

Toward a Cognitive Science of Markets: Economic Agents as Sense-Makers

Sam Johnson

University of Bath School of Management

How Trump's Triumph Roiled Markets

Sleepless traders were whipsawed by huge swings as election results trickled in

As Americans headed to the polls Tuesday morning, sales staff at Deutsche Bank's London offices circulated a light-hearted message on their terminals to gauge the chances they'd be able to turn in early that night.

By Corrie Driebusch in New York, Georgi Kantchev in London and Sarah Krouse in New York

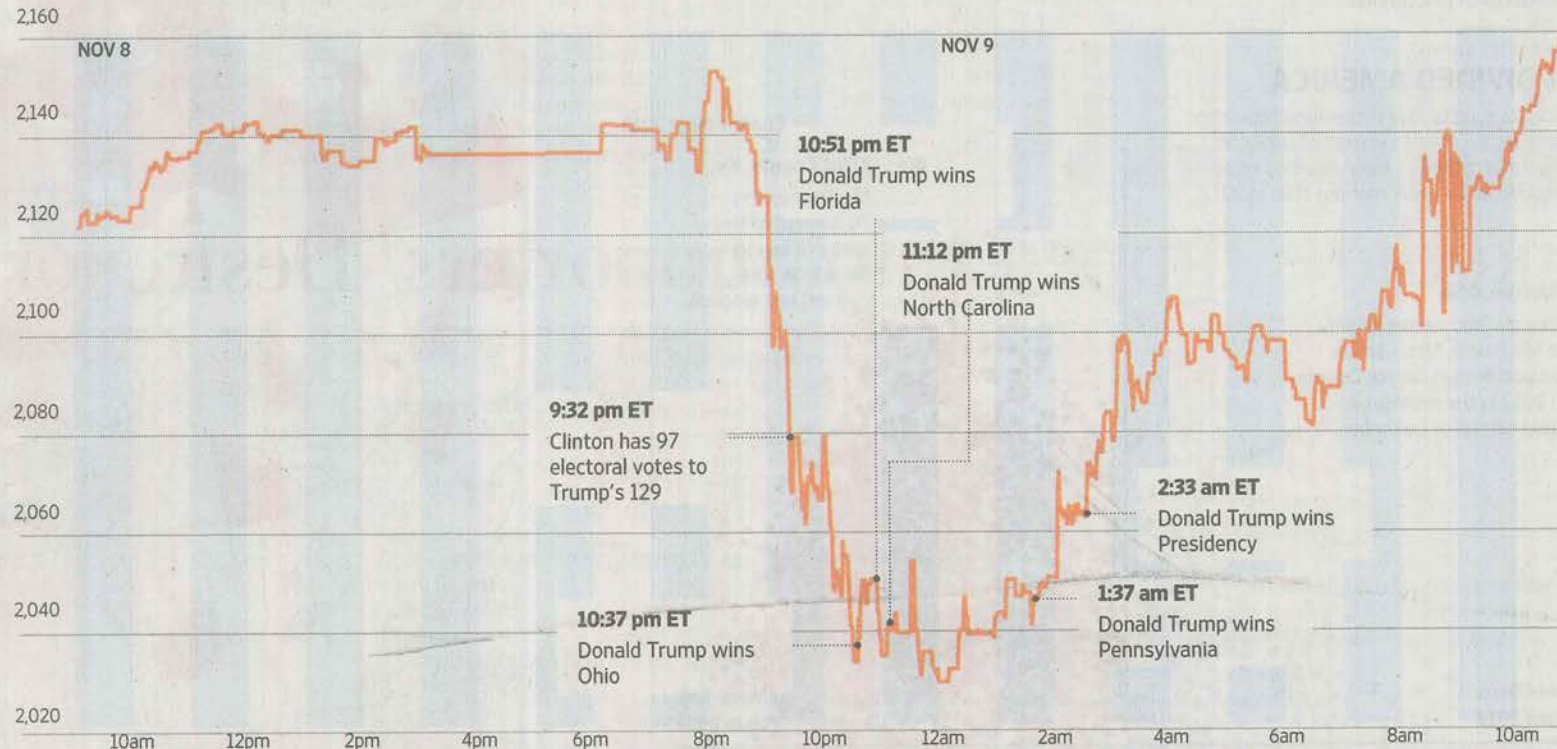
"If Clinton wins Florida, GO TO SLEEP. If she wins Georgia, definitely GO TO SLEEP," the message said. If Donald Trump were to win Pennsylvania and Michigan, which the message described as "both leaning to Clinton," then "GET READY FOR WORK."

By early Wednesday morning U.S. time, Mr. Trump had captured at least three of the four states in route to a stunning presidential victory that shook the political establishment to its core and sent shock waves through global markets.

Over a 12-hour period, markets for stocks, bonds, currencies and commodities plunged before ricocheting back toward all-time highs. The roller coaster ride spawned winners, losers and more than a little heartburn in trading centers world-wide. And while Wednesday ended on a bullish

Wild Night

The price of S&P 500 futures contracts for December gyrated sharply on U.S. election news.



Battle of Good Trump Versus Bad Trump

Markets have a tendency toward hyperbole and, as Donald Trump headed toward a win, they bet on the four horsemen of the Trum-pocalypse riding over Mexico.

