kisses webcam before sleep
„Good night Mr. FBI man.“
The FBI Agent:

Learning outcomes

Learn **what an agent is (yes, even the AI ones)**

Understand when agent-based modelling can be **applied**

Familiarise with **applications** in finance

A tale of rationality

Everybody is **perfectly rational**

A tale of rationality

Everybody is **perfectly rational**

We **always** make the **best** decision

We **always know how** to make the **best** decision

A tale of rationality

The **efficient market hypothesis** (EMH)

EUGENE FAMA

Efficient market hypothesis

Everybody is **perfectly rational**

Efficient market hypothesis

Everybody is **perfectly rational**

Price reflects all **available information**

Efficient market hypothesis

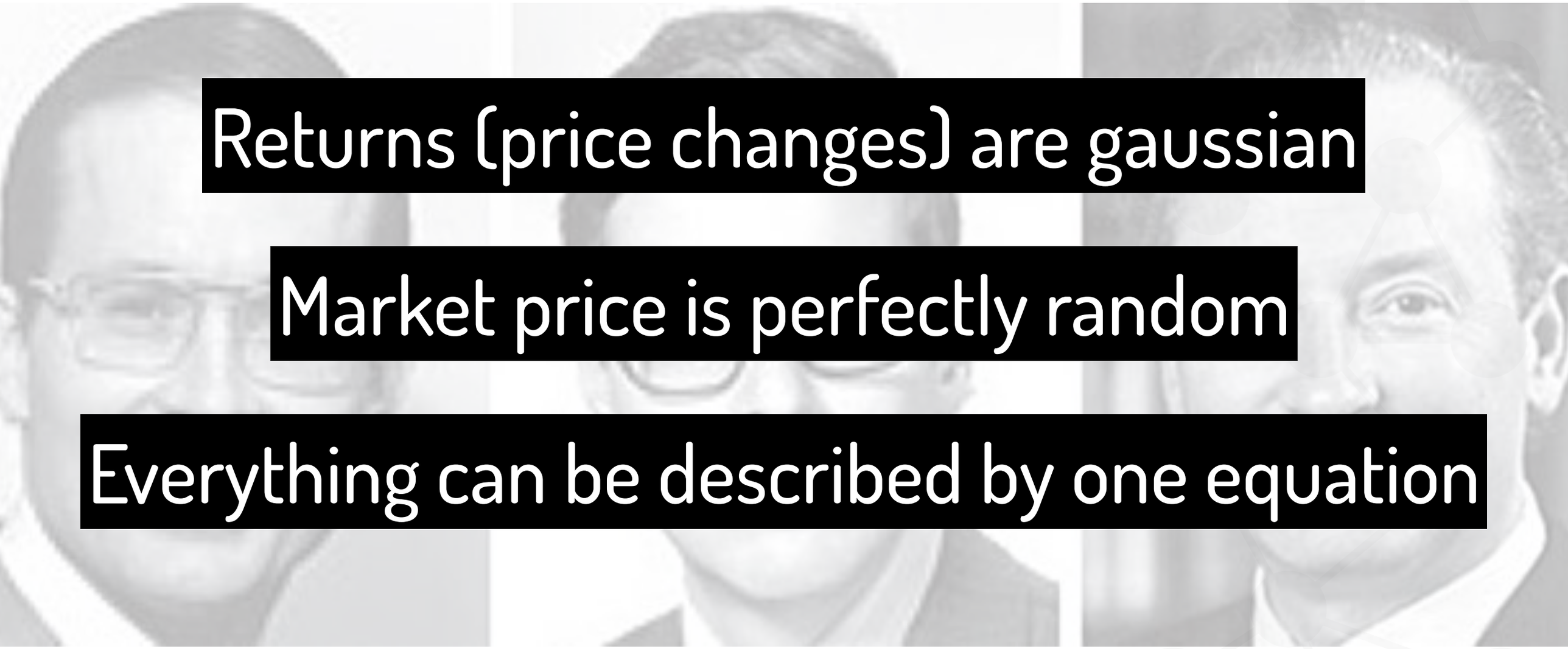
Everybody is **perfectly rational**

Price reflects all **available information**

Forms: Weak, semi-strong, strong

Black-Scholes

Black-Scholes



Returns (price changes) are gaussian

Market price is perfectly random

Everything can be described by one equation

A game of probabilities

Struck by **lightning**: 1 in 70,000

A game of probabilities

Struck by **lightning**: 1 in 70,000

