Debt sustainability measures and their explanatory power for estimating government bond yields: A panel data analysis

Prepared for 390039 UK PhD-E Econometric Methods for Panel Data with Prof. Robert Kunst

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Outline

- Government yields and public debt: some stylized facts
- The research objective and overview of existing research
- Sovereign financing and public debt measures
- Methodological issues, estimation strategy, data sample and source
- Results so far
- Summary and conclusion

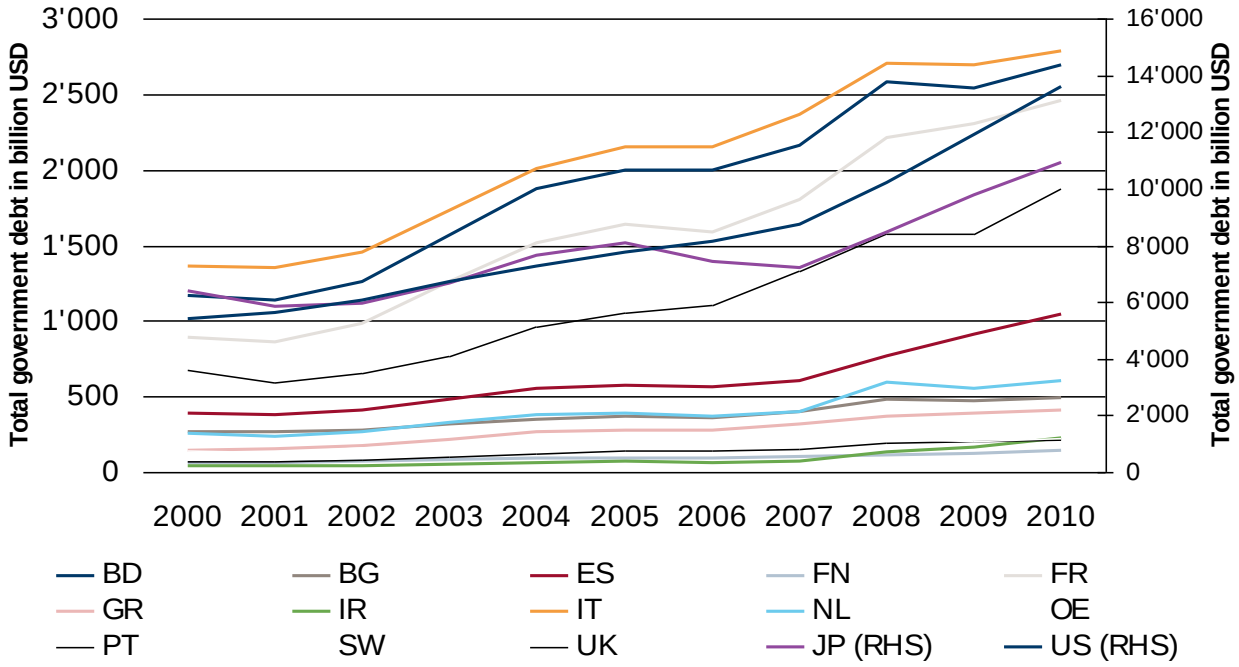
Government yields and public debt: some stylized facts

Government yields and public debt: some stylized facts

- Pubic debt has increased in recent years
- Government yields have been affected differently:
  - Lower yields (US, BD, SD,SW, etc...)
  - Higher yields (GR, PT, ES, IT,...)

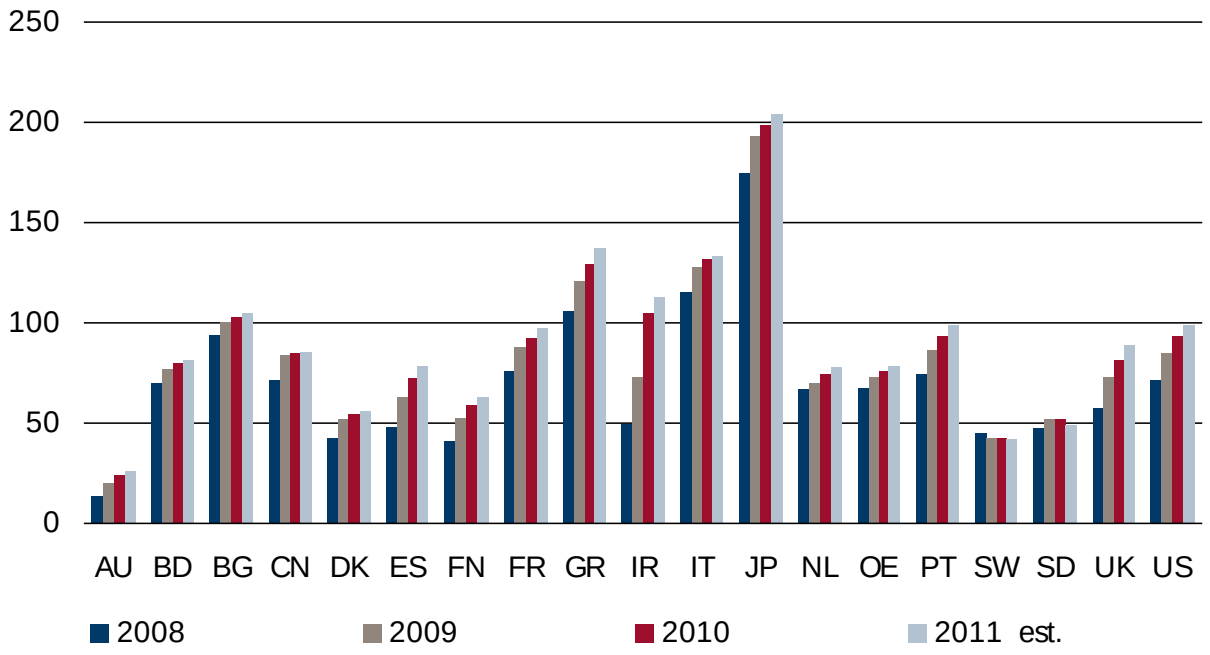
Public debt increased in recent years

- Public debt has increased for most countries over time (total public debt in billion USD)