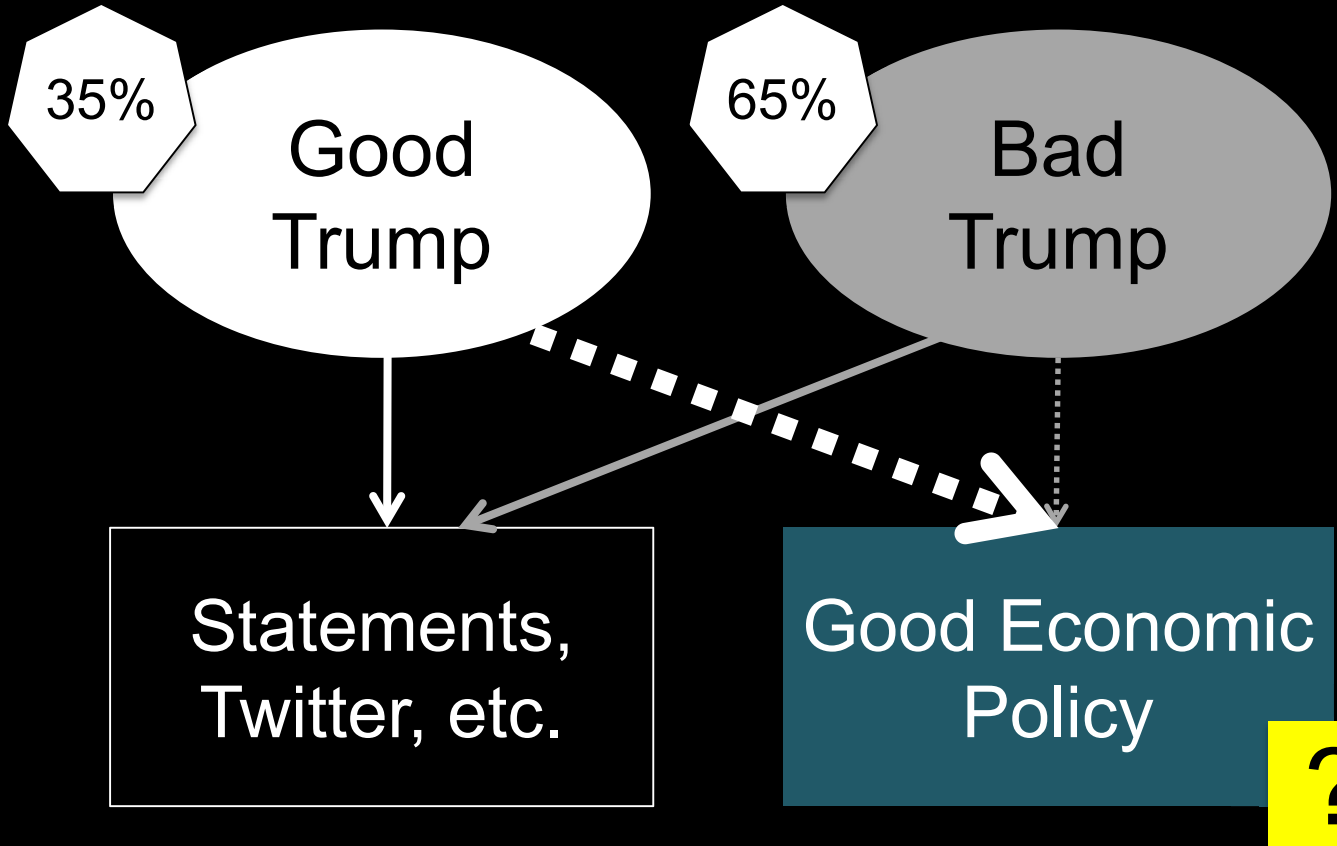
The peso fell more than 10% to its lowest ever

**STREETWISE
JAMES
MACKINTOSH**

against the dollar, as traders focused on the clearest Trump

trade.

By the time markets opened on Wednesday, Mr. Trump was confirmed as president-elect and the market had switched from worrying about the bad stuff he



Battle of Good Trump Versus Bad Trump

Markets have a tendency toward hyperbole and, as Donald Trump headed toward a win, they bet on the four horsemen of the Trum-pocalypse riding over Mexico.

The peso fell more than 10% to its lowest ever

**STREETWISE
JAMES
MACKINTOSH**

against the dollar, as traders focused on the clearest Trump

trade.

By the time markets opened on Wednesday, Mr. Trump was confirmed as president-elect and the market had switched from worrying about the bad stuff he



65%

Good Trump

35%

Bad Trump

Statements,
Twitter, etc.

Good Economic
Policy

?

Problems requiring explanatory thinking are ubiquitous across cognition...

- Causation
- Theory of mind
- Perception

Problems requiring explanatory thinking are ubiquitous across cognition...

- Causation
- Theory of mind
- Perception

...their solutions guide key mental operations...

- Judgment
- Prediction
- Choice

Problems requiring explanatory thinking are ubiquitous across cognition...

- Causation
- Theory of mind
- Perception

...their solutions guide key mental operations...

- Judgment
- Prediction
- Choice

...which underlie much of economic behavior.