Getting hit by **asteroid**: 1 in 1,068,820

A game of probabilities

Struck by **lightning**: 1 in 70,000

Getting hit by **asteroid**: 1 in 1,068,820

Winning the **jackpot** (uk lottery): 1 in 45,057,474

A game of probabilities

Struck by **lightning**: 1 in 70,000

Getting hit by **asteroid**: 1 in 1,068,820

Winning the **jackpot** (UK lottery): 1 in 45,057,474

Financial crisis: 1 in **10^72**

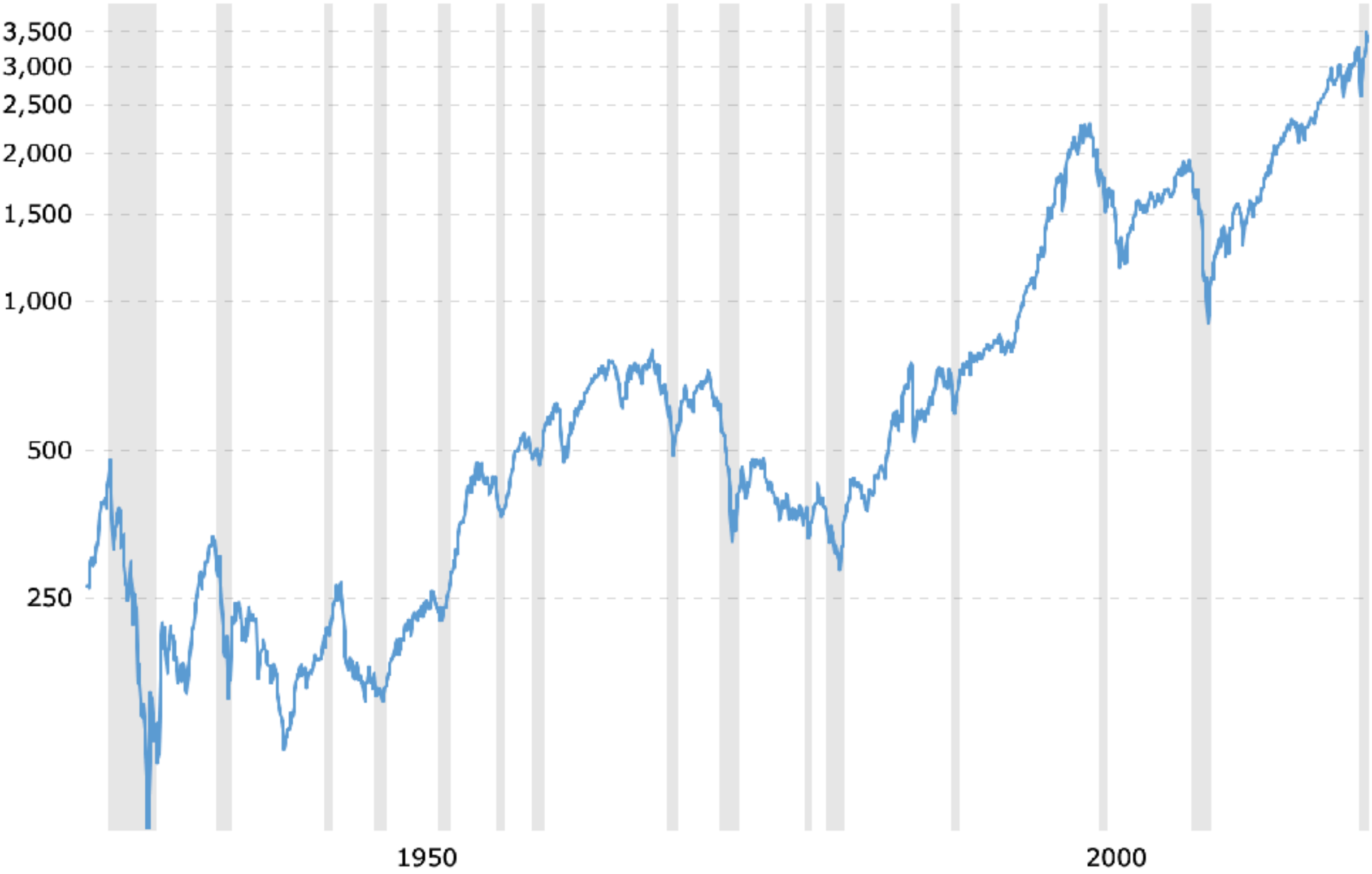
Should happen once every

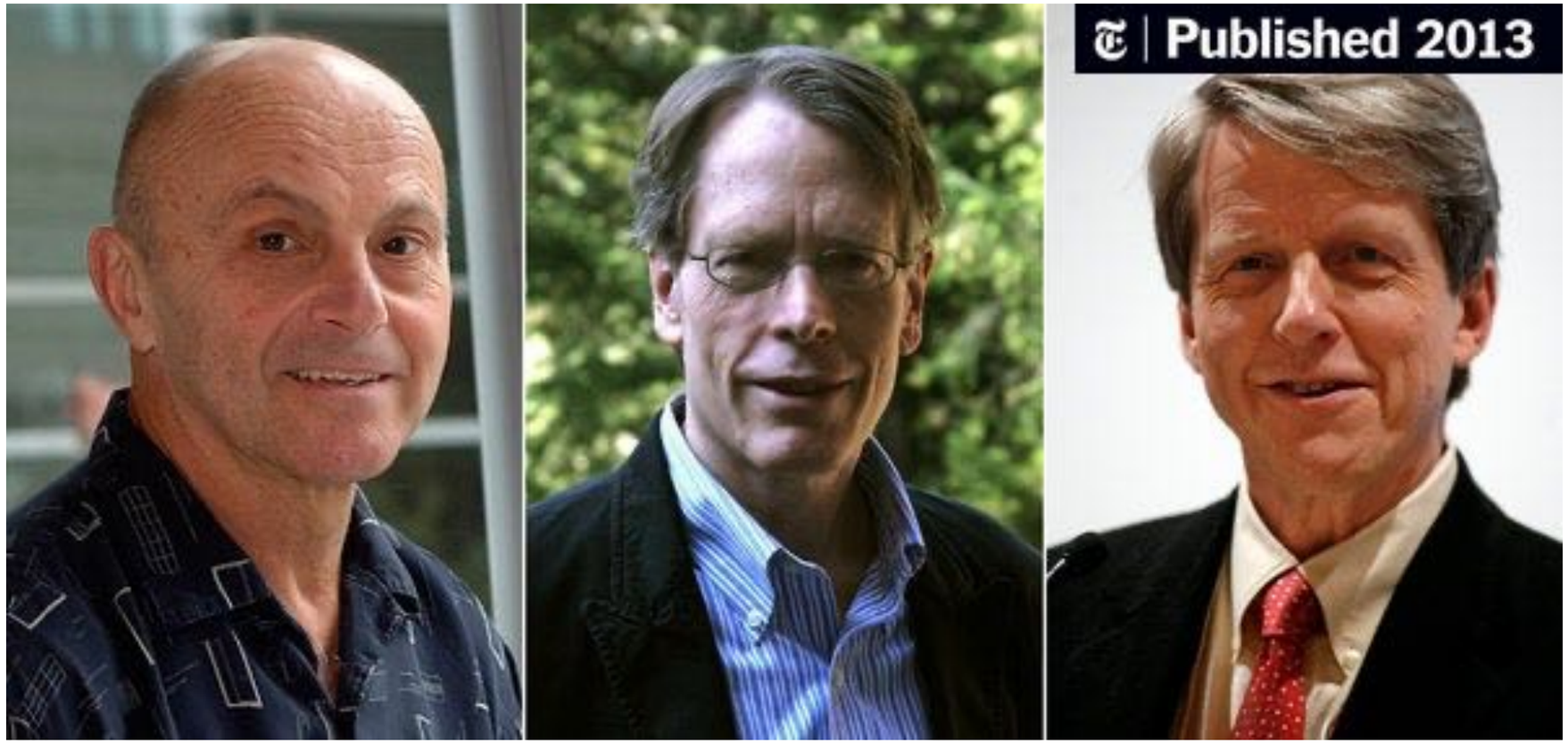
15,000,000,000,000,000,000,

000,000,0 **Years** 0,000,000,

000,000,000,000,000,000,

000,000,000,000,000


3,500
3,000
2,500
2,000
1,500
1,000
500
250
1950
2000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The century of complexity

"I think the next century will be the century of complexity."

Stephen Hawking

From 2008 complexity started to permeate economics/finance/business research and decision making

What is an ABM?

Objects **interact** with each other and/or with the environment

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Objects are **autonomous** (bottom-up approach)

What is an ABM?

Objects **interact** with each other and/or with the environment

