Navigating by Falling Stars: Monetary Policy with Fiscally-driven Natural Rates

Rodolfo G. Campos[1] Jesús Fernández-Villaverde[2] Galo Nuño[1,3] Peter Paz[1]

[1] *Banco de España*
[2] *University of Pennsylvania*
[3] *BIS*

The views expressed in this paper are those of the authors and do not necessarily coincide with those of the BIS, Banco de España or the Eurosystem.

Long-term inflation determination in the standard New Keynesian framework

- **Taylor rule**:

$$i_t = \overline{r} + \overline{\pi} + \phi(\pi_t - \overline{\pi}).$$

- **Natural Rate**

$$r^* = 1/\beta.$$

.

- **Long-term inflation determination**: If the central bank sets $\overline{r} = r^*$, it can achieve its inflation target $\overline{\pi}$.

What happens in a heterogeneous-agent New Keynesian model?

- In a HANK model, natural rates are a function of the stock of debt $\overline{B}$: $r^* = r(\overline{B})$
- Debt-financed fiscal expansions then act as "natural rate" shocks
- To achieve its target, the central bank should adapt its monetary policy to the long-term fiscal stance $\overline{r} = r(\overline{B})$
- This is a new form of monetary-fiscal interaction, unrelated to the FTPL

Preview of findings

- There is a minimum level of debt compatible with the inflation target
- Failing to adapt monetary policy to permanent fiscal changes leads to higher long-term inflation, and if debt is long-term, higher output and consumption.
- Dynamics are more inflationary even if the central bank adjusts, due to income effects.
- Robust monetary policy rules à la Orphanides-Williams perform much better in this environment than Taylor rules
- The theory can be employed to infer the *policy gap* between the central bank intercept $\bar{r}$ and the natural rate r^* in the data

Model

Model overview

1. Heterogeneous households
   - Mass 1 of households, subject to idiosyncratic labor productivity.
2. New Keynesian block
   - Unions are similar to intermediate good producers in a NK model.
   - Sticky wages: they set wages on behalf of workers.
   - Yields a simple wage Phillips curve.
3. Monetary and Fiscal Policy
   - Central bank follows a Taylor rule
   - Treasury follows a fiscal rule
4. Firms
   - Representative firm with aggregate production function.
   - Flexible prices.

Households

- Household solve

$$V(a_{i,t}, z_{i,t}) = \max_{c_{i,t}, a_{i,t+1}} u(c_{i,t}) - v(n_{i,t}) + \beta \mathbb{E}_t[V(a_{i,t+1}, z_{i,t+1})]$$

$$\text{s.t.} \quad c_{i,t} + a_{i,t+1} = (1 + r_t) a_{i,t} + (1 - \tau) \frac{W_t}{P_t} z_{i,t} n_{i,t},$$

$$a_{i,t+1} \geq 0,$$

- They choose $c_{i,t}$ and $a_{i,t+1}$. Their labor choice $n_{i,t}$ is is performed by unions.

- c_i : consumption
- n_i : working hours
- a_i : asset position
- r : return of bonds
- W : nominal wage
- P : price level
- z_i : idiosyncratic productivity

Treasury: Fiscal Policy

- The treasury can issue one-period nominal bonds. Tax collection is given by:

$$T_t = \int_0^1 \tau \frac{W_t}{P_t} z_{i,t} n_{i,t} di.$$

- Public debt B_t accumulates according to:

$$P_t B_t = (1 + i_{t-1}) P_{t-1} B_{t-1} + P_t (G_t - T_t),$$

- Fiscal rule:

$$G_t = \overline{G} - \phi_G (B_{t-1} - \overline{B})$$

- G_t : government consumption
- T_t : tax collection
- B_t : pubic debt
- $\overline{B}$: debt target

Central bank: Monetary Policy

- Central bank follows Taylor rule

$$\log(1+i_t) = \max\left\{\log(1+\bar{r}) + \log(1+\overline{\pi}) + \phi_\pi \log\left(\frac{1+\pi_t}{1+\overline{\pi}}\right), 0\right\}$$

- $\bar{r}$: real rate intercept
- i_t : nominal rate
- $\overline{\pi}$: inflation target
- π_t : inflation