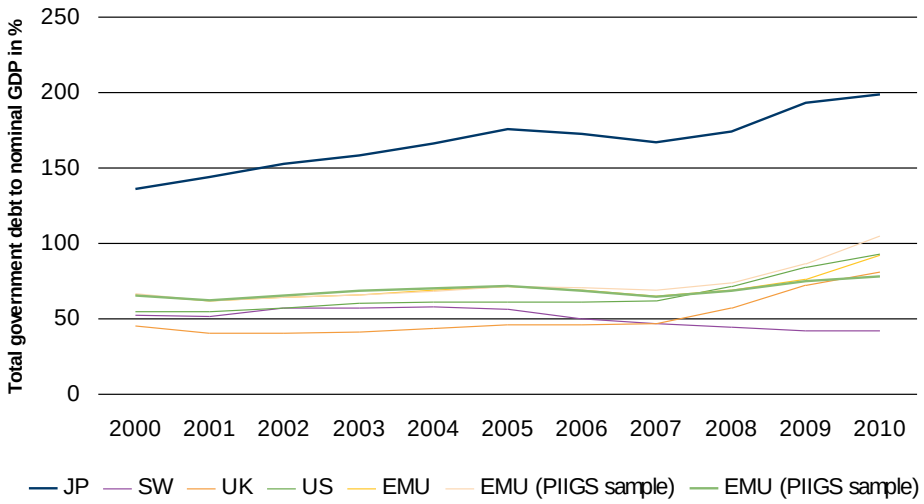
Public debt increased in recent years

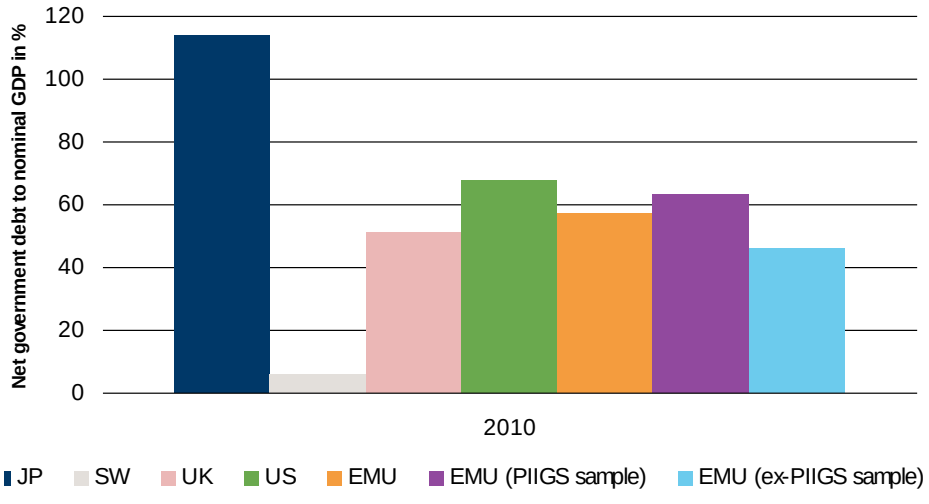
- Public debt to nominal GDP has increased for most countries over time



Public debt increased in recent years

- There are strong regional differences (PIIGS: Portugal, Italy, Ireland, Greece and Spain)





The research objective and overview of existing research

The research objective

- How much are government yields affected by changes in public debt?
- How much is the spread over central bank rates affected by government indebtness?
- How helpful is the conventional debt metric for estimating the influence on long-term yields?
- How helpful are alternative debt measures for estimating the influence on long-term yields?

Existing research

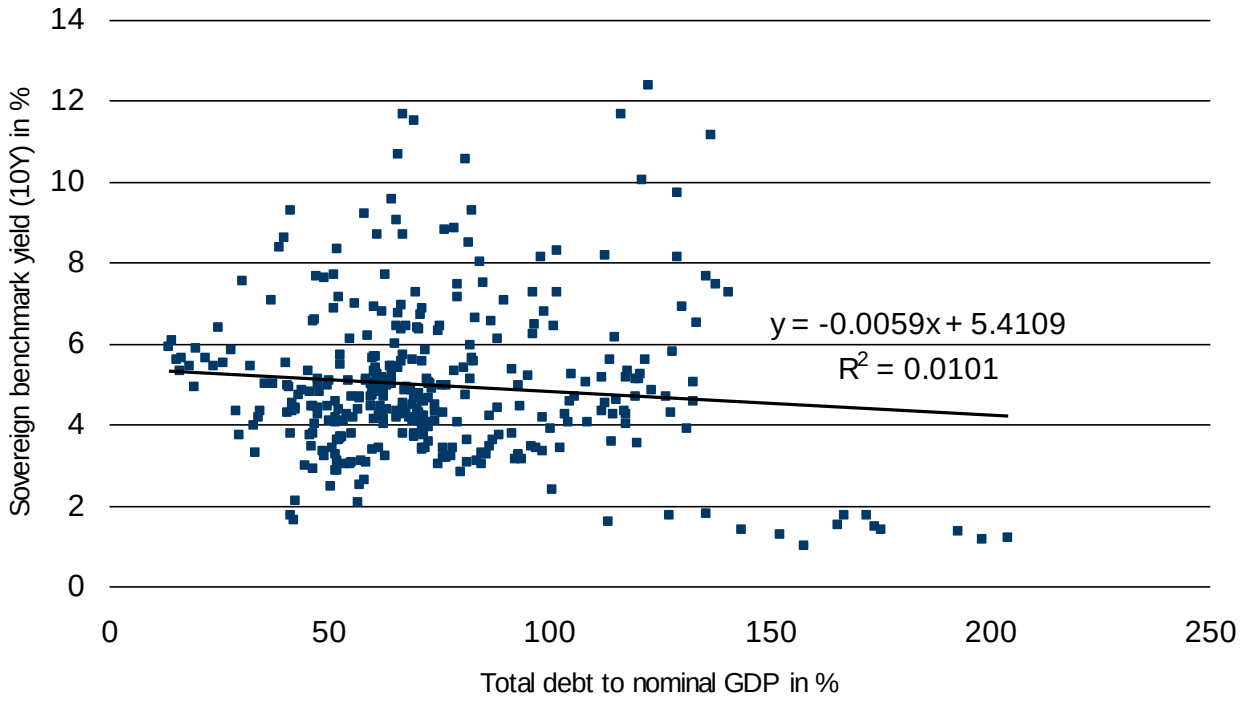
Related literature (debt influence on government bond yield):

- Engen and Glenn (2005), Federal Government Debt and Interest Rates, NBER Working Paper.
- Baldacci and Kumar (2010), Fiscal Deficits, Pubic Debt, and Sovereign Bond Yields, IMF Working Paper.
- Caner, Grennes and Koehler-Geib (2010), Finding the Tipping Point – When Sovereign Debt Turns Bad", World Bank Working Paper.
- Barbosa and Costa (2010), Determinants of Sovereign Bond Yield Spreads in the Euro Area in the context of the Economic and Financial Crisis, Banco de Portugal Working Paper.
- Jaramillo (2010), Determinants of Investment Grade Status in Emerging Markets, IMF Working Paper.
- Genberg and Sulstarova (2008), Macroeconomic volatility, debt dynamics, and sovereign interest rate spreads, JoIMF
- Rowland and Torres (2004), Determinants of Spread and Creditworthiness for Emerging Market Sovereign Debt: A Panel Data Study, Banco de la Republica Columbia Working Paper.
- Alesina et al. (1992), Default risk on government debt in OECD countries, Economic Policy.
- Dimond (1965), Natinoal debt in a neoclassical growth model, AER.

