

# Testing the effectiveness of the anti-doping fight via social simulation

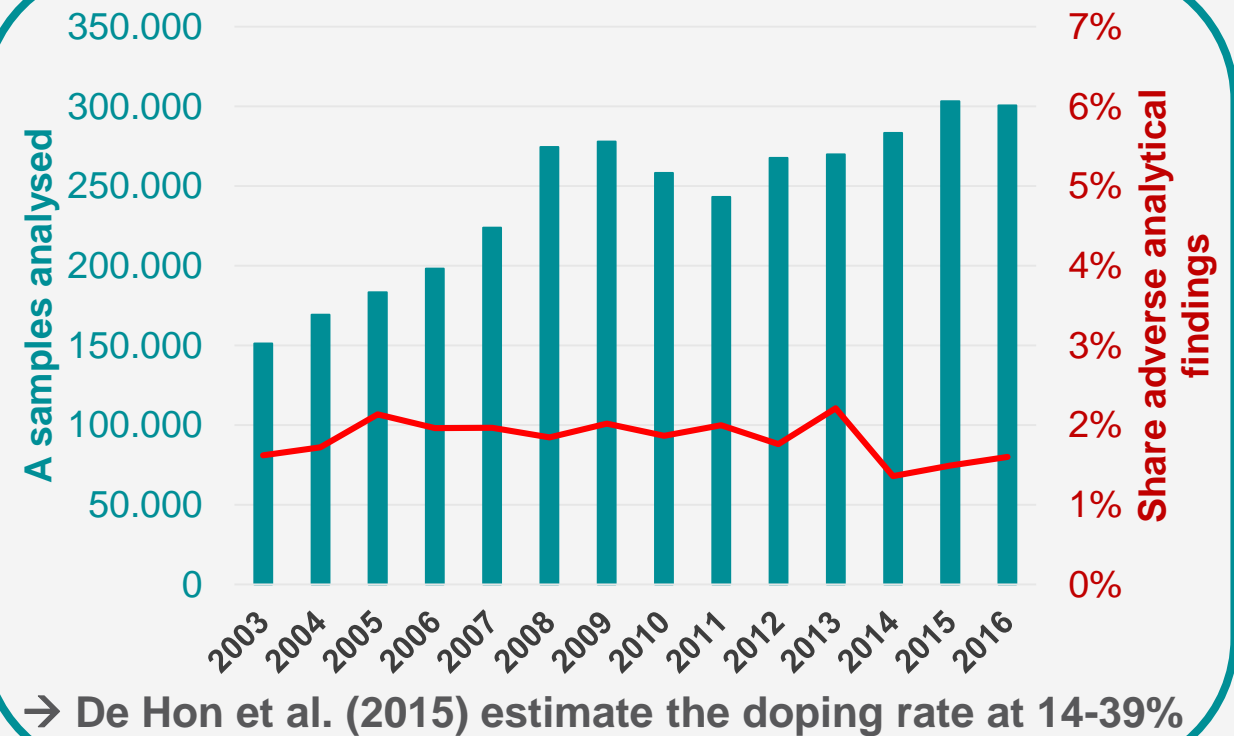
**Daniel Westmattmann,  
Marius Sprenger &  
Gerhard Schewe**