Firm

- Representative firm with aggregate production function, linear production function

$$Y_t = \Theta N_t$$

- Flexible prices: $P_t = W_t$

- Y_t : output
- Θ : constant productivity
- N_t : aggregate labor

Unions

- Wage Phillips curve:

$$\log\left(\frac{1+\pi_t^w}{1+\overline{\pi}}\right) = \kappa_w\left[-\frac{\epsilon_w-1}{\epsilon_w}(1-\tau)\frac{W_t}{P_t}\int u'(c_{it})z_{it}di + v'(N_t)\right]N_t + \beta\log\left(\frac{1+\pi_{t+1}^w}{1+\overline{\pi}}\right)$$

- π_t^w : wage inflation
- N : aggregate labor
- W : nominal wage
- P : price level

Aggregation and market clearing

- In equilibrium all agents optimize and the labor, bond, and good markets clear:

$$G_t + C_t = Y_t$$
$$A_t = B_t$$

where aggregates are:

$$N_t = \int_0^1 z_{i,t} n_{i,t} di,$$
$$A_t = \int_0^1 a_{i,t+1} di,$$
$$C_t = \int_0^1 c_{i,t} di,$$

Calibration

	Parameter	Value	Target/Sources
	Preferences		
σ	Elasticity of intertemporal substitution	1	Standard
φ	Frisch elasticity of labor supply	0.5	Standard
ν_φ	Disutility of labor parameter	0.881	$N_{ss} = 1$
β	Quarterly discount factor	0.991	1% real interest rate in DSS
	Income process		
ρ_e	Persistence income process (annual)	0.91	Floren and Lindé (2001)
σ_e	Std. dev. idiosyncratic shock (annual)	0.92	Floren and Lindé (2001)
	Production		
Y	Quarterly output	1	Normalization
Θ	Constant level of TFP	1	Normalization
κ_w	Slope of the wage Phillips curve	0.1	Aggarwal et al.(2023)
ϵ_w	Elasticity of substitution	10	Standard

Calibration

	Parameter	Value	Target/Sources
	Fiscal policy		
r	Real interest rate (annual)	0.01	Baseline case
$\overline{B}$	Debt target	2.8	Debt-to-GDP 70%
$\overline{G}$	Government spending target	0.2	Spending-to-GDP 20%
τ	Tax rate	0.207	B constant in DSS
ϕ_G	Coefficient in the fiscal rule	0.1	Baseline case
	Monetary policy		
ϕ_π	Taylor rule coefficient	1.25	Standard
$\overline{\pi}$	Inflation target (annual)	0.02	Standard

Monetary-fiscal interaction in the long run

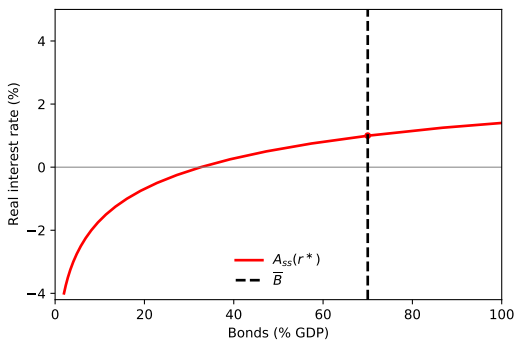
Natural rate determination

- Demand for bonds:

$$A_{ss}(r^*) = \int_0^1 a_{i,t+1} di.$$

- Supply of bonds:

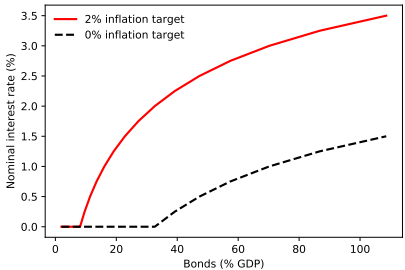
$$B_{ss} = \frac{(\overline{G} - G_{ss})}{\phi_G} + \overline{B}.$$

