Sovereign debt sustainability, the carbon budget and climate damages

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Contribution

- Two contemporaneous challenges: managing the risk of growing public indebtedness and dealing with the consequences of climate change
- First paper to address this critical issue by estimating national fiscal (or debt) limits in advanced economies under the Paris Agreement’s carbon constraints, while taking into account:
  - the economic costs of reducing carbon emissions,
  - climate damages,
  - the degree of political coordination of the transition.
- At the intersection of two literature domains: macro-financial research on fiscal limits and debt sustainability, and macro-climate research on the economic costs of environmental policies and climate change.

Model

- Fiscal Limit: the maximum debt-to-GDP ratio a government can accumulate without losing its repayment credibility.
- Extension of the model by Collard, Habib, and Rochet, 2015 [1], incorporating a reduced-form growth rate function related to carbon emissions:
  \[ b^H_t = \max \left( \frac{d_t}{R_t} \left( 1 - F(x_t) \right), \frac{\gamma e^\mu t}{\eta_t} \frac{\eta_t E_t}{E_t^P} \right) \]  
  where \( x_t \) is a random shock, \( \gamma \) constant borrowing factor (net of growth), \( R_t \) gross GDP growth rate, \( \mu_t \) and \( \eta_t \) “green” post-transition growth rate and volatility, \( E_t \) carbon emissions.
- The abatement cost function \( \eta(\cdot) \) is adapted and calibrated for 31 advanced economies by referencing the OECD’s empirical results in developing the “Environmentally Adjusted Multifactor Productivity” (Rodríguez et al., 2018 [3]):
  \[ \eta(E_t) = E_t^0 = c_t E_t^0 \approx \left[ (c + c_t) E_t^0 \right]^\beta \]  
  \( \beta \): short-term abatement cost parameter, \( c_t \): CCS parameter, \( E_t \): national carbon budget
- Maximum sustainable borrowing (MSB):
  \[ b^M_t = \max \left( \frac{d_t}{R_t} \left( 1 - F(x_t) \right), \frac{\gamma e^\mu t}{\eta_t} \frac{\eta_t E_t}{E_t^P} \right) \]  
  where \( \gamma \equiv \max \left( \frac{d_t}{R_t} \left( 1 - F(x_t) \right), \frac{\gamma e^\mu t}{\eta_t} \frac{\eta_t E_t}{E_t^P} \right) \]  
- Fiscal limit/ maximum sustainable debt (MSD):
  \[ d^M_t = b^M_t \]  

Data

Table 1: Columns 1-4 (6%), based on Rodríguez et al., 2018, [3] (period 1990-2013): average GDP growth rate (\( \gamma_t \)), its volatility (\( \sigma_t \)), average “green” GDP growth rate adjusted for pollution increase/reduction (\( \rho_t \)), and its volatility (\( \sigma_t \)).

Results

Governments’ maximization problem:

\[ \max_{E_t} b^H_t \quad \text{s.t.} \quad \sum_{t=1}^{\infty} e_t E_t \leq E_t^1, \quad E_t^1 \geq 0 \]  
Three long-term scenarios on the green growth rate

(1) optimistic: \( \mu_t \neq \mu_t, \sigma_t \neq \sigma_t \);
(2) parallel hypothesis (PL): \( \mu_t = \mu_t, \sigma_t = \sigma_t \);
(3) pessimistic: \( \mu_t = \mu_t(1 - (\mu_t E_t^1)) \), where \( m_t(E_t) = \sqrt{\theta} \sum_{t=1}^{\infty} e_t \theta = 0.0121 \).

References