- Strategy
- Finance
- Policy

But these problems are hard.

$$\frac{P(\text{Good Trump}|\text{Data})}{P(\text{Bad Trump}|\text{Data})} = \frac{P(\text{Good Trump})}{P(\text{Bad Trump})} \times \frac{P(\text{Data}|\text{Good Trump})}{P(\text{Data}|\text{Bad Trump})}$$

Posterior Odds

(our new beliefs)

Prior Odds

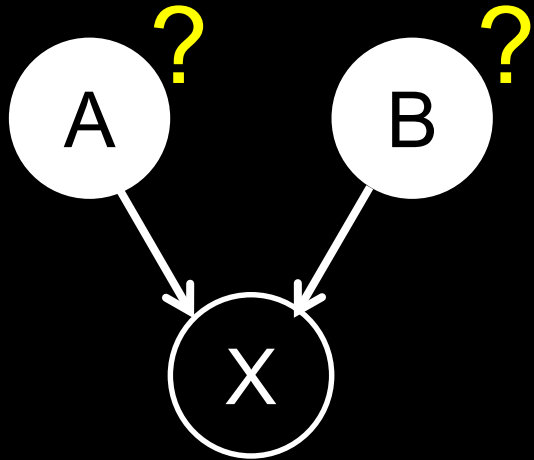
(our old beliefs)

Likelihood Ratio

(fit of hypotheses to data)

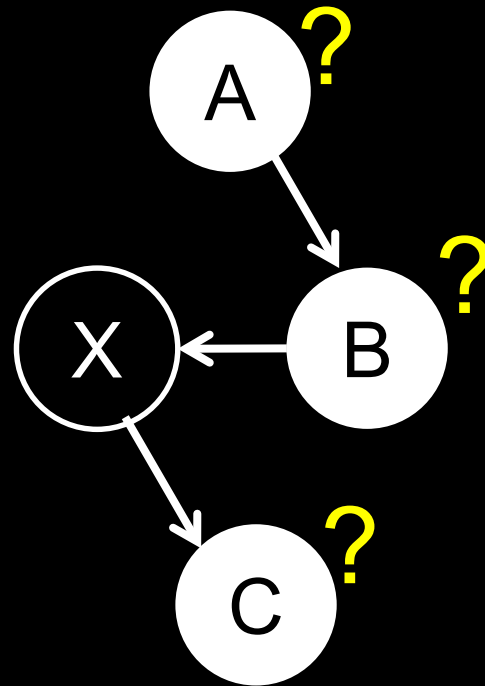
- Hypothesis Limits
- Information Limits
- Specification Limits
- Capacity Limits

Tools for sense-making



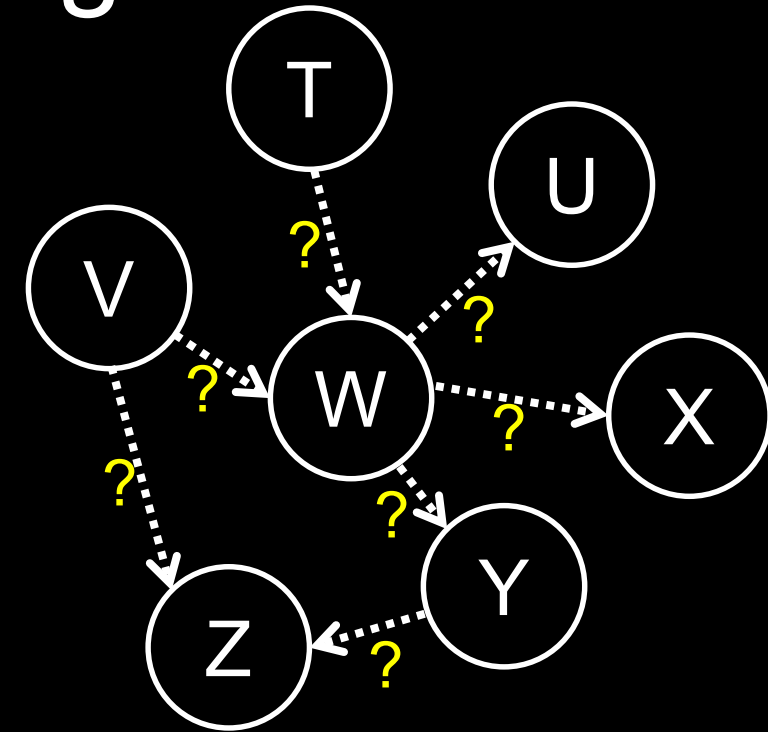
Causal Forks
Explanatory Heuristics

Inferring Policy Intentions



Causal Chains
Narrative Thinking

Forming Expectations



Causal Webs
Intuitive Theories

Predicting Consequences
of Policy Interventions

Today

- Two case studies on sense-making and expectations
 - Grey Swans
 - Price Patterns
- Why behavioral economics needs cognitive science

Today

- Two case studies on sense-making and expectations
 - Grey Swans
 - Price Patterns
- Why behavioral economics needs cognitive science