Sovereign financing and public debt measures

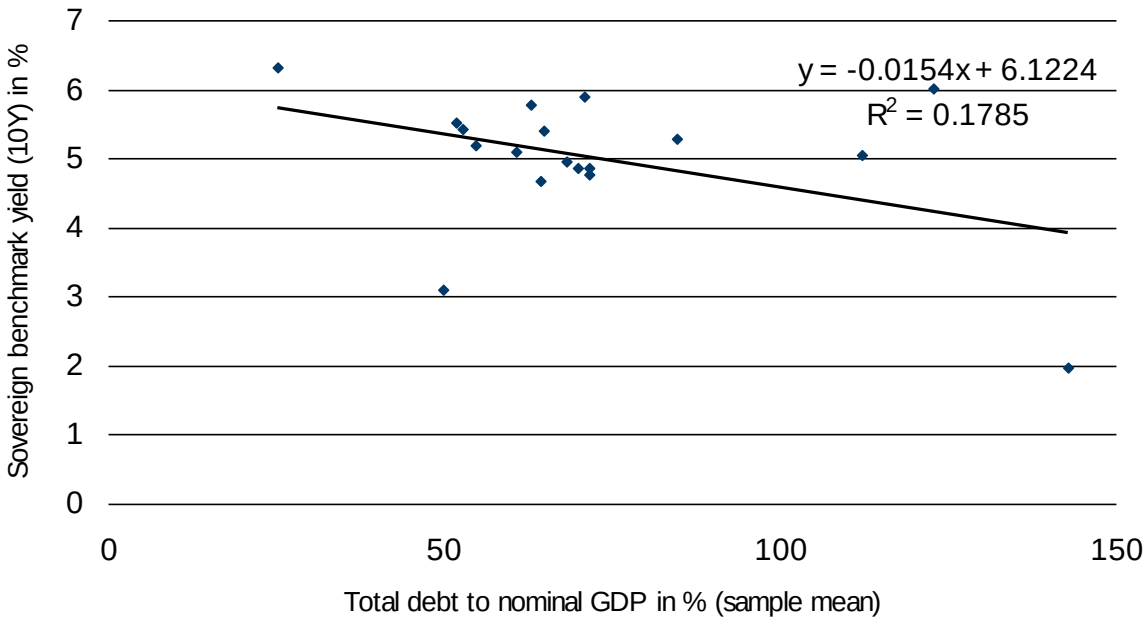
Sovereign financing and public debt measures

- Benchmark bond (10Y) and government debt (total debt to nominal GDP) – pooled data regression



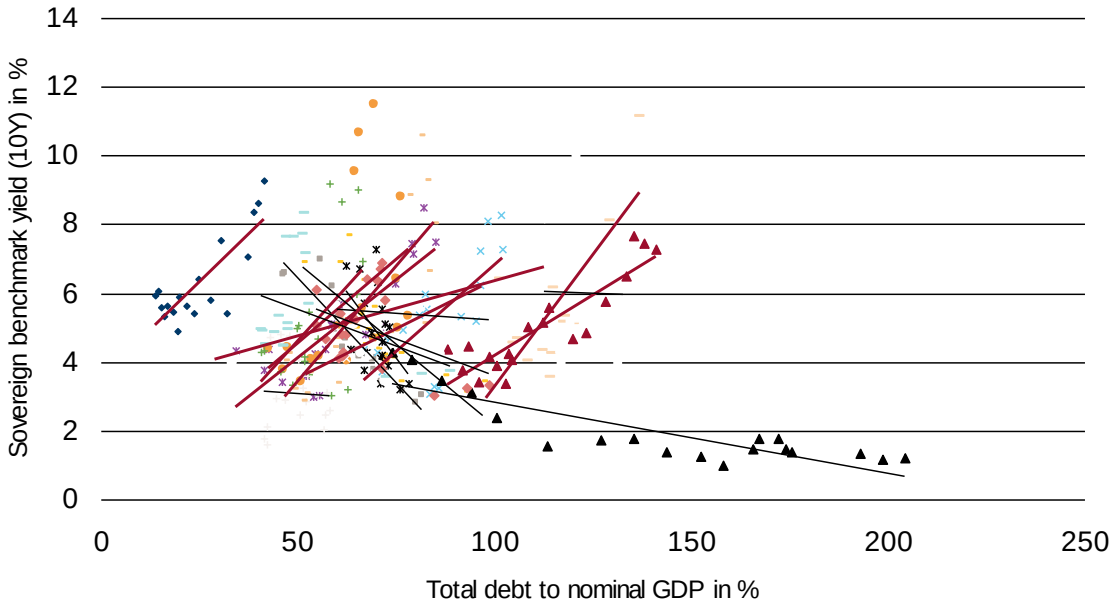
Sovereign financing and public debt measures

- Benchmark bond (10Y) and government debt (total debt to nominal GDP) – panel “between” estimator



Sovereign financing and public debt measures

- Benchmark bond (10Y) and government debt (total debt to nominal GDP)– individual OLS regression only (strong intercept heterogeneity => no pooled least-squares, no “between” estimator advisable)



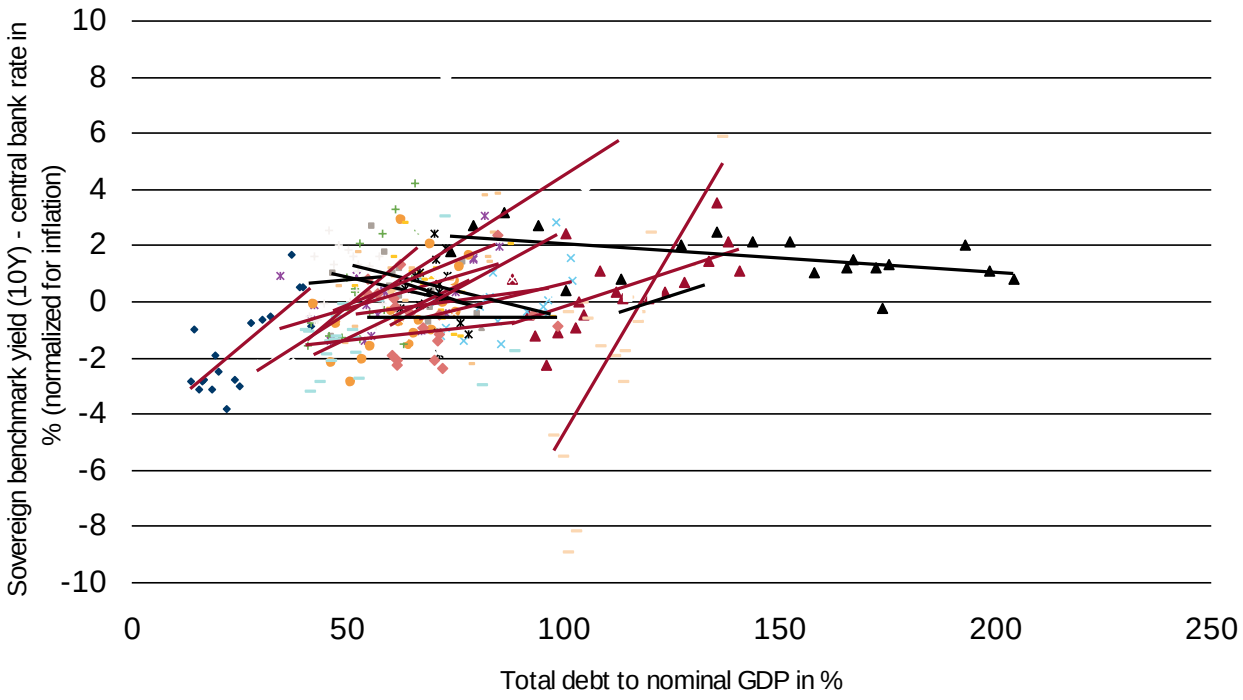
Questions:

- Apply panel regression (with fixed effects) using “within” estimator?
- Can we eliminate the slope heterogeneity?