# 1 Background & Motivation

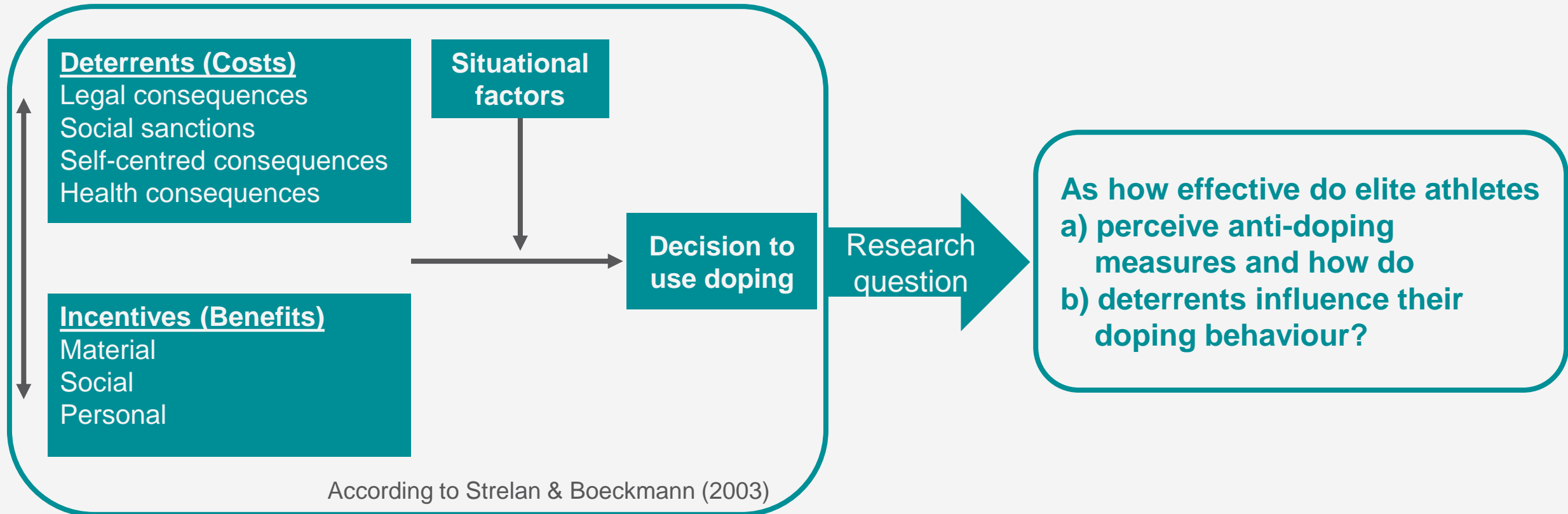
The World Anti-Doping Agency (WADA) was founded in 1999 as a result of various doping scandals.

- Doping is defined “[...] as the occurrence of one or more of the anti-doping rule violations set forth in Article 2.1 through Article 2.10 of the Code” (WADA, 2015)
- WADA budget:  
USD 17 million (2002) → USD 34 million (2019)
- Global anti-doping budget:  
> USD 228 million (Maenning, 2014)



# 1 Background & Motivation

Several models on doping behaviour exist, but they cannot yet be empirically verified.



## 2 Athletes' Perception of Anti-doping work

Perception of the current anti-doping regime – A quantitative study among German top-level cyclists (N=42) and track and field athletes (N=104).



	Mean (N=146)	SD	Athletics (N=104)	SD	Cycling (N=42)	SD
Improved diagnostics	4.288	.879	4.250	.943	4.381	0.697
Increase of bans	4.007	1.105	4.058	1.113	3.881	1.087
Anti-doping law	3.747	1.225	3.625	1.286	4.048	1.011
More follow-up controls	3.726	1.177	3.673	1.218	3.857	1.072
Indirect detection methods	3.712	1.017	3.558	1.022	4.095	0.906
Increase of control frequency	3.630	1.089	3.481	1.106	4.000	0.963
Education program	3.555	1.157	3.538	1.165	3.595	1.149
Increase of fines	3.247	1.195	3.192	1.133	3.381	1.343
Leniency program	3.000	1.057	3.048	1.018	2.881	1.152

Westmattelmann et al. (2018)

### 3 Why Agent-based Modelling?

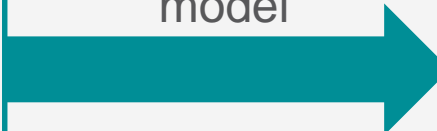
Using agent-based modelling, methodological constraints can be overcome.

