A TANK of Fiscal Policy Uncertainty

Filipe Stona (PPGE-UFRGS e Banco Sicredi) e
Marcelo S. Portugal (PPGE-UFRGS e CNPq)

October 2019

41^o Encontro da Sociedade Brasiliera de Econometria (SBE)
Escola de Economia de São Paulo (EESP - FGV) - São Paulo/SP

Facts

- Hand-to-Mouth agent: households with little liquid wealth consume all of their disposable income every period;
- The fraction HtM population in the US varies from 25% to 50% (depending on the definition).
- However, this fraction of HtM households remains stable over time;
- HtM agents represent 20% of total US income;
- Kaplan et al. (2014)

This Paper

- Two-Agent New Keynesian (TANK) general equilibrium model;
- We assume that a fraction of agents spend significant amounts of unexpected wealth when they arrive;
- We analyze the real effects of uncertainty shocks on a developed and developing country (US and Brazil);
- This framework generates larger **indirect effects** on aggregate consumption, which are absent on a RANK model.

Literature

Summary Results

- HtM households are more affected by uncertainty;
- Labor market is the main transmission channel of fiscal policy uncertainty from firms to households;
- The fraction of HtM agents in the economy can amplify uncertainty shocks;
- Risk aversion of HtM agents is higher in developing economies;
- Active fiscal policy by the government is more harmful to borrowing constraint households;

Main Ingredients in the Model

1. Fiscal shocks with stochastic volatility.
2. Two-Agent Model;
3. Epstein-Zin Preferences;
4. Sticky Prices and Wages;
5. Monopolistically competitive intermediate goods firms;
6. A perfectly competitive labor packer aggregates the different types of labor. Firms cannot distinguish agents type;
7. Monetary authority reacts to inflation, output and uncertainty shocks.

Main Ingredients in the Model

1. **Fiscal shocks with stochastic volatility.**
2. **Two-Agent Model;**
3. **Epstein-Zin Preferences;**
4. Sticky Prices and Wages; Rigidities
5. Monopolistically competitive intermediate goods firms; Firms
6. A perfectly competitive labor packer aggregates the different types of labor. Firms cannot distinguish agents type; Aggregation
7. Monetary authority reacts to inflation, output and uncertainty shocks. Taylor Rule

Fiscal Policy Rule

For $\mathsf{x} \in \{g, \tau^k, \tau^l\}$, the law of motion for each instrument is given by

$$\begin{aligned} \mathsf{x}_t - \mathsf{x} = & \rho_{\mathsf{x}}(\mathsf{x}_{t-1} - \mathsf{x}) + \rho_{\mathsf{x},y}\tilde{y}_{t-1} \\ & + \rho_{\mathsf{x},b}\left(\frac{b_{t-1}}{y_{t-1}} - \frac{b_s}{y_s}\right) + \exp\{\sigma_{\mathsf{x},t}\}\varepsilon_{\mathsf{x},t}, \quad \varepsilon_{\mathsf{x},t} \sim \mathcal{N}(0,1), \end{aligned}$$

where the log standard deviation of each policy instrument ($\sigma_{e,t}$) has a time-varying stochastic volatility process,

$$\sigma_t = (1-\rho_\sigma)\sigma + \rho_\sigma\sigma_{t-1} + (1-\rho_\sigma^2)^{1/2}\eta_\sigma u_t, \quad u_t \sim \mathcal{N}(0,1).$$

Fiscal Policy Rule

For $\mathsf{x} \in \{g, \tau^k, \tau^l\}$, the law of motion for each instrument is given by

$$\begin{aligned} \mathsf{x}_t - \mathsf{x} =& \rho_{\mathsf{x}}(\mathsf{x}_{t-1} - \mathsf{x}) + \rho_{\mathsf{x},y}(\tilde{y}_{t-1}) \\ &+ \rho_{\mathsf{x},b}\tilde{b}_{t-1} + \exp\{\sigma_{\mathsf{x},t}\}\varepsilon_{\mathsf{x},t}, \quad \varepsilon_{\mathsf{x},t} \sim \mathcal{N}(0,1), \end{aligned}$$

where the log standard deviation of each policy instrument $(\sigma_{e,t})$ has a time-varying stochastic volatility process,

$$\sigma_t = (1-\rho_\sigma)\sigma + \rho_\sigma \sigma_{t-1} + (1-\rho_\sigma^2)^{1/2}\eta_\sigma u_t, \quad u_t \sim \mathcal{N}(0,1).$$

- Notation: $\tilde{b}_{t-1}$ is the debt gap and $\tilde{y}_{t-1}$ is the output gap.

Fiscal Policy in Developing Countries Government Budget Constraint

Environment

- A fraction μ is hand-to-mouth (HtM) and $(1-\mu)$ is non-hand-to-mouth (bondholders/savers);
- Both agents have preferences represented by an **Epstein-Zin** aggregator between the period utility U_t and the continuation V_{t+1}:

$$V_t^{1-\psi} = (1-\beta)U_t(c_t, h_t)^{1-\psi} + \beta \mathbb{E}_t (V_{t+1}^{1-\gamma})^{\frac{1-\psi}{1-\gamma}}, \tag{1}$$

  where $U_t = c_t^{\eta}(1-h_t)^{1-\eta}$.
- Notation: $\gamma_i$and ψ_i are the risk-aversion and inverse IES of agents type i, for $i = h, b$.

Households

- The budget constraint for the **HtM agent** is:

$$c_t^h + \Omega_t^h = (1 - \tau_t^w) \int_0^1 w_{j,t} h_{j,t}^h dj - AC_{j,t}^w, \tag{2}$$

Households

- The budget constraint for the **HtM agent** is:

$$c_t^h + \Omega_t^h = (1 - \tau_t^w) \int_0^1 w_{j,t} h_{j,t}^h dj - AC_{j,t}^w, \tag{2}$$

- The **Bondholder agent** faces the following budget constraint:

$$\begin{aligned} c_t^b + x_t + b_t + \Omega_t^b =& (1 - \tau_t^w) \int_0^1 w_{j,t} h_{j,t}^b dj \\ & + (1 - \tau_t^k) r_t^k u_t k_{t-1} + \frac{R_{t-1} b_{t-1}}{\Pi_t} - AC_{j,t}^w + F_t, \end{aligned} \tag{3}$$

Wages | Capital LOM

Calibration

	Description	Brazil	United States	Source
Preferences				
β	Time-discount factor	0.9785	0.9959	Calibration
γ_h	HtM Risk Aversion	1329.10	370.34	Calibration
γ_b	Bondholder Risk Aversion	373.46	661.83	Calibration

Solution and Calibration More Parameters Model Fit

Results - United States

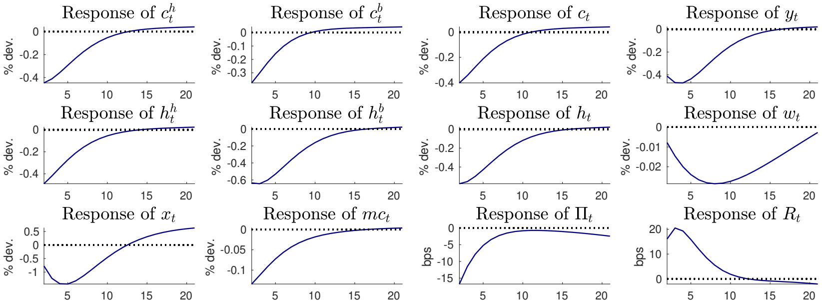

Figure 1: IRF to a Fiscal Policy Uncertainty Shock

Note: GIRFs to a positive two-standard-deviations innovation to a fiscal volatility shock to the capital income tax. Interest rate and inflation are in annualized basis points. In the first line the plots presents the reaction of consumption of HtM agent (c_t^h), bondholder (c_t^b), aggregate consumption and product (c_t and y_t). Second line, HtM, Saver and aggregate hours worked (h_t^h, h_t^b and h_t) and wages (w_t). Finally, investments (x_t), marginal cost (mc_t), inflation (Π_t) and interest rates (R_t).

Results - United States

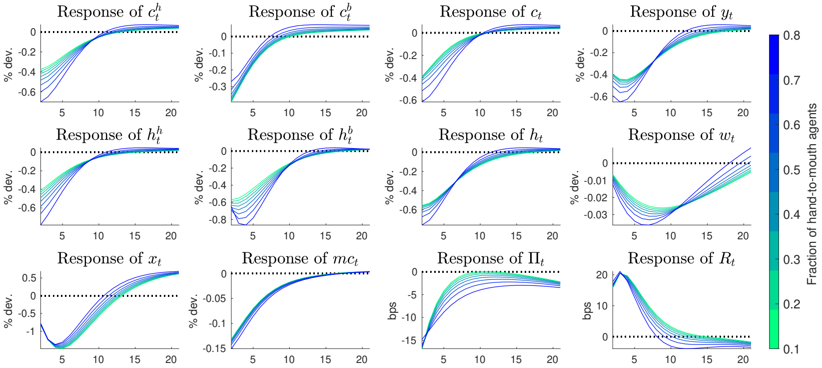

Figure 2: Sensitivity to the fraction of HtM agents

Note: Sensitivity test to the fraction of HtM agents on the economy μ given a positive two-standard-deviations innovation to a fiscal volatility shock to the capital income tax. Interest rate and inflation are in annualized basis points. In the first line the plots presents the reaction of consumption of HtM agent (c_t^h), bondholder (c_t^b), aggregate consumption and product (c_t and y_t). Second line, HtM, Saver and aggregate hours worked (h_t^h, h_t^b and h_t) and wages (w_t). Finally, investments (x_t), marginal cost (mc_t), inflation (Π_t) and interest rates (R_t).

Results - Brazil

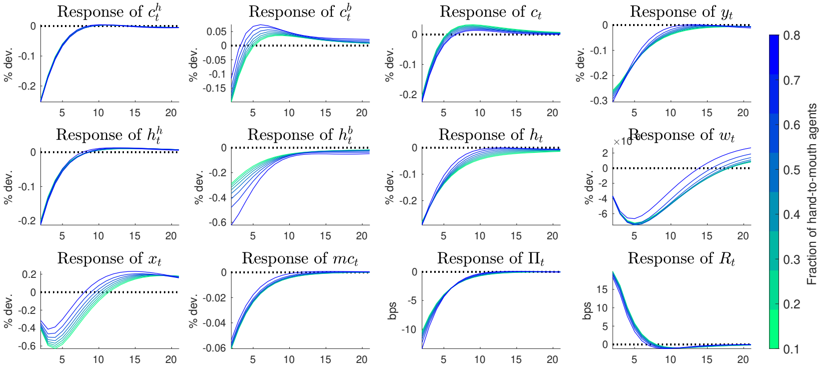

Figure 3: Sensitivity to the fraction of HtM agents

Note: Sensitivity test to the fraction of HtM agents on the economy μ given a positive two-standard-deviations innovation to a fiscal volatility shock to the capital income tax. Interest rate and inflation are in annualized basis points. In the first line the plots presents the reaction of consumption of HtM agent (c_t^h), bondholder (c_t^b), aggregate consumption and product (c_t and y_t). Second line, HtM, Saver and aggregate hours worked (h_t^h, h_t^b and h_t) and wages (w_t). Finally, investments (x_t), marginal cost (mc_t), inflation (Π_t) and interest rates (R_t).

Fiscal Policy Rule

For $\mathsf{x} \in \{g, \tau^k, \tau^l\}$, the law of motion for each instrument is given by

$$\begin{aligned}\mathsf{x}_t - \mathsf{x} =& \rho_{\mathsf{x}}(\mathsf{x}_{t-1} - \mathsf{x}) + \rho_{\mathsf{x},y}(\tilde{y}_{t-1}) \\ &+ \rho_{\mathsf{x},b}\tilde{b}_{t-1} + \exp\{\sigma_{\mathsf{x},t}\}\varepsilon_{\mathsf{x},t}, \quad \varepsilon_{\mathsf{x},t} \sim \mathcal{N}(0,1),\end{aligned}$$

where the log standard deviation of each policy instrument ($\sigma_{e,t}$) has a time-varying stochastic volatility process,

$$\sigma_t = (1-\rho_\sigma)\sigma + \rho_\sigma \sigma_{t-1} + (1-\rho_\sigma^2)^{1/2}\eta_\sigma u_t, \quad u_t \sim \mathcal{N}(0,1).$$

Output and government responses

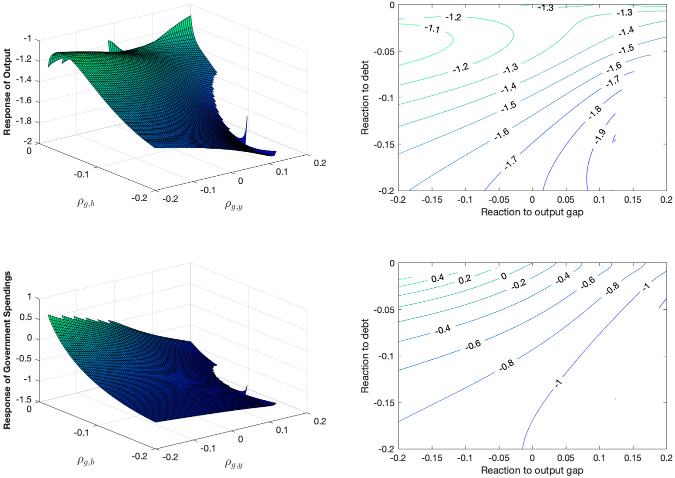

Figure 4: Sensitivity to government reaction parameters

Consumption responses

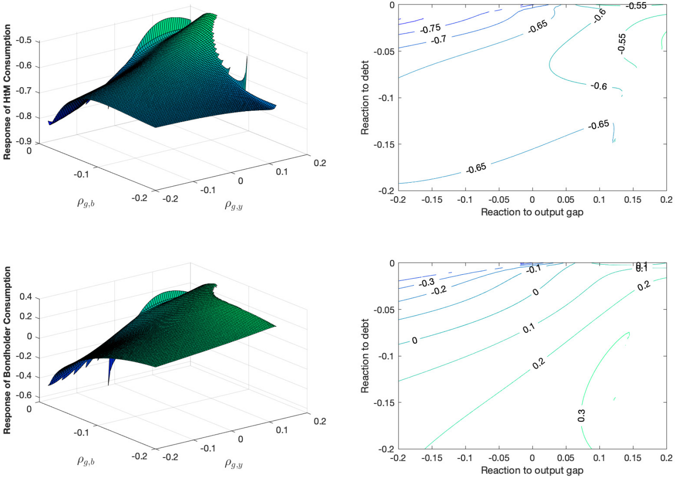

Figure 5: Sensitivity to government reaction parameters

Final Remarks

- Transmission of fiscal policy uncertainty through labor market;
- Contrast between risk aversion of HtM agents;
- Prominence of the fraction of HtM in the US and its effects on Bondholders for Brazil;
- The harmfulness of active fiscal policy by the government in borrowing constraint households;
- Results of fiscal policy volatility shock are similar to those presented by Bayer et al. (2019) as income risk on a fully heterogeneous model with incomplete markets;

A TANK of Fiscal Policy Uncertainty

Filipe Stona [fstona.com]

October 2019

41^o Encontro da Sociedade Brasiliera de Econometria (SBE)
Escola de Economia de São Paulo (EESP - FGV) - São Paulo/SP

References

Alesina, A., F. R. Campante, and G. Tabellini (2008): "Why is Fiscal Policy Often Procyclical?" *Journal of the European Economic Association*, 6, 1006–1036.

Basu, S. and B. Bundick (2017): "Uncertainty Shocks in a Model of Effective Demand," *Econometrica*, 85, 937–958.

Bayer, C., R. Luetticke, L. Pham-Dao, and V. Tjaden (2019): "Precautionary Savings, Illiquid Assets, and the Aggregate Consequences of Shocks to Household Income Risk," *Econometrica*, 87, 255–290.

Born, B. and J. Pfeifer (2014): "Policy risk and the business cycle," *Journal of Monetary Economics*, 68, 68 – 85.

Campos, E. L. and R. P. Cysne (2019): "A Time-Varying Fiscal Reaction Function for Brazil," *Estudos EconÃ ´micos (SÃPaulo)*, 49, 5 – 38.

Debortoli, D. and J. Galí (2017): "Monetary policy with heterogeneous agents: Insights from TANK models," *Manuscript*.

Drautzburg, T. and H. Uhlig (2015): "Fiscal stimulus and distortionary taxation," *Review of Economic Dynamics*, 18, 894 – 920.

Fernández-Villaverde, J., P. Guerrón-Quintana, K. Kuester, and J. Rubio-Ramírez (2015): "Fiscal Volatility Shocks and Economic Activity," *American Economic Review*, 105, 3352–84.

Gavin, M. and R. Perotti (1997): "Fiscal Policy in Latin America," in *NBER Macroeconomics Annual 1997, Volume 12*, National Bureau of Economic Research, Inc, NBER Chapters, 11–72.

Kaplan, G., B. Moll, and G. L. Violante (2018): "Monetary Policy According to HANK," *American Economic Review*, 108, 697–743.

Kaplan, G., G. L. Violante, and J. Weidner (2014): "The Wealthy Hand-to-Mouth," *Brookings Papers on Economic Activity*, 45, 77–153.

Vegh, C. A. and G. Vuletin (2015): "How Is Tax Policy Conducted over the Business Cycle?" *American Economic Journal: Economic Policy*, 7, 327–70.

Vissing-Jørgensen, A. (2002): "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution," *Journal of Political Economy*, 110, 825–853.

Literature

General equilibrium quantitative macro models:

- With heterogeneous agents and incomplete markets (HANK): Kaplan et al. (2018);
- Two-Agent NK Models: Debortoli and Galí (2017);
- TANK with Fiscal Policy: Drautzburg and Uhlig (2015);
- RANK with Uncertainty: Born and Pfeifer (2014), Fernández-Villaverde et al. (2015) and Basu and Bundick (2017).

This Paper

Agents Aggregation

Firms cannot distinguish the type of each agent on the labor market, thus,

$$h_t = \mu h_t^h + (1-\mu) h_t^b.$$

Consumption and lump-sum taxes can also be represented as

$$\begin{aligned} c_t &= \mu c_t^h + (1-\mu) c_t^b \\ \Omega_t &= \mu \Omega_t^h + (1-\mu) \Omega_t^b. \end{aligned}$$

Back: Main Ingredients

Firms

- There is a continuum of **monopolistically competitive intermediate goods firms**, which produce differentiate goods $y_{j,t}$;
- It rent labor $h_{i,t}$ from both agents and capital $k_{i,t-1}$ from the saver agent;
- Intermediate producers solve a two-stage problem.
- Cobb-Douglas with CRS;
- Prices subject to quadratic adjustment cost.

Back: Main Ingredients

Details of the firm's problem

- Since the firms do not hire labor services provided by the labor packer and there is no distinguish between labor supplied by saver or buyers, the intermediate firms problem will be standard;
- Cobb-Douglas RCE production function $y_{i,t} = k_{i,t-1}^{\alpha}[z_t h_{i,t}^{d}]^{1-\alpha}$, where z_t is the labor-augmenting productivity that follows an AR(1) process.
- Cost minimization implies marginal cost $mc_t = \left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)\frac{w_t^{1-\alpha} r_t^{\alpha}}{A_t^{1-\alpha}}$.
- Prices are subject to quadratic adjustment costs,

$$AC_{i,t}^{p} = \frac{\phi_p}{2}\left(\frac{p_{i,t}}{p_{i,t-1}} - \Pi_s\right)^2 y_{i,t},$$

where Π_s is the steady state level of inflation.

Back: Main Ingredients

Details of the firm's problem

- Firms solve:

$$\max_{p_{i,t+s}} \quad \mathbb{E}_t \sum_{s=0}^{\infty} \left[\frac{\partial V_t / \partial c^2_{t+s}}{\partial V_t / \partial c^2_t} \right] \left[\frac{p_{i,t+s}}{p_{t+s}} y_{i,t+s} - mc_{i,t+s} y_{i,t+s} - AC^p_{i,t+s} \right] \tag{4}$$

subject to $y_{i,t} = \left(\frac{p_{i,t}}{p_t} \right)^{-\varepsilon_p} y^d_t$ and $AC^p_{i,t}$.

Back: Main Ingredients

Wages and Labor Market

- Wages are subject to a quadratic adjustment cost

$$AC^w_{j,t} = \frac{\phi_w}{2}\left(\frac{w_{j,t}}{w_{j,t-1}} - z_s\right)^2 y_t,$$

  where z_s is the steady-state of the productivity shock z_t.

- A perfect competitive labor packer aggregate the different types of labor $h_{j,t}$ into homogeneous labor, so $h_{j,t} = h^d_t \int_0^1 \left(\frac{w_{j,t}}{w_t}\right)^{-\varepsilon_w} dj$.

Back: Main Ingredients Household

Capital

The law of motion of capital is:

$$k_t = (1 - \delta(u_t))k_{t-1} + \left(1 - \mathcal{S}\left[\frac{x_t}{x_{t-1}}\right]\right) x_t, \tag{5}$$

where the adjustment cost of investments assumes a quadratic form $\mathcal{S}\left[\frac{x_t}{x_{t-1}}\right] = \frac{\kappa}{2}\left(\frac{x_t}{x_{t-1}} - z_s\right)^2$, and $\delta(u_t) = \delta + \delta_1(u_t - 1) + \frac{1}{2}\delta_2(u_t - 1)^2$ is the depreciation rate that depends on the capacity utilization rate.

Household

Taylor Rule

- Monetary authority sets the nominal interest rate according to the following Taylor rule:

$$R_t = R_s \left(\frac{R_{t-1}}{R_s} \right)^{\phi_R} \left[\left(\frac{\Pi_t}{\Pi_s} \right)^{\phi_\Pi} \left(\frac{y_t}{y_s} \right)^{\phi_y} \right]^{1-\phi_R} \exp\{\sigma_m \Phi_t\}, \quad (6)$$

  where the monetary policy shock Φ_t follows a $\mathcal{N}(0,1)$ process.

- The parameter ϕ_R generates interest-rate smoothing;
- ϕ_Π and ϕ_y control the responses to deviations of inflation from target inflation and output.

Back: Main Ingredients

Taylor Rule

Fernández-Villaverde et al. (2015) highlight that this Taylor Rule does not generates the same effects from empirical estimations for the **inflation** and **interest rates**, so they propose the following alternative:

$$R_t = R_s \left(\frac{R_{t-1}}{R_s} \right)^{\phi_R} \left[\left(\frac{\Pi_t}{\Pi_s} \right)^{\phi_\Pi} \left(\frac{y_t}{y_s} \right)^{\phi_y} \left(\frac{e^{\sigma_{e,t}}}{e^{\sigma_{e,s}}} \right)^{\phi_\sigma} \right]^{1-\phi_R} \exp\{\sigma_m \Phi_t\},$$

where the monetary authority also reacts to fiscal volatility shocks.

Back: Main Ingredients

Government

- The government budget constraint is

$$\begin{aligned} b_t = & \frac{R_{t-1} b_{t-1}}{\Pi_t} + g_t - \tau_t^w w_t h_t - \tau_t^k r_t^k k_{t-1} \\ & - z_t \left[\phi_{d,b} \left(\frac{b_{t-1}}{z_{t-1} y_s} - \frac{b_s}{y_s} \right) + \mu \Omega_t^h + (1-\mu) \Omega_t^b \right], \end{aligned} \tag{7}$$

- Spending g_t and taxes are set according to fiscal rules which incorporate stochastic volatility.

Back: Fiscal Rule

Fiscal Policy in Developing Countries

- Developing countries do not have the same fiscal policy reaction of advanced countries:
  - Gavin and Perotti (1997) for Latin America;
  - Alesina et al. (2008) and Vegh and Vuletin (2015) show that countercyclical reaction of the government spending to the output does not hold for many developing countries;
  - Campos and Cysne (2019) evidences for Brazil.
- We also relaxed the the procyclicality assumption on the reaction of labor and capital tax to lagged debt, since direction for this relation are absent on the literature of developing countries.

Back: fiscal policy rules

- Third-order approximation with punning;
- Internally calibrated parameters: γ_h, γ_b, β, δ, δ_2, κ, Π_s, ϕ_R, ϕ_Π, ϕ_y and σ_m.
- SMM calibration matching 26 moments to calibrate 11 parameters:
  - The average of interest rates and inflation,
  - standard deviation, auto-correlation with one lag and correlation of all variables with output, and
  - the correlation between interest rates and inflation.

Data Desc. Back: Calibration

Data for the period 1970:I–2014:II (jun) are taken from St. Louis Fed's FRED database.

1. GDPC1 : Real Gross Domestic Product, Billions of Chained 2012 Dollars, Seasonally Adjusted Annual Rate
2. GPDIC1 : Real Gross Private Domestic Investment, Billions of Chained 2012 Dollars, Seasonally Adjusted Annual Rate
3. PCECC96 : Real Personal Consumption Expenditures, Billions of Chained 2012 Dollars, Seasonally Adjusted Annual Rate
4. FEDFUNDS: Effective Federal Funds Rate, Percent, Not Seasonally Adjusted (Monthly)
5. GDPDEF : Gross Domestic Product: Implicit Price Deflator, Index 2012=100, Seasonally Adjusted
6. HCOMPBS : Business Sector: Compensation Per Hour, Index 2012=100, Seasonally Adjusted
7. HOABS : Business Sector: Hours of All Persons, Index 2012=100, Seasonally Adjusted
8. TCU : Capacity Utilization: Total Industry, Percent of Capacity, Seasonally Adjusted (Monthly)

Back: Calibration

Data for the period 1999:I–2014:II (jun) for Brazil.

1. Real Gross Domestic Product (GDPC1),
2. Real Gross Private Domestic Investment (GPDIC1),
3. Real Personal Consumption Expenditures (PCECC96), chained indexes (Source: System of Quarterly National Accounts, IBGE),
4. Effective SELIC Rate (FEDFUNDS), Percent, Not Seasonally Adjusted (Source: BCB-SGS id code 4390),
5. Broad Consumer Price Index, IPCA, (GDPDEF), Index 1993 = 100, (Source: (IBGE/SNIPC, IPEADATA id code 36482),
6. Average nominal salary in industry in the State of São Paulo (HCOMPBS), Index 2006 = 100, (Source: *Federação e Centro das Indústrias do Estado de São Paulo, Levantamento de Conjuntura*, Fiesp, IPEADATA id code 33689),
7. Industry: Hours of All Persons (HOABS)m Index 2006 = 100, Seasonally Adjusted, (Source: *Confederação Nacional da Indústria*, IPEADATA id code 33209),
8. Capacity Utilization: Total Industry (TCU), Percent of Capacity, Seasonally Adjusted Monthly, (Source: *Confederação Nacional da Indústria*, IPEADATA id code 33211).

Back: Calibration

Summary Calibration for the US

	Description	Value	Source
Preferences			
β	Time-discount factor	0.9959	Calibration
γ_h	HtM Risk Aversion	370.34	Calibration
γ_b	Bondholder Risk Aversion	661.83	Calibration
ψ_h	HtM Inverse IES	0.40	Vissing-Jørgensen (2002)
ψ_b	Bondholder Inverse IES	1.25	Vissing-Jørgensen (2002)
μ	Fraction of HtM agents	0.40	Kaplan et al. (2014)
η	Consumption preferences	0.4034	Endogenous
Ω^h	HtM lump-sum tax steady state	-0.2263	Endogenous
Ω^b	Lump-sum tax steady state	0.3019	Endogenous
Technology			
α	Capital Share	0.36	FGKR
ε_p	Demand elasticity goods	21.0	FGKR
ε_w	Demand elasticity labor	21.0	FGKR
δ	Steady state depreciation	0.0451	Calibration
δ_1	Rate of capital depreciation	0.01	**?**
δ_2	Rate of capital depreciation	0.0139	Calibration
κ	Investment cost	0.9419	Calibration
Taylor Rule			
ϕ_R	Smoothing of past interest rate	0.7584	Calibration
ϕ_Π	Response to inflation deviations	1.6966	Calibration
ϕ_y	Response to output gap deviations	0.0863	Calibration
ϕ_σ	Response to capital tax volatility	0.005	FGKR
Π_s	Steady state inflation	1.0090	Calibration
σ_m	Standard dev. of the monetary shock	2.0e-4	Calibration

Note: parameters fixed prior to the estimation are referred with their corresponding source. Parameters estimated with SMM procedure are tagged with "Calibration". The consumption preference parameter η is tagged with "Endogenous" because we normalize the steady state of hours worked to 1/3 using η. We also set Ω^h and Ω^b endogenously to achieve a balanced HtM and governmental budget constraint, respectively.

Summary Calibration for Brazil

	Description	Value	Source
Preferences			
β	Time-discount factor	0.9785	Calibration
γ_h	HtM Risk Aversion	1329.10	Calibration
γ_b	Bondholder Risk Aversion	373.46	Calibration
η	Consumption preferences	0.4034	Endogenous
Ω^h	HtM lump-sum tax steady state	-0.2263	Endogenous
Ω^b	Lump-sum tax steady state	0.3019	Endogenous
Technology			
δ	Steady state depreciation	0.0442	Calibration
δ_2	Rate of capital depreciation	0.003	Calibration
κ	Investment cost	0.9458	Calibration
Taylor Rule			
ϕ_R	Smoothing of past interest rate	0.7611	Calibration
ϕ_Π	Response to inflation deviations	1.5701	Calibration
ϕ_y	Response to output gap deviations	0.0097	Calibration
Π_s	Steady state inflation	1.0124	Calibration
σ_m	Standard dev. of the monetary shock	0.0034	Calibration

Note: Parameters estimated with SMM procedure are tagged with "Calibration". The consumption preference parameter η is tagged with "Endogenous" because we normalize the steady state of hours worked to 1/3 using η. We also set Ω^h and Ω^b endogenously to achieve a balance HtM and governmental budget constraint, respectively.

Back: Calibration

Fitting - US

Moments	Data	Model	Moments	Data	Model
Mean					
R_t	0.8885	0.8912	Π_t	1.4028	1.2852
Standard Deviation			*Auto-Correlation*		
y_t	1.5278	1.8796	$corr(y_t, y_{t-1})$	0.8779	0.9178
c_t	1.2481	0.7818	$corr(c_t, c_{t-1})$	0.8909	0.8343
x_t	7.0489	6.9979	$corr(x_t, x_{t-1})$	0.8532	0.9511
w_t	0.9329	0.2090	$corr(w_t, w_{t-1})$	0.7074	0.9694
h_t	1.9474	1.6701	$corr(h_t, h_{t-1})$	0.9276	0.8315
u_t	3.2484	2.4141	$corr(u_t, u_{t-1})$	0.8993	0.8970
R_t	0.9365	0.7355	$corr(R_t, R_{t-1})$	0.9701	0.9842
Π_t	0.6079	0.7192	$corr(\Pi_t, \Pi_{t-1})$	0.9038	0.9349
Correlation					
$corr(y_t, c_t)$	0.8796	0.7932	$corr(y_t, u_t)$	0.8777	0.6230
$corr(y_t, x_t)$	0.9214	0.8232	$corr(y_t, R_t)$	0.2021	-0.4609
$corr(y_t, w_t)$	0.1196	0.5958	$corr(y_t, \Pi_t)$	0.1160	-0.2736
$corr(y_t, h_t)$	0.8702	0.8959	$corr(\Pi_t, R_t)$	0.6651	0.9113

Note: All data, except nominal interest rates and inflation, are in logs, HP-filtered, and multiplied by 100 to express them in percentage deviation from trend. Nominal interest rates and inflation are directly expressed in percentage points. We omitted model fit for the mean and auto-correlation for a lag of five in the interest of space.

Fitting - Brazil

Moments	Data	Model	Moments	Data	Model
Mean					
R_t	3.6402	4.0196	Π_t	1.5861	1.6439
Standard Deviation			*Auto-Correlation*		
y_t	1.758	1.7623	$corr(y_t, y_{t-1})$	0.74388	0.69098
c_t	1.29	1.1464	$corr(c_t, c_{t-1})$	0.55825	0.48726
x_t	3.9761	4.5304	$corr(x_t, x_{t-1})$	0.60349	0.89865
w_t	2.0259	0.10741	$corr(w_t, w_{t-1})$	0.6087	0.94596
h_t	2.3639	2.0404	$corr(h_t, h_{t-1})$	0.71218	0.62762
u_t	1.6326	1.6537	$corr(u_t, u_{t-1})$	0.77985	0.69937
R_t	1.3517	1.3567	$corr(R_t, R_{t-1})$	0.67623	0.60661
Π_t	0.87585	0.24949	$corr(\Pi_t, \Pi_{t-1})$	0.49848	0.66197
Correlation					
$corr(y_t, c_t)$	0.77616	0.7664	$corr(y_t, u_t)$	0.90875	0.56632
$corr(y_t, x_t)$	0.67929	0.74621	$corr(y_t, R_t)$	0.12665	-0.76572
$corr(y_t, w_t)$	-0.38174	-0.050341	$corr(y_t, \Pi_t)$	0.23915	0.40929
$corr(y_t, h_t)$	0.49078	0.64953	$corr(\Pi_t, R_t)$	0.35504	-0.55523

Note: All data, except nominal interest rates and inflation, are in logs, HP-filtered, and multiplied by 100 to express them in percentage deviation from trend. Nominal interest rates and inflation are directly expressed in percentage points. We omitted model fit for the mean and auto-correlation for a lag of five in the interest of space.

Back: Calibration