Risk Management Optimization for Sovereign Debt Financing with Debt Sustainability Constraints

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European Stability Mechanism

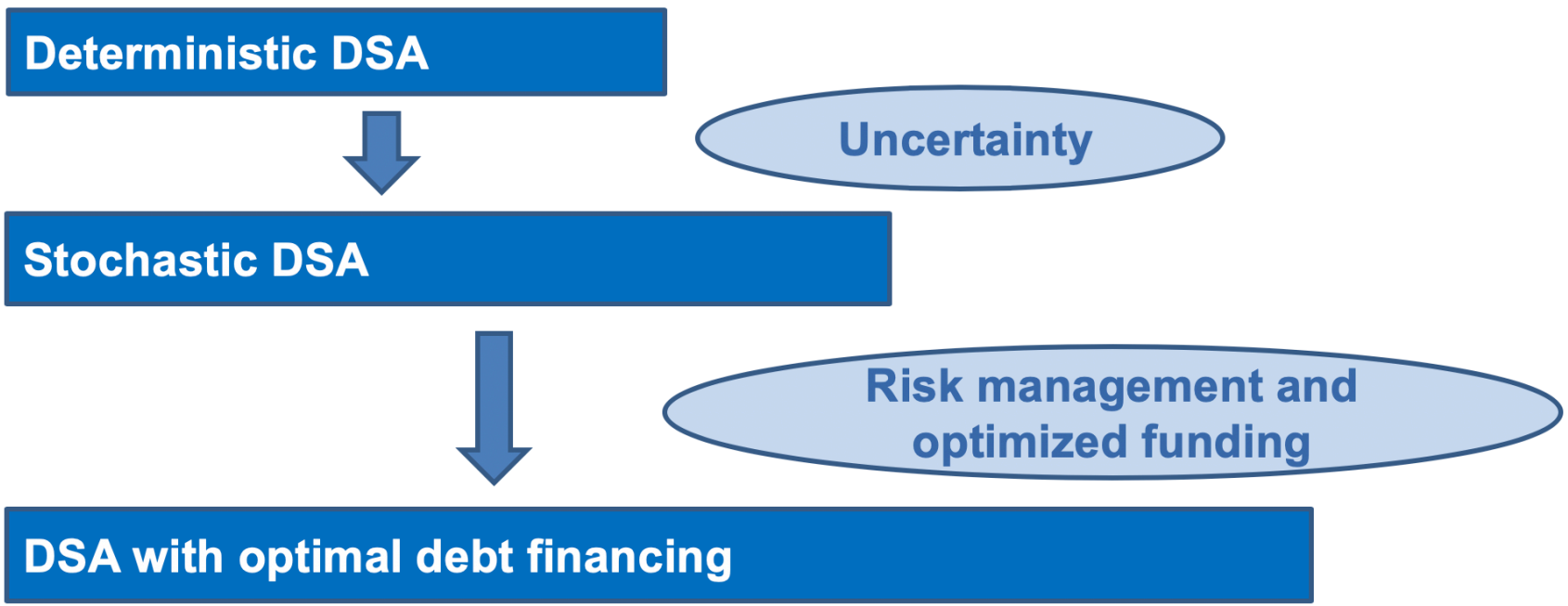
Quantitative Finance @ WORK, Rome, 2019.

Some history

- Consiglio and Staino (2012), FIRB project *Managing Public Debt*, A stochastic programming model for the optimal issuance of government bonds.
- Consiglio and Zenios (January 2015) The devil is in the tails, `//Voxeu.org`.

- Consiglio and Zenios (2016), Risk management optimization for sovereign debt restructuring, *J. of Globalization & Development*, 6:181–213, J. Stiglitz (ed)

Research issues



Contributions

Q1 Optimize debt financing

Q2 Sustainability controls

Q3 Bound risks with high probability

Q4 Go beyond simple rules

Q4 Additional fiscal effort

The economic problem

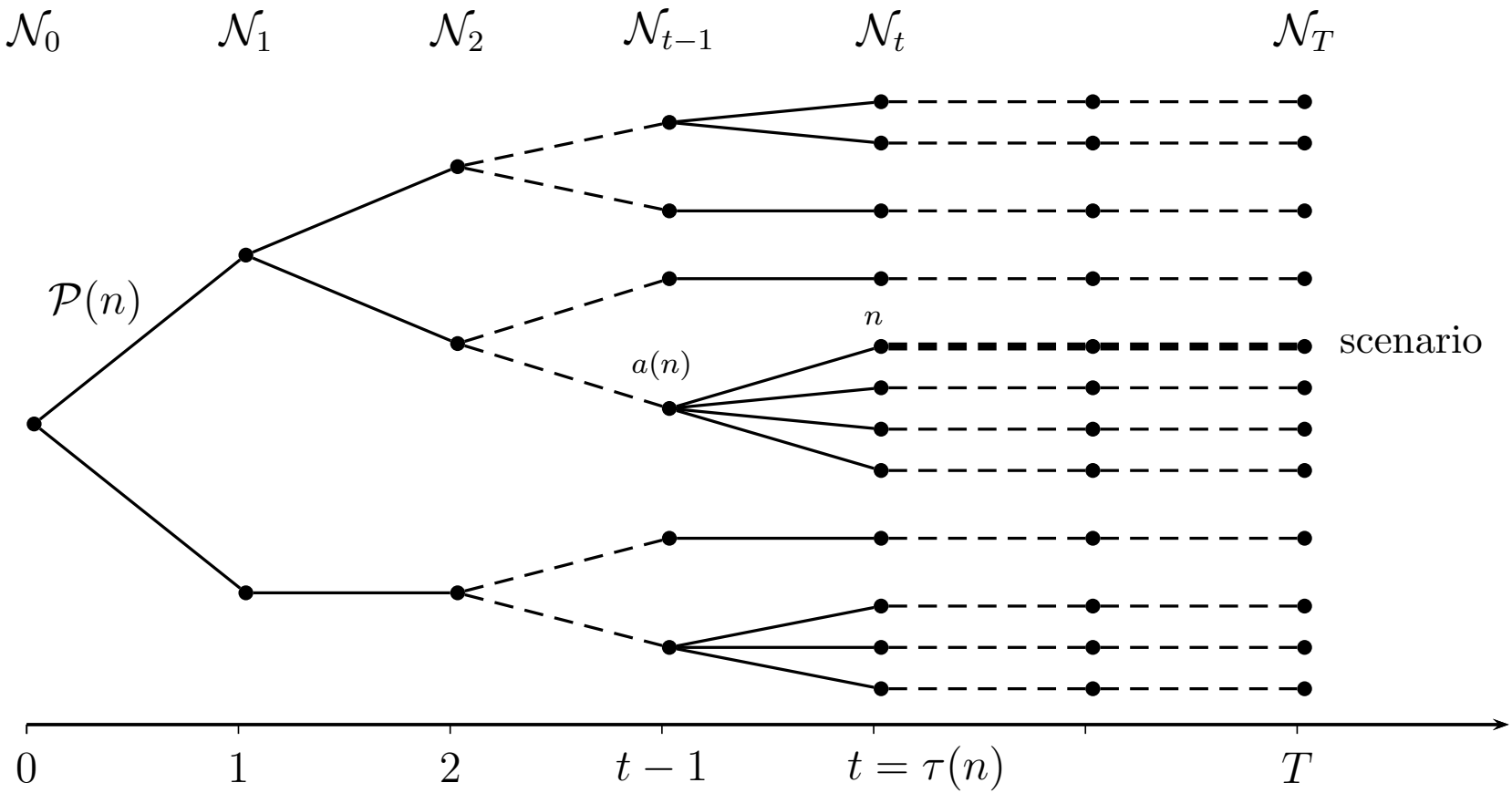
- Sovereign issues debt X to finance its debt
- Uncertain correlated financial, economic, fiscal variables
- Debt sustainability controls
- Feedback loop

$$X \to D \to r \to X$$

Q3. (Modeling uncertainty)

- **First innovation: Scenario tree**

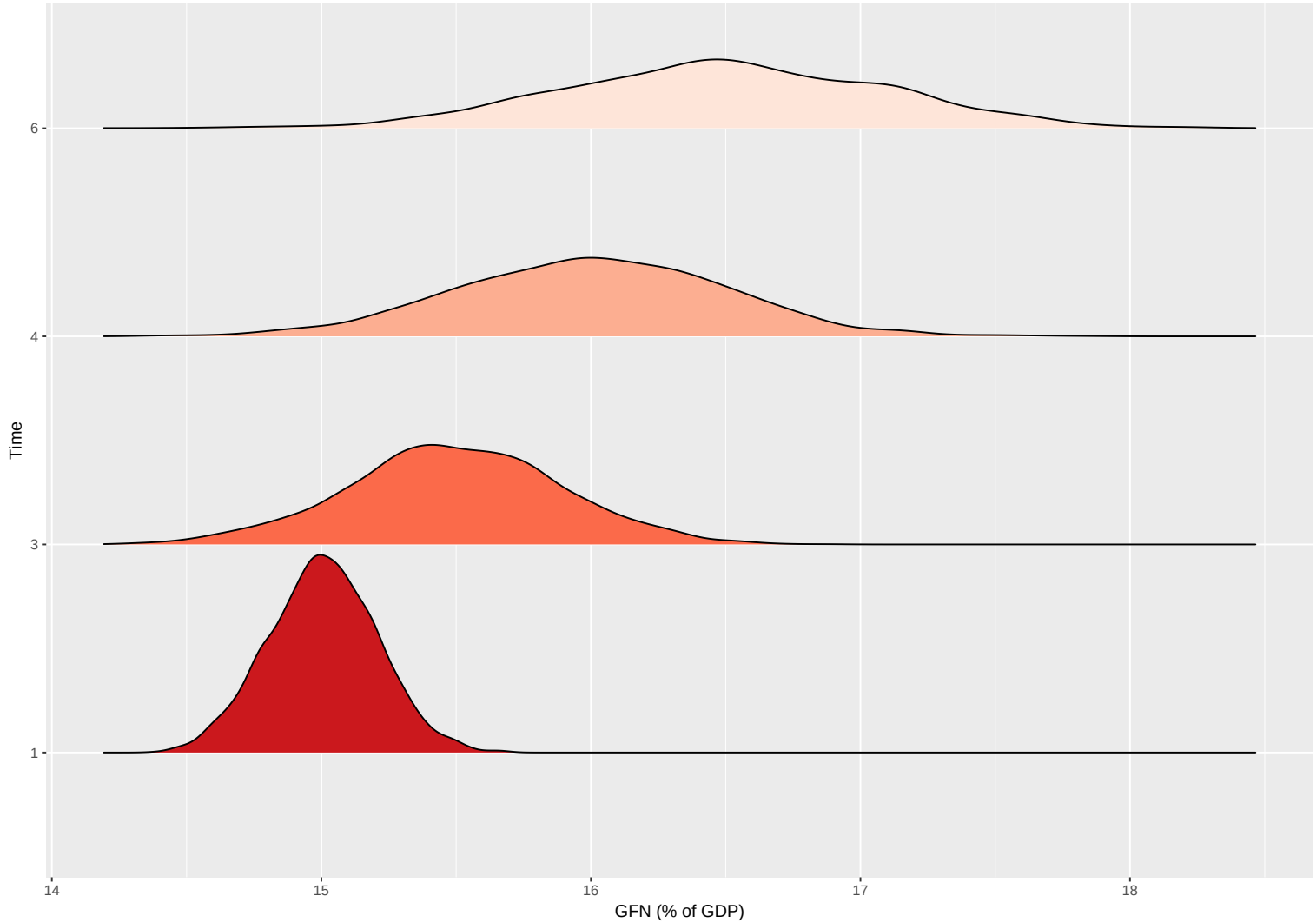
Q3. (Modeling uncertainty)



(Consiglio, Carollo, Zenios, *Quantitative Finance*, 16:201-212, 2016.)

