Non-Ricardian Regimes and Exchange Rates: A High-Frequency Identification

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Summary

Focus
- Behaviour of exchange rates in Non-Ricardian regimes where
  - fiscal policy raises taxes insufficiently to offset higher govt debt
  - the government defaults or inflates the debt away

Contribution
- Theory: few studies explore it in a NK model
- Empirics: test hypothesis on high-frequency (daily) data

Findings
- In the NR equilibria, the exchange rate depreciates after
  - unexpected monetary tightening
  - unexpected government spending shock
- Example country: Brazil (Blanchard, 2004; De Bolle 2015)
  - unconventional signs of the effect of policy shocks on USDBRL around 2002-2003 and 2015
  - probability of the NR regime related to govt debt service
Model

- Continuous time, Markov Switching New Keynesian small open economy model

- Study the reaction of nominal exchange rate to
  - unexpected increase in gov expenditures
  - unexpected increase in mon policy rate

- Under different policy scenarios:
  - **Ricardian equilibrium**: the govt raises taxes to repay debt
  - **Default equilibrium**: the govt defaults on foreign debt
  - **Inflation equilibrium**: the central bank inflates debt away
- The representative Home household maximizes

\[
\int_0^\infty e^{-\rho t} \left[ \ln \left( C_H(t)^{1-\alpha} C_F(t)^\alpha \right) - \frac{L(t)^{1+\varphi}}{1+\varphi} \right] dt
\]

- Households save in domestic government bonds $D$, thus

\[
dD(t) = [D(t)i(t) - P(t)C(t) + P_H(t)(Y(t) - T(t))] dt
\]

where $Y$ is output and $T$ are real lump-sum taxes
- Monopolistic firms, \( j \in [0, 1] \), produce differentiated goods

\[ Y_j(t) = L_j(t) \]

- Firms choose their domestic-currency price and the LOOP holds:

\[ P^*_H,j(t) = P_{H,j}(t) / \mathcal{E}(t) \]

where \( \mathcal{E} \) is the nominal exchange rate (price of foreign currency)

- Firms set prices infrequently, a la Calvo

\[
\max_{\hat{P}_{H,j}(t)} \int_t^{\infty} \theta e^{-(\rho+\theta)(k-t)} Y_j(k|t) \frac{\hat{P}_{H,j}(t) - (1 - \tau(k)) W(k)}{C(k) P(k)} dk
\]
- The government issues domestic-currency debt $B$

$$B(t) = \underbrace{D(t)}_{\text{dom debt}} + \underbrace{F(t)}_{\text{for debt}}$$

- The government can raise taxes $T$ or default on foreign debt

$$dB(t) = [i(t)B(t) - \delta(t)F(t) - P_H(t)(T(t) - G(t))]\,dt$$

where $\delta$ is the default rate and $G$ are exogenous expenditures

- Foreign investors are risk-neutral, thus

$$i(t) - \delta(t) - i^*(t) - \frac{d\mathcal{E}(t)}{\mathcal{E}(t)} = 0$$
Government policies

- The government follows the fiscal rule

\[ T(t) = T + \phi_T \tilde{B}(t) \]

where \( \tilde{B} \equiv B/P_H \) denotes real debt and \( \phi_T \geq 0 \)

- The default rate (or the prob. of default) is increasing in the real stock of debt

\[ \delta(t) = \begin{cases} 
\phi_D \left( \frac{\tilde{B}(t)}{\tilde{B}} - 1 \right) & \text{if } \tilde{B}(t) \geq \tilde{B} \\
0 & \text{otherwise}
\end{cases} \]

- The central bank follows the Taylor rule

\[ i(t) = \rho + (1 + \phi_\pi) \pi_H(t) + m(t) \]

where \( m \) is an exogenous monetary policy shock
Fiscal policy is stochastic: the Ricardian regime, denoted with \( R \) and a non-Ricardian regime, denoted with \( NR \).