#### Game Theoretical Background

		B	
		no-dope	dope
A	no-dope	(3,3)	(1,4)
	dope	(4,1)	(2,2)

- 21 Models identified with focus on Fines, Bans, Whistleblowing and Prize Money
- Exclusively Rational Choice assumed
- Complex models cannot be analytically solved

Need for a  
computer-based  
model

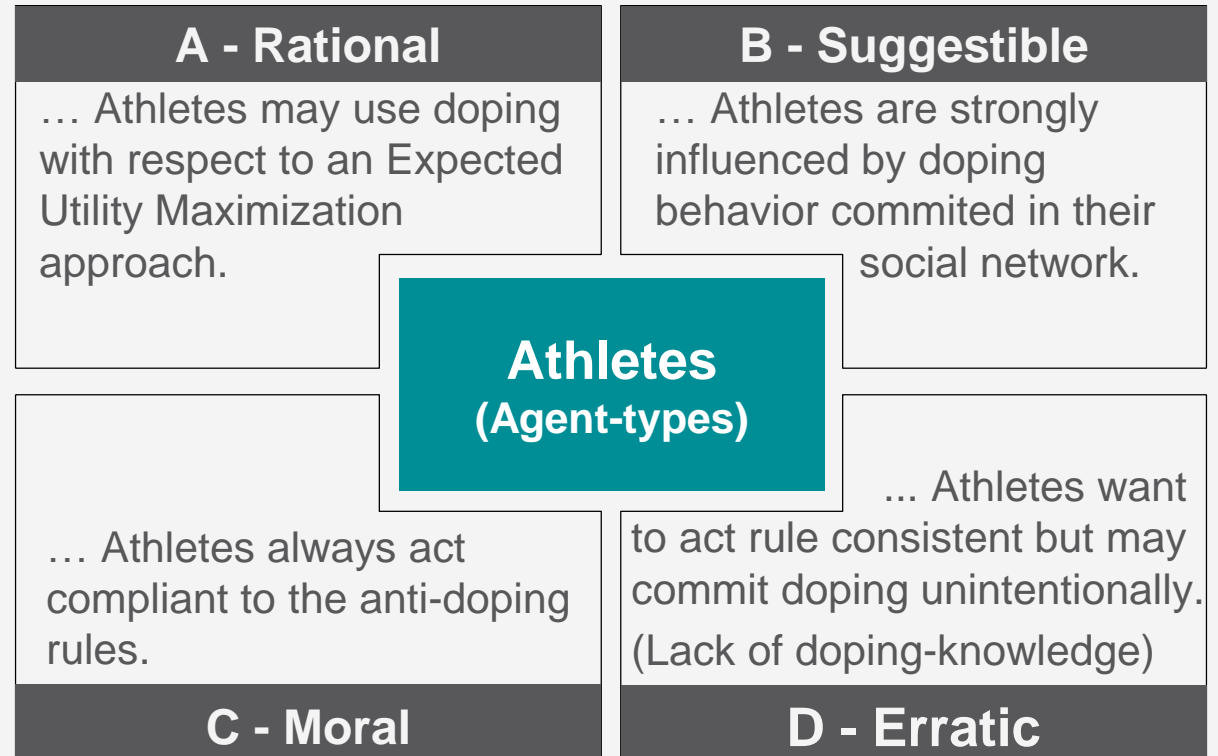
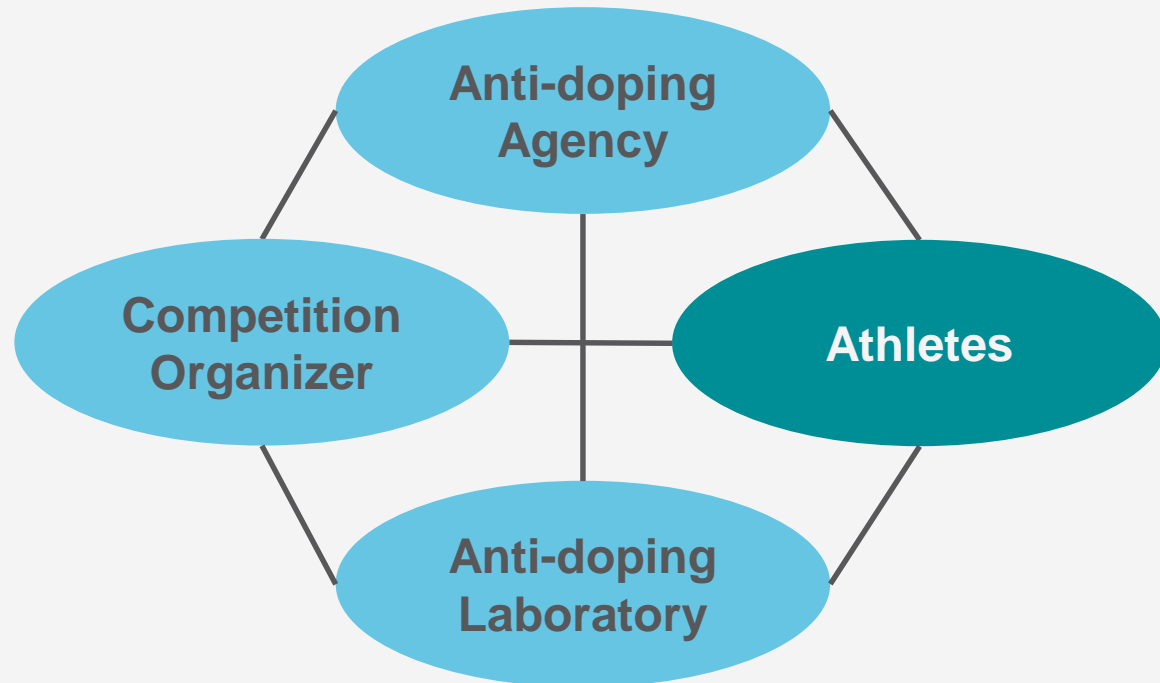