Sovereign financing and public debt measures

Modifying the LHS of the equation

- Sovereign yield over central bank rate and inflation



Questions:

- Can we eliminate the slope heterogeneity further by changing the RHS variable?

Sovereign financing and public debt measures

- Alternative government indebtness measures
  - Overborrowing ratio (net debt / NFA*)
  - Debt barrier to NFA ratio
  - Distance to distress ratio

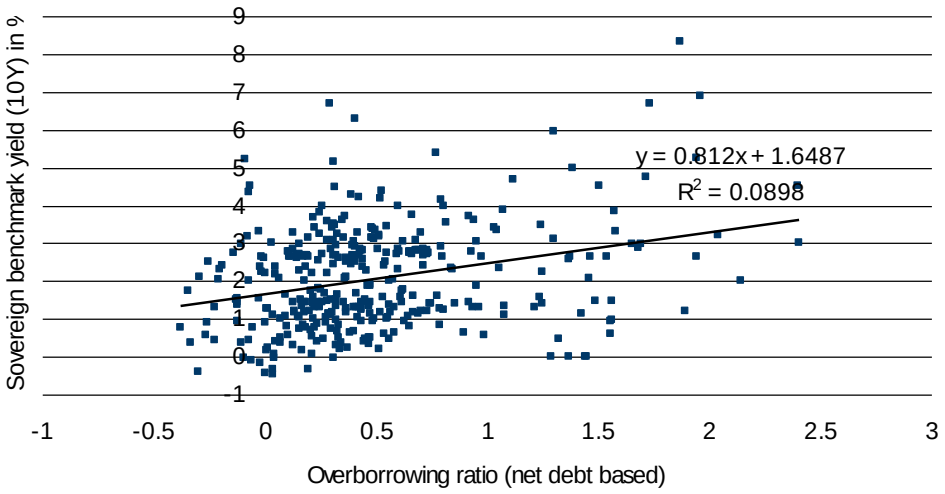
*__NFA__: net fiscal assets calculated as the present value of expected future primary budget surpluses discounted by the current country specific benchmark rate and averaged over five years

Sovereign financing and public debt measures

- Alternative debt measures help to reduce the intercept heterogeneity bias of pooled data

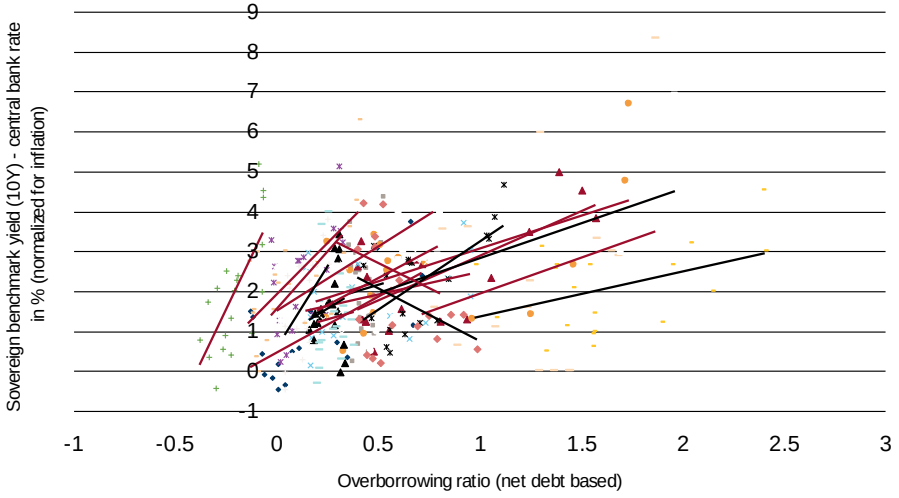
Pooled data regression

Overborrowing ratio



Individual OLS regressions

Overborrowing ratio



Methodological issues, estimation strategy, data sample and source

Methodological issues and estimation strategy

- Methodology: Panel regression (balanced panel T≈N) with cross section and time component (N: number of countries (19), T: number of years (19), K: number of sovereign credit control variables)

$$y_{it} = \alpha y_{it-1} + \beta X_{it} + \Gamma Z_{it} + \delta_i + \lambda_t + \varepsilon_{it}$$

Endogenous variable specification $y_{it} : NT \times 1$ vector

Time varying credit control variables $\beta_{it} : NT \times K$ matrix

Time varying country indebtness variables $\Gamma_{it} : NT \times 1$ vector

Cross section fixed effects $\delta_i : NT \times N$ matrix

Time (year) fixed effects $\lambda_t : NT \times T$ matrix

Methodological issues and estimation strategy

- Endogenous variable specification $y_{it} : NT \times 1 \text{ vector}$
  - Sovereign 10Y benchmark yield over average realized (future) central bank yield
  - Sovereign 5Y5Y benchmark yield over average realized future central bank yield
  - Sovereign 10Y benchmark yield over average 3M Libor forward rate
  - Sovereign 5Y5Y benchmark yield over average 3M Libor forward rate

Methodological issues and estimation strategy

- Time varying credit control variables

$$\beta_{it} : NT \times K \text{ matrix}$$

  - Business cycle (real GDP – real policy rate)
  - Real policy rate
  - Inflation growth

to capture cycle component, real yield component

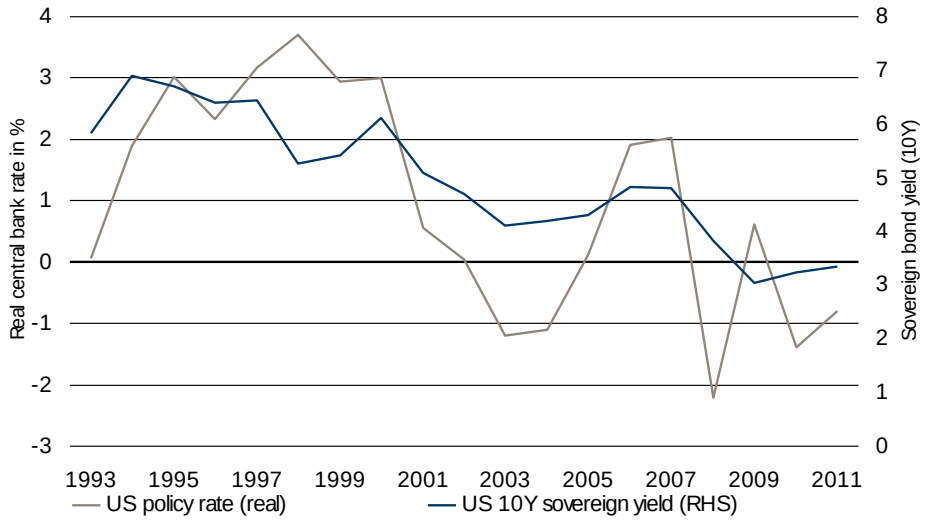
  - Risk aversion (measured as geometrically weighted change in wealth over time)