Q3. (Risk measure)

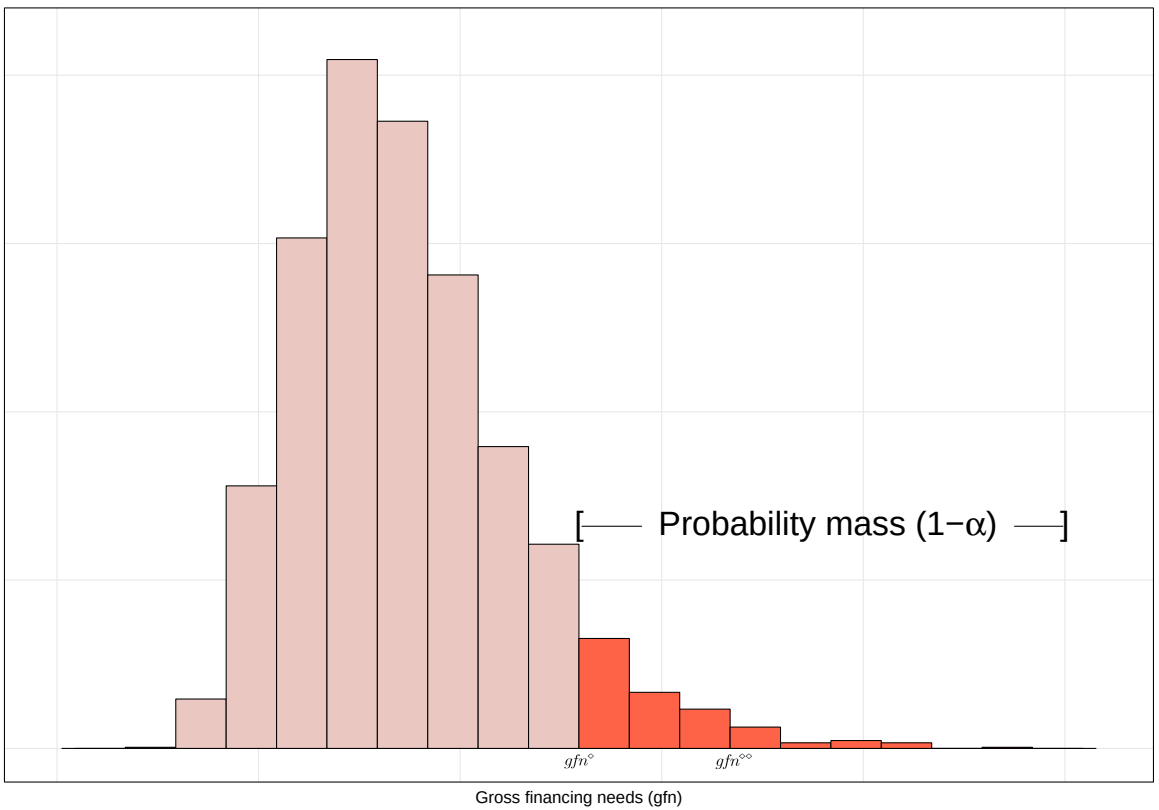
- Scenario dynamics of debt



Q3. (Risk measure)

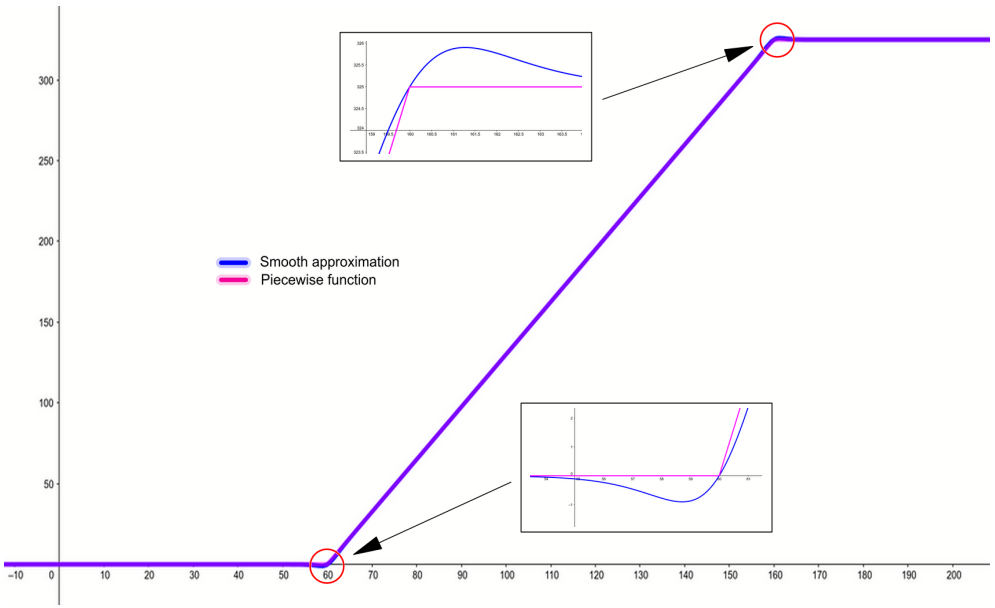
Second innovation: Conditional Flow at Risk (CFaR)

$$\Psi(gfn) \doteq \mathbb{E}\left(gfn \mid gfn \geq gfn^{\diamond}\right)$$



Q3. (Endogenous interest rates)

Third innovation: Endogeneity of interest rates



Q1+Q2. Risk optimization of debt financing with sustainability controls

$$\begin{aligned} \text{Minimize}_x \quad & \sum_{n \in \mathcal{N}} p^n NIP_t^n \\ \text{s.t.} \quad & \\ \Psi(gfn) \quad & \leq \quad \omega \\ \frac{\partial d^n}{\partial t} \quad & \leq \quad \delta \end{aligned}$$

Q1+Q2. Risk optimization of debt financing with sustainability controls

Sovereign issues debt $X^n(j)$ to finance its debt

Fixed-mix (rules)

Adaptive fixed-mix

Dynamic

Debt Model @ WORK

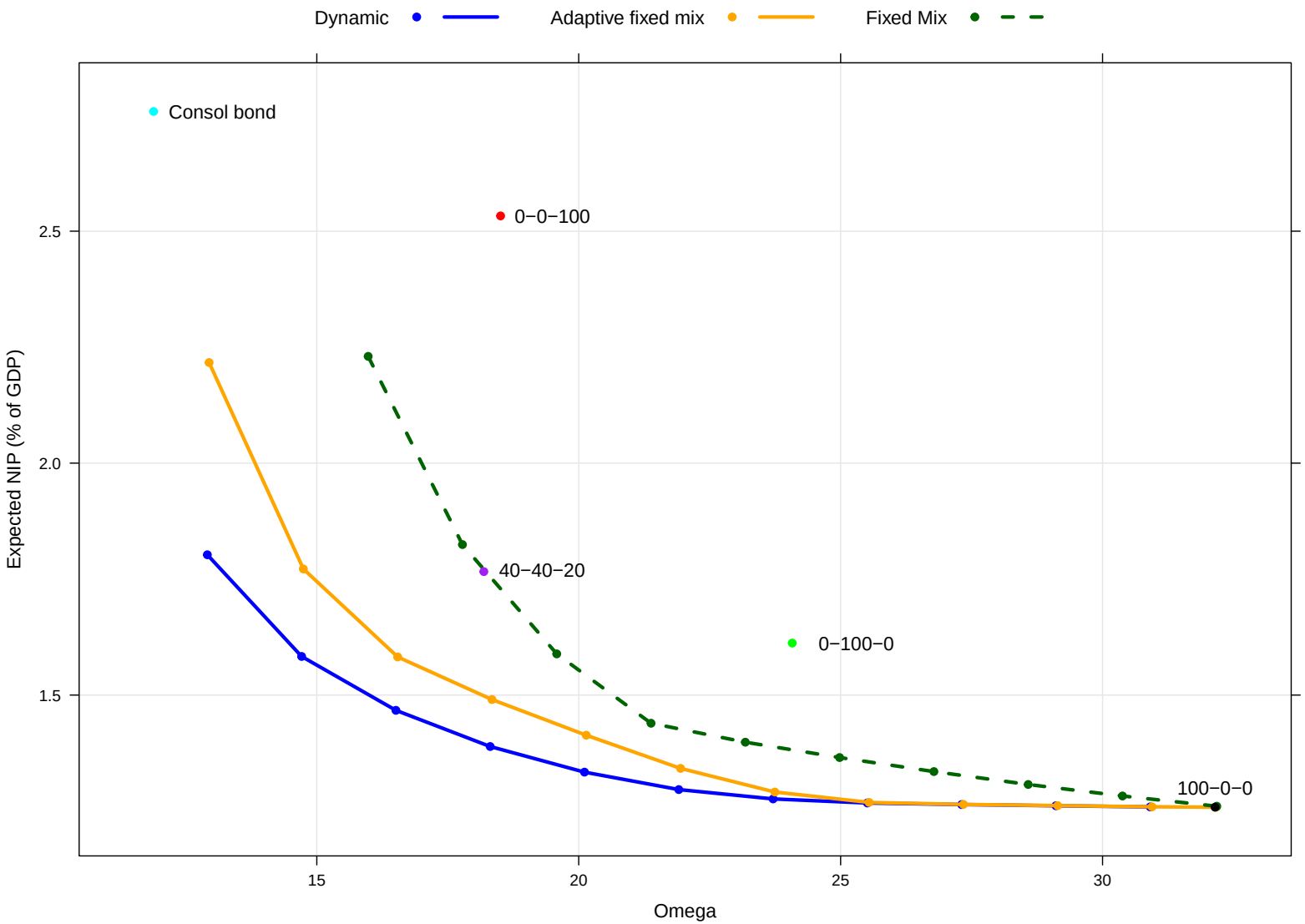
Typical eurozone crisis country

Netherlands

Italy

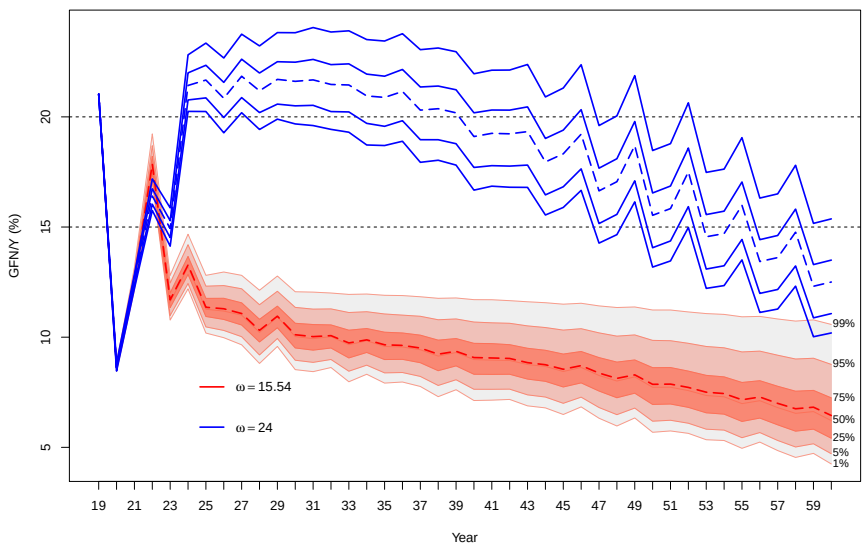
Q4. Beyond simple rules, with high probability

