Early-warning indicators for debt sustainability

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Hugo Rojas-Romagosa
Our main message in the words of Rudi Dornbusch

Think of someone who has made a great expertise of drunk driving, regularly drives drunk, tells you that he never has a problem, and one day there is a terrible, terrible accident. And he’ll say, "Well, it was the red light. It wasn’t my being drunk. Normally that light is green."
How to assess debt sustainability?

- A sustainable fiscal policy can be continued without losing control over the debt level.
- Towards stochastic analysis:
  - Macro-volatility of interest and growth (economic uncertainty).
  - Response of fiscal policy to setbacks (policy maker).
- Indicator captures upward risk of the debt level:
  - Expected debt increase which happens every 40 years.
  - In 2007, indicator identifies countries with sustainability issues.
  - Complements SGP (3%, 60%) and ageing (S1, S2) indicators.
Stochastic analysis

Which government is more ’in control of its debt level’?

Belgium

Portugal
‘at risk’ indicator captures upward risk

Iceland

debt / GDP

2011 2016 2021 2026 2031

97.5%
95%
median
2.5%
5%

‘at risk’ indicator
Rest of the presentation

1. What drives the debt level?
2. Theoretical debt sustainability: Modified Aaron condition
3. Stochastic simulations
4. The added value of the indicator
What drives the debt level?

- Accounting equation for the debt level:

\[ \text{debt}_{t+1} = \frac{1 + \text{interest}_t}{1 + \text{growth}_t} \times \text{debt}_t - \text{primary surplus}_t. \]

- Contributing channels
  1. Growth
  2. Interest
  3. Surplus (fiscal response)
Autonomous debt reduction till 80s

Interest minus growth rate

The Netherlands

Gamma parameter

year

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Early-warning indicators | 8 October 2013
What drives the debt level?

- Accounting equation for the debt level:
  \[\text{debt}_{t+1} = \frac{1 + \text{interest}_t}{1 + \text{growth}_t} \times \text{debt}_t - \text{primary surplus}_t.\]

- Contributing channels
  1. Growth
  2. Interest
  3. Surplus (fiscal response)
When Belgian debt increased, government budget responded
When Portuguese debt increased, government budget did not respond
Theoretical debt sustainability: Modified Aaron condition

Modified Aaron condition: \( \text{interest} - \text{growth} - \text{fiscal response} < 0 \).

with fiscal response the estimated responsiveness of surplus to debt. Then: If this condition is satisfied, debt converges to a steady state.
Data, simulation method & results
Data: long time series for fiscal response estimation

- Main results: Post-WW2 data
- Robustness: entire sample

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1792-2011</td>
<td>220</td>
</tr>
<tr>
<td>GBR</td>
<td>1691-2011</td>
<td>321</td>
</tr>
<tr>
<td>NLD</td>
<td>1816-2011*</td>
<td>188</td>
</tr>
<tr>
<td>BEL</td>
<td>1830-2011*</td>
<td>160</td>
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<tr>
<td>DEU</td>
<td>1970-2011</td>
<td>42</td>
</tr>
<tr>
<td>ITA</td>
<td>1862-2011</td>
<td>150</td>
</tr>
<tr>
<td>ESP</td>
<td>1850-2011*</td>
<td>159</td>
</tr>
<tr>
<td>PRT</td>
<td>1852-2011</td>
<td>160</td>
</tr>
<tr>
<td>ISL</td>
<td>1908-2011</td>
<td>103</td>
</tr>
</tbody>
</table>

