

Implementation of European Commission's DSA using MATLAB

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DSA Framework

$$d_t = \frac{1-i_t}{1-g_t^{nim}} d_{t-1} - p_t + \Delta coa_t + sfa_t$$

Commission's debt sustainability analysis (DSA)

$$debt_t = \frac{1 + interest_t}{1 + growth_t} debt_{t-1} - primary\ balance_t + other\ factors_t$$

DSA-based criteria

Downward path

The debt ratio follows a continuously declining path according to deterministic modelling.

Plausible path

The debt ratio is highly likely to be on a downward path according to stochastic modelling.

Reference value for deficit

The deficit must be brought and maintained below the 3% reference value during the adjustment period.

Safeguards

Debt sustainability

The debt ratio must be reduced on average by:

- a) 0.5% point when the debt ratio is 60% to 90% of GDP
- b) 1% point when the debt ratio exceeds 90% of GDP

Deficit resilience*

The deficit must not exceed 1.5% of GDP, considering the business cycle.

Otherwise, the annual consolidation must be 0.4% point of GDP and 0.25% point in the case of an extended plan.

Projections

Macroeconomic

Growth rate of real and potential GDP.

Other factors

Stock-flow adjustment, age-related expenditure, property income.

Corrective arm*

The path must be in line with the corrective arm. The previous year's deficit must not exceed 3% of GDP. Otherwise, the annual consolidation must be 0.5% point of GDP.

Assumptions

Macroeconomic

Closing of the output gap, inflation trajectory, fiscal policy coefficient, and semi-elasticity of the budget.

Modelling-based

Assumptions related to deterministic and stochastic modelling.

Financial

Trajectories of short and long market interest rates, short and long-term debt instruments issued, and the maturity of long-term debt portfolio.

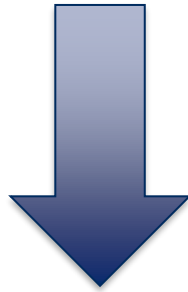
● Criteria to be met * Applied at annual level

Structure of the Code

DSA model parameters



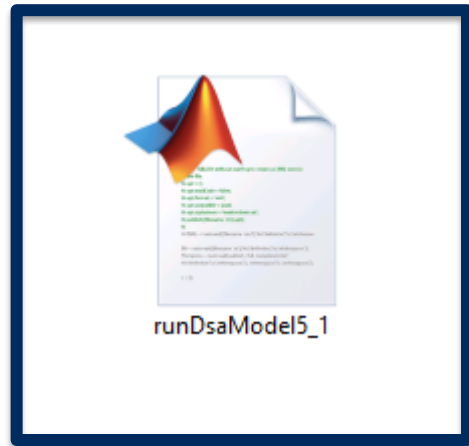
defineDsaModel5_1



DSA model



runDsaModel5_1



project_debt5_1v

Debt dynamic equation



Data file



CommissionPriorGui
danceFinland

DSA model parameters

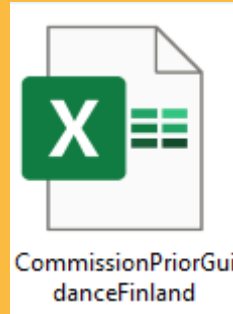


DSA model parameters

```
%% Define parameters in a structure for runDsaModel5_1.m  
params = struct;  
params.adjustmentPeriods = 7;  
params.sfa_method = 0;  
params.apply_debt_safeguard = 1;  
params.apply_deficit_benchmark = 1;  
params.apply_deficit_safeguard = 1;  
params.plotting = 0;  
params.power = 2;  
params.plausibility = 7;  
params.language = 1;  
params.stoch_method = 1;  
params.saveFlag = 0;
```

- adjustment periods
- SFA method
- is the criteria applied?
 - debt sustainability safeguard
 - deficit benchmark
 - deficit resilience safeguard
- plotting
- nbr of stochastic simulations
- plausibility
- language
- simulation method
- saving