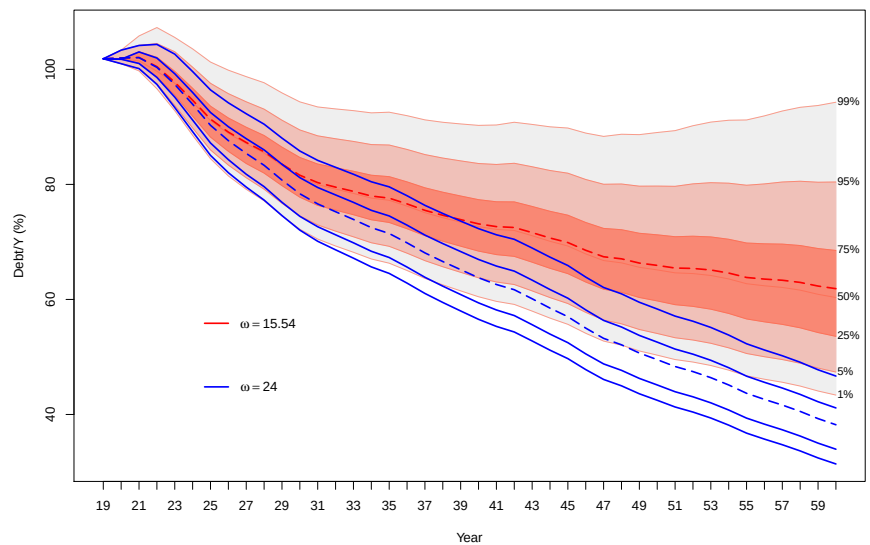
The relevance of optimizing



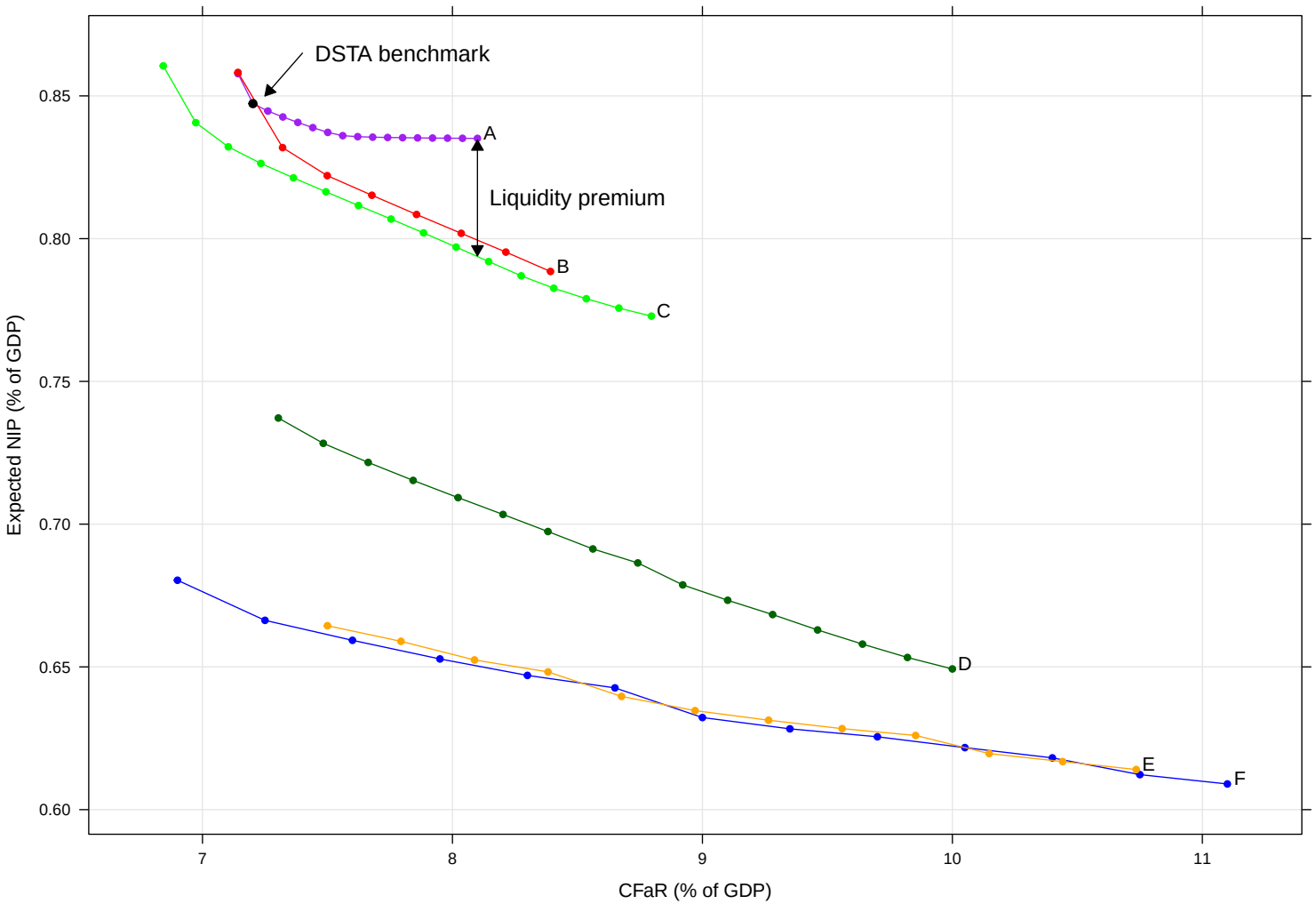
Q4. Beyond simple rules, with high probability

Tradeoff debt stock and flow

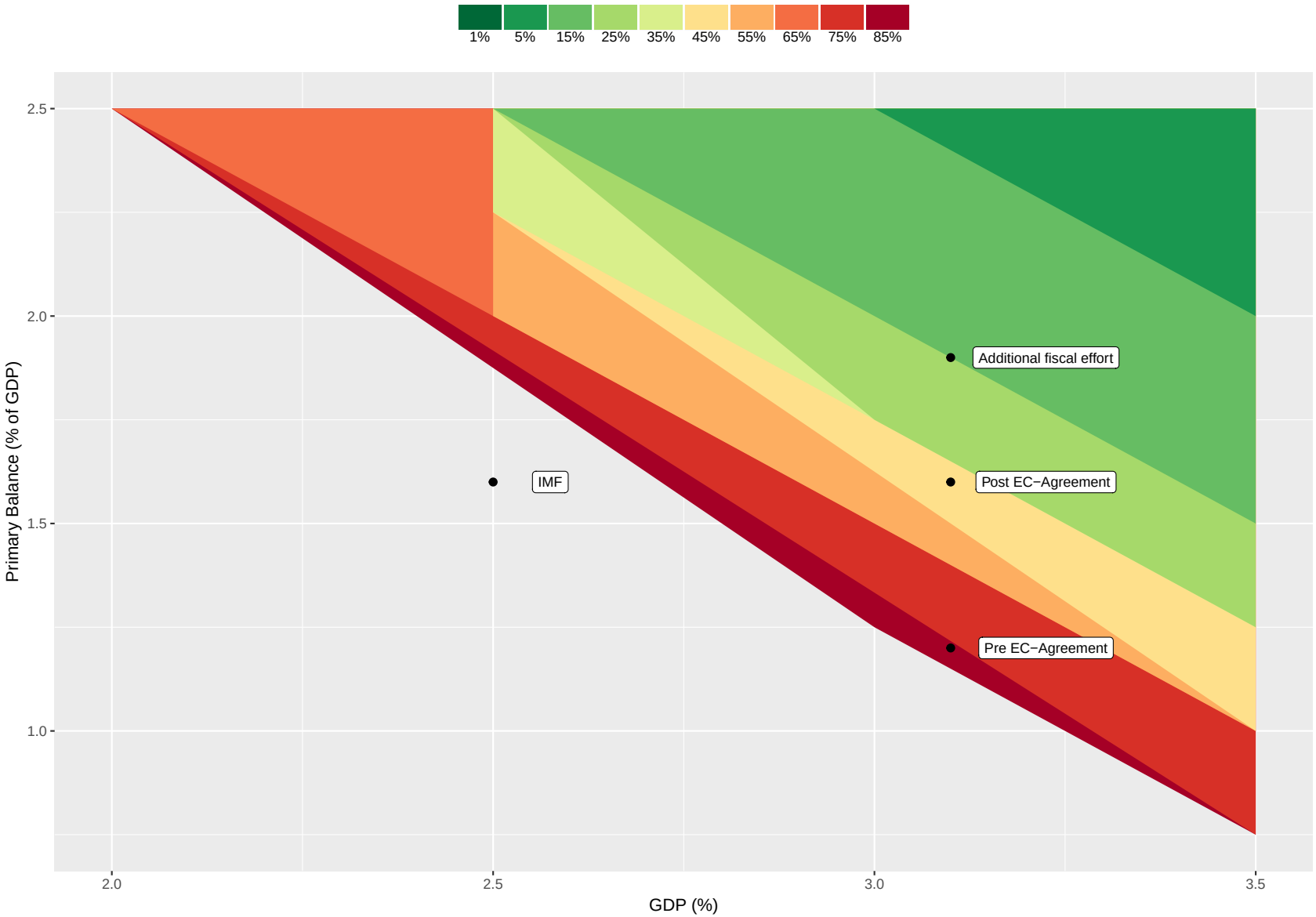




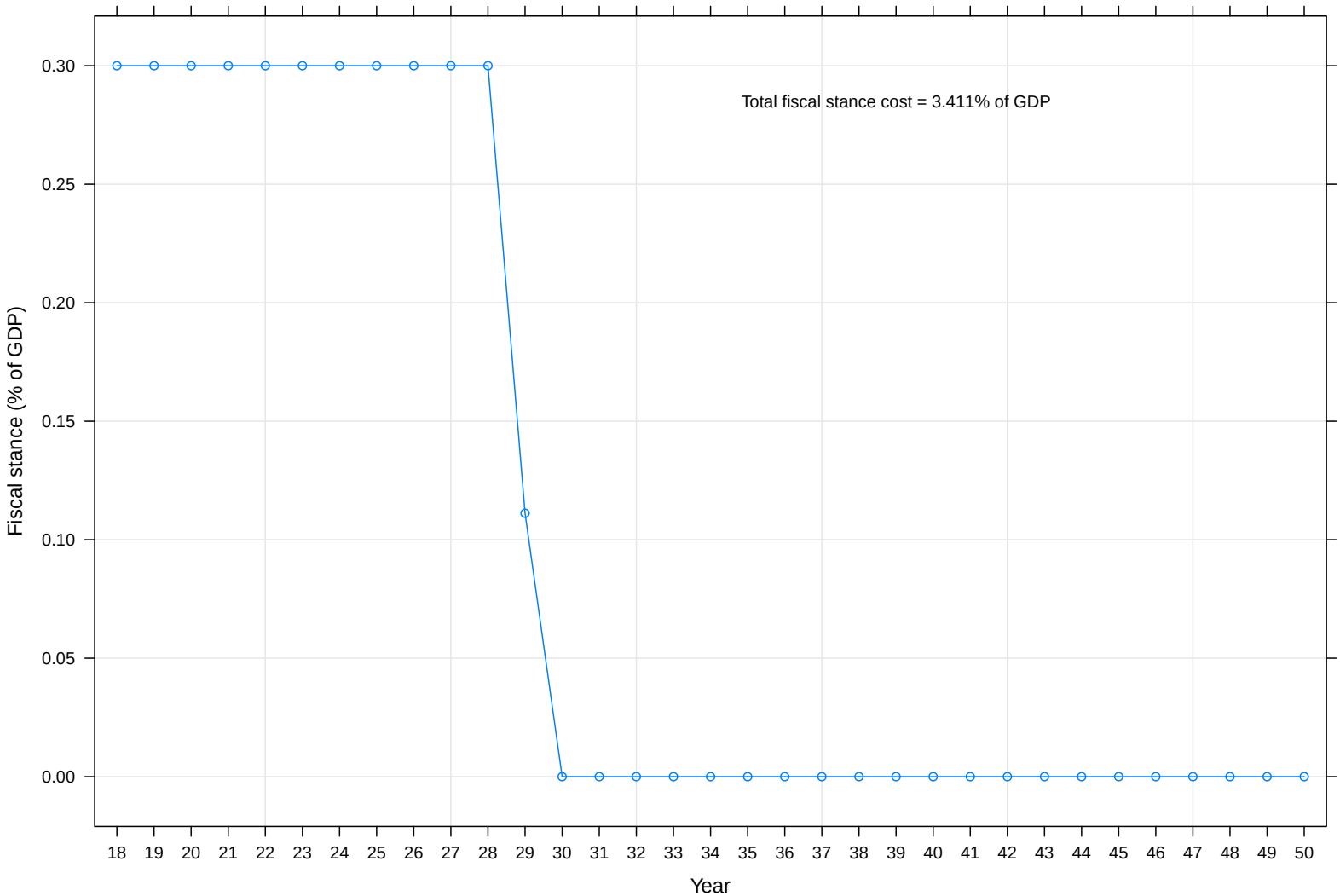
Q4. Netherlands: forward guidance



Q4. Italy: this is fun (-:



Q4. Italy: Additional fiscal effort: this is not fun)-:



Conclusions

Risk management is a rich framework for debt sustainability

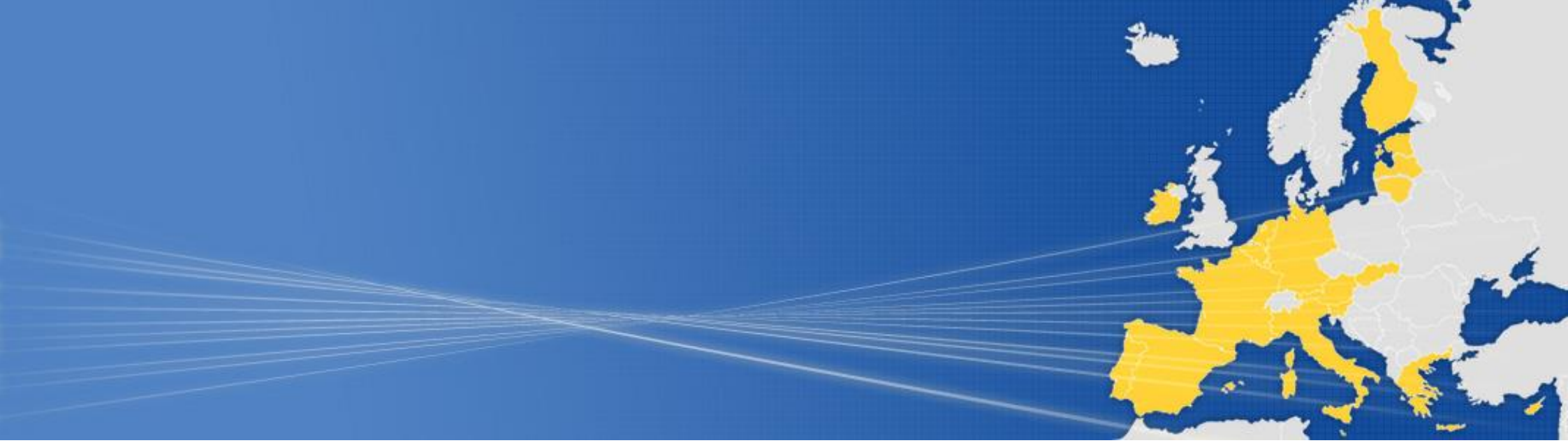
- Debt financing with sustainability controls
- Stochastic financial, economic, and fiscal variables
- Coherent risk measure
- Endogenous interest rates
- .... and more

Publications

Athanasopoulou et al., *Risk management for sovereign financing within a debt sustainability framework*, European Stability Mechanism, Working Paper Series 31, Luxembourg, July 2018.

DISCLAIMER

The views and opinions expressed in this presentation are those of the authors and do not necessarily reflect the official policy or position of the European Stability Mechanism.



ESM Risk Management (RiMa) DSA framework

Marialena Athanasopoulou

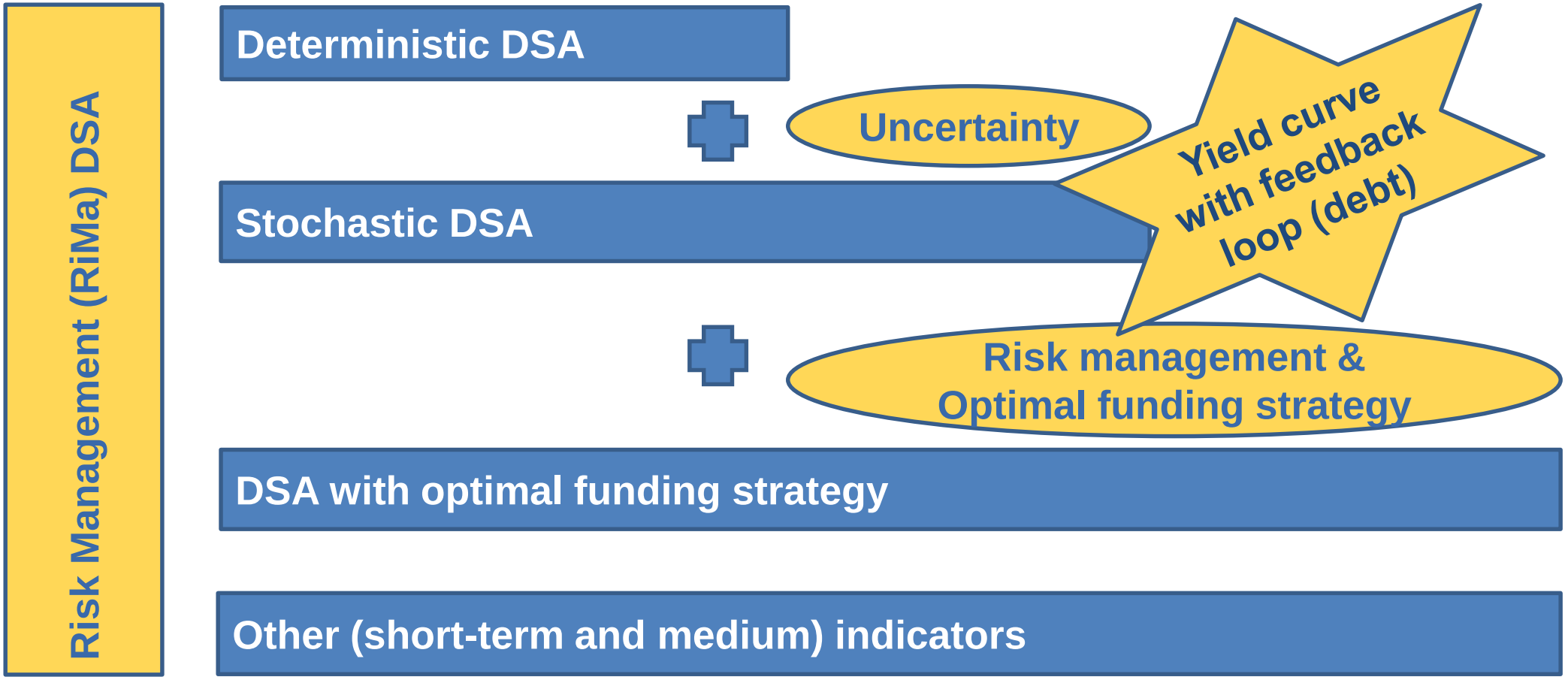
Rome, May 2019

European Stability Mechanism

Overview of the presentation

- Overview of the ESM DSA framework
- Funding assumptions: How important are for assessing debt sustainability?
- Risk management in the DSA
- Conclusions

ESM RiMa DSA building blocks



DSA with optimal funding strategy – Motivation

Liquidity crisis can translate into solvency issues as …

…countries with larger refinancing needs face higher risks of losing market access.

Assessing debt sustainability has moved from **stocks**… to **flows**. *

Flow metric in DSA: Gross financing needs (GFN)

*/ C. Gabriele et al (2017), Debt stocks meets gross financing needs: A flow perspective into sustainability. Working Paper Series No. 24, European Stability Mechanism, Luxembourg, 2017.

** / Corsetti, G., Erce, A., and T. Uy (2017), Debt Sustainability and the Terms of Official Support. Mimeo Working Paper.

*** / Corsetti (2018), Debt Sustainability Assessments: The state of the art, European Parliament (study).

How important are funding assumptions for assessing debt sustainability?

Indicative example: Identical macro and fiscal assumptions, fixed interest rates, flat yield curve.

Funding strategy: Only 5Y bonds

	Short term	Med. term	Long term
	2019	2020-23	2024-30
Debt % GDP	100.3	94.9	87.8
GFN % GDP	14.3	13.6	24.6

Funding strategy: Only 5Y WAM

	Short term	Med. term	Long term
	2019	2020-23	2024-30
Debt % GDP	100.3	94.9	87.8
GFN % GDP	14.3	18.3	21.7

GFN graph

Example with debt at 120%

Note: Values in the heat map refer to end-period for debt and period maximum for GFN. Colours refer to period maxima: Green for Debt (GFN) below 70% of GDP (15%), Yellow for Debt (GFN) above 70% of GDP (15%), but below 100% (20%), and Red for Debt (GFN) above 100% of GDP (20%). These thresholds are broadly in line with IMF empirical findings for advanced economies (Baldacci et al., 2011).

DSA with optimal funding strategy– Implementation

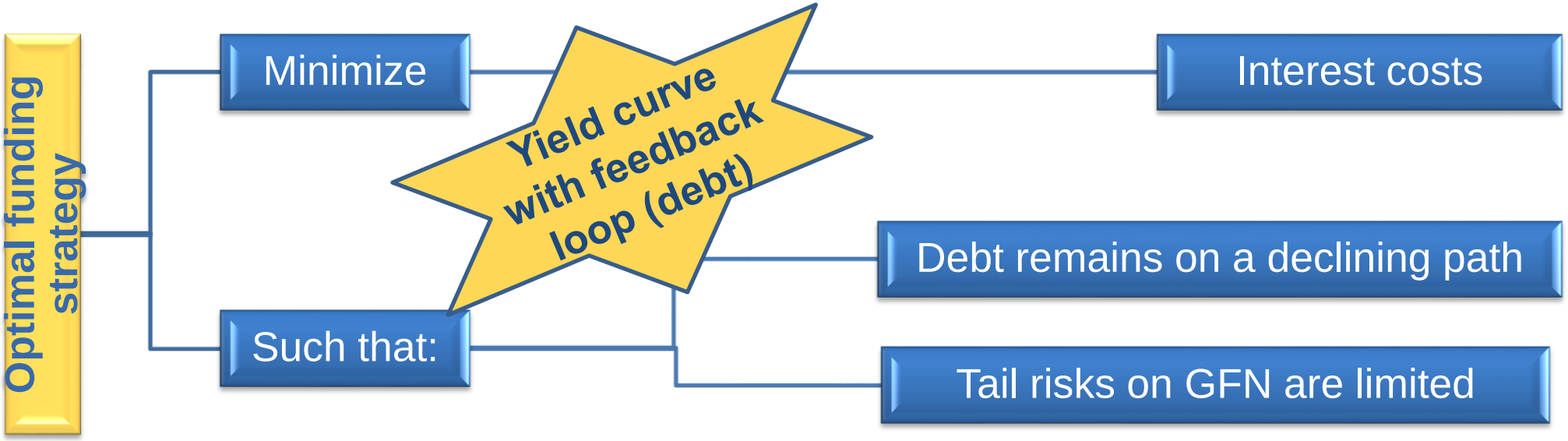
Key element of the evolution of debt dynamics is the **financing decisions**

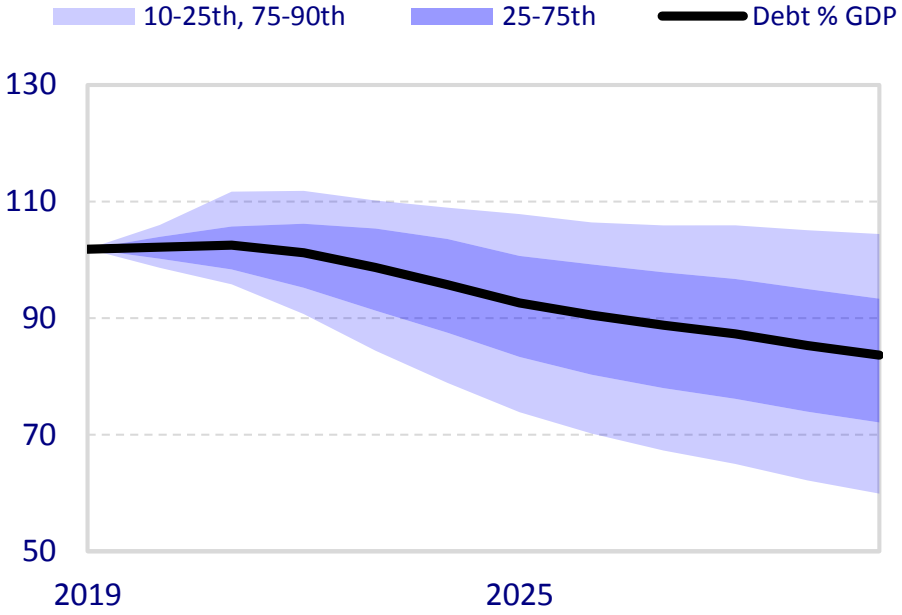
- Neglecting this aspect undermines the importance on debt flows

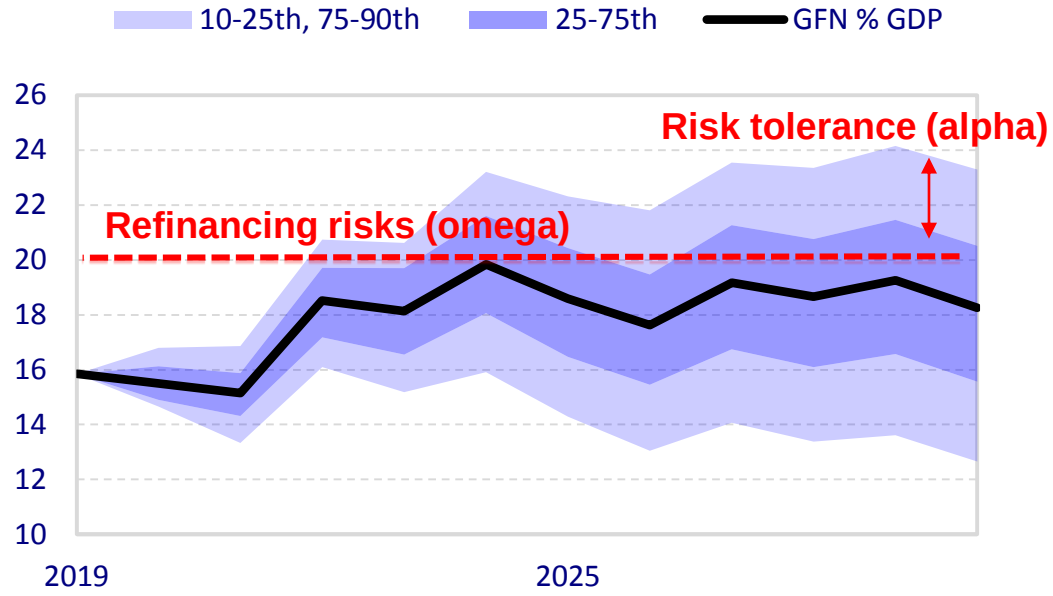
We extend standard DSA models to incorporate **optimal debt-financing decisions** for an economy facing uncertainty

We optimize the **maturity of debt instruments** to **trade off borrowing costs with refinancing risks**

Optimal funding strategy







Optimizing DSA – New elements in assessing debt sustainability

The RiMa DSA ***complements*** the standard DSA by reflecting refinancing risks and costs of trade-offs

Cost and benefits of reducing refinancing risks.

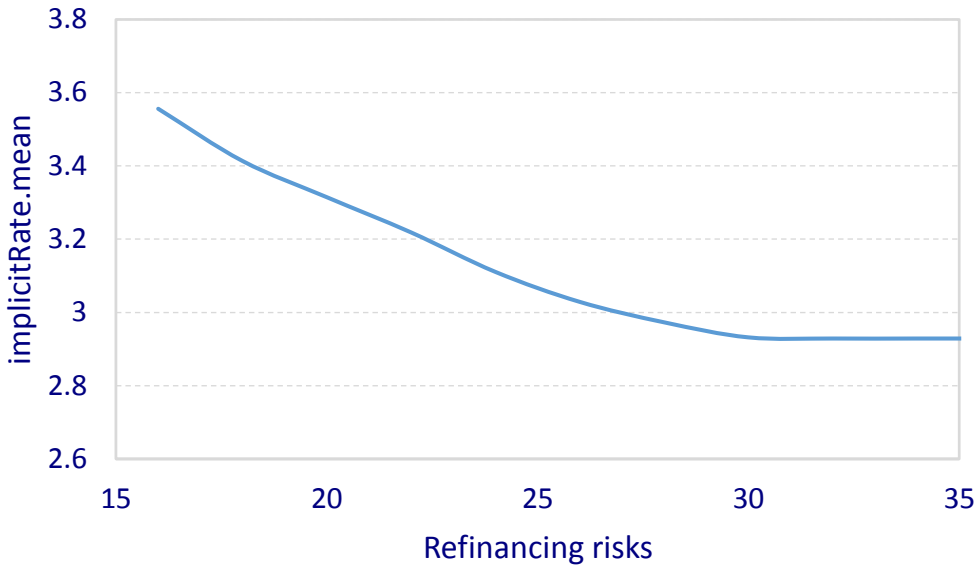
Debt dynamics under an *optimal* funding strategy.

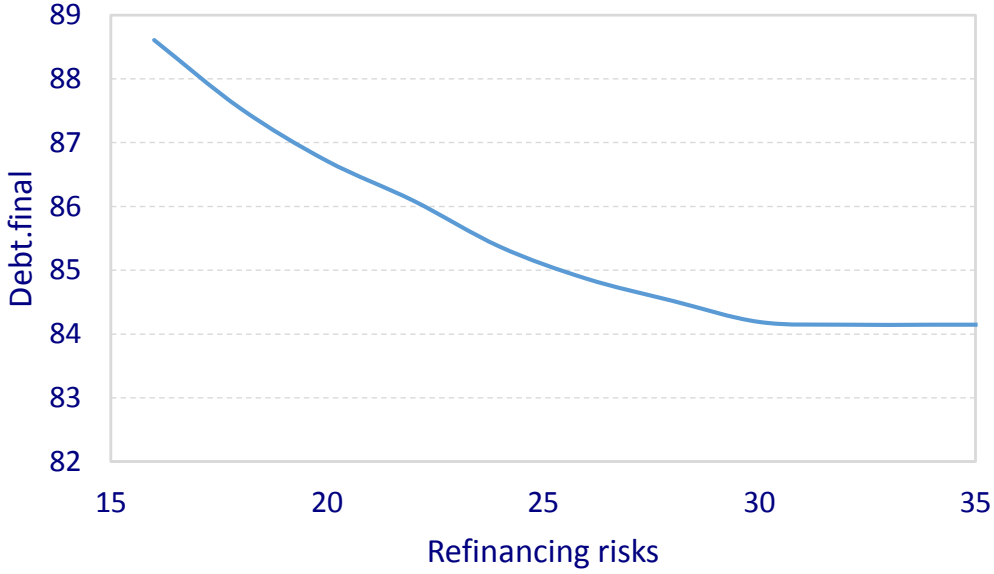
Size and timing for addressing potential hot spots

Quantifying the trade-off: Costs and benefits from reducing refinancing risks

Reducing refinancing risks, increases interest costs (unless the yield curve is inverted) and weighs on debt.

Refinancing risks and implicit interest rate (in %, lhs) and debt (in % of GDP, rhs)

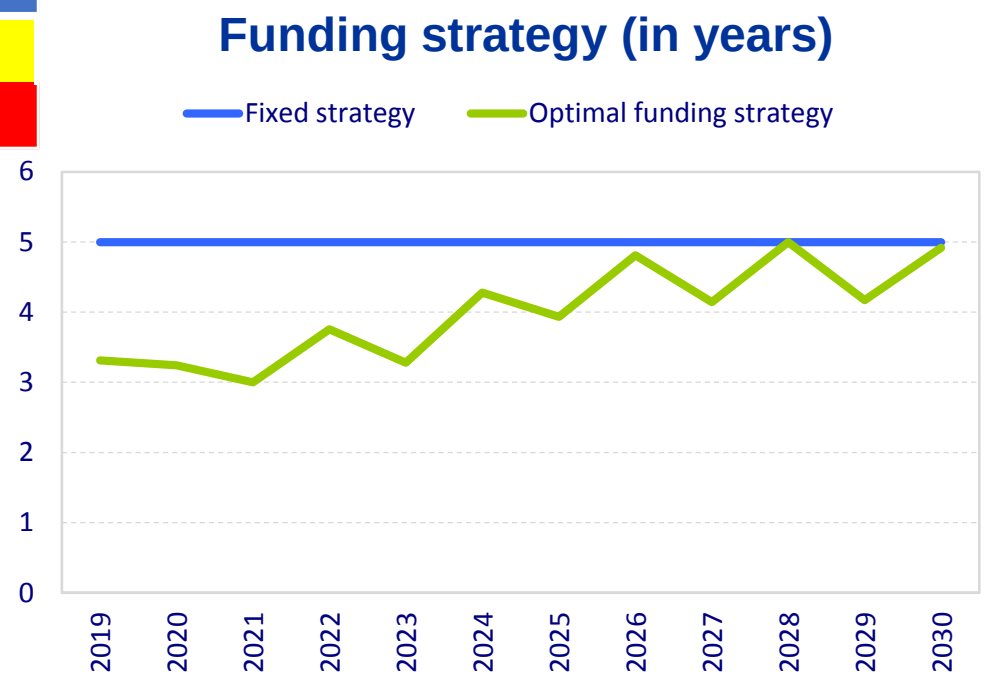




Indicative example: Debt dynamics under the optimal funding strategy.

Fixed strategy: 5y WAM, interest rates with feedback loop

	Short term 2019	Med. term 2020-23	Long term 2024-30
Debt % GDP	100.3	93.8	84.6
GFN % GDP	14.3	17.9	21.1



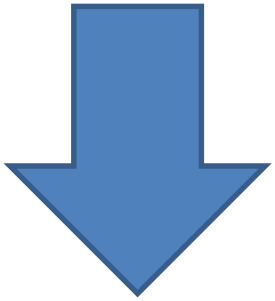
With optimal funding strategy

	Short term 2019	Med. term 2020-23	Long term 2024-30
Debt % GDP	100.3	93.3	82.7
GFN % GDP	14.3	22.3	24.8

Explaining the results

What if there is no solution to our optimization problem?

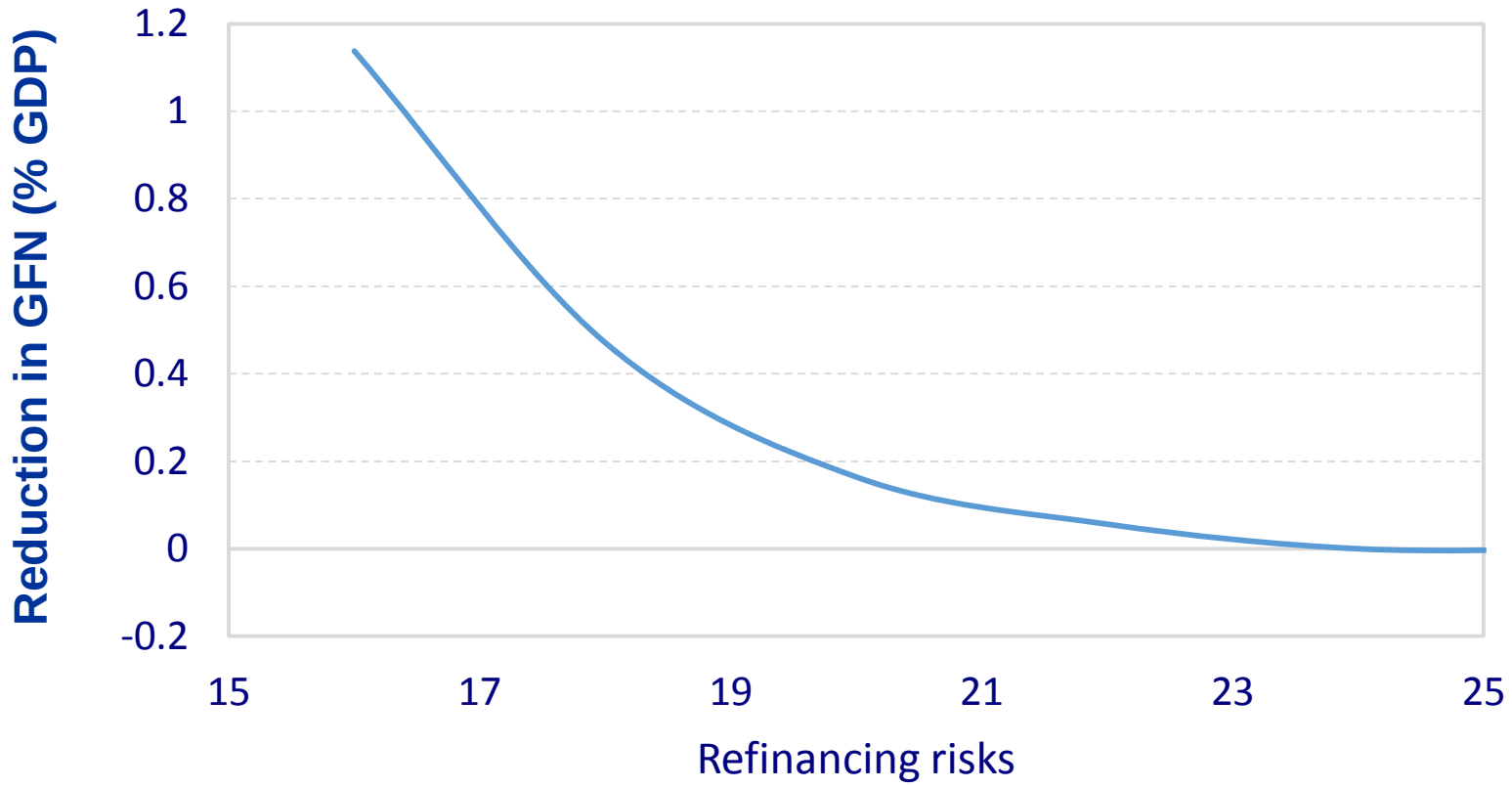
The model, gives us when and by how much GFN need to be reduced in order to obtain an optimal solution given the constraints.



Hot spots

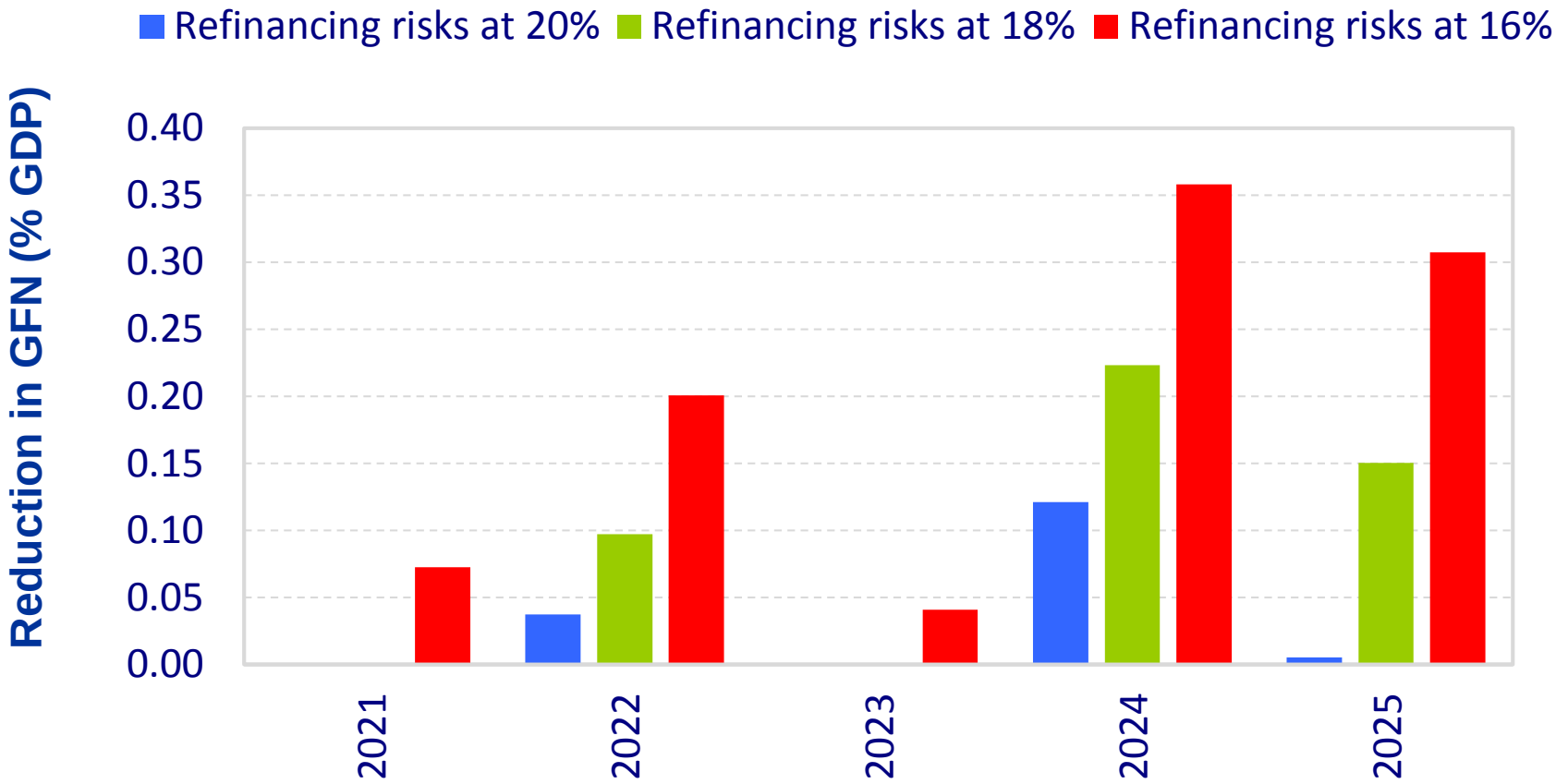
Hot spots are a powerful tool for…

…identifying the **size** of the necessary reduction on GFN under the constraints.



Hot spots are a powerful tool for…

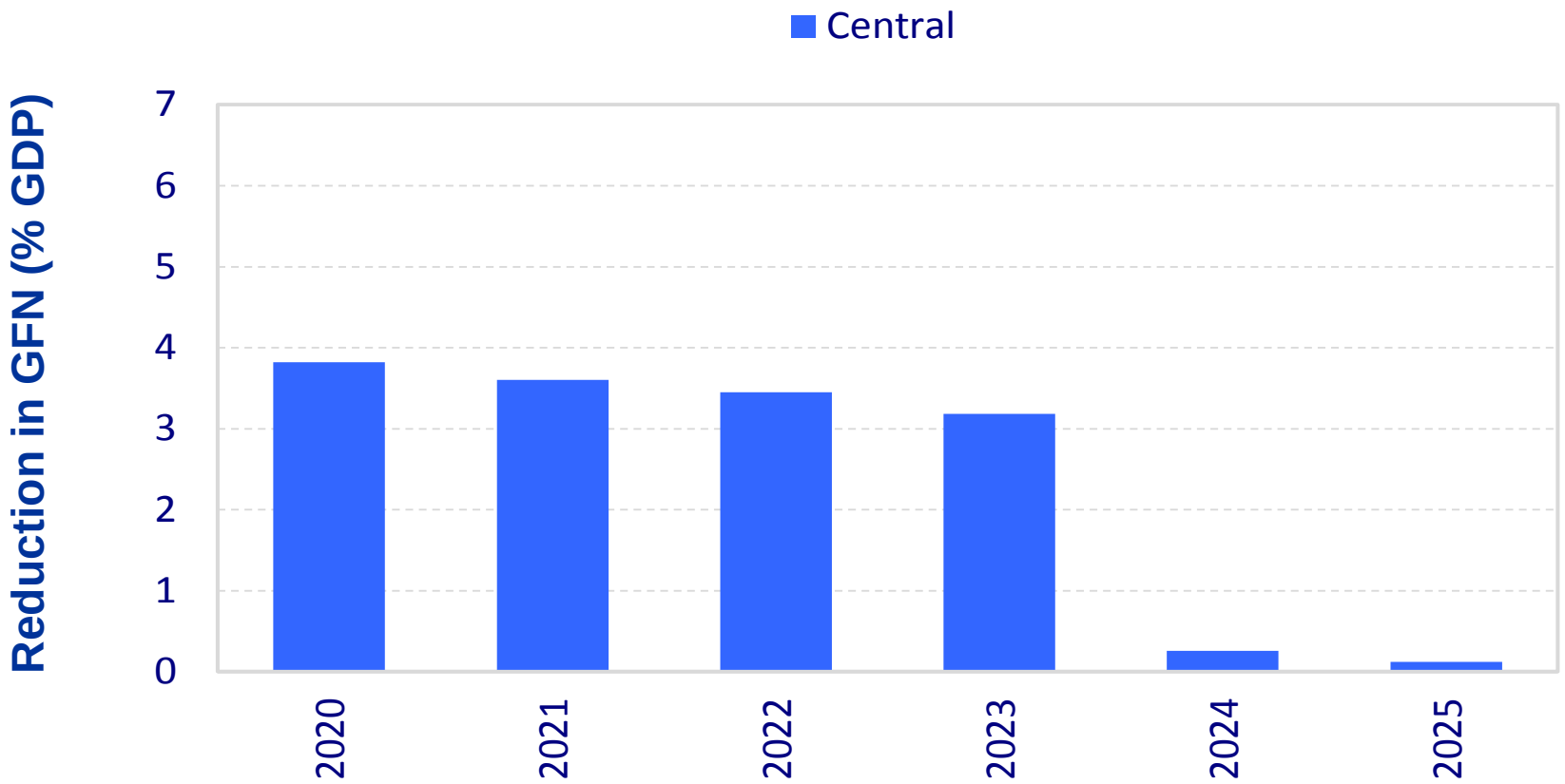
…identifying **the time and size** of the necessary reduction on GFN under the constraints.



Hot spots are a powerful tool for…

…programme design.

For example: What if we want debt decreasing by 5% until 2023 and non increasing thereafter while GFN remain below 20% of GDP?



Conclusions

- Funding assumptions are key for assessing debt sustainability as debt flows give important insights regarding the sovereign's vulnerabilities.

- Our model complements the standard DSA frameworks as it allows us to assess debt sustainability under an *optimal* funding strategy.
- Debt dynamics under this strategy could reveal different vulnerabilities.

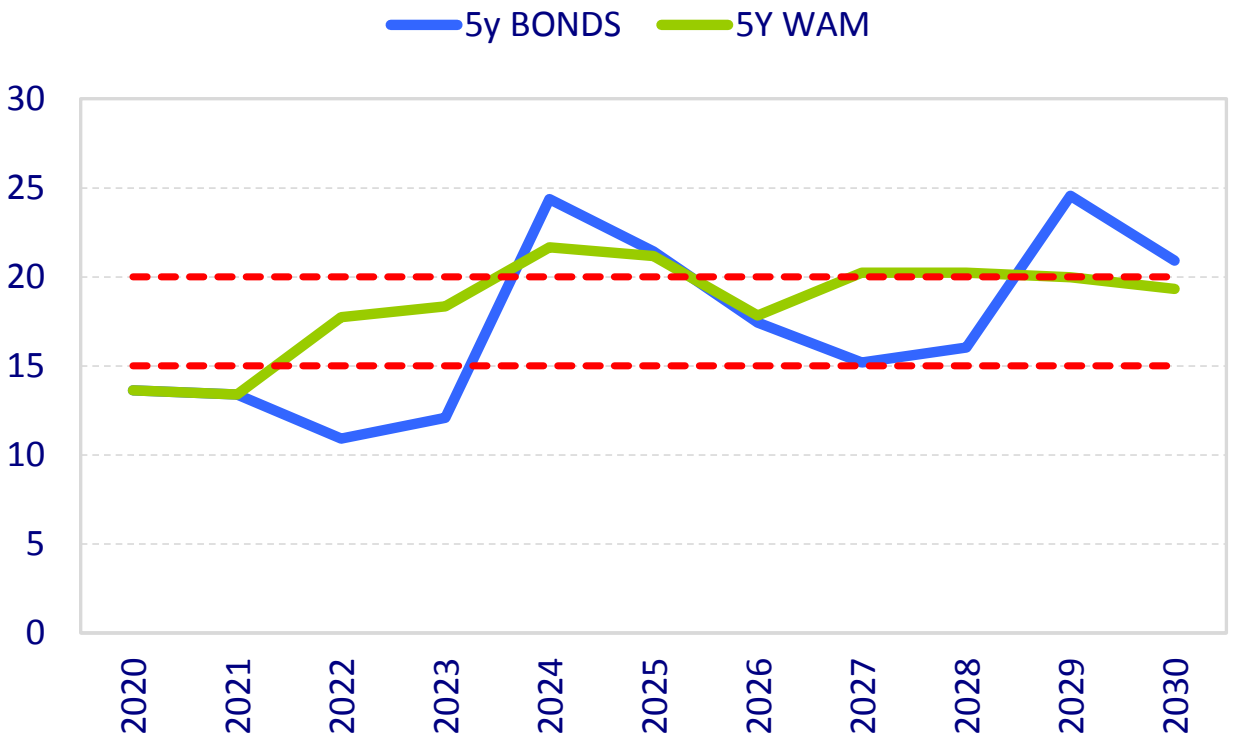
Thank you …

Annex

DSA assumptions – central

		Avg 2019-2030
Nominal GDP	*% growth*	3.5
Primary surplus	*% of GDP*	1.0
Market rates	*%*	3.5

Annex. Central scenario: GFN under fixed strategy, fixed rates



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Annex. DSA with higher starting debt

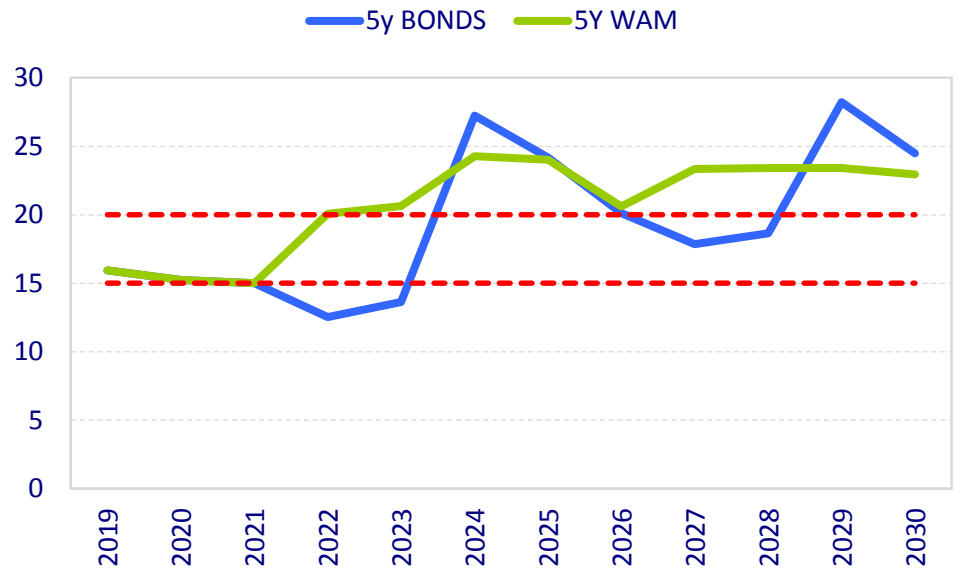
Indicative example: Identical macro and fiscal assumptions, fixed interest rates, flat yield curve but debt starts at 120%.

Funding strategy: Only 5Y bonds

	Short term	Med. term	Long term
	2019	2020-23	2024-30
Debt % GDP	120.9	116.0	107.4
GFN % GDP	15.9	15.2	28.2

Funding strategy: Only 5Y WAM

	Short term	Med. term	Long term
	2019	2020-23	2024-30
Debt % GDP	120.9	116.0	107.4
GFN % GDP	15.9	20.6	24.3



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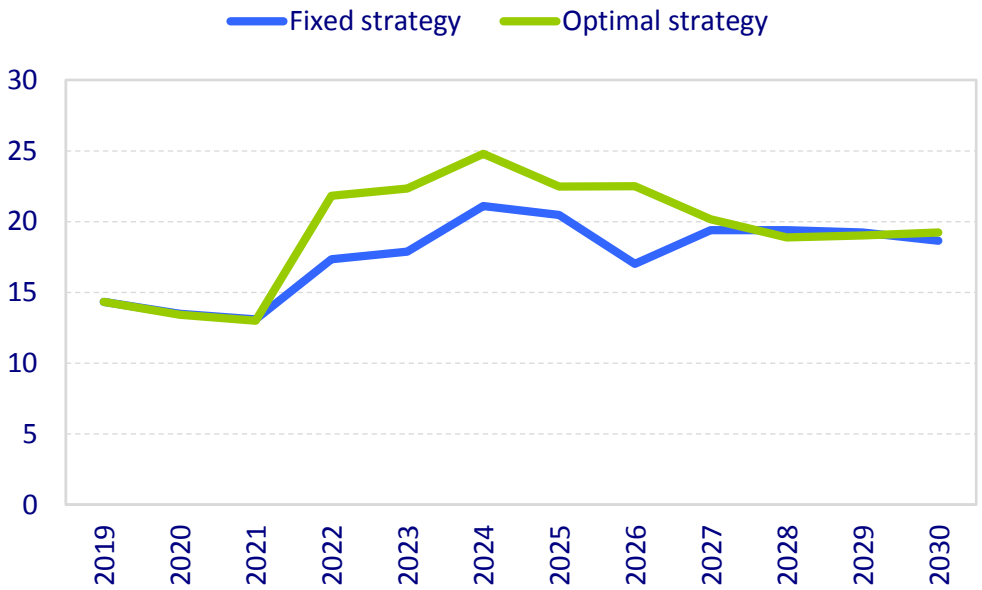
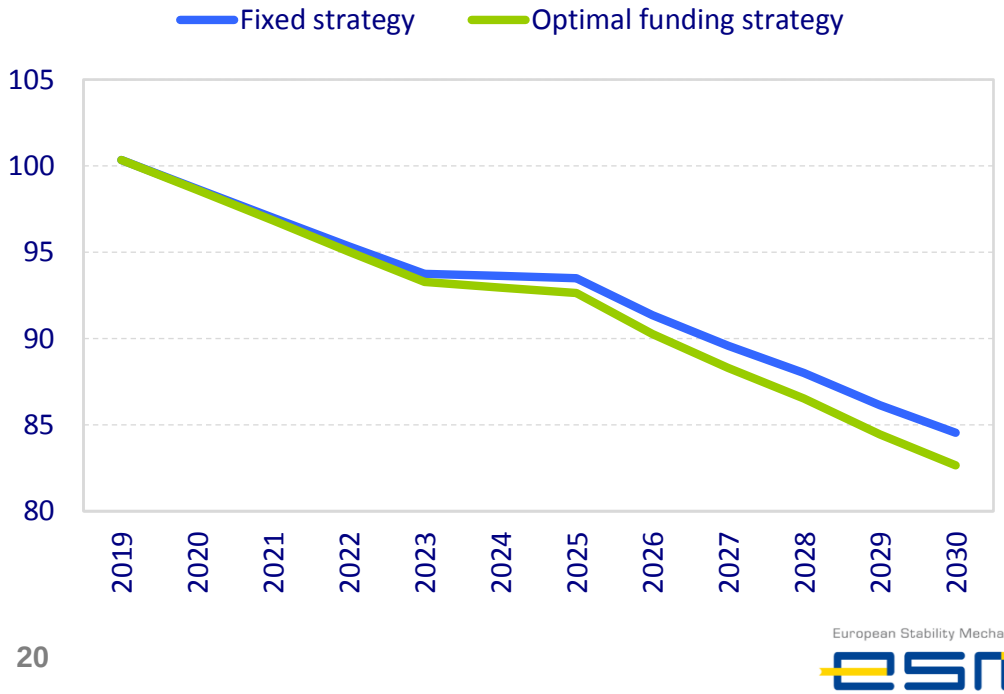
Note: Values in the heat map refer to end-period for debt and period maximum for GFN. Colours refer to period maxima: Green for Debt (GFN) below 70% of GDP (15%), Yellow for Debt (GFN) above 70% of GDP (15%), but below 100% (20%), and Red for Debt (GFN) above 100% of GDP (20%). These thresholds are broadly in line with IMF empirical findings for advanced economies (Baldacci et al., 2011).

Indicative example: Explaining the results

GFN-to-GDP (%)



Debt-to-GDP (%)



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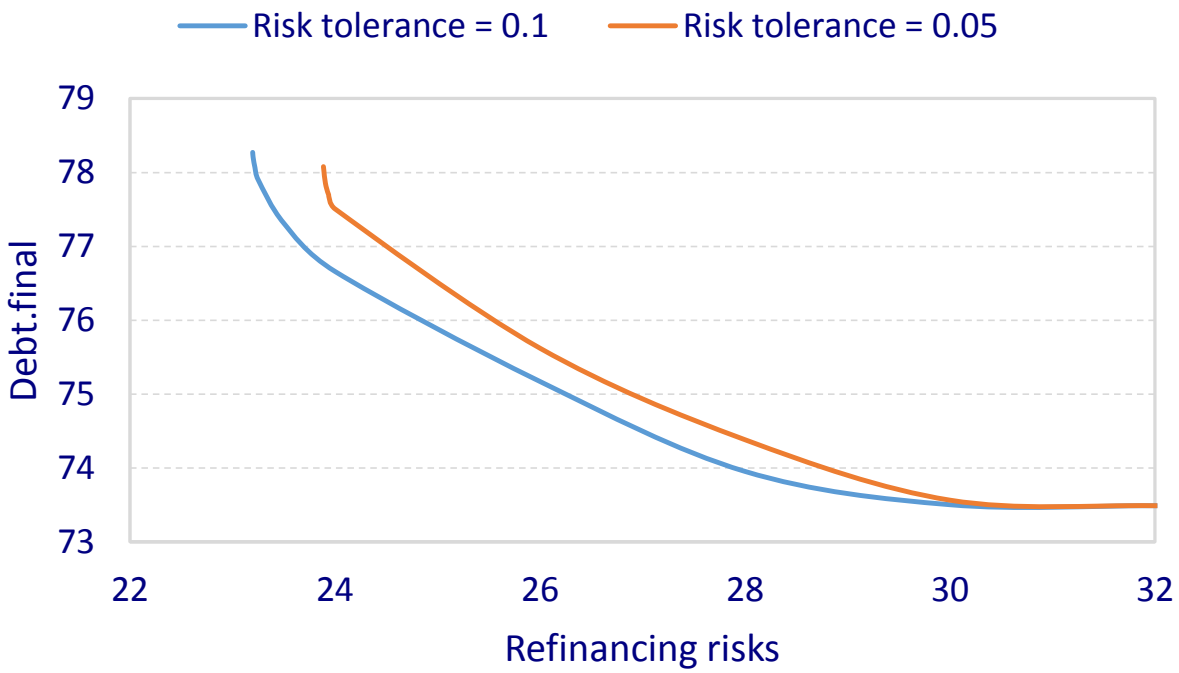
Indicative example: Higher risk tolerance

- Higher risk aversion implies longer maturities—if possible—which implies higher debt.

- Targeting the same level of debt, requires the sovereign to accept higher refinancing risks.



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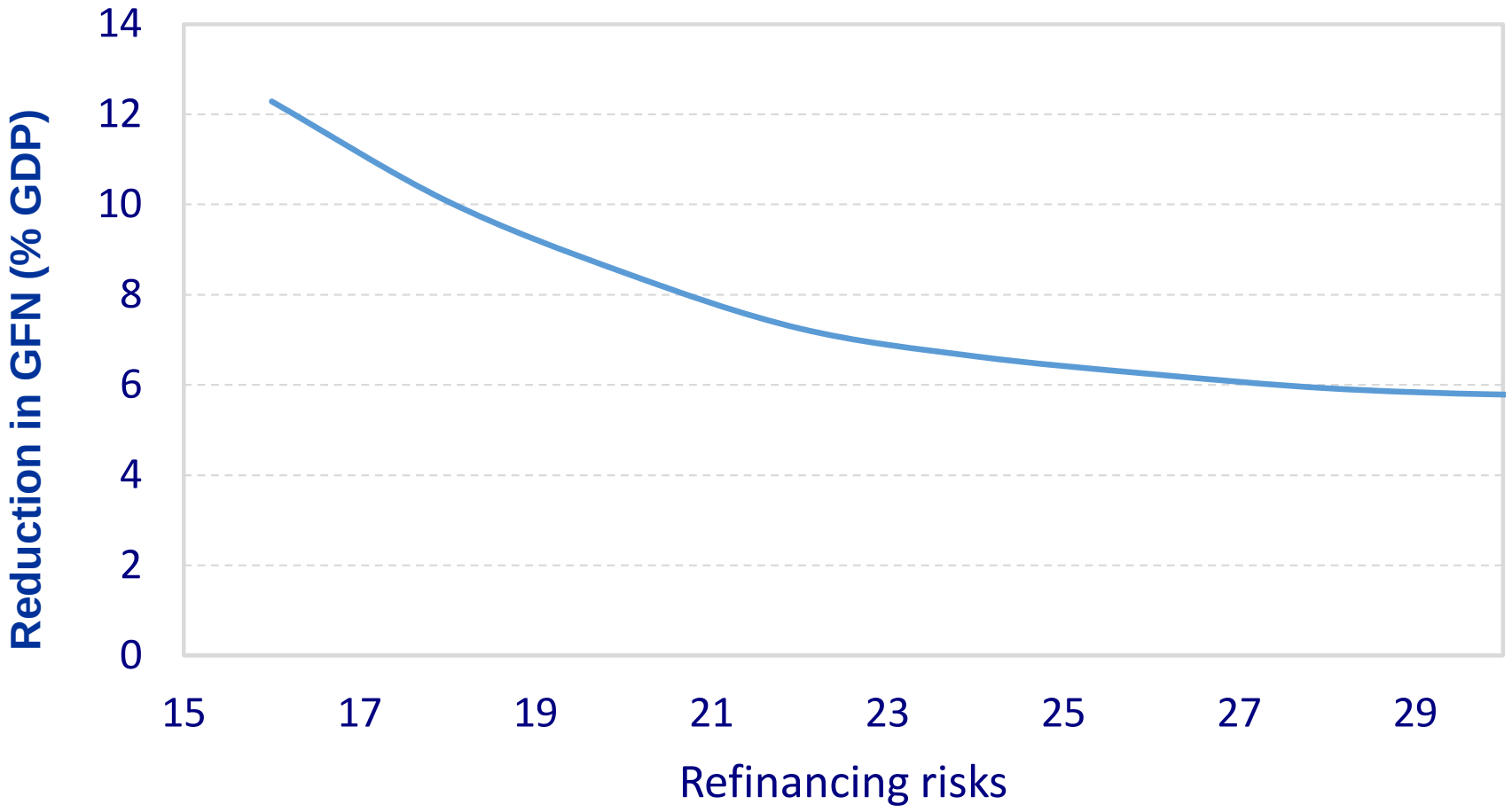
Indicative example: What if higher macroeconomic uncertainty?

Higher macroeconomic uncertainty pushes optimal strategy to longer maturities which weighs on debt.
→ In our example, increased uncertainty makes the optimization problem infeasible.

Allowing for **hot spots** the model gives us the time and size of the necessary reduction in GFN in order to obtain an optimal solution.

Indicative example: What if higher macroeconomic uncertainty?



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Indicative example: Shorter maturity

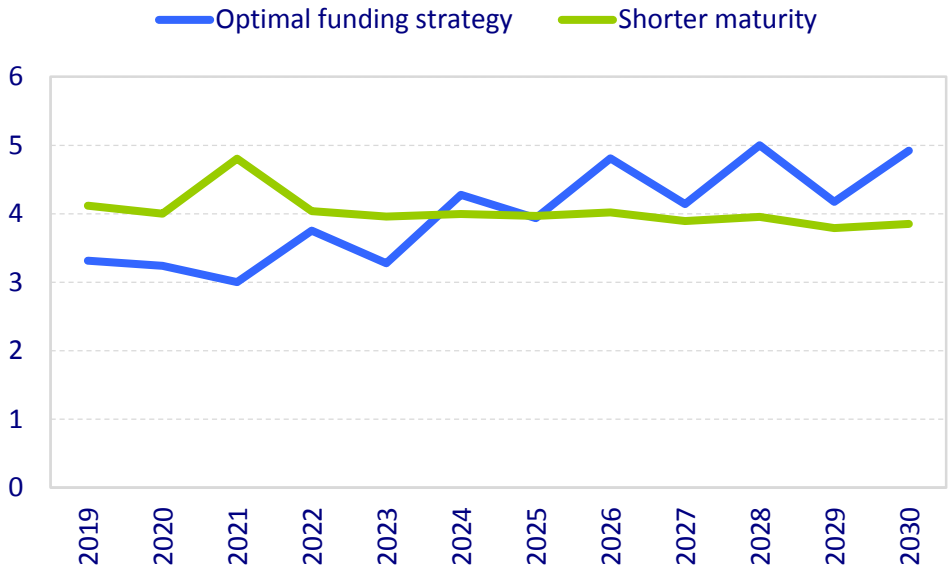
Shorter maturity of existing debt pushes optimal strategy to longer maturities when debt payments are high…

With optimal funding strategy

	Short term	Med. term	Long term
	2019	2020-23	2024-30
Debt % GDP	100.3	93.3	82.7
GFN % GDP	14.3	22.3	24.8

With shorter maturities

	Short term	Med. term	Long term
	2019	2020-23	2024-30
Debt % GDP	100.3	93.1	82.3
GFN % GDP	26.8	23.3	25.2



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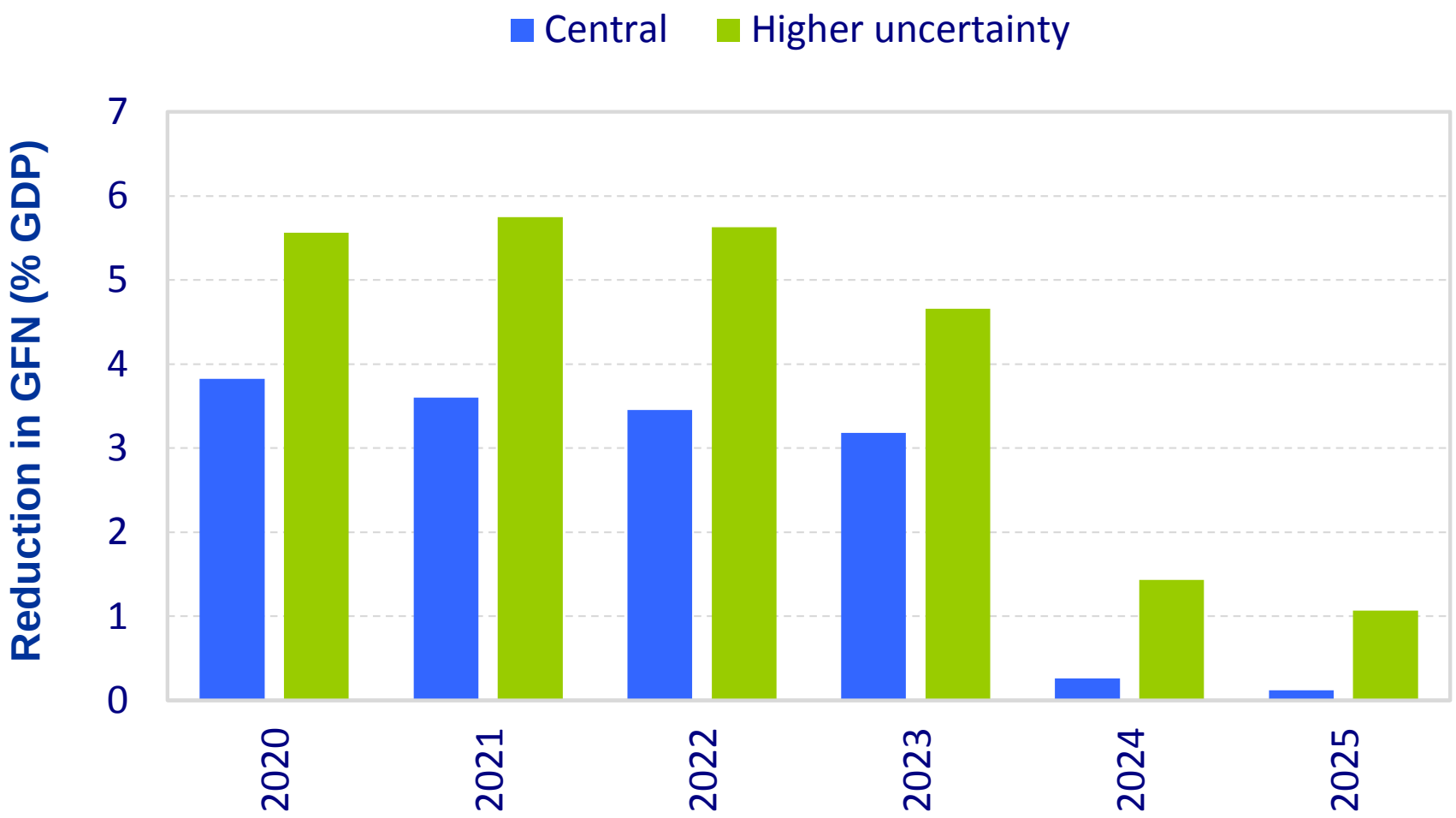
Indicative example: What if we want debt decreasing by 5% until 2023?



Ongoing work

On the model:

- Enrich the yield curve with feedback loop that includes debt flows and the interaction of stocks and flows.

On the RiMa DSA framework:

- Fully operationalize the model including the thresholds relevant for assessing debt sustainability as well as other risk indicators.