predictions for default amplification and monetary discipline

- Nominal nominal rates always more volatile with default (NK-reference 1.3)
- Spreads always lower with monetary frictions (Default-reference 3.2)

Welfare: Tradeoff between monetary frictions and default risk frictions

- Strict inflation targeting (no monetary frictions) not optimal
- High weight on inflation α_P and local currency debt are best

Conclusion

- Integrated framework of monetary policy and sovereign risk

  New Keynesian model with default

- Important interactions between monetary frictions and default risk
  - Default risk amplifies monetary frictions and response
  - Monetary frictions discipline borrowing
- Model consistent with emerging market data
- Framework potentially useful for central banks

Robustness

- Local currency government debt

  balance of payment condition becomes

$$e_t^{\rho}\xi = e_t C_t^f + \frac{B_t}{\pi_t} - q_t\left(B_{t+1} - \delta\frac{B_t}{\pi_t}\right)$$

  bond price schedule becomes

$$q_t = \frac{1}{1+r^*}\mathbf{E}\left[\frac{e_t}{e_{t+1}\pi_{t+1}}(1-D_{t+1})(1+\delta q_{t+1})\right].$$

- Variants on the interest rate rule
  - Larger weight on inflation
  - Weight on output gap

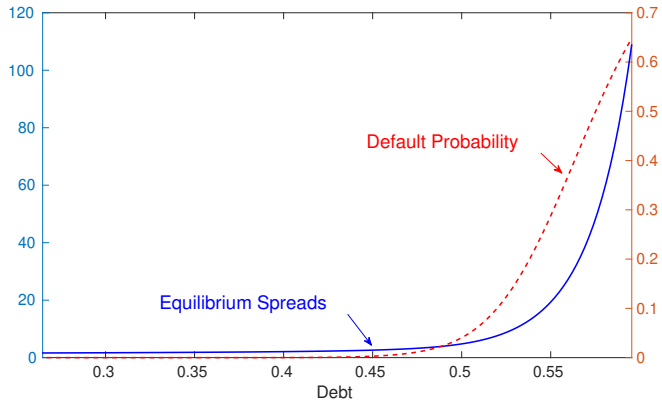
$$i = \bar{i}\left(\frac{\pi_t}{\overline{\pi}}\right)^{\alpha_P}\left(\frac{Y_t}{Y_t^{\text{flex}}}\right)^{0.5} m_t$$

Parameter Values

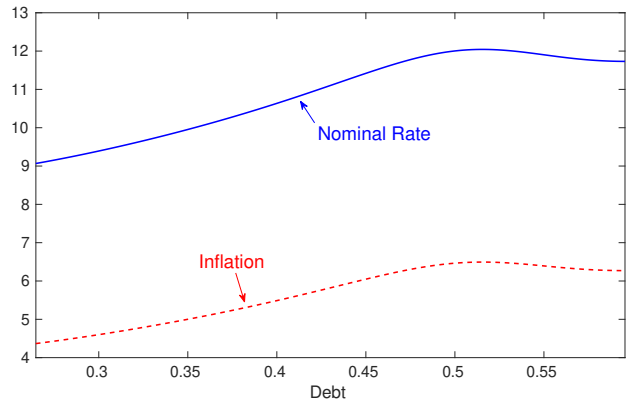
Assigned Parameters	
Share domestic in consumption	$\theta = 0.62$
Frisch elasticity	$\zeta = 0.33$
Persistence of productivity	$\rho_z = 0.9$
Trade elasticity	$\rho = 5$
Export demand level	$\xi = 1$
Varieties elasticity	$\eta = 6$
Interest rate rule intercept	$\bar{i} = \overline{\pi}/\beta$
International rate	$r^* = 0.5\%$
Market reentry probability	$\iota = 4.17\%$
Price adjustment cost	$\varphi = 58$
Parameters from Moment Matching	
Private discount factor	$\beta = 0.9866$
Government discount factor	$\beta_g = 0.9766$
Inflation target	$\overline{\pi} = 1.015$
Interest rate rule	$\rho = 1.4$
Std of productivity shock	$\sigma_z = 0.95\%$
Productivity in default	$\lambda_0 = -0.17$
	$\lambda_1 = 0.19$
Enforcement shock	$\varrho_D = 1e^{-4}$