to capture save haven specific components

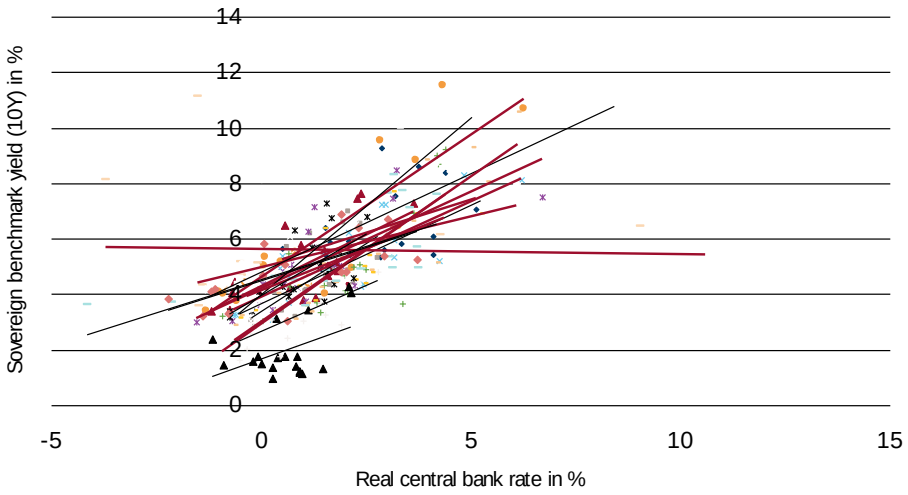
Methodological issues and estimation strategy

- Capture real yield component
  - real central bank yield = > capture real yield element

Sovereign yield vs. real policy rate



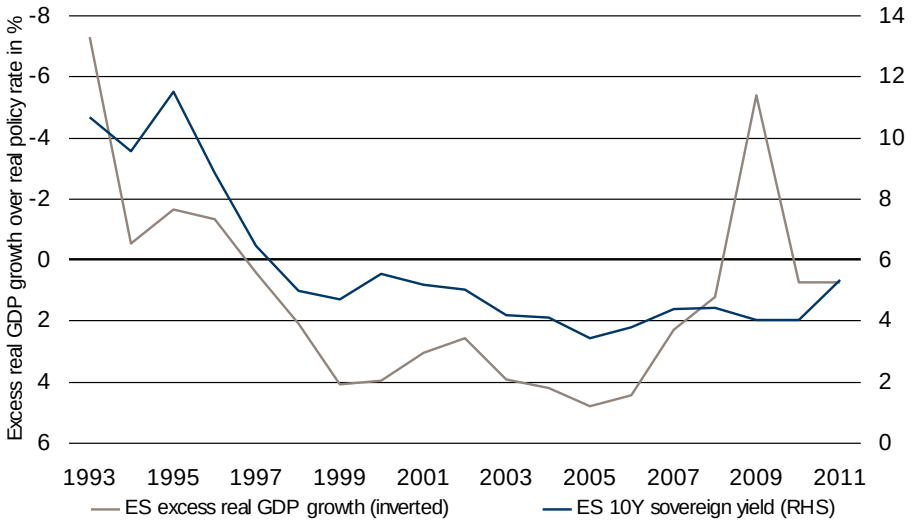
Individual OLS regressions



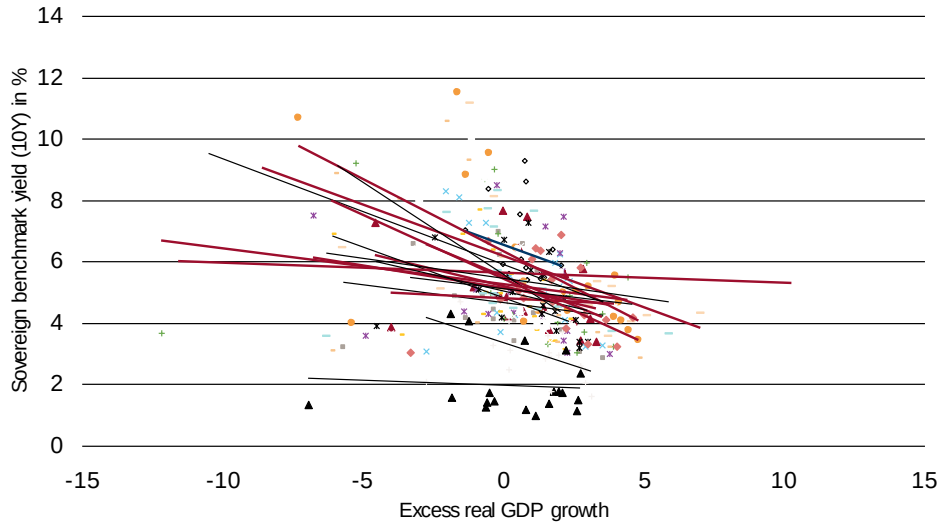
Methodological issues and estimation strategy

- Capture cycle component
  - GDP growth – real central bank yield => capture cycle element