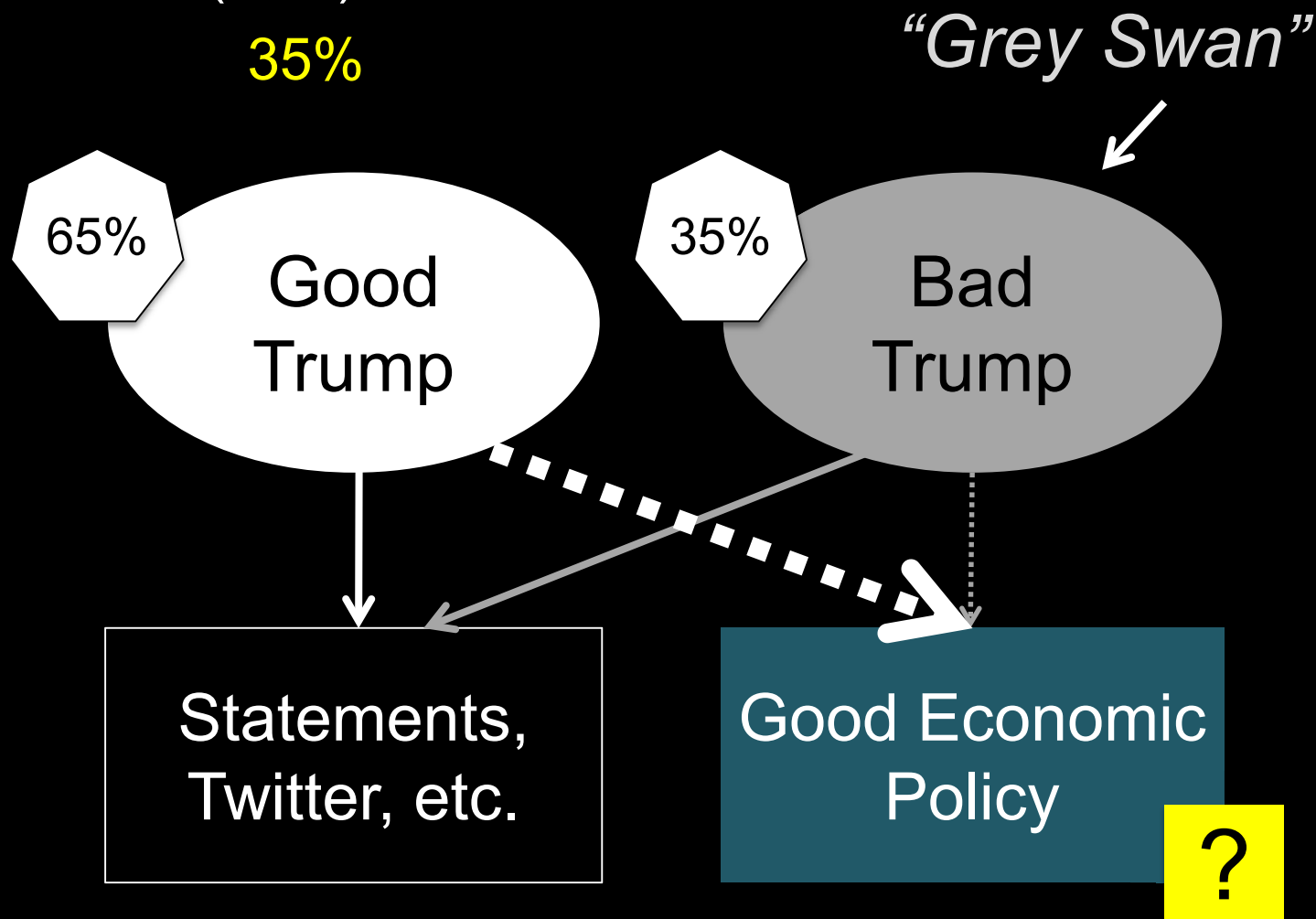


Do Investors Account for Grey Swans?

- *Grey Swans*: Events with low but nontrivial probability
- On the one hand:
 - Human inference sometimes appears Bayesian (*Chater & Oaksford, 2008; Tenenbaum, Griffiths, & Kemp, 2006*)
- On the other:
 - People often ignore uncertainty in prediction (*Johnson, Merchant, & Keil, 2018; Murphy & Ross, 1994*)