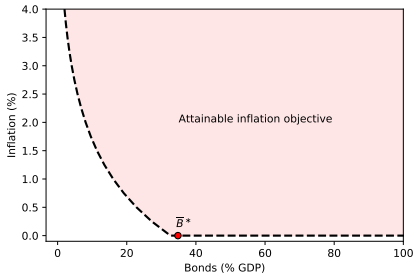


Deviations from the natural rate in the Taylor rule (policy gap) imply long-term inflation deviations

$$\pi_{ss} \approx \overline{\pi} + \frac{r^* - \overline{r}}{\phi_\pi - 1}.$$

There is a minimum debt level compatible with price stability



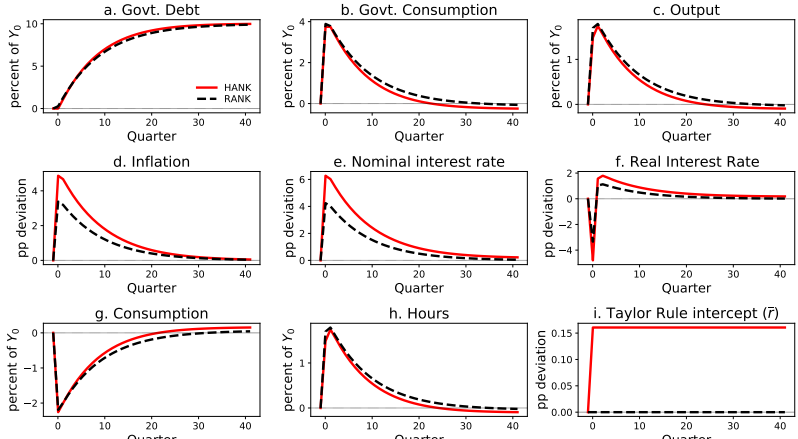


Steady-state nominal interest rate and inflation for different inflation targets

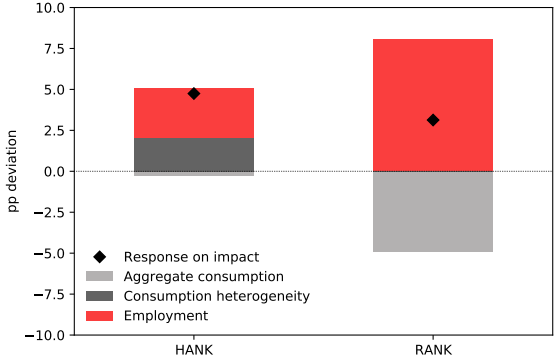
A surprise debt-financed fiscal expansion

	Initial steady state	New steady state		Difference	
		HANK	RANK	HANK	RANK
Bonds (% GDP)	70.00	80.00	80.00	10.00	10.00
Real interest rate	1.00	1.18	1.00	0.18	0.00
Nominal interest rate	3.02	3.20	3.02	0.18	0.00
Output	100.00	99.89	99.96	-0.11	-0.04
Consumption	80.00	80.15	80.07	0.15	0.07
Govt. consumption	20.00	19.73	19.89	-0.27	-0.11
Tax revenue	20.70	20.67	20.69	-0.02	-0.01
Primary surplus (% GDP)	0.70	0.94	0.80	0.24	0.10