Sovereign yield vs. excess growth



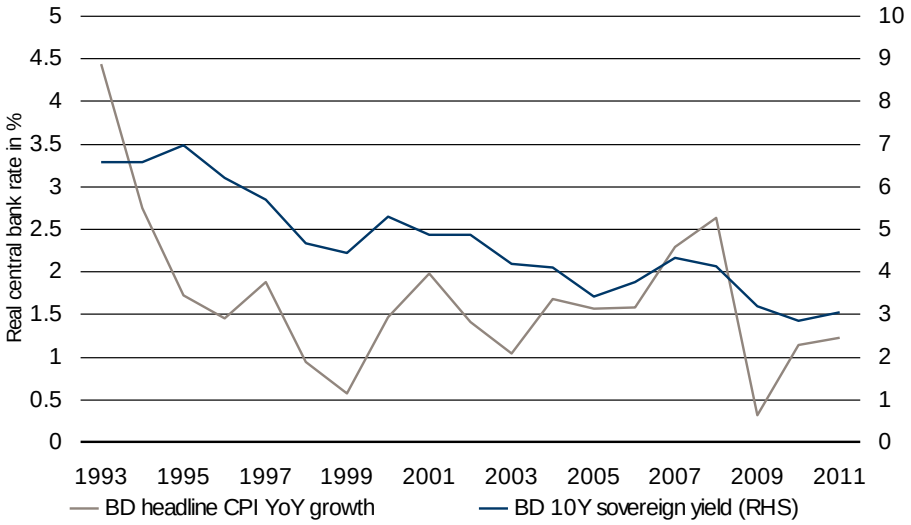
Individual OLS regressions



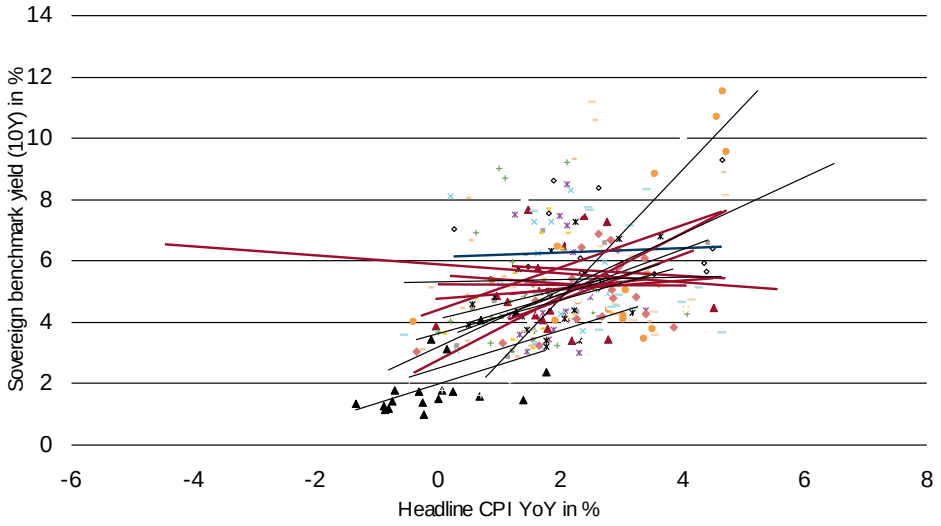
Methodological issues and estimation strategy

- Capture inflation component
  - Headline CPI growth => capture inflation component

Sovereign yield vs. CPI growth



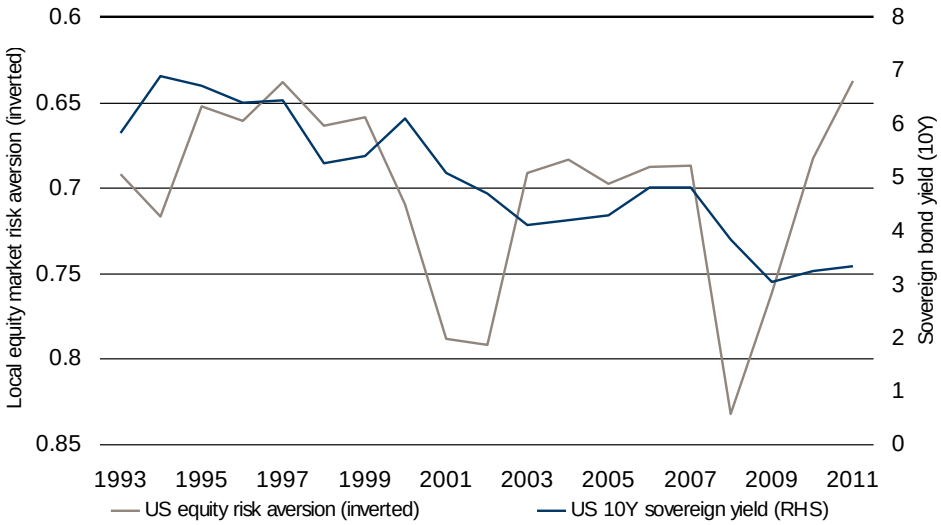
Individual OLS regressions



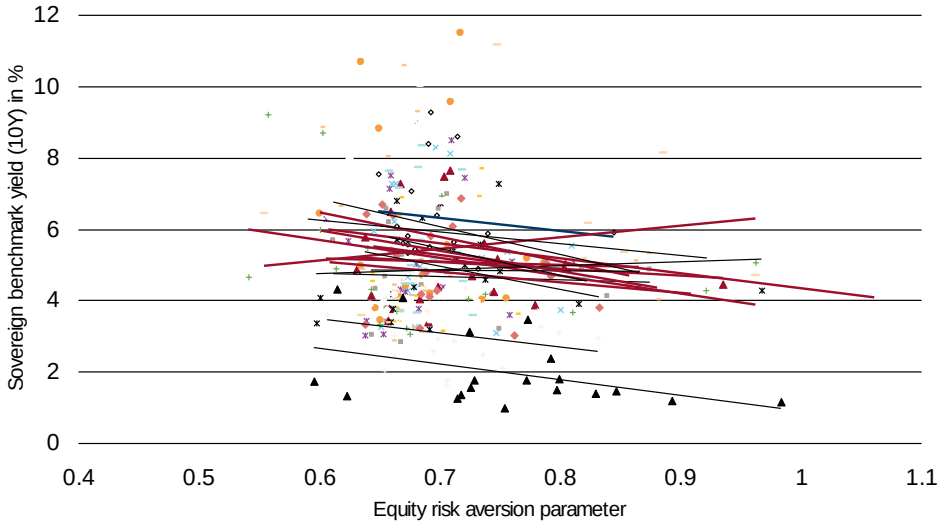
Methodological issues and estimation strategy

- Capture market risk (risk aversion) component
  - Risk aversion (see Ilmanen (1995), Time-Varying Expected Returns in International Bond Markets, JF) => capture save haven component

Risk aversion and sovereign yields



Individual OLS regressions



Methodological issues and estimation strategy

- Time varying country indebtness variables $\Gamma_{it} : NT \times 1 \text{ vector}$
  - Gross debt to nominal GDP
  - Net debt to nominal GDP
  - Debt service coverage (debt interest payment to collected taxes)
  - Net revenues to total Debt
  - Overborrowing ratio
  - Debt barrier to net fiscal assets ratio
  - Distance to distress ratio

Methodological issues and estimation strategy

- Estimation strategy:
  - Start with ordinary equation with pure control variables.
  - Expand regression by including public debt measure elements.
  - Extend framework with instrument variables (dynamic panel data analysis).
  - Enhance dynamic panel by using:
    - 2SLS estimator
    - FD-2SLS estimator
    - *adjusted LSDV estimator (not yet implemented)*

Data sample and source

- Sample 1993-2011
- Number of countries: 19 (11 EMU+AU, CN, DK,JP, SW, SD, UK, US)
- Sovereign debt database (OEDC)
  - total debt, net debt, interest expenses, etc...
- Sovereign bond yield database
  - Datastream: 2Y, 3Y, 5Y, 7Y and 10Y
- Marco economic data
  - Datastream: GDP, CPI, policy rates, etc...
- Central bank policy rate forecasts:
  - Bloomberg
    - average central bank policy expectation (2011-2014)

Results so far...

Explaining the sovereign-central bank spread

- Applying simple OLS (pooled) regression.