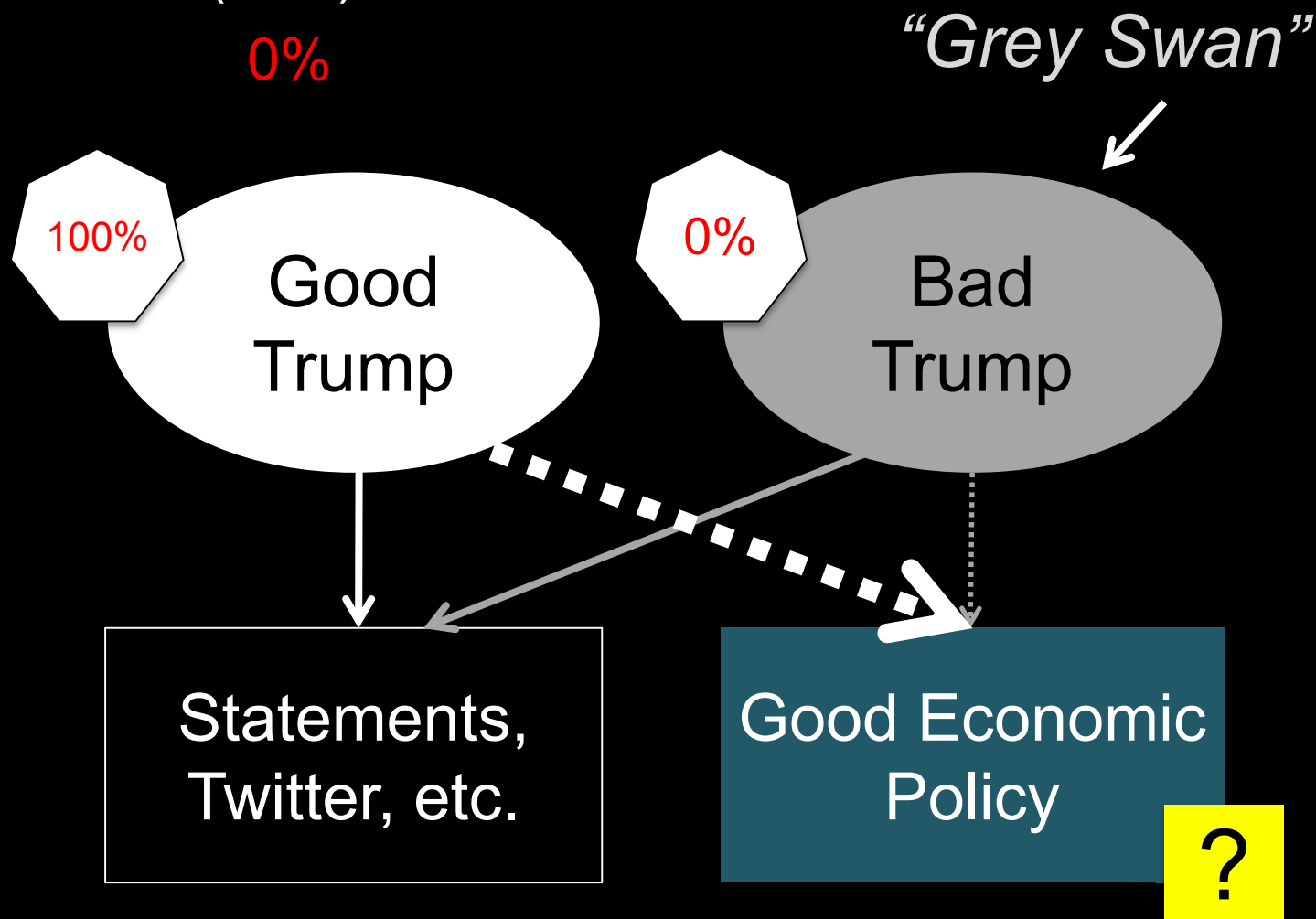
$$\begin{aligned}
 P(\text{Policy}) = & P(\text{Policy}|\text{Good}) \times P(\text{Good}) + P(\text{Policy}|\text{Bad}) \times P(\text{Bad}) \\
 = & 90\% \times 65\% + 10\% \times 35\% = 62\%
 \end{aligned}$$

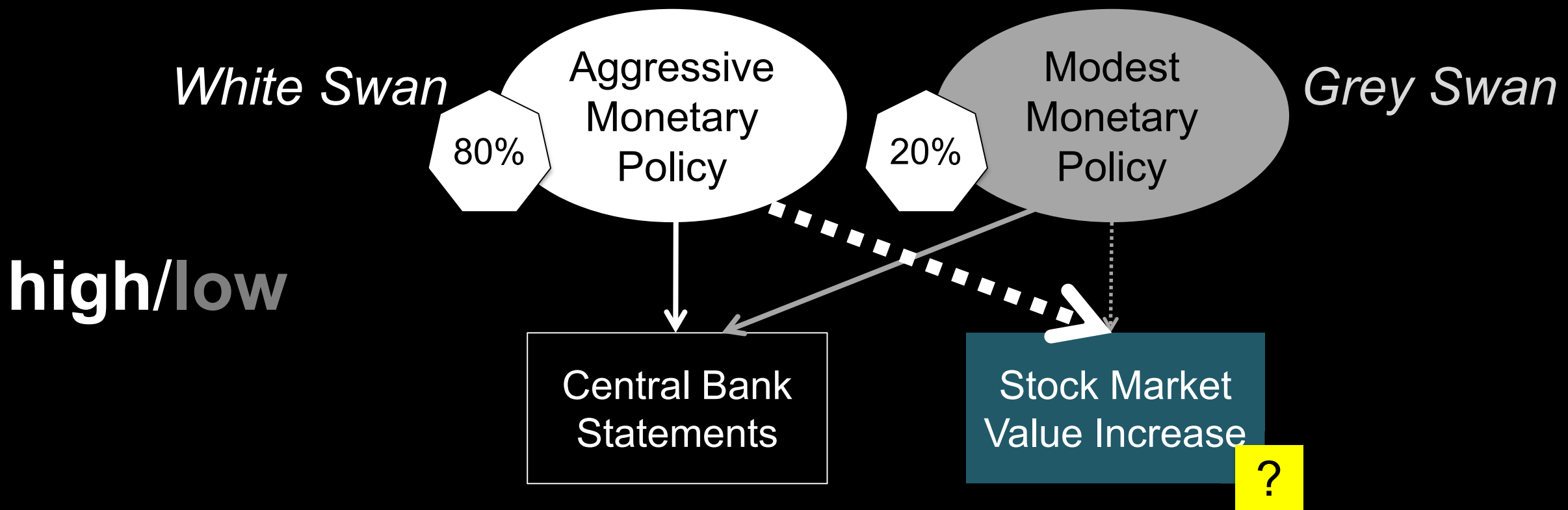
Degrees of belief



$$\begin{aligned}
 P(\text{Policy}) = & P(\text{Policy}|\text{Good}) \times P(\text{Good}) + P(\text{Policy}|\text{Bad}) \times P(\text{Bad}) \\
 = & 90\% \times 100\% + 10\% \times 0\% = 90\%
 \end{aligned}$$