Data file



Input data

Additional parameters	
Fiscal multiplier	0.75
Budget balance semi-elasticity	0.6
Long-term nominal interest rate (T+10 convergence value)	3.2
Short-term nominal interest rate (T+10 convergence value)	2.7
Long-term nominal interest rate (T+30 convergence value)	4.0
Short-term nominal interest rate (T+30 convergence value)	2.0
Share of short-term debt in total government debt	0.1083
Share of long-term debt in total government debt	0.8917
Share of long-term debt that matures every year (T+10 convergence value)	0.0378
GDP deflator (national currency) (T+10 convergence value)	2.6
GDP deflator (national currency) (T+30 convergence value)	2.0
Share of primary expenditure in GDP in 2024	55.2
Share of outstanding debt in total debt in 2022	0.8033
Share of rolled-over long-term debt in 2022	0.0349
Share of rolled-over short-term debt in 2022	0.0909
Share of new long-term debt in 2022	0.0640
Share of new short-term debt in 2022	0.0069
Stochastic projections: ranges around adjustment scenario	
T+1	
...	<div> <div>Input data</div> <div>Baseline NFPC</div> <div>Adjustment scenario</div> <div>Adjust. no safeguard</div> <div>Financi</div> </div>

Baseline NFPC

Fiscal assumptions (% of GDP)

Structural primary balance ('+' means 'surplus')	-2.1	0.3	-0.2446	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
One-off and other temporary measures	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock flow adjustments (without exchange rate)	-1.1	4.8	2.3	2.6	1.7	1.7	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.2	1.1

Cost of ageing and selected public revenue (based on the Commission-Council 2024 Ageing Report ("AR 2024"))

Total ageing cost (net of taxes on pensions)	0.0	23.7	23.8	24.0	23.9	23.9	24.0	24.2	24.2	24.2	24.3	24.3	24.3	24.3	24.3
Property income	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2

GDP growth assumptions

Actual GDP (real)

Level	230.6	233.6350	231.2160	231.3	235.1	238.2	241.6	244.1	245.5	246.9	248.4	250.0	251.7	254.0	256.7
Growth rate	2.8	1.3	-1.0	0.0	1.7	1.3	1.4	1.0	0.6	0.6	0.6	0.7	0.7	0.9	1.1

Potential GDP (real)

Level	231.2	234.0	236.531	238.022	239.526	241.166	242.580	244.128	245.547	246.918	248.364	249.999	251.710	253.950	256.732
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Output gap

Output gap	-0.3	-0.1	-2.247	-2.821	-1.830	-1.220	-0.407	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
------------	------	------	--------	--------	--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	-------

Actual GDP (nominal, national currency)

Growth rate	5.3	6.8	3.7	1.8	3.8	3.5	3.7	3.4	2.9	3.0	3.0	3.2	3.3	3.4	3.6
Interest rate - growth diff						-1.5	-1.6	-1.2	-0.7	-0.7	-0.7	-0.7	-0.8	-0.9	-1.0

Interest rate

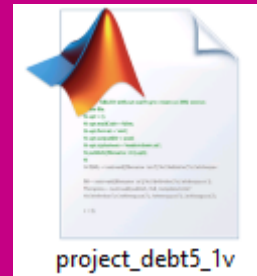
Nominal implicit interest rate on debt	0.7	0.8	1.5804	1.6625	1.8896	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.6
Long-term interest rate			3.0	2.9	3.0	3.0	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.3	3.3
Short-term interest rate			3.4	3.6	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7
Share of long-term debt that matures every year	0.00616	0.04165	0.03943	0.03178	0.03245	0.03313	0.03380	0.03448	0.03515	0.03582	0.03650	0.03717	0.037849	0.03785	0.03785

Inflation and exchange rate

GDP deflator (national currency)	2.4	5.4	4.8	1.8	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5500	2.5	2.5
Exchange rate composite change (weighted by	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

ta	Baseline NFPC	Adjustment scenario	Adjust. no safeguard	Financial stress	Lower SPB	Adverse (r-g)	Stochastic	FASTOP reporting	Data_stochastic	STOCH	+	:			
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Debt Dynamic Equation



Debt Dynamic Equation

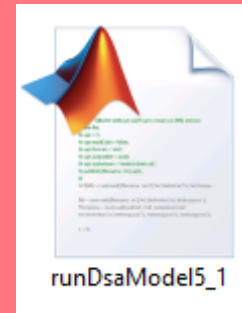
function **project_debt5_1v** produces debt path and other related variables given projection and parameters

```
% Function to project the debt for a given adjustment for runDsaModel5_1.m
function [debt_out,g_out,drgdp_out,iir_out,pb_out,spb_out,ob_out,sb_out,rgdp_out]=project_debt5_1v(...
    scenario, adjustment, iir, potgdp, og, epsilon, m, dcoa, dprop, sfa, inflation, rgdp_initial, debt_initial, ...
    alpha_initial, beta_initial, spb, i_st, i_lt, m_lt, pb, ob, sb, stoch_method, g_shock, pb_shock, iir_shock, adj_periods, theta_lt)
```