* = War data missing
Modified Aaron condition satisfied for all countries

Table 1  Modified Aaron condition for stability of public debt

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>GBR</th>
<th>NLD</th>
<th>BEL</th>
<th>DEU</th>
<th>ITA</th>
<th>ESP</th>
<th>PRT</th>
<th>ISL</th>
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</thead>
<tbody>
<tr>
<td>1948-2009</td>
<td>2.2</td>
<td>1.5</td>
<td>2.1</td>
<td>4.4</td>
<td>3.6</td>
<td>-1.2</td>
<td>-0.1</td>
<td>-3.6</td>
<td>-5.4</td>
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<tr>
<td>1946-2011</td>
<td>3.2</td>
<td>2.2</td>
<td>3.7</td>
<td>2.8</td>
<td>2.5</td>
<td>4.4</td>
<td>4.2</td>
<td>3.8</td>
<td>5.3</td>
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<tr>
<td>Interest rate $r$</td>
<td>-0.9</td>
<td>-0.7</td>
<td>-1.6</td>
<td>1.6</td>
<td>1.0</td>
<td>-5.5</td>
<td>-4.3</td>
<td>-7.3</td>
<td>-10.7</td>
</tr>
<tr>
<td>Growth rate $g$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aaron cond. $r-g$ (&lt;0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiscal response $b$</td>
<td>7.8***</td>
<td>4.5***</td>
<td>7.7***</td>
<td>3.8***</td>
<td>2.6*</td>
<td>7.1***</td>
<td>0.5</td>
<td>-0.5</td>
<td>-0.2</td>
</tr>
<tr>
<td>Mod. Aaron cond. $r-g-b$ (&lt;0)</td>
<td>-8.7</td>
<td>-5.2</td>
<td>-9.3</td>
<td>-2.2</td>
<td>-1.6</td>
<td>-12.6</td>
<td>-4.8</td>
<td>-6.8</td>
<td>-10.5</td>
</tr>
</tbody>
</table>

Units are percentages; italic and grey = not significant, * = significant at 10% level, ** = significant at 5% level, *** = significant at 1% level.
Historically debt was sustainable

- High growth and low real interest contributes to sustainability
- Fiscal response significant and positive for USA, GBR, NLD, BEL, DEU and ITA not significant for ESP, PRT and ISL
- Fiscal response robust when pre-WWII years are included
  \[\Rightarrow\] measures persistent institutional characteristic
Since mid 80s: fiscal response required

Table 2  Aaron condition \((r-g < 0)\) no longer satisfied in many countries after 1987

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>GBR</th>
<th>NLD</th>
<th>BEL</th>
<th>DEU</th>
<th>ITA</th>
<th>ESP</th>
<th>PRT</th>
<th>ISL</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaron condition before 1987</td>
<td>-2.2</td>
<td>-2.0</td>
<td>-3.2</td>
<td>0.9</td>
<td>0.0</td>
<td>-7.3</td>
<td>-8.8</td>
<td>-9.7</td>
<td>-15.2</td>
<td>-5.3</td>
</tr>
<tr>
<td>Aaron condition after 1987</td>
<td>1.1</td>
<td>1.3</td>
<td>2.0</td>
<td>2.1</td>
<td>2.4</td>
<td>2.0</td>
<td>4.1</td>
<td>-2.6</td>
<td>-2.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Units are percentages.

- growth > interest prior to 1987 and interest > growth afterwards
  \(\Rightarrow\) fiscal response required for sustainability
- How bad is it?
  \(\Rightarrow\) Simulation needed
Volatility much higher in Iceland

![Graphs showing real growth and real interest for USA and ISL](image)

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18/30

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Stochastic simulation

Simulate debt going forward:
1. Estimate the fiscal response
2. Simulate volatility in interest and growth rates (Budina and van Wijnbergen, 2008) using a VAR
3. Simulate debt at time $t + 1$ from time $t$ debt, simulated volatility in interest and growth and estimated fiscal response
Fiscal response reduces debt levels and volatility

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Volatility in interest and growth increase debt volatility

Germany, response=2.6%

Spain, response=0
Simulation outcomes

- Larger fiscal response reduces debt levels
- Larger fiscal response and smaller interest and growth rate volatility reduce debt volatility
- Define ’at risk’ indicator: debt level that is higher then 97.5% of the debt levels minus median debt level after 10 years. Remaining 2.5% ≈ > once every 40 years
'at risk' indicator

Iceland

debt / GDP

97.5%
95%
median
2.5%
5%

2011 2016 2021 2026 2031
## 2011 indicator

<table>
<thead>
<tr>
<th></th>
<th>2011 Initial debt</th>
<th>2021 Median debt</th>
<th>‘At risk’</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>102</td>
<td>89</td>
<td>6</td>
</tr>
<tr>
<td>GBR</td>
<td>82</td>
<td>73</td>
<td>9</td>
</tr>
<tr>
<td>NLD</td>
<td>65</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>BEL</td>
<td>99</td>
<td>83</td>
<td>6</td>
</tr>
<tr>
<td>DEU</td>
<td>80</td>
<td>83</td>
<td>11</td>
</tr>
<tr>
<td>ITA</td>
<td>120</td>
<td>137</td>
<td>33</td>
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<tr>
<td>ESP</td>
<td>68</td>
<td>56</td>
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<td>PRT</td>
<td>107</td>
<td>199</td>
<td>167</td>
</tr>
<tr>
<td>ISL</td>
<td>99</td>
<td>78</td>
<td>54</td>
</tr>
</tbody>
</table>