*Digital
(all-or-nothing)
beliefs*



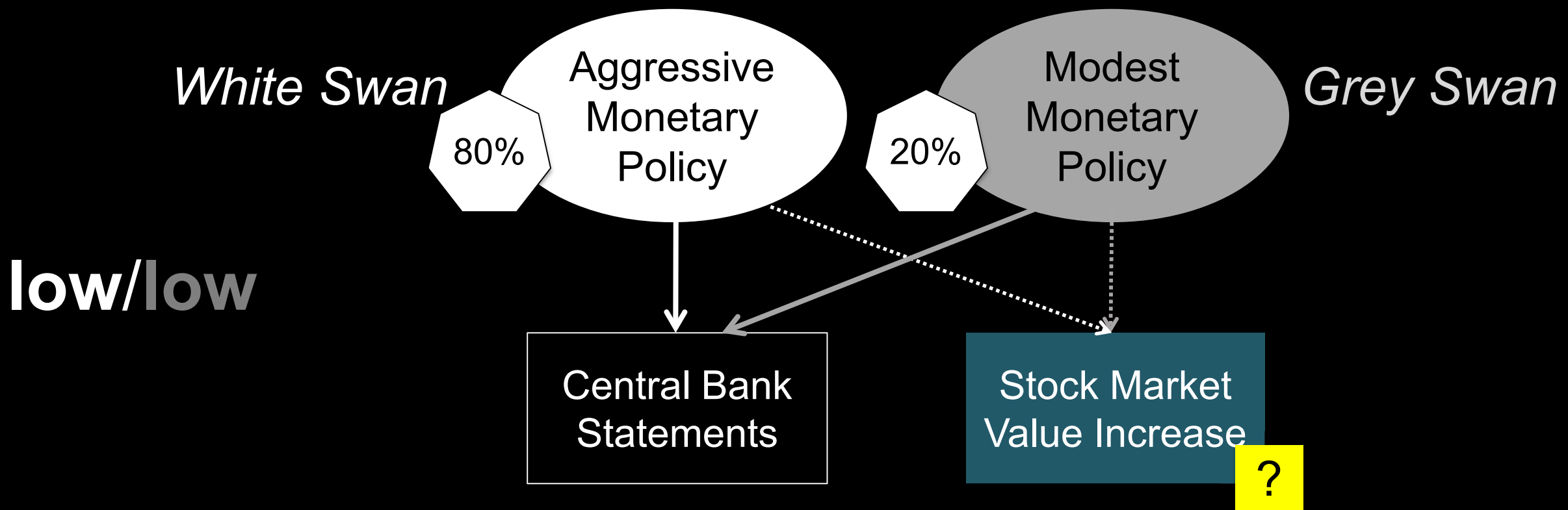


Imagine that the U.S. central bank is deciding what policies to adopt.

If they intend to adopt an aggressive monetary policy, the value of the stock market is **likely** to go up.

If they intend to adopt a modest monetary policy, the value of the stock market is **unlikely** to go up.

Suppose that the central bank chair says that the bank is concerned about the economy and considering a more aggressive monetary policy.