\[
\begin{align*}
\phi^R_T &> \rho & \phi^R_D &= 0 \\
\phi^{NR}_T &= 0 & \phi^{NR}_D &> 0
\end{align*}
\]

The transition between the two regimes is exogenous and governed by following transition rates: \( \sigma^{NR} \) is the instantaneous probability of switching from the Ricardian to the non-Ricardian regime, and \( \sigma^R \) is the probability of switching from the non-Ricardian to the Ricardian regime.
The log-linear dynamics around a steady state with $\tilde{F} > 0$ are

\[
\mathbb{E}[d\lambda(t) | j] = \phi_D^j \hat{b}(t) \, dt
\]
\[
\mathbb{E}[dy(t) | j] = (1 - \gamma) \left( \phi_{\pi} \pi_H(t) - \alpha \eta \phi_D^j \hat{b}(t) + m(t) \right) \, dt + \gamma dg(t)
\]
\[
\mathbb{E}[d\pi_H(t) | j] = \left( \rho \pi_H(t) - \frac{\kappa \omega}{1 - \gamma} y(t) + \frac{\kappa \gamma}{1 - \gamma} g(t) \right) \, dt
\]
\[
\mathbb{E}[d\hat{b}(t) | j] = \left[ \left( \rho - \phi_T^j - \phi_D^j \right) \hat{b}(t) + \beta g(t) + m(t) \right] \, dt
\]
\[
\mathbb{E}[d\hat{z}(t) | j] = (\rho \hat{z}(t) + \alpha \lambda(t)) \, dt
\]

and the exogenous variables

\[
dg = -\varrho_g g dt
\]
\[
dm = -\varrho_m m dt
\]
The system of SDEs (1) has a unique solution iff $\phi_\pi > 0$. The solution is mean-square stable iff

$$\phi^{NR}_D > \rho - \frac{\sigma^R (\phi^R_T - \rho)}{\sigma^{NR} + 2 (\phi^R_T - \rho)}$$

(1)
Proposition

Assume $\phi^R_T \downarrow \rho$ and $\phi^{NR}_D \uparrow \rho$. Then the responses of the nominal exchange rate to a government spending shock in the Ricardian and non-Ricardian regimes are

$$\frac{e^R(0)}{g(0)} = -\frac{\gamma \varphi \kappa \phi_\pi}{\rho \rho + \rho^2 + \omega \kappa \phi_\pi} + \sigma^{NR} \beta \psi$$

(2)

$$\frac{e^{NR}(0)}{g(0)} = \eta \beta \frac{1 - \alpha}{\rho + \varrho} - \frac{\gamma \varphi \kappa \phi_\pi + \rho \alpha \eta \beta \left(1 - \frac{\rho \rho + \rho^2}{\omega \kappa \phi_\pi}\right)}{\rho \rho + \rho^2 + \omega \kappa \phi_\pi} - \sigma^R \beta \psi$$

(3)

where $\psi$ is defined in the appendix and $g(0) > 0$. Similarly, the responses of the nominal exchange rate to a monetary policy shock in the two regimes are

$$\frac{e^R(0)}{m(0)} = -\frac{\rho + \varrho}{\omega \kappa \phi_\pi} + \sigma^{NR} \psi$$

(4)
Key equation

$$e(0) = \int_0^\infty \left[ \delta(t) + \pi_H(t) - (i(t) - i^*) \right] dt$$
High-frequency identification

- Asset prices reflect all the available information
- Some reflect expectations of future policy
e.g. Fed funds futures
- Price changes around policy actions reflect unexpected or “surprise” policy changes
  i.e. policy shocks
Introducing Markov Switching

\[ e_d - e_{d-1} = \delta_0(s_d) + \delta_1(s_d)\xi_{v,d} + \delta_2 M_d + \varepsilon_d \]

where

d – the announcement day

e_d – asset price (e.g. exchange rate)