#### Agent-based Modelling (ABM)

- Computational model for simulating (inter-) actions of autonomous agents
- Incorporates elements of human and social behavior
- A system-behavior evolves (**Emergence**)
- Has potential to become ‘**a third way of doing science**’ besides argumentation and formalization (Axelrod & Tesfatsion, 2005)

### 3 Agent-based Model (ABM) on Anti-doping

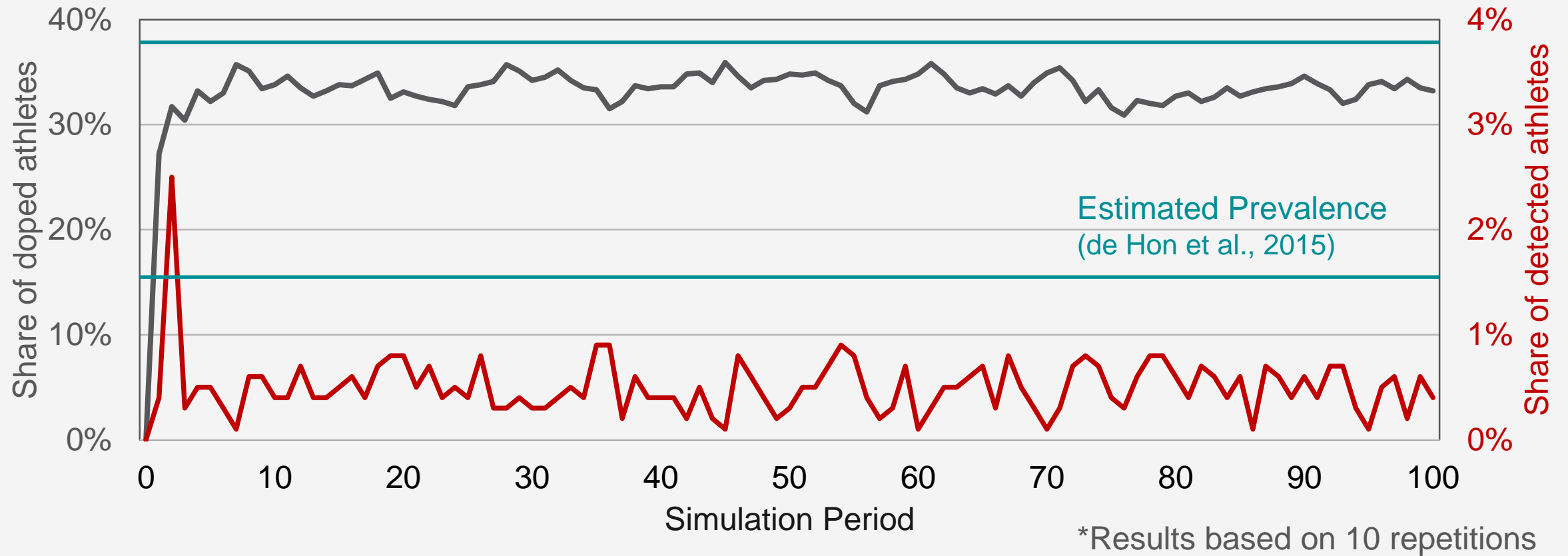
The ABM is based on 4 interacting objectives and 4 types of athletes are distinguished.



Westmattmann et al. (2019)

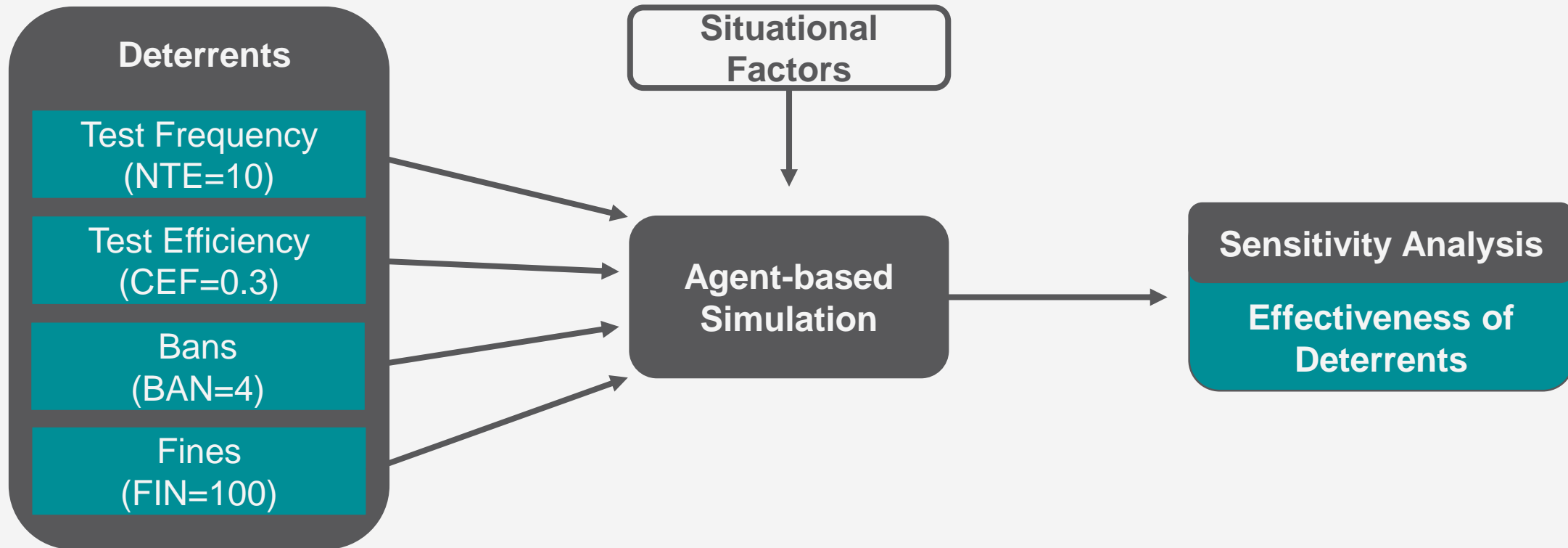
## 4 ABM Results – Status Quo

The simulation data matches the WADA’s testing figures and estimated doping prevalence.



## 4 Analysis Procedure

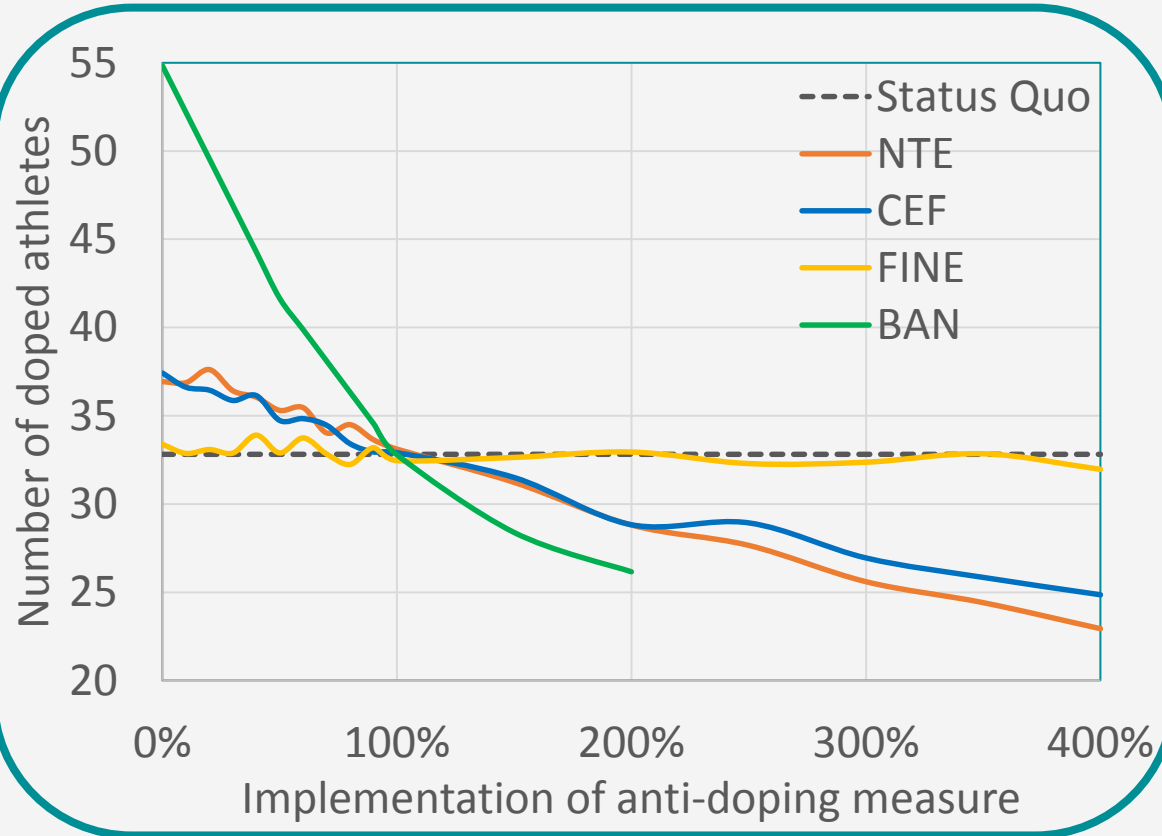
Simulation study quantifies the effectiveness of four anti-doping measures.





## 4 Sensitivity Analysis

Sensitivity analysis shows that the effectiveness of the examined deterrents differs greatly.



- If all measures are set to 0%, doping rate is 58.64%
- By doubling measures c.p., doping rate decreases:
  - Ban (-20.25%)
  - Test Frequency (-12.20%)
  - Test Efficiency (-12.18%)
  - Fines (+0.38%)
- Saturation effects for all measures
- Simultaneous doubling: 16.45% (-49.88%)

## 5 Implications for Practise

By using ABM, concrete recommendations for sports organisations can be derived.



### 1. Allocation of Anti-doping Budget

- Effectiveness of Bans, Test Frequency & Efficiency and Fines differs
- Saturation effects are identified
- Harmonization of anti-doping measures by considering costs

### 2. Testing new Concepts before Launching

- New testing strategies
- Innovations in anti-doping

## 6 Limitations and Future Directions

The presented ABM marks the first step in the simulation of doping behaviour.

### Limitations:

- Assumptions:
  - Rigid simulation process
  - Stereo types
  - No doping distinction
- Lack of valid data for model calibration



### Future Directions:

- Next model extensions:
  - Sample Re-Testing
  - Whistleblowing
  - Further actors (Federations, Management, Media etc.)
- More qualitative and quantitative findings necessary
- Cooperation with Anti-Doping Agencies

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