Back

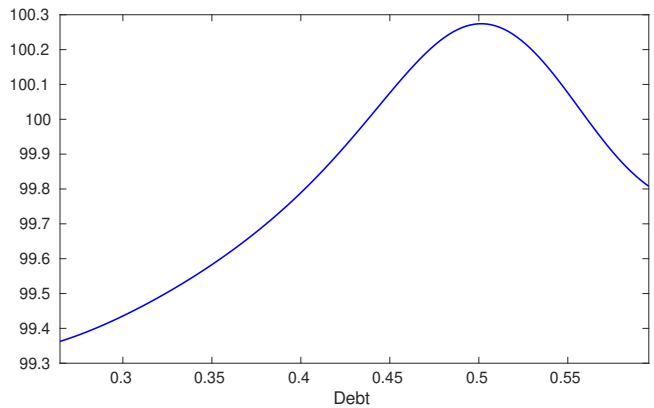
Policy Rules



(c) Spreads and Default Risk

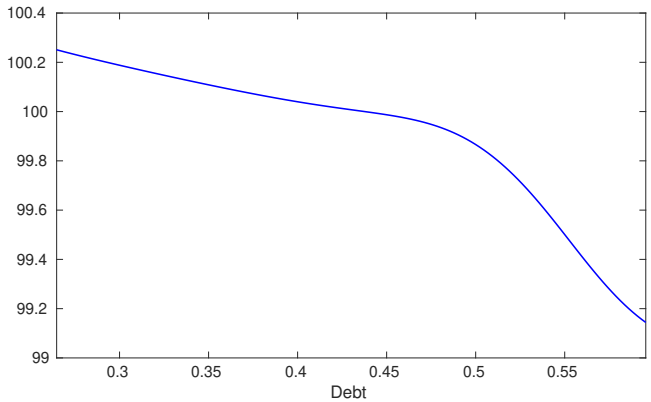


(d) Nominal Rate and Inflation

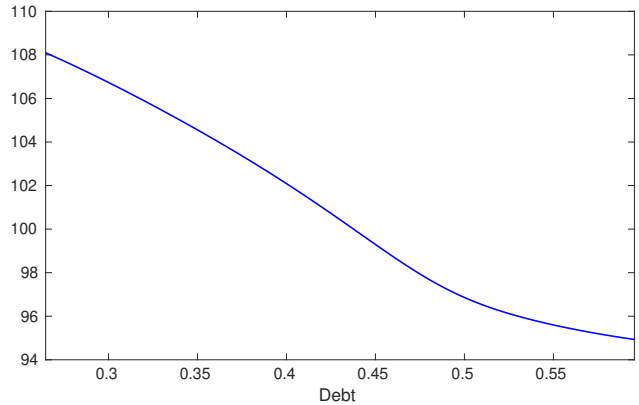


(e) Output

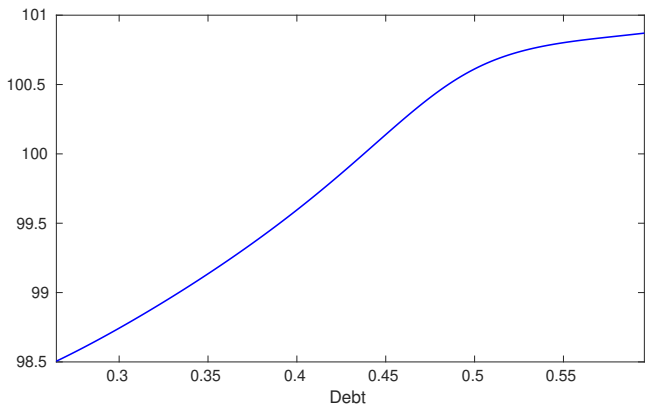
Policy Rules



(f) Domestic Consumption

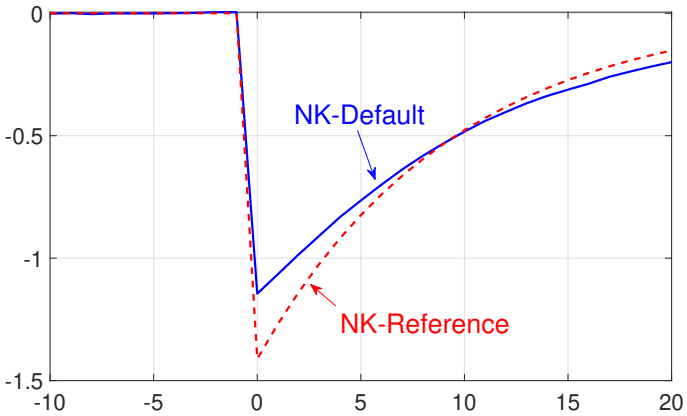