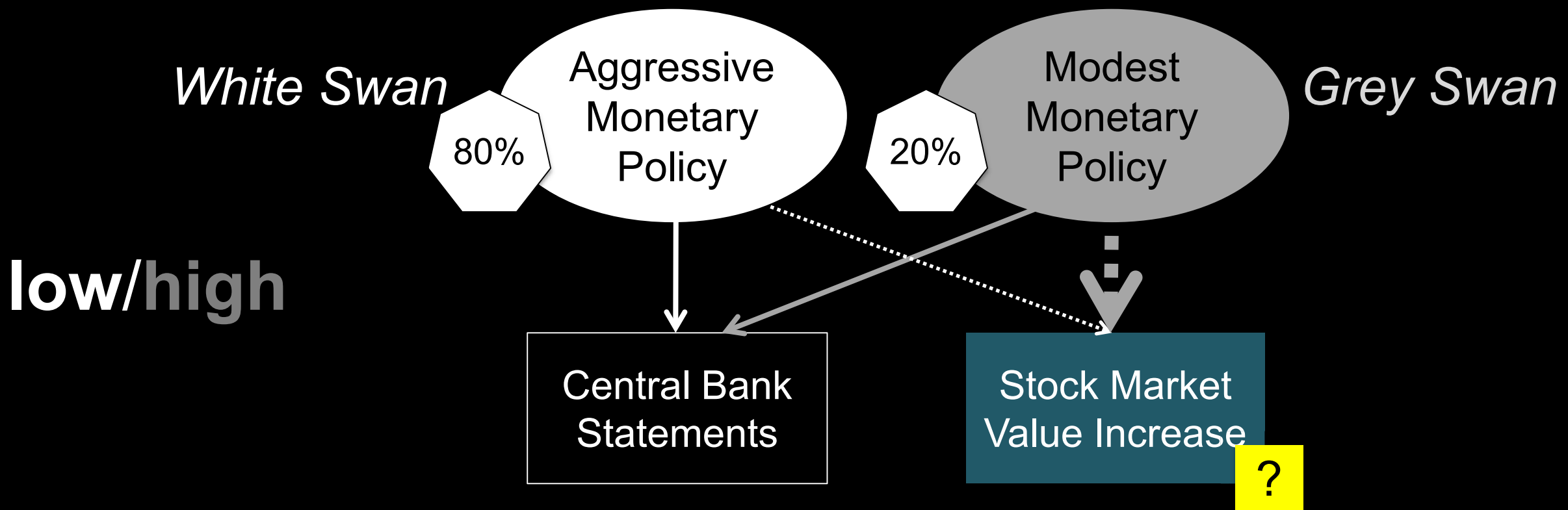


Imagine that the U.S. central bank is deciding what policies to adopt.

If they intend to adopt an aggressive monetary policy, the value of the stock market is unlikely to go up.

If they intend to adopt a modest monetary policy, the value of the stock market is unlikely to go up.

Suppose that the central bank chair says that the bank is concerned about the economy and considering a more aggressive monetary policy.



Imagine that the U.S. central bank is deciding what policies to adopt.

If they intend to adopt an aggressive monetary policy, the value of the stock market is unlikely to go up.

If they intend to adopt a modest monetary policy, the value of the stock market is likely to go up.

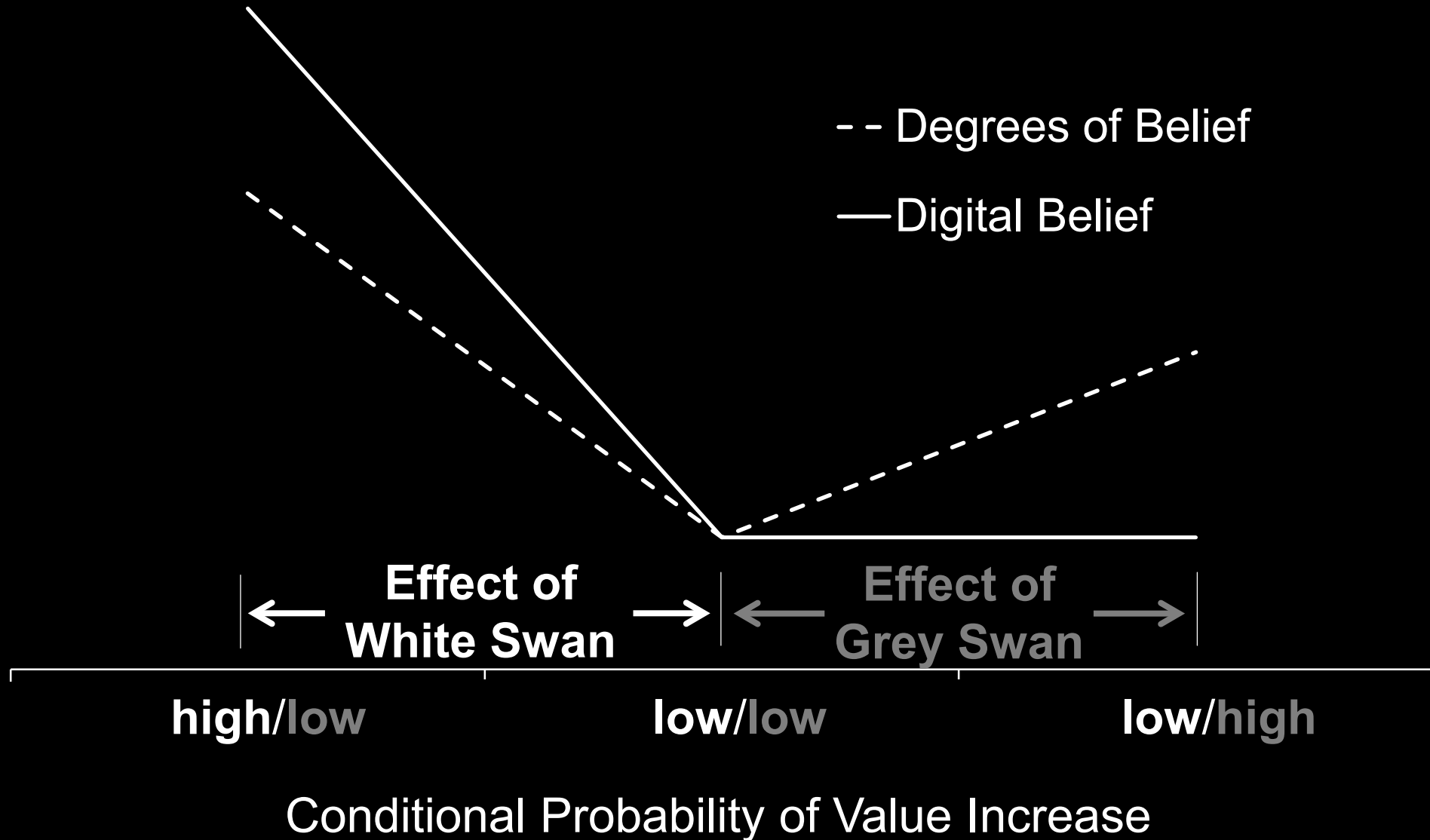
Suppose that the central bank chair says that the bank is concerned about the economy and considering a more aggressive monetary policy.