Objects are **autonomous** (bottom-up approach)

The outcome of their interactions is numerically **computed**

What is an agent?

Individual or group

What is an agent?

Individual or group

Interact with environment

What is an agent?

Individual or group

Interact with environment

Act/react

Scope of ABM

Explanation and replication

No predictions*

Describe the system by describing its elements

Scope of ABM

WHAT IF scenarios

When to use ABM

Model complex systems

Get quick intuition of the dynamics of the system

Why use ABM

Numerical computation of analytical models

Testing robustness of analytical models

Stand-alone simulation models

Why use ABM

Numerical computation of analytical models

Model is **not** analytically **soluble** for some variable

empirical distribution of variable needs to be compared with **theoretical**

Out of equilibrium solutions not possible analytically

Why use ABM

Testing robustness of analytical models

Changing assumptions or values often leads to no solution or intractability

Why use ABM

Stand-alone simulation models

Substitute, not complementary, to mathematical analysis

Problems are analytically intractable

Analytical solution bears no advantage

Why use ABM

Bonus: Replace the (crazy) assumptions of neoclassical economics

Agents are fully rational with unbounded computational skills

Equilibrium defined by re and no-arbitrage condition

Interactions and heterogeneity only add noise

Case study: financial markets

Basic financial abm

Chartists

Fundamentalists

Basic financial ABM

Introduced by **Frankel and Froot**

Based on **surveys** with professionals

They found traders had **different expectations**, especially with respect to long/short-term trades

Chartists

Follow the trend
Short-term investors

$$s^e_{t+1} = (1-g)s_t + gs_{t-1}$$

Expected price

Price at time t

Price at time t-1

$$\Delta s^e_{t+1} = -g\Delta s_t$$

$$s^e_{t+1} = (1-g)s_t + gs_{t-1}$$

Fundamentalists

Derive the “fundamental” price
Long-term investors

$$s^e_{t+1} = (1 - v)s_t + v\bar{s}_t$$

Expected price

Price at time t

Fundamental Price at time t

$$\Delta s^{e}_{t+1} = v\left(\bar{s}_t - s_t\right)$$

Switching behaviour

Agents can compare different heuristics and choose
Agents can change their behaviour

Basic Financial ABM

Basic Financial ABM

Basic Financial ABM

Basic Financial ABM

Basic Financial ABM

Analysis for MSFT