Note: Debt levels and indicators in percent of GDP.
Early-warning indicator

- ’07 indicator value is highly correlated with ’09–’12 sovereign spreads.
- ’07 sovereign spreads are not correlated with ’09–’12 sovereign spreads.
Discussion
How to use the indicators?

- Assess whether fiscal response is sufficient to sustain medium term debt levels when other instruments are absent
- NOT: Ability to refinance or probability of liquidity crisis

Complements current set of indicators:

- Debt-level (SGP norms)
- Structural balances
- Ageing study sustainability indicators
Take aways

• Medium term debt sustainability depends on macro-volatility
  ⇒ Stochastic simulation required
• And country specific response of fiscal policy
• Our framework first step towards full stochastic analysis
• The ‘at risk’- indicator distinguishes countries with sustainability
  issues (ITA, ESP, PRT) from countries without (USA, GBR, NLD,
  BEL)
Thank you for your attention!
Bibliography I


Figure 1  Debt-to-GDP ratios in the post-war period
Estimating the fiscal response

- Estimation:

\[ \text{primary surplus}_t = \alpha + \text{fiscal response} \times \text{debt}_t + \beta \text{other}_t + \epsilon_t. \]

- 'Other' corrects for:
  - Business cycle
  - Temporary government spending

- Fiscal response:
  - Measures long-term response of fiscal policy to government debt
  - Indicates whether governments reduce their debt over time
Stationarity conditions

From Bohn (2007) we know:

- $\delta < 1$  \quad Debt stationary, steady state $-\frac{\gamma a}{1 - \delta}$
- $1 < \delta < \rho$  \quad Debt explosive but consistent with the IBC
- $1 < \delta$ and $\rho < \delta$  \quad Debt explosive

For $\delta = \frac{1+r}{1+y}(1 - \rho)$
Fiscal response

• Estimation:

\[ s_t = \alpha + \rho d_t + \beta Z_t + \varepsilon_t. \]

• With \( Z_t \):
  ▶ Business cycle
  ▶ Temporary government spending
<table>
<thead>
<tr>
<th>Year</th>
<th>Military expenditure / GDP</th>
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<tbody>
<tr>
<td>1691</td>
<td></td>
</tr>
<tr>
<td>1711</td>
<td></td>
</tr>
<tr>
<td>1731</td>
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<td>1771</td>
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</tr>
<tr>
<td>1991</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
</tr>
</tbody>
</table>

United Kingdom
Empirical procedure

1. Estimate the fiscal response:

\[ s_t = \alpha + \rho d_t + \beta Z_t + \varepsilon_t. \]

2. Estimate a VAR for interest and growth rates (Budina and van Wijnbergen, 2008):

\[
\begin{pmatrix}
    r_t \\
    y_t
\end{pmatrix}
= \alpha_0 + \sum_{j=1}^{\infty} A_j \begin{pmatrix}
    r_{t-j} \\
    y_{t-j}
\end{pmatrix} + \eta_t, \quad \text{var}(\eta_t) = \Sigma.
\]

3. Simulate debt at time \( t + 1 \) from time \( t \) data:

\[
d_{t+1} = \frac{1 + r_t}{1 + y_t} (1 - \rho) d_t - \gamma \alpha,
\]

using the VAR shocks and the fiscal response coefficients.
Countries with $\rho$ significant

United States, $\rho=7.8$

United Kingdom, $\rho=4.5$

Netherlands, $\rho=7.7$

Belgium, $\rho=3.8$

Germany, $\rho=2.6$

Italy, $\rho=7.1$

Spain, $\rho=7.0$

Portugal, $\rho=7.0$

Iceland, $\rho=7.0$

Countries with $\rho$ not significant, $\rho = 0.07$ assumed
Countries with $\rho$ significant, $\rho = 0$ assumed

Countries with $\rho$ not significant, $\rho = 0$