Qualitative Predictions

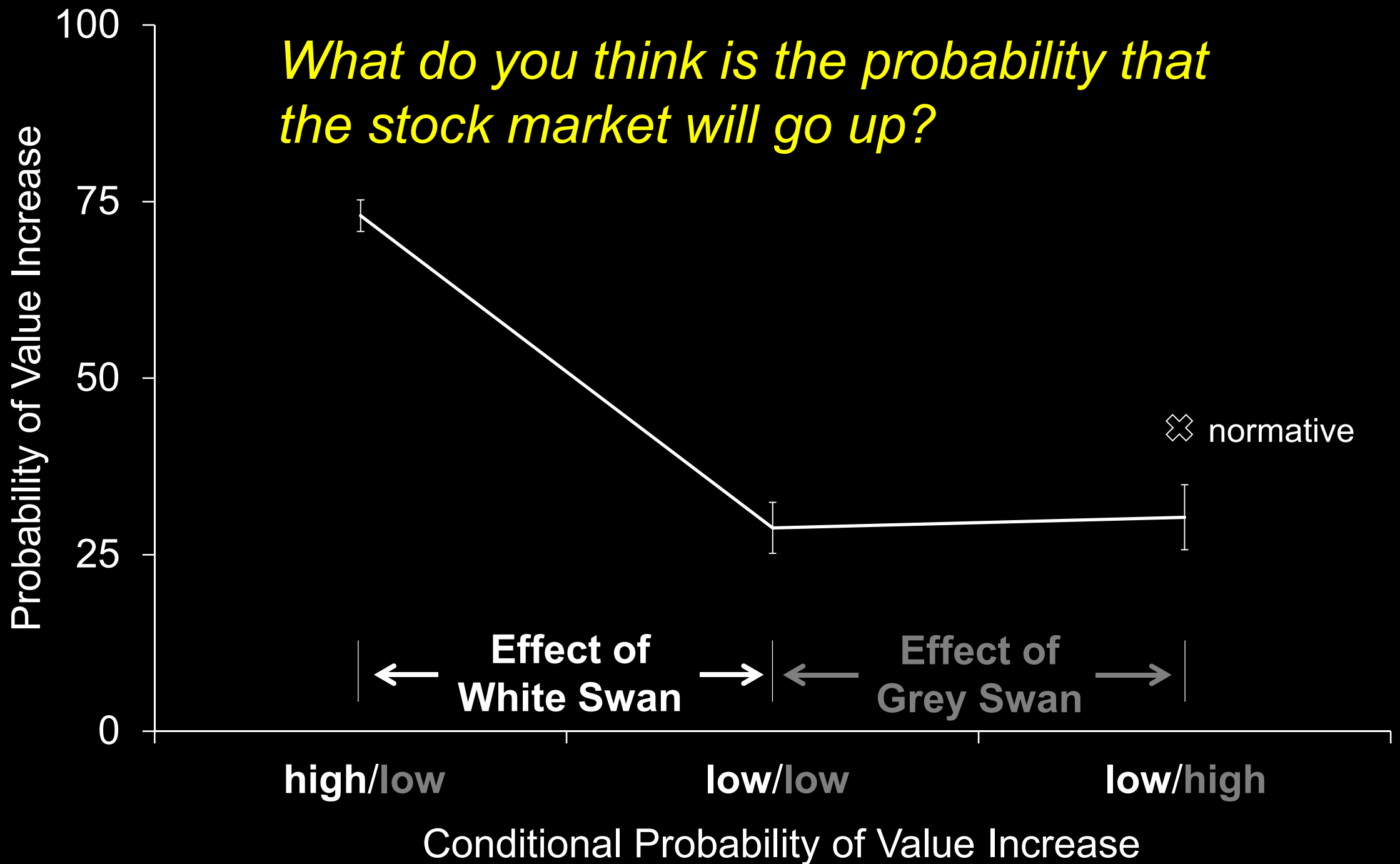
Probability of Value Increase

-- Degrees of Belief

— Digital Belief



What do you think is the probability that the stock market will go up?



N=100

Further Evidence

- Similar results...
 - when priors explicitly given
 - when predicting price levels
 - for individual stocks
- Effects of expertise?
 - Not within sample of laypeople
 - Possibly similar effects among finance experts (preliminary)

Implications

- *In behavioral economics*
 - A source of investor overconfidence
 - A possible explanation for high trading volatility (*Shiller, 1981*)
- *In cognitive science*
 - A heuristic that can circumvent computational explosions
 - A boundary on probabilistic cognitive models

Today

- Two case studies on sense-making and expectations
 - Grey Swans
 - Price Patterns
- Why behavioral economics needs cognitive science



Price Predictability: Competing Intuitions

- *Momentum*: If a price has been trending in the same direction, it should continue in that direction.
 - E.g., my friend John's adventures with Bitcoin
- *Mean Reversion*: If a price has been trending in the same direction, it's only a matter of time before it reverses.
 - E.g. me, giving desperate advice to my friend John
- *Conjecture*: These intuitions *coexist* in the same individuals, and patterns in price history can influence which narrative is taken up

Price Patterns

- People linearly project past price trends *(De Bondt, 1993)*
- Would people also match more complex patterns?
 - Existence of technical trading suggests they may
 - Taps into human propensity for story-telling
- