



*CENTRO DE ESTUDOS
MACRO BRASIL*

Equilibrium Interest Rates in Brazil: A Laubach and Williams Approach

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Brazil: Equilibrium Interest Rate

- Worldwide downward trend of interest rate
- Real rates in Brazil: Convergence at last
- For the first time in the history of the country, we have a loose monetary policy and a more restrictive fiscal policy.
- Equilibrium rate is falling as fast as the effective real interest rate?
- Is Brazil going to zero real rate as Developed Countries or it is only a temporary phenomenon?

Brazil: Equilibrium Interest Rate

- Laubach and Williams (2003) focus their work in estimating the real interest rate
 - the real interest rate consistent with output equalizing potential and stable inflation –
 - based on the definition of the natural rate of interest considering deviation of output from potential.
 - the natural rate of interest estimation entails finding the potential output as well.
- Moreira and Portugal (2019) found that neutral rate at 1.8% in 19Q2.

O modelo:

IS Curve Estimates

- Output gap as dependent variable and real interest gap on the right hand side.

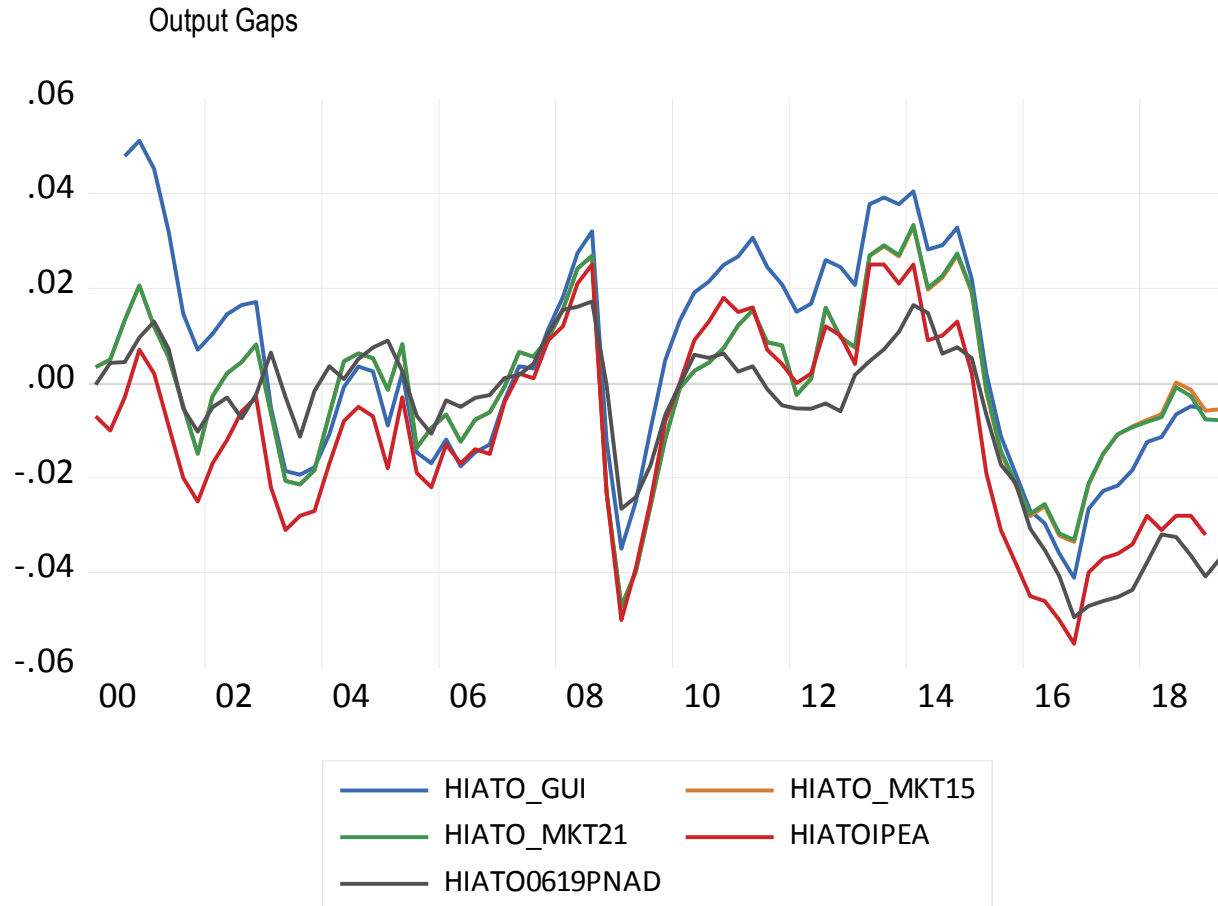
$$h_t = \beta_1 h_{t-1} + \beta_2 [r_t - (sv_t + \beta_3 \Delta GDP_{4t}^* +$$

Dados

- Output gap (h):
 - Hodrick-Prescott filter extending the sample until 2022
 - weighting average between labor market and industrial capacity utilization slackness
- Real Rate (r) – it is the Selic rate deflated by 12-month ahead inflation expectation.
- ΔGDP_{4t}^* 4-quarter increasing in our default potential output growth
- r_t^{US} 3-month US Treasury rates
- CDS_t^{5y} Brazilian risk premium measured by Credit Default Swaps (with 5 year mature). residual of the risk premium against the output gap.
- FCI financial condition index. This variable is year over year household credit growth controlled by output gap and Selic rate as well.
- Δg_t is the first difference in central government expenditures measured in BRL terms.

Different Methodologies for Output Gap

The Hodrick Prescott has a problem to bend towards zero at the end of the sample. The Hiato 0619 is a weighted average between the lag in unemployment and the lag in capacity utilization .



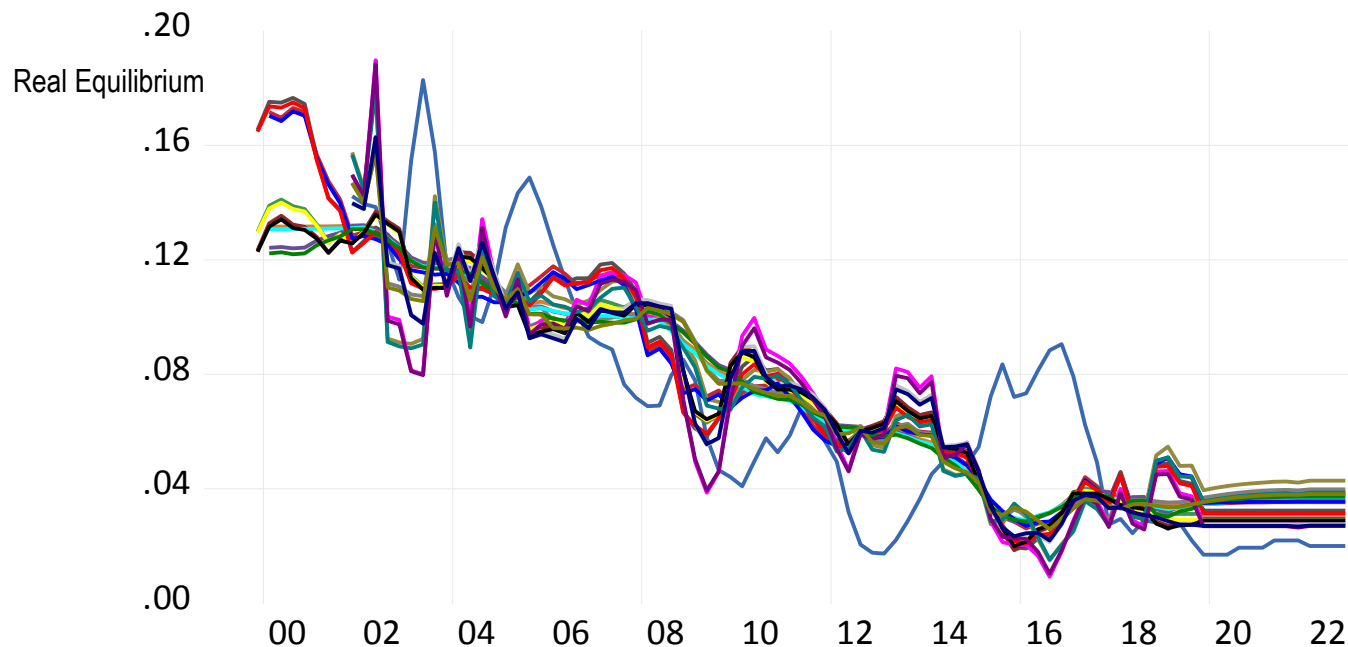
Sources: IBGE and MK4

IS Estimations

| | Output -1 | R-rate | Potential GDP | Credit | CG Expend | Dum Crises | US inter | cds | sv1 |
|----------|-------------|---------------|---------------|--------------|-------------|---------------|----------|-------------|--------------|
| | b(1) | b(2) | b(3) | b(4) | b(5) | b(6) | b(7) | b(8) | |
| Model 1 | 0.74 | -0.14 | 0.73 | | 0.1 | -0.04 | | | 0.028 |
| | 0.03 | 0.02 | 0.46 | | 0.014 | 0.002 | 0 | | 0.013 |
| Model 3 | 0.74 | -0.132 | 0.33 | | 0.1 | -0.039 | -1 | | 0.037 |
| | 0.03 | 0.021 | 0.46 | | 0.013 | 0.0027 | | | 0.014 |
| Model 5 | 0.75 | -0.137 | 0.93 | | 0.11 | -0.042 | -0.25 | | 0.026 |
| | 0.034 | 0.025 | 0.53 | | 0.014 | 0.0038 | 0.49 | | 0.014 |
| Model 7 | 0.74 | -0.12 | 1.21 | | 0.1 | -0.041 | -1 | -1 | 0.04 |
| | 0.034 | 0.018 | 0.45 | | 0.014 | 0.0028 | | | 0.015 |
| Modelo 9 | 0.74 | -0.14 | 1.19 | | 0.1 | -0.042 | -0.075 | 0.52 | 0.031 |
| | 0.035 | 0.026 | 0.53 | | 0.015 | 0.002 | 0.49 | 0.24 | 0.014 |
| Model 11 | 0.76 | -0.13 | 0.63 | 0.03 | 0.1 | -0.04 | | | 0.027 |
| | 0.03 | 0.019 | 0.51 | 0.018 | 0.014 | 0.003 | | | 0.013 |
| Model 13 | 0.76 | -0.12 | 0.24 | 0.03 | 0.1 | -0.039 | -1 | | 0.035 |
| | 0.035 | 0.021 | 0.52 | 0.018 | 0.014 | 0.003 | | | 0.015 |
| Model 15 | 0.77 | -0.13 | 0.86 | 0.03 | 0.11 | -0.041 | -0.29 | | 0.024 |
| | 0.03 | 0.024 | 0.57 | 0.019 | 0.014 | 0.003 | 0.55 | | 0.014 |
| Model 17 | 0.76 | -0.11 | 1.04 | 0.035 | 0.1 | -0.04 | -1 | -1 | 0.039 |
| | 0.034 | 0.017 | 0.52 | 0.017 | 0.015 | 0.003 | | | 0.015 |
| Model 19 | 0.76 | -0.127 | 1.13 | 0.031 | 0.1 | -0.041 | -0.1 | 0.55 | 0.028 |
| | 0.035 | 0.025 | 0.57 | 0.018 | 0.015 | 0.003 | 0.55 | 0.26 | 0.014 |

Different Methodologies for Interest Rate

The Hodrick Prescott has a problem to bend towards zero at the end of the sample. The Hiato 0617 is a weighted average between the lag in unemployment and the lag in capacity utilization .



Sensitivity Analysis

| | Equilibrium Real Interest Rate | | | |
|------------|--------------------------------|--------|----------|--------|
| | Average | | Model 19 | |
| | 2019Q3 | 2022Q4 | 2019Q3 | 2022Q4 |
| Normal | 3.5 | 3.3 | 3.4 | 3.8 |
| High CDS | 3.9 | 3.8 | 3.8 | 4.4 |
| Low CDS | 3.3 | 3 | 3.1 | 3.2 |
| Hiato IPEA | 0 | 0.5 | neg | neg |
| Hiato Pnad | 0.7 | 0.7 | 0.3 | 0.6 |
| Hiato_gui | 3.5 | 3.6 | 2.9 | 3.8 |
| Hiato21 | 3.3 | 3.1 | 3.2 | 3.5 |

The Brazilian Reaction Function

The estimated Taylor rule has coefficients with expected value and also statistically significantly.

Taylor Rule

Sample (adjusted): 2002Q3 2019Q3

Included observations: 69 after adjustments

LSWAPREAL360MAY19Q = C(1)*LSWAPREAL360MAY19Q(-1) + C(2)

*(LEXPECT(2)/4-LMETA(2)/4) + C(3)*HIATO0319PNAD(0)+C(10)+C(11)

*D0304+C(12)*DUM1113+C(13)*D0204(0)+C(14)*D0804(-1)+C(15)

*D0204(1)+C(15)*D0804+C(17)*D1601(-2)

| | Coefficient | Std. Error | t-Statistic | Prob. |
|--------------------|-------------|--------------------|-------------|----------|
| C(1) | 0.911392 | 0.024614 | 37.02697 | 0.0000 |
| C(2) | 0.227431 | 0.079322 | 2.867183 | 0.0057 |
| C(3) | 0.035857 | 0.011609 | 3.088601 | 0.0031 |
| C(10) | 0.001310 | 0.000500 | 2.621023 | 0.0111 |
| C(11) | -0.005221 | 0.001444 | -3.615062 | 0.0006 |
| C(12) | -0.001617 | 0.000545 | -2.965800 | 0.0044 |
| C(13) | -0.004005 | 0.001630 | -2.456484 | 0.0170 |
| C(14) | -0.002831 | 0.001429 | -1.981667 | 0.0522 |
| C(15) | -0.002538 | 0.001137 | -2.233402 | 0.0293 |
| C(17) | 0.003306 | 0.001447 | 2.284594 | 0.0259 |
| R-squared | 0.977282 | Mean dependent var | | 0.015982 |
| Adjusted R-squared | 0.973816 | S.D. dependent var | | 0.008656 |
| F-statistic | 282.0029 | Durbin-Watson stat | | 1.583743 |
| Prob(F-statistic) | 0.000000 | | | |

Source: FGV-EESP

- The expected inflation coefficient is significant at 10% the as expected by Taylor
- The output gap coefficient is significant but lower than expected in calibration exercises using the Taylor rule.
- The interest rate persistence is about in line with expectation.

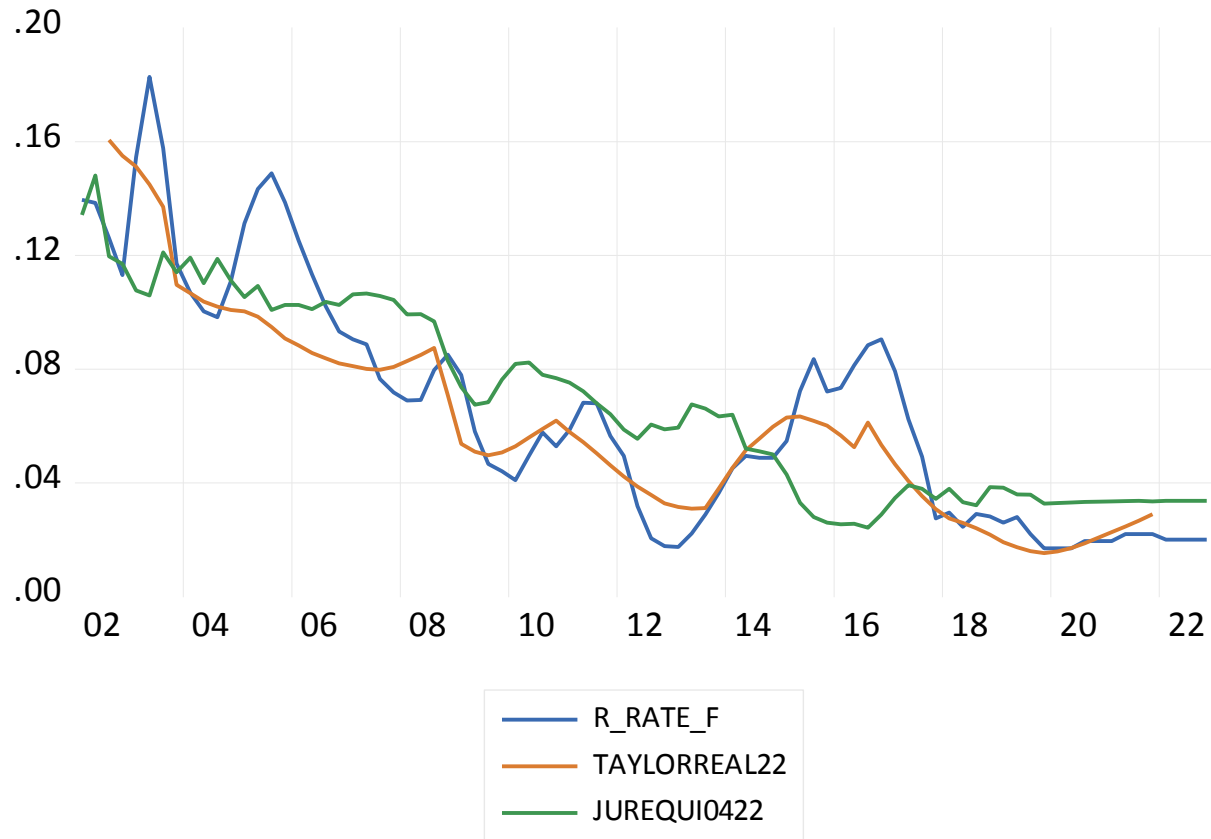
CPI Breakdown (YoY)

| Time | FX | Swap 360 | Inflation | Output Gap |
|--------|------|----------|-----------|------------|
| mar/19 | 3.74 | 6.81 | 4.60 | -4.00 |
| jun/19 | 3.90 | 6.72 | 3.38 | -3.64 |
| set/19 | 3.99 | 6.56 | 2.95 | -3.28 |
| dez/19 | 4.09 | 5.94 | 3.60 | -2.96 |
| mar/20 | 4.14 | 5.89 | 3.37 | -2.65 |
| jun/20 | 4.15 | 5.69 | 3.36 | -2.38 |
| set/20 | 4.15 | 5.81 | 3.53 | -2.12 |
| dez/20 | 4.15 | 6.03 | 3.67 | -1.93 |
| mar/21 | 4.14 | 6.23 | 3.61 | -1.75 |
| jun/21 | 4.15 | 6.45 | 3.75 | -1.59 |
| set/21 | 4.16 | 6.67 | 3.85 | -1.43 |
| dez/21 | 4.16 | 6.91 | 3.45 | -1.29 |

Sources: FGV-Macro Brasil

Interest Rate: Taylor Rule and Equilibrium Rate

The red line is the effective real interest rate and the blue is the one predicted by the Taylor Rule



Sources: MK4

Bjornland et al. (2011): Estimating the natural rates in a simple New Keynesian framework

- A teoria novo keynesiana tornou-se a estrutura principal para a análise da política monetária.
- Um ponto de referência importante para o formulador de políticas é como a economia teria se desenvolvido caso os preços fossem totalmente flexíveis
- Chamamos taxa de juros e o nível do produto sob preços flexíveis, como taxa natural de juros e produto natural
- A estratégia da política monetária é frequentemente formulada em termos de desvios dessas taxas naturais, ou seja, em termos de hiato da taxa de juros e do hiato do produto

Bjornland et al. (2011): Estimating the natural rates in a simple New Keynesian framework

- Hiato da taxa de juros:
 - Se a taxa corrente $<$ taxa natural \rightarrow Política Monetária Expansionista
 - Se a taxa corrente $>$ taxa natural \rightarrow Política Monetária Contracionista
- Utilização de um modelo novo keynesiano, que é mais consistente com a abordagem de otimização e expectativas racionais, deste modo as taxas naturais serão derivadas de forma a seguir a teoria econômica
- Métodos bayesianos no processo de estimação são bastante atrativos, ao se desejar estimar parâmetros estruturais em um período relativamente curto
- Estimativas plausíveis da variação temporal das taxa natural de juros e hiatos do produto correspondentes usando estimativas bayesianas

Modelo Novo Keynesiano Simplificado

- Curva IS: $\Delta y_t = \frac{\sigma}{\gamma_1(\sigma-1)} E_t \Delta y_{t+1} - \frac{\gamma_2}{\gamma_1} \Delta y_{t-1} - \frac{1}{\gamma_1(\sigma-1)} (i_t - \Delta \pi_{t+1} - \rho) + \frac{1}{\gamma_1} (v_t - E_t v_{t+1})$
- Choque de preferência: $v_t = \rho_v v_{t-1} + \varepsilon_t^v$
- Curva de Phillips: $\pi_t = \mu E_t \pi_{t+1} + (1 - \mu) \sum_{i=0}^3 \alpha_i \pi_{t-i} + \kappa x_t + \varepsilon_t$
- Produto natural é assumido ser um processo exógeno:
$$\Delta y_t^n = \nu + \omega_t \text{ e } \omega_t = \phi \omega_{t-1} + \varrho_t$$
- O hiato do produto segue o processo: $x_t = x_{t-1} + \Delta y_t - \Delta y_t^n$

Modelo Novo Keynesiano Simplificado

- Regra de Taylor: $i_t = \psi i_{t-1} + (1 - \psi)(i_t^n + \theta_\pi(\pi_t - \pi_t^{meta}) + \theta_x x_t) + u_t$
- A meta de inflação evolui de acordo com: $\pi_t^{meta} = (1 - \rho_\pi)\pi^* + \rho_\pi \pi_{t-1}^{meta} + \zeta_t$
- Choque para meta de inflação: $\zeta_t = \rho_\zeta \zeta_{t-1} + \varepsilon_t^\zeta$
- A taxa natural de juros:

$$i_t^n = \delta + E_t \pi_{t+1} + \sigma E_t \Delta y_{t+1}^n - \gamma_1 (\sigma - 1) \Delta y_t^n - \gamma_2 (\sigma - 1) \Delta y_{t-1}^n + (\sigma - 1)(v_t - E_t v_{t+1})$$

- A taxa real natural de juros é definida como: $r_t^n = i_t^n - E_t \pi_{t+1}$

Taxa Natural Real de Juros



Taxa Natural: DSGE e LW