[illegible]

```
% FUNCTION OUTPUTS %%%%%%%%%%
% debt: debt-to-gdp projection
% g: nominal growth of gdp
% drgdp: real gdp growth
% iir_out: implicit interest rate output
% pb_out: primary balance output
% spb_out: structural primary balance output
% ob_out: overall balance output
% sb_out: structural balance output
% rgdp_out: real gdp level
%%%%%%%%%%%%%%%%%%%%%%%%%
```

DSA model



DSA model

the main model function **runDsaModel5_1** produces final adjustment and net expenditure paths given parameters

```
%% COM DSA MODEL version 5.1 %%  
function [final adjustment path, nomNetPrimaryExpenditure,params,BindingCriteria] = runDsaModel5_1(params)
```

lines 116 - 300

1. Get input data from Excel
2. Define variables and parameters

lines 301 - 383

3. Deterministic scenarios
4. Check DSA criteria

lines 384 - 671

5. Stochastic scenario
6. Plausibility of debt paths

lines 672 - 836

7. Check safeguards etc.

lines 837 - 856

8. Calculate net expenditure path

Example output 1 vs EC excel

```
*****
**** DSA-BASED CRITERIA (deterministic) ****
*****
```

Scenario is: 4, $a^*=0.24$, $SPB^*=1.15$, 7 year plan.
 Scenario is: 3, $a^*=0.29$, $SPB^*=1.50$, 7 year plan.
 Scenario is: 2, $a^*=0.26$, $SPB^*=1.29$, 7 year plan.
 Scenario is: 1, $a^*=0.22$, $SPB^*=1.01$, 7 year plan (with 3% deficit rule).
 Number of replaced outlier values: 8

```
*****
****  DSA-BASED CRITERIA (stochastic)  ****
*****
```

Shock generation method is: 1, $a^*=0.3$, 7 year plan.

 ***** DEBT SUSTAINABILITY SAFEGUARD *****

```
Scenario is: 1, a* = 0.76, 7 year plan.
*****
**** DEFICIT BENCHMARK ****
*****
```

No need to check deficit benchmark.

 ***** DEFICIT RESILIENCE SAFEGUARD *****

No need to check deficit resilience safeguard.

```
*****
**** Final Adjustment Path, pp. (in SPB terms) ****
*****
```

2025	0.76
2026	0.76
2027	0.76
2028	0.76
2029	0.76
2030	0.76
2031	0.76

```
*****
**** Reference Trajectory Path, growth rate, % ****
*****
```

2025	1.38
2026	1.49
2027	1.44
2028	1.54
2029	1.54
2030	1.57
2031	1.65

Table 6 - Reference trajectory						
2025	2026	2027	2028	2029	2030	2031
1.38	1.49	1.44	1.54	1.54	1.57	1.65
0.76	0.76	0.76	0.76	0.76	0.76	0.76

EC DSA with MoF assumptions: pot gdp

```
*****
**** DSA-BASED CRITERIA (deterministic) ****
*****

Scenario is: 4, a*=0.21, SPB*=0.94, 7 year plan.
Scenario is: 3, a*=0.26, SPB*=1.29, 7 year plan.
Scenario is: 2, a*=0.23, SPB*=1.08, 7 year plan.
Scenario is: 1, a*=0.18, SPB*=0.73, 7 year plan (with 3% deficit rule).
Number of replaced outlier values: 8

*****
**** DSA-BASED CRITERIA (stochastic) ****
*****

Shock generation method is: 1, a*=0.28, 7 year plan.

*****
**** DEBT SUSTAINABILITY SAFEGUARD ****
*****

Scenario is: 1, a* = 0.70, 7 year plan.
*****
**** DEFICIT BENCHMARK ****
*****

No need to check deficit benchmark.

*****
**** DEFICIT RESILIENCE SAFEGUARD ****
*****

No need to check deficit resilience safeguard.

*****
**** Final Adjustment Path, pp. (in SPB terms) ****
*****

2025      0.7
2026      0.7
2027      0.7
2028      0.7
2029      0.7
2030      0.7
2031      0.7

851 disp('*****');
*****
**** Reference Trajectory Path, growth rate, % ****
*****

2025      1.79
2026      1.84
2027      1.9
2028      1.95
2029      2
2030      2.06
2031      2.11
```

pot gdp + sfa

```
*****
**** DSA-BASED CRITERIA (deterministic) ****
*****

Scenario is: 4, a*=0.21, SPB*=0.94, 7 year plan.
Scenario is: 3, a*=0.26, SPB*=1.29, 7 year plan.
Scenario is: 2, a*=0.23, SPB*=1.08, 7 year plan.
Scenario is: 1, a*=0.19, SPB*=0.80, 7 year plan (with 3% deficit rule).
Number of replaced outlier values: 8

*****
**** DSA-BASED CRITERIA (stochastic) ****
*****

Shock generation method is: 1, a*=0.28, 7 year plan.

*****
**** DEBT SUSTAINABILITY SAFEGUARD ****
*****

Scenario is: 1, a* = 0.61, 7 year plan.
*****
**** DEFICIT BENCHMARK ****
*****

No need to check deficit benchmark.

*****
**** DEFICIT RESILIENCE SAFEGUARD ****
*****

No need to check deficit resilience safeguard.

*****
**** Final Adjustment Path, pp. (in SPB terms) ****
*****

2025      0.61
2026      0.61
2027      0.61
2028      0.61
2029      0.61
2030      0.61
2031      0.61

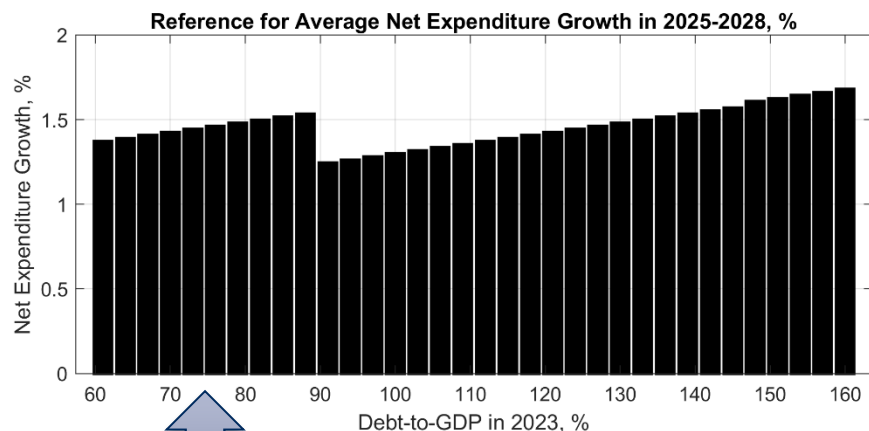
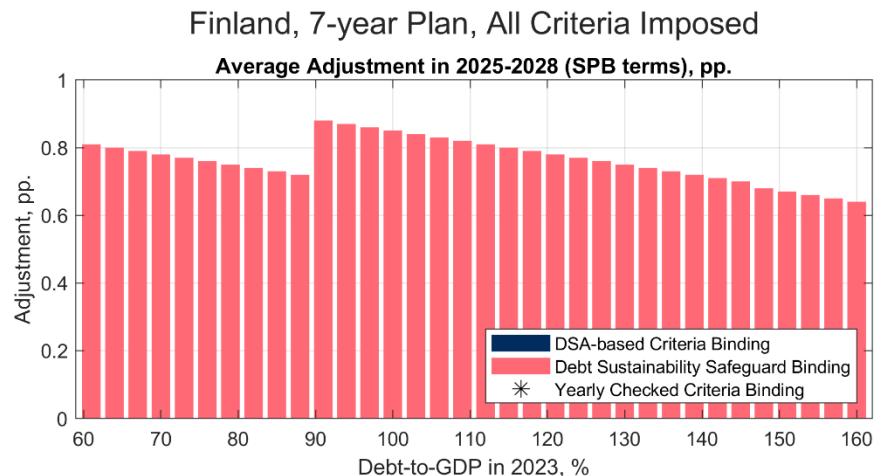
*****
**** Reference Trajectory Path, growth rate, % ****
*****

2025      1.95
2026      2.01
2027      2.06
2028      2.11
2029      2.17
2030      2.22
2031      2.27
```


Extensions

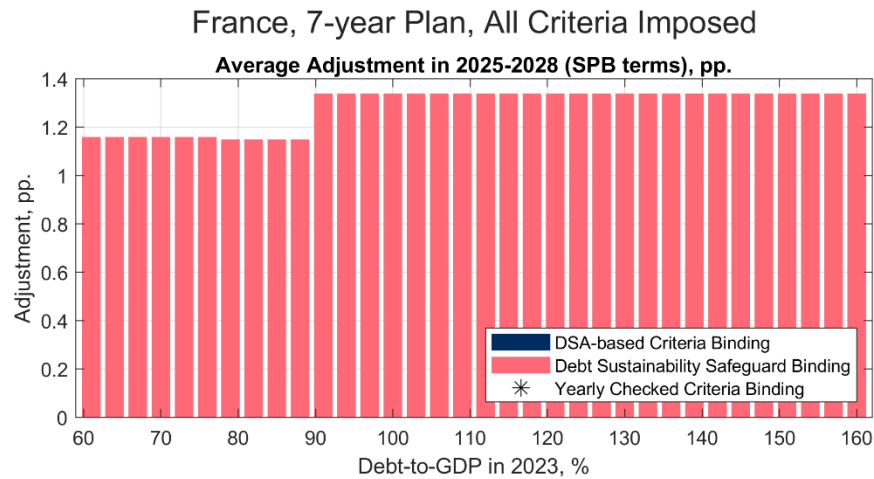
Extensions

Extensions: different initial debt level (1)

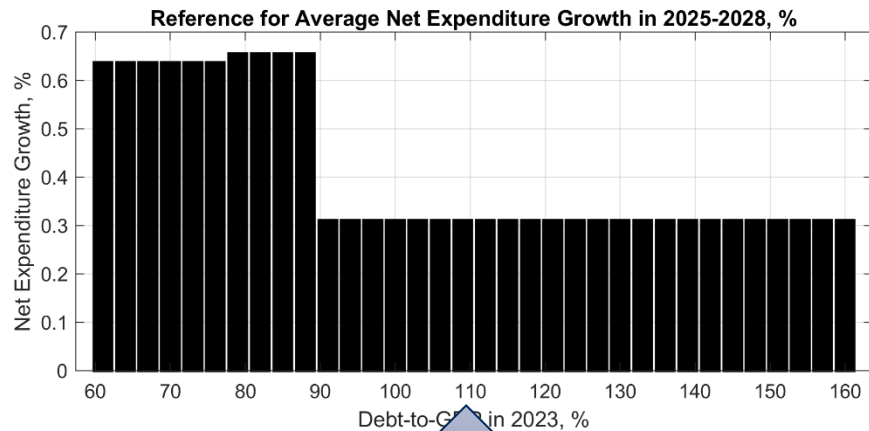


- Extensions allow many types of analyses
- Here we have varied **the initial debt level** of Finland (year 2023).
- Actual debt level is 75,8% (2023)
- Everything else fixed
 - too simplistic if far away from actual level
 - much higher debt levels affect other variables!

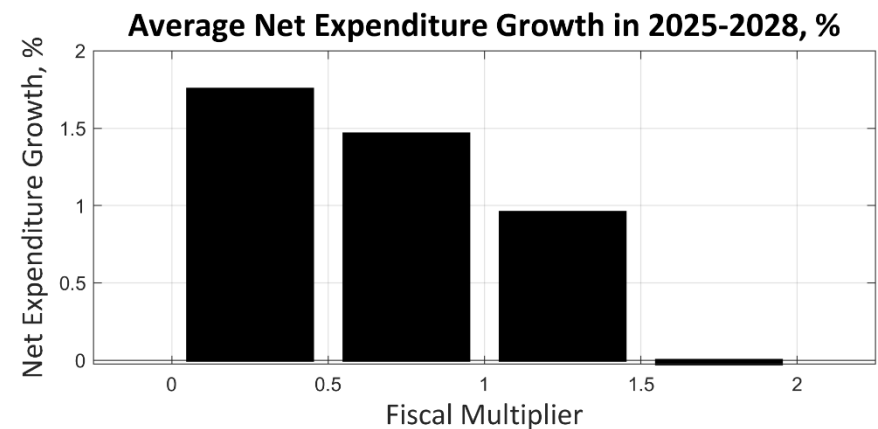
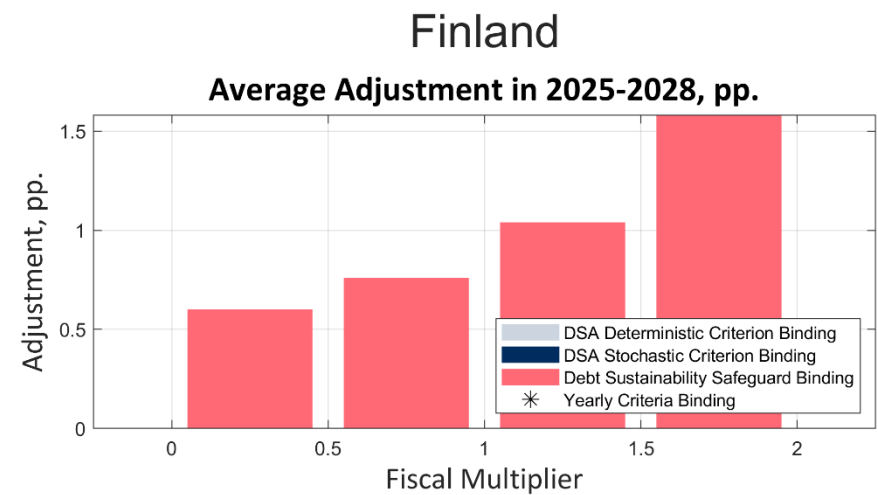
Extensions: different initial debt level (2)



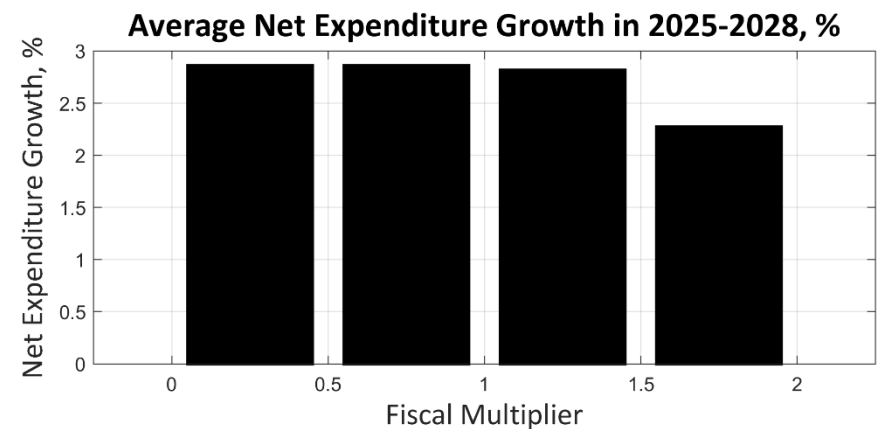
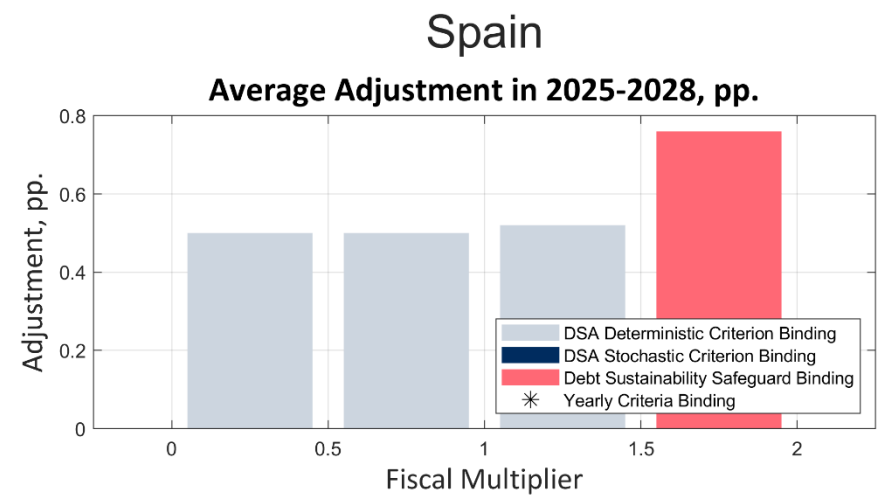
- Same for France without EDP.
- debt level 2023: 110,6%



Extensions: different fiscal multipliers



Note: Results based on 7-year plan.



Note: Results based on 7-year plan.

Thank



You!