\( \xi_{v,d} \) – policy shock (e.g. \( v \) is the key policy rate)

\( M_d \) – other macro shocks

\( \varepsilon_d \sim N(0, \sigma_{s_d}^2) \)

\( s_d = \{1, 2\} \)
Markov Switching regimes

- Ricardian (R) vs. Non-Ricardian (NR)

Expected signs of the slope coefficients:

- negative (appreciation of the exchange rate) when agents perceive that the economy is in a Ricardian regime state.
- positive (deprecation of the exchange rate) when agents perceive that the economy is in a non-Ricardian regime state and the risk-premium channel dominates.
- negative (appreciation of the exchange rate) when agents perceive that the economy is in non-Ricardian regime state and the inflation channel dominates.

Additionally, Markov-switching effect, which works to average the response of the exchange rate across the two regimes.
Example country: Brazil

- dependent variable: USDBRL exchange rate
  - Daily from July 1999 to April 2018 from the BIS
- independent variable: monetary policy shock
  - 1-day difference in DI futures rates from Bloomberg
  - 179 policy actions by the Brazilian Central Bank (BCB) from July 1999 to April 2018
- independent variable: fiscal policy shock
  - realized minus the (average) expected primary balance from Bloomberg Survey
  - 180 announcements of primary balance from April 2003 to April 2018
- relating unobservable regimes to fiscal stance: primary deficit, interest payments and probability of default.
## Results

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<tr>
<th></th>
<th>FP Regression</th>
<th>MP Regression</th>
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<tbody>
<tr>
<td></td>
<td>States</td>
<td>States</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>NR</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.99</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>NR</strong></td>
<td>0.18</td>
<td>0.82</td>
</tr>
<tr>
<td><strong>σ</strong></td>
<td>5.36</td>
<td></td>
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<tr>
<td></td>
<td>(0.00)</td>
<td></td>
</tr>
<tr>
<td><strong>δ₀</strong></td>
<td>-0.49</td>
<td>4.56</td>
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<tr>
<td></td>
<td>(0.01)</td>
<td>(0.00)</td>
</tr>
<tr>
<td><strong>δ₁</strong></td>
<td>0.07</td>
<td>4.61</td>
</tr>
<tr>
<td></td>
<td>(0.71)</td>
<td>(0.00)</td>
</tr>
<tr>
<td><strong>δ_{GDP}</strong></td>
<td>-0.10</td>
<td></td>
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<tr>
<td></td>
<td>(0.88)</td>
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<tr>
<td><strong>δ_{EMBI}</strong></td>
<td>7.07</td>
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</tr>
<tr>
<td></td>
<td>(0.01)</td>
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</tr>
<tr>
<td><strong>δ_{macro}</strong></td>
<td>65.86</td>
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<td></td>
<td>(0.35)</td>
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## Results

<table>
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<tr>
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<th>FP Shock</th>
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<th>MP Shock</th>
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<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Slope</td>
<td>Intercept</td>
<td>Slope</td>
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<tr>
<td>Primary deficit</td>
<td>-1.44</td>
<td>0.14</td>
<td>-1.24</td>
<td>0.13</td>
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<tr>
<td></td>
<td>(0.00)</td>
<td>(0.03)</td>
<td>(0.00)</td>
<td>(0.06)</td>
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<tr>
<td>Interest payments</td>
<td>-4.61</td>
<td>0.45</td>
<td>-3.22</td>
<td>0.26</td>
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<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.07)</td>
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<tr>
<td>Prob of default</td>
<td>-2.25</td>
<td>3.63</td>
<td>-1.91</td>
<td>1.54</td>
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<td></td>
<td>(0.00)</td>
<td>(0.01)</td>
<td>(0.00)</td>
<td>(0.02)</td>
</tr>
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<td>Observations</td>
<td>180</td>
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<td>148</td>
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Thank you for attention.