Predicting Sovereign Fiscal Crises: High-Debt Developed Countries

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Fiscal crisis occurs when creditors refuse to lend
  - Can we predict them?
  - Greece lost access with debt \( \approx 130\% \) of GDP, but Belgium retained access with higher debt

Every country faces a **fiscal limit** on debt
  - Value of debt so large the country cannot repay and/or service
  - Governments do not announce their fiscal limits
  - How do we (and creditors) estimate each country's possibly unique fiscal limit?

Relationship between fiscal crises and estimates of fiscal limits
  - Creditors do not lend when the probability of reaching fiscal limit is unity
  - Debt nearing the fiscal limit raises the probability of a crisis
Fiscal limit

- Two ways to estimate fiscal limits
  - Laffer curves Bi (2012), Bi, Leeper & Leith (2013)
  - Fiscal rules Ghosh, Kim, Mendoza, Ostry & Qureshi (2013)
- We use fiscal rules
Fiscal Solvency with Fiscal Limits

- Solvency: government must raise present-value future surpluses sufficiently to equal debt

- Solvency with fiscal limits: debt must be expected to remain below its fiscal limit forever
  1. rule out explosive debt with parameters yielding global stability
  2. along stable trajectory debt must remain below fiscal limit
Global Stability

- Simple fiscal rule

\[ s_t = c + \beta s_{t-1} + \gamma d_{t-1} + \epsilon_t, \]

  - \( s_t \) is the primary surplus/GDP
  - \( d_{t-1} \) is lagged debt/GDP
  - \( \gamma \) is the surplus-responsiveness to debt

- Evolution of debt

\[ d_t = (1 + r) d_{t-1} - s_t \]

  - \( r \) is the risk-free growth-adjusted real interest rate

- Stability requires

\[ \frac{\partial s_t}{\partial d_{t-1}} = \gamma > r (1 - \beta). \]
Debt is not explosive

Debt-surplus pair at A would exceed the fiscal limit even in the absence of any default premia
Larger responsiveness keeps the path from A below the fiscal limit.
Debt Must Remain Below Effective Fiscal Limit

- Fiscal crisis
  - As debt approaches fiscal limit, agents anticipate default
  - Interest rate increases to equate expected rate of return, inclusive of probability of default, with market rate
  - Higher interest rate causes debt to rise more quickly
  - Debt-surplus pair for which no interest rate could both provide market rate of return and assure debt remains below fiscal limit
  - Agents refuse to lend at this debt-surplus pair

- Effective fiscal limit is the projection of the debt-surplus pair using risk-free interest rate, for which peak debt equals the fiscal limit

  - Along this path (or above) probability that debt will exceed fiscal limit is unity (Daniel and Shiamptanis 2012)
  - Explanation: probability that debt will exceed its fiscal limit is so high that interest rate rises to reflect default premium implying that debt increases even faster than along the projection, thereby exceeding the fiscal limit with probability one
Equivalent measures of insolvency

- Initial debt-surplus pair above effective fiscal limit
- Projection from initial debt-surplus pair exceeds fiscal limit
Problem: Governments do not announce fiscal limits

Perhaps responsiveness varies with the value of debt
If responsiveness falls enough for high levels of debt that system becomes unstable at high debt, can identify an effective fiscal limit
Debt at which system becomes unstable becomes an effective fiscal limit
Once debt exceeds effective fiscal limit, it becomes explosive, eventually exceeding any finite fiscal limit
Responsiveness varies with debt: Cubic model in debt

- Ghosh et al. (2013) panel model of fiscal rule with surplus-responsiveness a cubic function of debt
  - Surplus responsiveness is low at both high and low values of debt and high at intermediate values
  - Negative coefficient on cubic debt implies that responsiveness continues to fall as debt rises
  - "fiscal fatigue" allows identification of fiscal limit

- Caveats of their approach
  - Value of debt for which responsiveness becomes negative
    - might not exist
    - in a panel model, based on a few high-debt countries
  - If responsiveness ever weakens, it continues to weaken
    - in a panel model, weakening could occur for debt outside sample
  - Panel requires identical responsiveness to debt across countries
  - Requires that system be stable at lower debt – rejected for three of our high-debt countries
Individual-country regressions allow country-specific responsiveness

Responsiveness changes as debt crosses a threshold

\[ s_t = c + \beta s_{t-1} + \gamma_0^h d_{t-1} + \gamma_1^h (d_{t-1} - \tilde{d}_1) + \gamma_2^h (d_{t-1} - \tilde{d}_2) + \epsilon_t. \]

\( \tilde{d}_1 \) and \( \tilde{d}_2 \) represent increasingly higher threshold values of debt

If responsiveness weakens enough to make system unstable, inference on effective fiscal limit

Responsiveness can weaken insufficiently to create instability
Phase Diagram for a country which fails the stability criterion

- Saddlepath becomes effective fiscal limit
Phase Diagram for a country which does not fail the stability criterion

- No effective fiscal limit
Apply the model

- Six high-debt countries: Belgium, Canada, France, Portugal, Italy, and Greece
- Annual data from the OECD database during the period 1970-2008
- To estimate the threshold model:
  1. Test for the presence of thresholds
     a. Find them for all countries except Portugal
     b. Belgium and Greece have two
     c. Others have one
  2. Estimate the threshold levels of debt
  3. Estimate the surplus responsiveness to debt
Estimate the threshold levels of debt

<table>
<thead>
<tr>
<th></th>
<th>$\tilde{d}_1$</th>
<th>$\tilde{d}_2$</th>
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</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>65.66</td>
<td>98.36</td>
</tr>
<tr>
<td>Canada</td>
<td>62.27</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>39.72</td>
<td>-</td>
</tr>
<tr>
<td>Greece</td>
<td>56.39</td>
<td>94.86</td>
</tr>
<tr>
<td>Italy</td>
<td>84.17</td>
<td>-</td>
</tr>
<tr>
<td>Portugal</td>
<td>-</td>
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</tr>
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Estimate the responsiveness

<table>
<thead>
<tr>
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<th>Italy</th>
<th>Portugal</th>
</tr>
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<tbody>
<tr>
<td>$c$</td>
<td>6.041</td>
<td>-0.430</td>
<td>0.375</td>
<td>0.385</td>
<td>-5.023***</td>
<td>-3.034***</td>
</tr>
<tr>
<td></td>
<td>(4.412)</td>
<td>(1.361)</td>
<td>(0.546)</td>
<td>(0.712)</td>
<td>(1.121)</td>
<td>(1.094)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.680***</td>
<td>0.566***</td>
<td>0.195</td>
<td>0.451***</td>
<td>0.306***</td>
<td>0.357***</td>
</tr>
<tr>
<td></td>
<td>(0.075)</td>
<td>(0.050)</td>
<td>(0.122)</td>
<td>(0.153)</td>
<td>(0.105)</td>
<td>(0.128)</td>
</tr>
<tr>
<td>$\gamma^h_0$</td>
<td>-0.121</td>
<td>-0.016</td>
<td>-0.039**</td>
<td>-0.058*</td>
<td>0.030**</td>
<td>0.041*</td>
</tr>
<tr>
<td></td>
<td>(0.077)</td>
<td>(0.025)</td>
<td>(0.016)</td>
<td>(0.031)</td>
<td>(0.013)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>$\gamma^h_1$</td>
<td>0.208**</td>
<td>0.096***</td>
<td>0.063**</td>
<td>0.164**</td>
<td>0.126***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.100)</td>
<td>(0.034)</td>
<td>(0.025)</td>
<td>(0.073)</td>
<td>(0.037)</td>
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<tr>
<td>$\gamma^h_2$</td>
<td>-0.073**</td>
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<td></td>
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<td>-0.273**</td>
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<tr>
<td></td>
<td>(0.035)</td>
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<td></td>
<td></td>
<td>(0.117)</td>
</tr>
<tr>
<td>$\delta_1$</td>
<td>0.316**</td>
<td>0.453***</td>
<td>0.235**</td>
<td>-0.055</td>
<td>0.237</td>
<td>0.286**</td>
</tr>
<tr>
<td></td>
<td>(0.182)</td>
<td>(0.069)</td>
<td>(0.114)</td>
<td>(0.084)</td>
<td>(0.184)</td>
<td>(0.130)</td>
</tr>
<tr>
<td>$\delta_2$</td>
<td>-0.422**</td>
<td>-0.371***</td>
<td>-0.499***</td>
<td>-0.201**</td>
<td>-0.023</td>
<td>-0.228*</td>
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<tr>
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<td>(0.219)</td>
<td>(0.081)</td>
<td>(0.100)</td>
<td>(0.079)</td>
<td>(0.102)</td>
<td>(0.144)</td>
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<tr>
<td>$\bar{R}^2$</td>
<td>0.889</td>
<td>0.954</td>
<td>0.635</td>
<td>0.735</td>
<td>0.918</td>
<td>0.455</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>1.322</td>
<td>0.752</td>
<td>0.655</td>
<td>1.402</td>
<td>1.083</td>
<td>1.244</td>
</tr>
</tbody>
</table>
Greece: beyond effective fiscal limit, debt explodes with probability one
Threshold model: Test with Greece

- Predicts crises in many years in which there were no crises
- Falling responsiveness as debt rises does not obviously make sense
- Perhaps debt is capturing something else
  - Early, debt and interest rates were low
  - Middle, debt and interest rates were high
  - Late, interest rates were low while debt rose for some and fell for others
- Higher interest rate increases risk and higher responsiveness can offset this increased risk
Responsiveness varies with the interest rate

- Use break tests to identify separate interest rate regimes for each country.
- Fiscal rule has a different constant ($c_i$) and responsiveness ($\gamma_i^r$) in each interest rate regime.

$$s_t = c_i + \beta s_{t-1} + \gamma_i^r d_{t-1} + \epsilon_t,$$
Breaks in the growth adjusted interest rate

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>R2</td>
<td>3.461</td>
<td>3.583</td>
<td>3.209</td>
<td>3.382</td>
<td>1.985</td>
<td>2.638</td>
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<tr>
<td>R3</td>
<td>0.353</td>
<td>-0.627</td>
<td>0.461</td>
<td>-1.767</td>
<td></td>
<td>-0.496</td>
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</table>
### Estimate the surplus responsiveness

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<tr>
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<th>Portugal</th>
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</thead>
<tbody>
<tr>
<td>$c_1$</td>
<td>-4.641</td>
<td>-6.502*</td>
<td>-0.288</td>
<td>0.085</td>
<td>-5.718***</td>
<td>0.995</td>
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<tr>
<td></td>
<td>(6.262)</td>
<td>(3.470)</td>
<td>(1.259)</td>
<td>(0.993)</td>
<td>(2.071)</td>
<td>(3.998)</td>
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<td>(3.549)</td>
<td>(0.956)</td>
<td>(0.582)</td>
<td>(2.249)</td>
<td>(2.630)</td>
<td>(2.107)</td>
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<tr>
<td>$c_3$</td>
<td>-4.476**</td>
<td>-5.378***</td>
<td>-3.797</td>
<td>-7.311</td>
<td>-5.020**</td>
<td>-3.503*</td>
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<tr>
<td></td>
<td>(2.090)</td>
<td>(1.361)</td>
<td>(3.486)</td>
<td>(12.492)</td>
<td>(1.711)</td>
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</tr>
<tr>
<td>$\beta$</td>
<td>0.393***</td>
<td>0.592***</td>
<td>0.284*</td>
<td>0.356**</td>
<td>0.422***</td>
<td>0.171*</td>
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<tr>
<td></td>
<td>(0.075)</td>
<td>(0.077)</td>
<td>(0.144)</td>
<td>(0.152)</td>
<td>(0.114)</td>
<td>(0.096)</td>
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<tr>
<td>$\gamma_1^r$</td>
<td>0.053</td>
<td>0.0116</td>
<td>-0.004</td>
<td>-0.051</td>
<td>0.056</td>
<td>-0.136</td>
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<td></td>
<td>(0.114)</td>
<td>(0.070)</td>
<td>(0.016)</td>
<td>(0.044)</td>
<td>(0.042)</td>
<td>(0.125)</td>
</tr>
<tr>
<td>$\gamma_2^r$</td>
<td>0.091***</td>
<td>0.077***</td>
<td>0.047**</td>
<td>0.130***</td>
<td>0.091***</td>
<td>0.085**</td>
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<tr>
<td></td>
<td>(0.031)</td>
<td>(0.011)</td>
<td>(0.016)</td>
<td>(0.027)</td>
<td>(0.027)</td>
<td>0.041</td>
</tr>
<tr>
<td>$\gamma_3^r$</td>
<td>0.067*</td>
<td>0.067***</td>
<td>0.047</td>
<td>0.066</td>
<td>0.035</td>
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<tr>
<td></td>
<td>(0.136)</td>
<td>(0.022)</td>
<td>(0.056)</td>
<td>(0.120)</td>
<td>(0.027)</td>
<td></td>
</tr>
<tr>
<td>$\bar{R}^2$</td>
<td>0.908</td>
<td>0.958</td>
<td>0.650</td>
<td>0.779</td>
<td>0.905</td>
<td>0.517</td>
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<tr>
<td>$\sigma$</td>
<td>1.201</td>
<td>0.714</td>
<td>0.641</td>
<td>1.260</td>
<td>1.164</td>
<td>1.171</td>
</tr>
</tbody>
</table>

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Interest rate model and the fiscal limit

- Surplus-responiveness in increasing in the interest rate
- All countries are stable in the second and third interest rate regimes
- No estimate for the effective fiscal limit
- Create estimate of lower bound on fiscal limit
  - Long-run value of debt implied by estimates must be below fiscal limit
  - Historical maximum value of debt must be below fiscal limit
- Separate countries into two risk categories
  - High risk if debt projection exceeds lower bound on fiscal limit
  - Low risk if not
• Portugal 2010 debt projection exceeds 90.29
• Greece 2008 debt projection exceeds 110.03
• Additionally, both deviated strongly from path projected by fiscal rule
Fiscal Risk: France and Italy

- France debt projections never exceed 104.22
- Italy debt projections exceed 121.25 in 2012
- Difficulty following fiscal rule not as severe as for Greece and Portugal
Belgium debt projections never exceed 139.12
Canadian debt projections never exceed 109.4
Both were closer to following fiscal rule
Conclusion

- Simple data-based method for assessing risk of fiscal crises in high-debt developed countries
- Estimate fiscal rule in which surplus-responsiveness to debt is increasing in the interest rate
- Compute lower bound on fiscal limit on debt
- Country is at "high risk" when debt projections using the risk-free interest rate exceed the lower bound
- Model predicts Greek and Portuguese crises which occurred and warns of an Italian one
Thank You