Dependent variable: 10 year sovereign yield - central bank rate average over four years (leading): sample (1993-2011)

Explanatory variables										
Intercept	-2.4535***	-2.7652***	-2.5247***	-2.4455***	-2.5049***	-2.5308***	-2.6457***	-2.3628***	-2.1017***	-2.492***
lagged dependend variable	0.6469***	0.6298***	0.6445***	0.6377***	0.6465***	0.632***	0.6193***	0.6469***	0.6292***	0.6158***
Real central bank rate	0.1635***	0.2002***	0.1909***	0.1649***	0.1925***	0.1769***	0.1701***	0.1635***	0.1582***	0.1582***
Business cycle	-0.0008	0.0031	0.0035	0.0017	0.0027	0.0006	-0.0015	-0.0008	-0.005	-0.0042
Headline CPI	0.2439***	0.2979***	0.2592***	0.2327***	0.2643***	0.2493***	0.2465***	0.2439***	0.242***	0.2383***
Risk aversion	3.2351***	3.0929***	3.253***	3.2748***	3.189***	3.361***	3.4118***	3.2351***	3.2031***	3.3084***
total debt/nom. GDP		0.0055***								
net debt/nom. GDP			0.0029**							
debt service coverage				0.0188						
net debt/revenues					0.1299**					
overborrowing ratio						0.2202**				
debt barrier/total pubic assets							0.5175**			
prob. of distress								0.225		
distance to distress									-0.0335**	
debt barrier/total pubic assets										0.4665
distance to distress										-0.0046
R2	0.6250	0.6441	0.6352	0.6302	0.6357	0.6353	0.6373	0.6275	0.6311	0.6337
adj. R2	0.6196	0.6378	0.6288	0.6236	0.6293	0.6289	0.6309	0.6209	0.6245	0.6261

Explaining the sovereign-central bank spread

- Applying a two-way error component regression model (i.e. LSDV - fixed cross section and fixed time effect).

Dependent variable: 10 year sovereign yield - central bank rate average over four years (leading): sample (1993-2011)

Explanatory variables										
Intercept	-1.9681***	-2.1409***	-2.0031***	-1.9267***	-1.9946***	-1.9515***	-2.1677***	-1.8458***	-1.62***	-3.1007***
lagged dependend variable	0.7985***	0.7926***	0.7885***	0.7868***	0.7916***	0.7761***	0.7682***	0.7985***	0.8008***	0.7211***
Real central bank rate	0.0862**	0.0906**	0.0889**	0.063	0.0896**	0.0916**	0.0868**	0.0862*	0.0815*	0.0657
Business cycle	-0.0895***	-0.0865***	-0.0882***	-0.0901***	-0.0884***	-0.0846***	-0.0859***	-0.0895***	-0.0889***	-0.0907***
Headline CPI	0.2288***	0.2494***	0.2491***	0.2197***	0.2508***	0.2439***	0.2419***	0.2288***	0.2324***	0.2163***
Risk aversion	2.3524***	2.3442***	2.3325***	2.2717***	2.3123***	2.2254***	2.179***	2.3524***	2.241***	2.1695***
total debt/nom. GDP		0.0036								
net debt/nom. GDP			0.0039							
debt service coverage				0.0339*						
net debt/revenues					0.1546					
overborrowing ratio						0.4174**				
debt barrier/total pubic assets							1.0842***			
prob. of distress								-0.1111		
distance to distress									-0.0322*	
debt barrier/total pubic assets										2.4265***
distance to distress										0.1044***
R2	0.8755	0.8796	0.8797	0.8780	0.8797	0.8815	0.8841	0.8763	0.8772	0.8857
adj. R2	0.8591	0.8629	0.8631	0.8610	0.8631	0.8652	0.8680	0.8591	0.8602	0.8694

Explaining the sovereign-central bank spread

- Applying 2SLS - two-way error component regression model (i.e. LSDV - fixed cross section and fixed time effect with instrumental variables).

Dependent variable: 10 year sovereign yield - central bank rate average over four years (leading): sample (1993-2011)

Explanatory variables										
Intercept	-0.4155	-2.432*	-1.3398	-1.0971	-1.3877	-1.12	-3.3905**	-0.0098	4.327*	-0.0065
lagged dependend variable	0.3263**	0.3446**	0.3884***	0.3222**	0.4187***	0.1013	0.0889	-0.0773	0.547**	0.2559
Real central bank rate	0.0066	-0.0164	-0.0126	-0.1045	-0.012	-0.0977	-0.1564	-0.5632	-0.1681	-0.1966
Business cycle	-0.1566***	-0.147***	-0.149***	-0.1456***	-0.149***	-0.1136**	-0.108**	-0.0856	-0.0816	-0.099
Headline CPI	0.1989***	0.2875***	0.2733***	0.1322**	0.2856***	0.1533*	0.0954	-0.3634	0.1367	0.0875
Risk aversion	2.1311**	1.8923	1.8168	1.9252**	1.7407	1.2752	1.4364	3.8433	1.1665	1.2062
total debt/nom. GDP		0.0268**								
net debt/nom. GDP			0.0233*							
debt service coverage				0.1803***						
net debt/revenues					0.9699*					
overborrowing ratio						4.1137***				
debt barrier/total pubic assets							9.8971***			
prob. of distress								12.6194		
distance to distress									-0.8373**	
debt barrier/total pubic assets										6.1982
distance to distress										-0.3741
R2	0.8200	0.8075	0.8274	0.8120	0.8274	0.6222	0.5483	-2.2691	0.2495	0.4077
adj. R2	0.7956	0.7802	0.8029	0.7852	0.8029	0.5687	0.4842	-2.7345	0.1427	0.3210

Explaining the sovereign-central bank spread

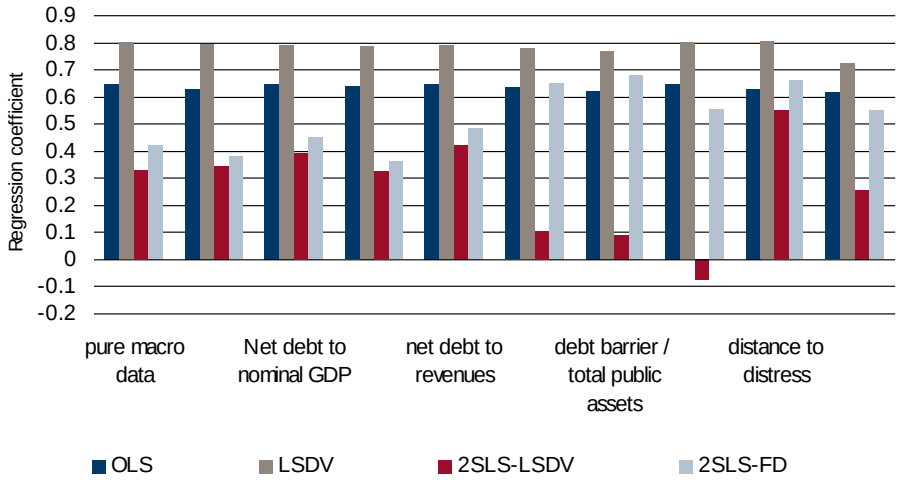
- Applying 2SLS - two-way error component regression model (i.e. LSDV - fixed cross section and fixed time effect with instrumental variables) in first differences with two-steps lagged dependent variable as additional instrument.