(g) Imported Consumption

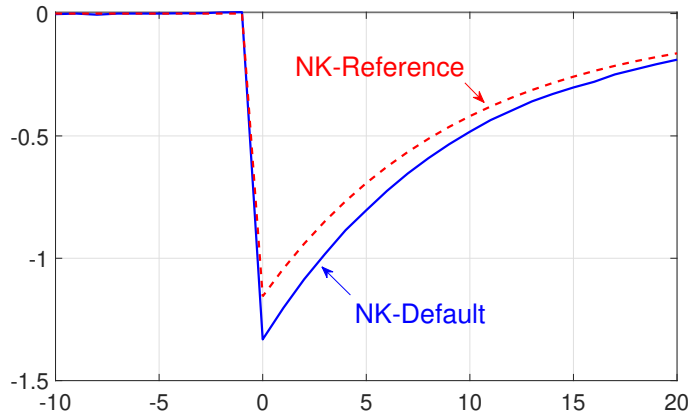


(h) Terms of Trade

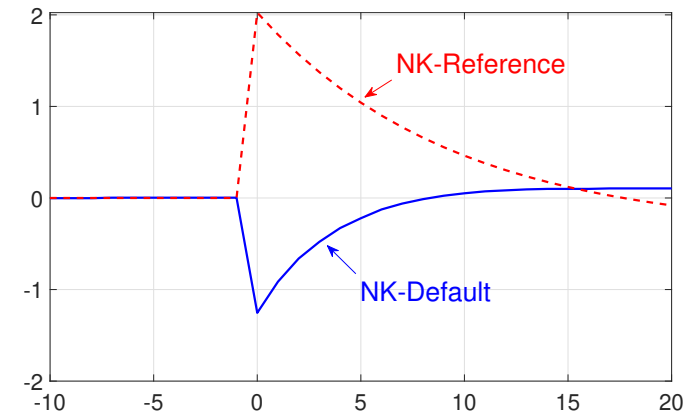
Impulse Responses to Productivity Shock



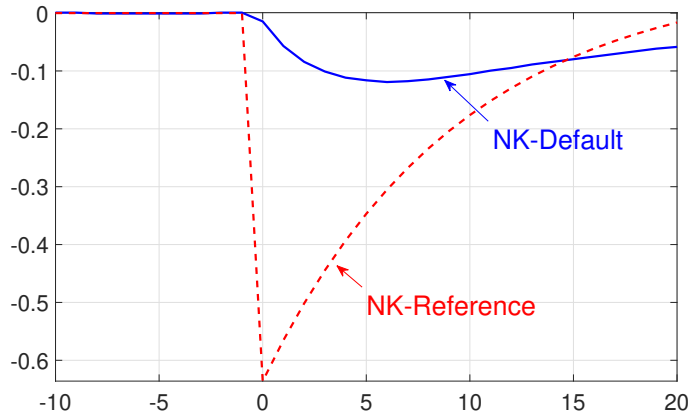
(a) Output



(b) Domestic Consumption (C)



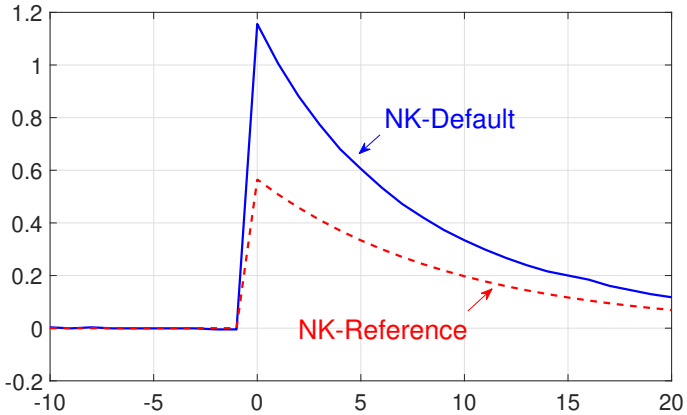
(c) Imported Consumption (C^f)



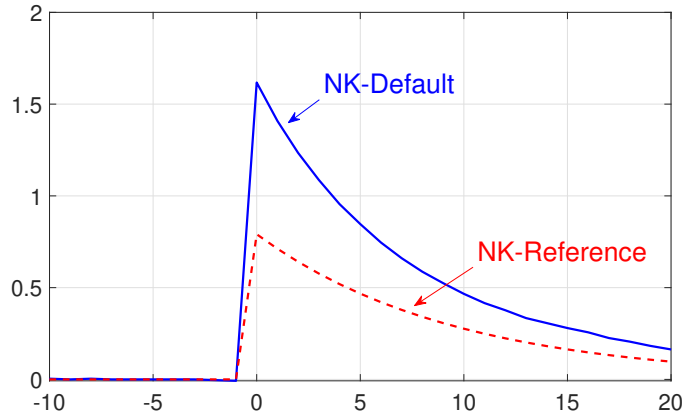
(d) Terms of Trade (e)

- Decline in domestic and imported consumption
- Smaller appreciation in benchmark $\Rightarrow$ more muted decline in export

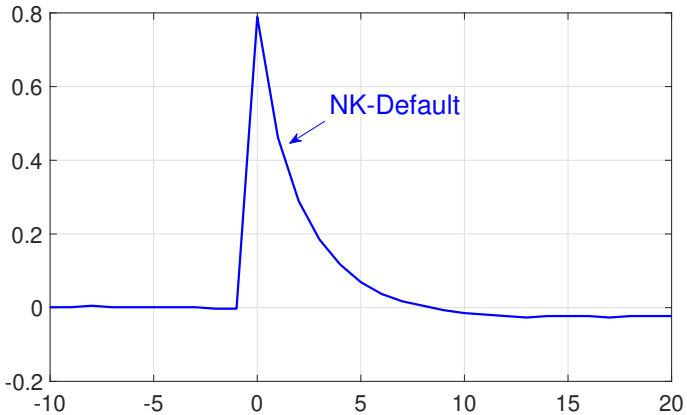
Impulse Responses to Productivity Shock



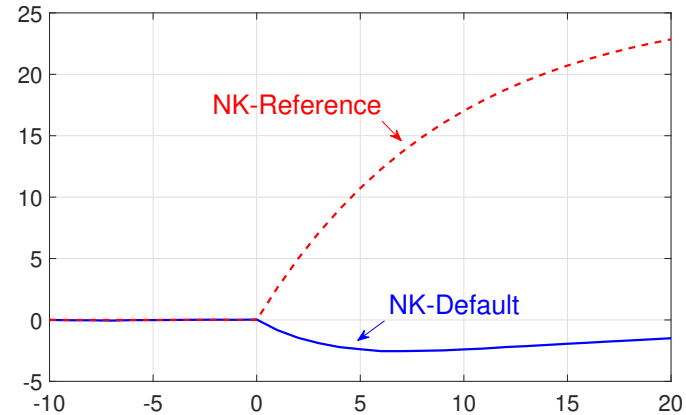
(a) Inflation (π)



(b) Nominal Interest Rate (i)



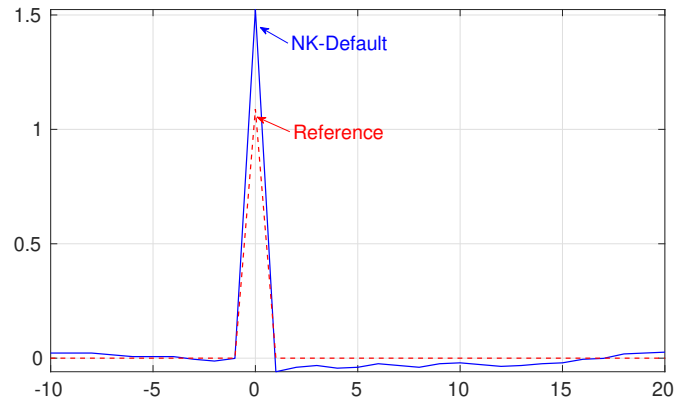
(c) Spread



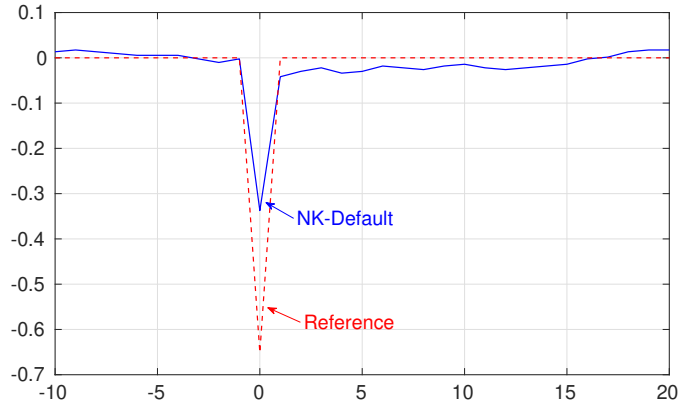
(d) Debt (B)

- High nominal rates and spreads
  - Associated with recession and high inflation
- Nominal rates respond more forcefully with default risk

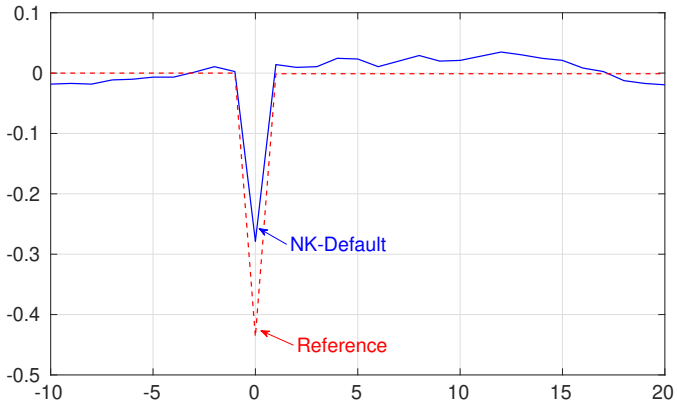
Impulse Responses to Money Shock



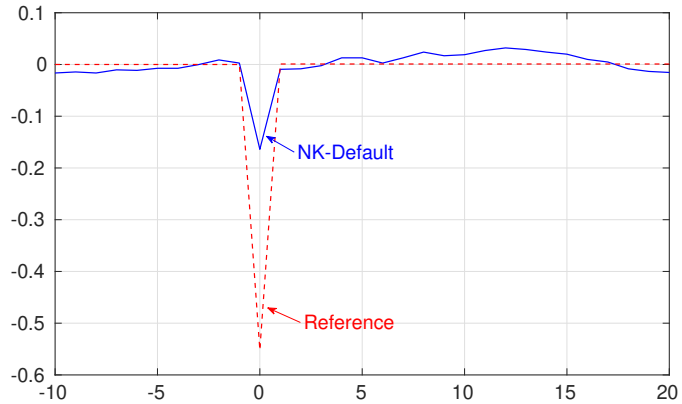
(a) Nominal Interest Rate



(b) Inflation



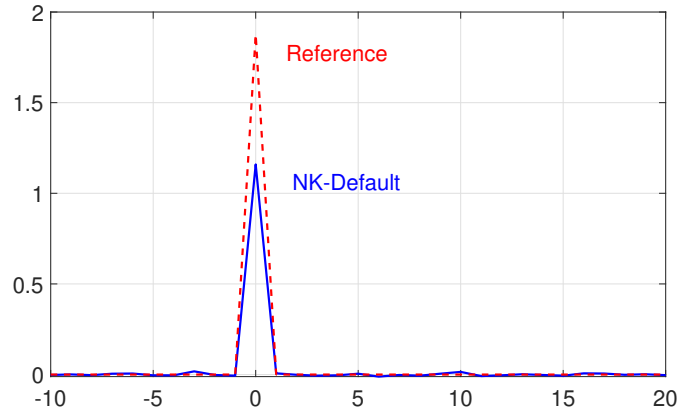
(c) Domestic Consumption



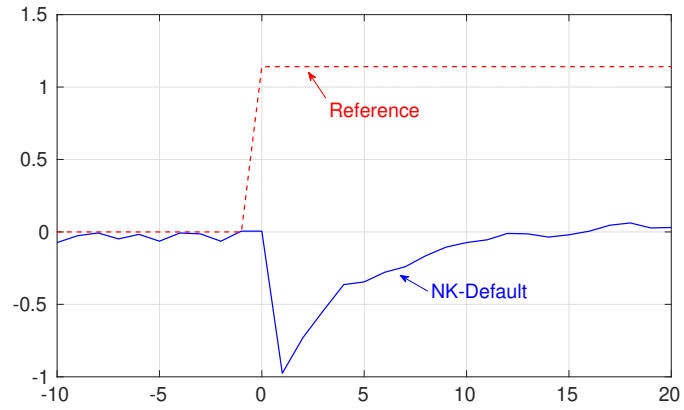
(d) Output

- High nominal rates depress inflation, consumption, and output (standard)
- NK-Default larger response of nominal rates

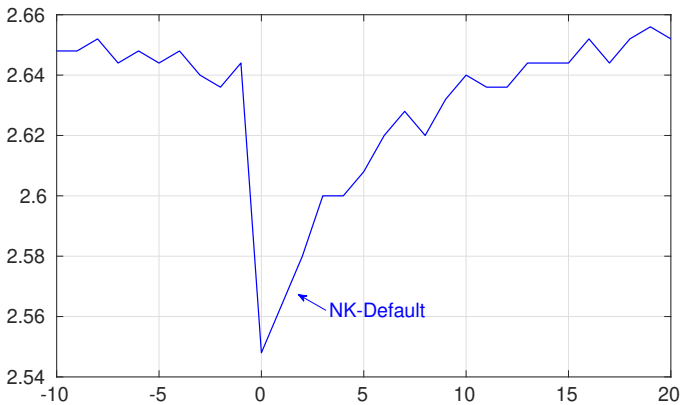
Impulse Responses to Money Shock



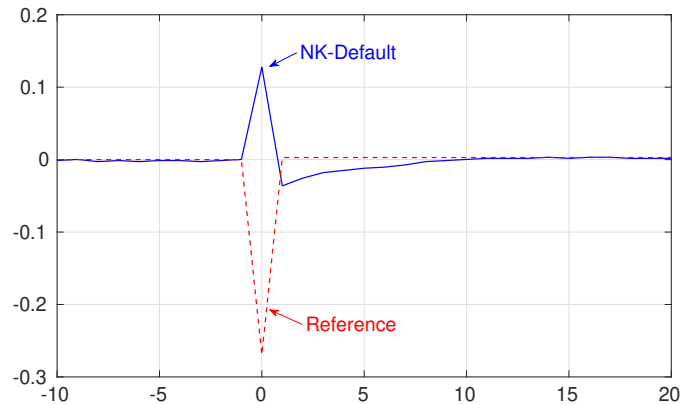
(a) Labor wedge



(b) Borrowing



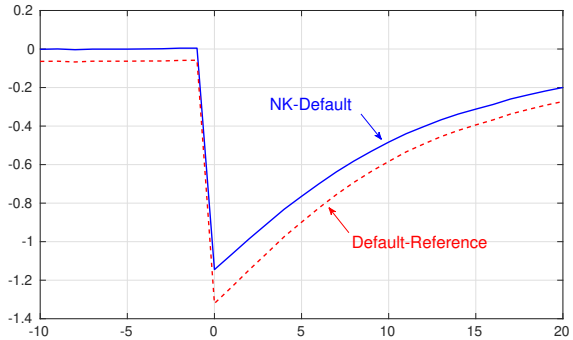
(c) Spread



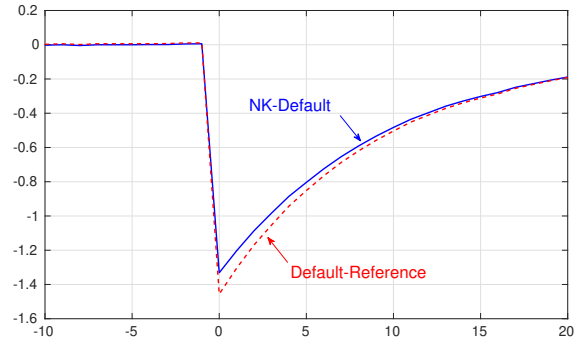
(d) Terms of Trade

- High i increases labor wedge $\Rightarrow$ reduces borrowing and spread (new)
- Monetary friction disciplines borrowing
- Low borrowing leads to depreciation (UIP violated in our model) ▸ TFP IRF

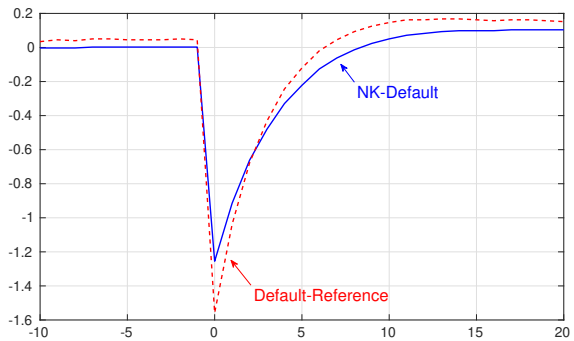
Impulse Responses to Productivity Shock



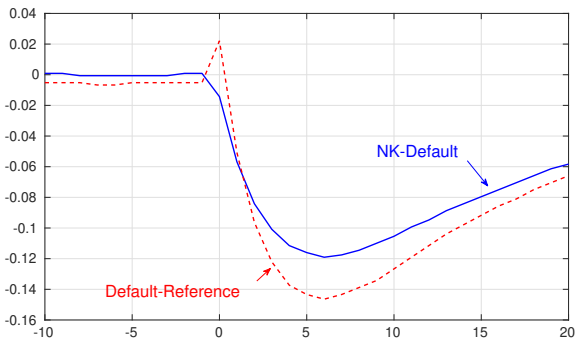
(e) Output



(f) Domestic Consumption (C)

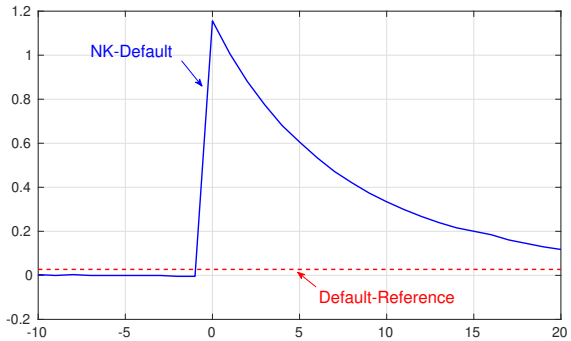


(g) Imported Consumption (C^f)

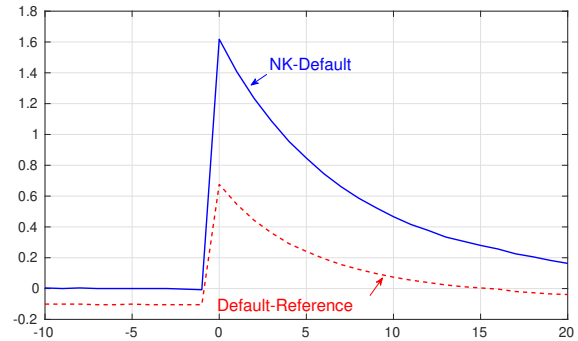


(h) Terms of Trade (e)

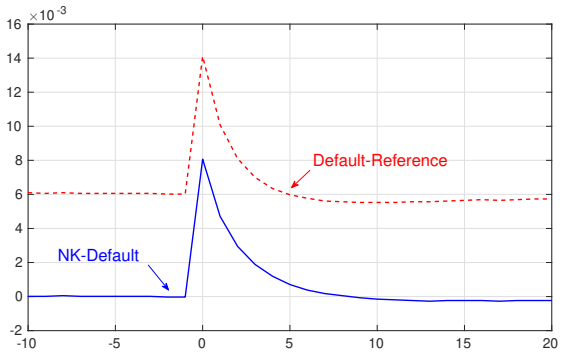
Impulse Responses to Productivity Shock



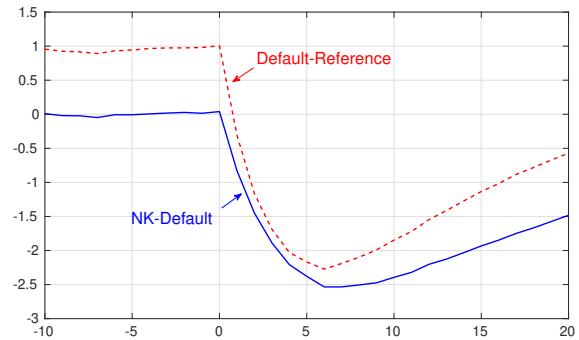
(i) Inflation (π)



(j) Nominal Interest Rate (i)



(k) Spread



(l) Debt (B)

Real model: More muted response of inflation and nominal rates