Table 1: Steady state in the baseline HANK model and in the RANK model

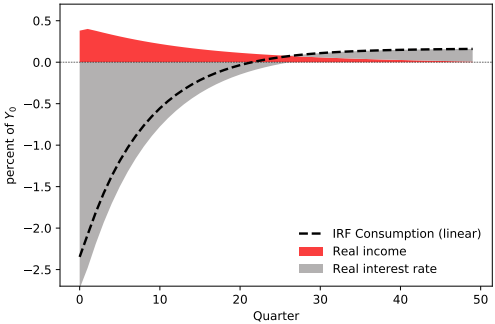


Dynamics after a surprise debt-financed fiscal expansion

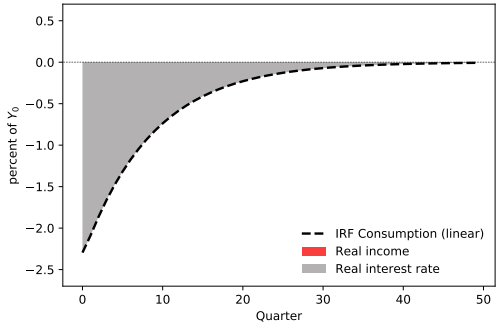


Decomposition of the response of inflation on impact

Decomposition of the response of aggregate consumption

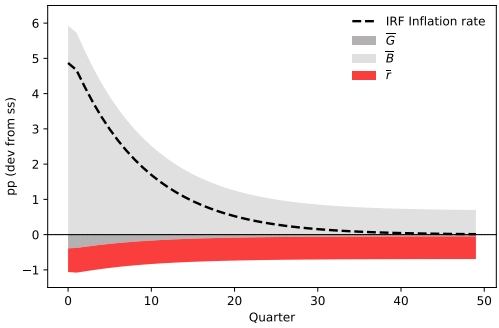


HANK model

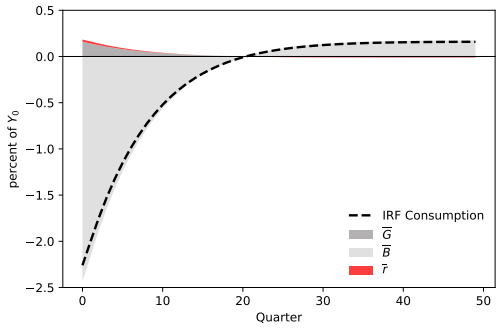


RANK model

Decomposition of the response of inflation and consumption in terms of policy variables

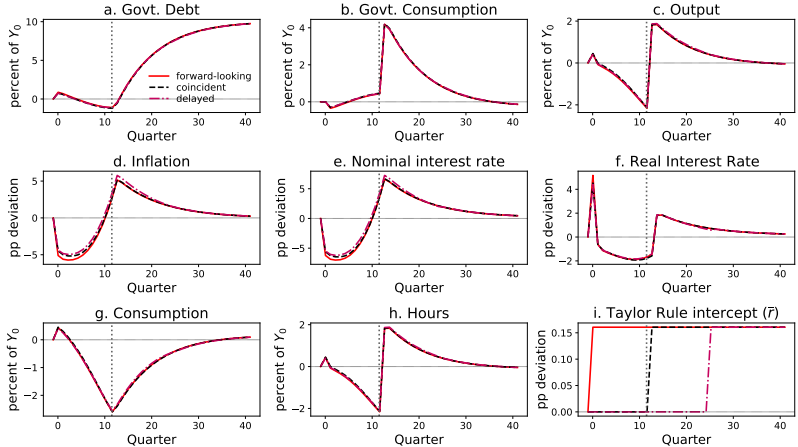


Inflation



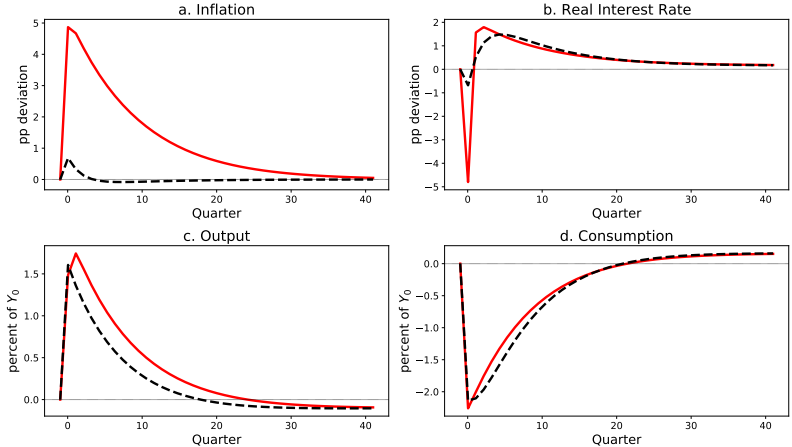
Consumption

Extensions: Anticipated effects



Dynamics of an anticipated debt-financed fiscal expansion

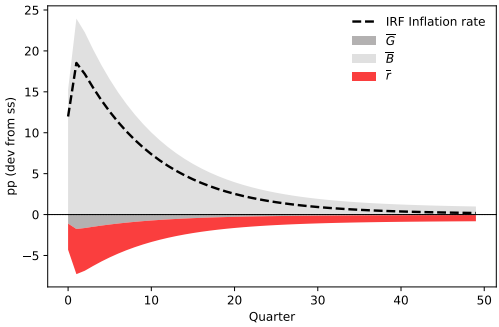
Extensions: Robust monetary rules



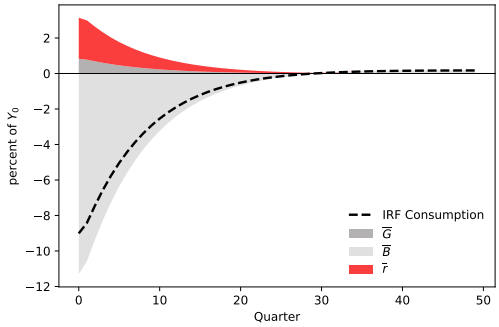
Comparison of a standard Taylor Rule and Orphanides-Williams Rule in the HANK model

Extensions: Introducing long-term debt

Decomposition of the response of inflation and consumption in terms of policy variables



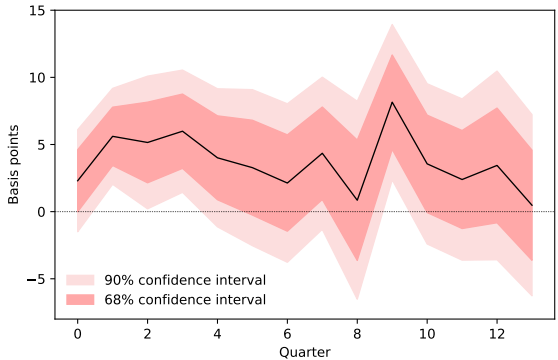
Inflation



Consumption

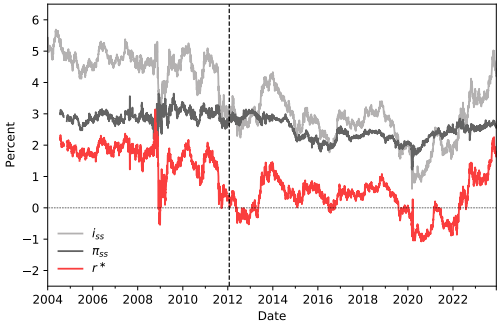
Validating evidence

Quantitative similar response of the natural rate to permanent increase in debt

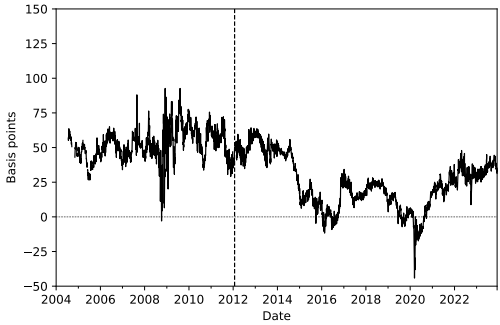


IRF of r^* to a 1% increase on the goverment debt-to-GDP ratio,LP

Inferring the policy gap from market data

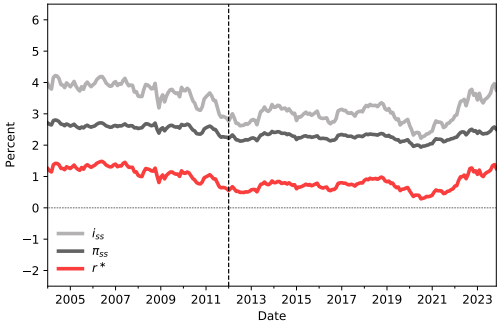


Long-term nominal and real rates and inflation

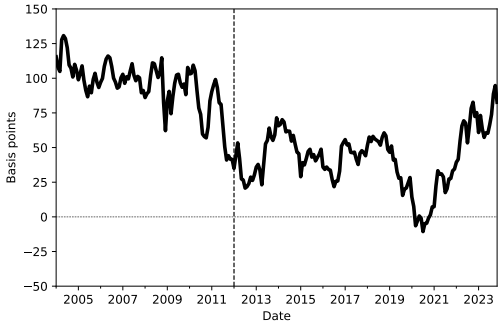


Policy gap $r^* - \overline{r}$

Correcting for term premium



Data adjusted for term premia



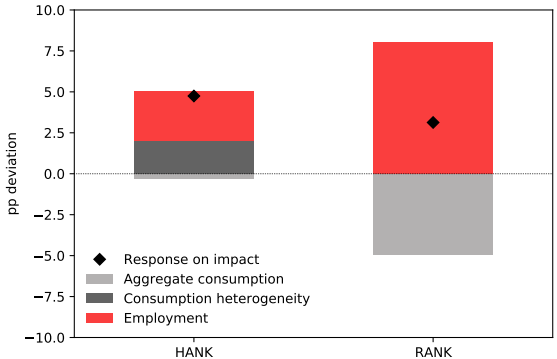
Policy gap $r^* - \overline{r}$ (adj. data)

Thank you!

Appendix

A surprise debt-financed fiscal expansion

Nonlinearities



Decomposition of the response of inflation on impact