Dependent variable: 10 year sovereign yield - central bank rate average over four years (leading): sample (1993-2011)

Explanatory variables										
Intercept	0.1041	0.0916	0.0963	0.1136	0.0866	0.22	0.2752	0.1774	0.3751	0.4501
lagged dependend variable	0.4207***	0.3761***	0.4511***	0.3599***	0.4846***	0.6492***	0.678***	0.55**	0.6568***	0.5456**
Real central bank rate	0.6426***	0.6208***	0.6947***	0.624***	0.7254***	0.6633***	0.6654***	0.5286***	0.6722***	0.6606***
Business cycle	0.0087	-0.0054	-0.001	-0.0148	-0.0025	0.0401	0.0527	0.0662	0.0608	0.054
Headline CPI	0.5922***	0.597***	0.6685***	0.607***	0.7178***	0.6072***	0.6032***	0.4513***	0.6031***	0.5958***
Risk aversion	0.7788	0.7218	0.3805	0.6357	0.265	-0.1958	-0.438	0.3834	-0.6944	-0.7298
total debt/nom. GDP		-0.0006								
net debt/nom. GDP			0.0541							
debt service coverage				0.0863						
net debt/revenues					3.0587*					
overborrowing ratio						7.4485***				
debt barrier/total pubic assets							13.496***			
prob. of distress								13.2619**		
distance to distress									-1.521***	
debt barrier/total pubic assets										-19.5992
distance to distress										-3.342*
R2	0.4890	0.5024	0.3725	0.5224	0.2670	-0.3893	-0.2811	-2.3934	-0.8401	-1.7299
adj. R2	0.4808	0.4926	0.3602	0.5130	0.2526	-0.4166	-0.3063	-2.4604	-0.8764	-1.7929

Results: Explaining the sovereign-central bank spread

lagged dependend variable	pure macro data	Total debt to nominal GDP	Net debt to nominal GDP	Debt service coverage	net debt to revenues	overborrowing ratio	debt barrier / total public assets	default probability	distance to distress	debt barrier / total public assets + distress distance
OLS	0.6469***	0.6298***	0.6445***	0.6377***	0.6465***	0.632***	0.6193***	0.6469***	0.6292***	0.6158***
LSDV	0.7985***	0.7926***	0.7885***	0.7868***	0.7916***	0.7761***	0.7682***	0.7985***	0.8008***	0.7211***
2SLS-LSDV	0.3263**	0.3446**	0.3884***	0.3222**	0.4187***	0.1013	0.0889	-0.0773	0.547**	0.2559
2SLS-FD	0.4207***	0.3761***	0.4511***	0.3599***	0.4846***	0.6492***	0.678***	0.55**	0.6568***	0.5456**

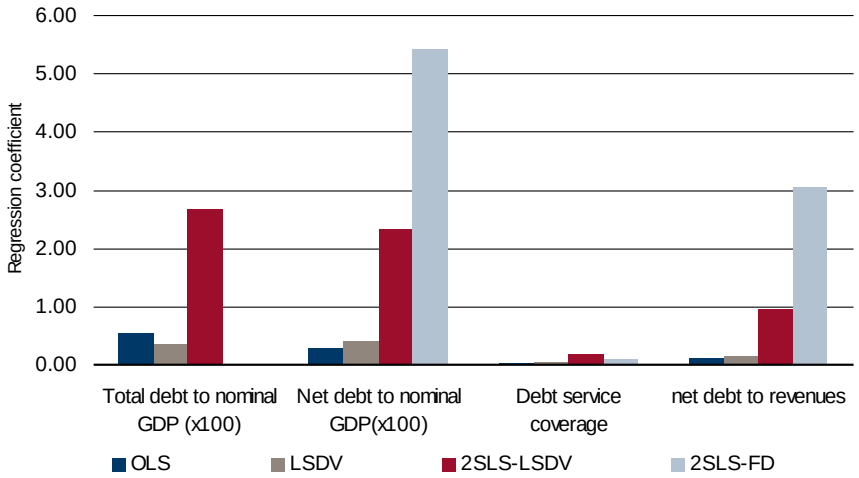


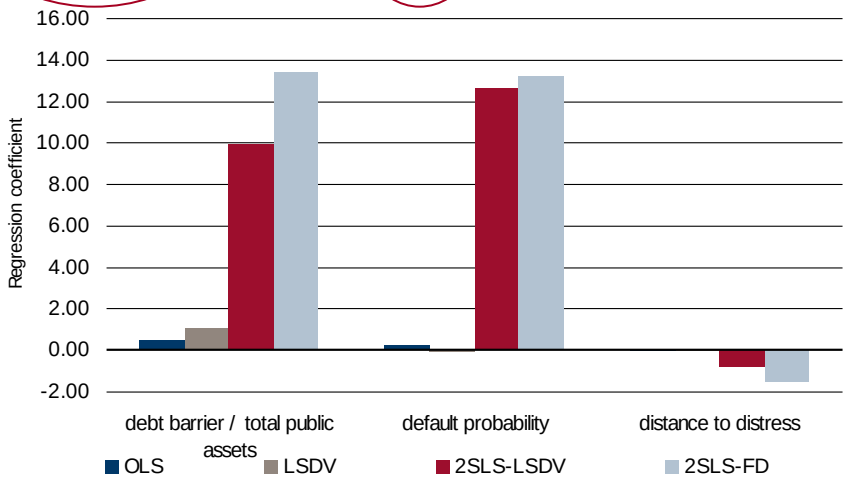
main conclusion:

- Lagged dependent variable significant for nearly all indebtness specifications.
- Pure OLS estimates overemphasize the persistence of the process.
- Coefficients drop sharply if we correct for the fixed effect bias.

Results: Explaining the sovereign-central bank spread

coefficients for	Total debt to nominal GDP (x100)	Net debt to nominal GDP(x100)	Debt service coverage	net debt to revenues	overborrowing ratio	debt barrier / total public assets	default probability	distance to distress	debt barrier / total public assets + distress distance
OLS	0.0055***	0.0029**	0.0188	0.1299**	0.2202**	0.5175**	0.225	-0.0335**	0.4665
LSDV	0.0036	0.0039	0.0339*	0.1546	0.4174**	1.0842***	-0.1111	-0.0322*	2.4265***
2SLS-LSDV	0.0268**	0.0233*	0.1803***	0.9699*	4.1137***	9.8971***	12.6194	-0.8373**	6.1982
2SLS-FD	-0.0006	0.0541	0.0863	3.0587*	7.4485***	13.496***	13.2619**	-1.521***	-19.5992





Summary and conclusion

- Summary:
  - Most debt measures have significant explanatory power in forecasting the sovereign-central bank spread.
  - The estimated coefficients are highly dependent on the bias correction choice.
  - Applying estimators that correct for the dynamic panel-fixed effect bias lead to higher indebtness sensitivity coefficients while lowering the lagged dependent variable coefficient significantly.
  - Forward looking indebtness measures outperform (in terms of significance) conventional indebtness measures like debt/GDP or debt servicing ratios.

Thank you for your attention!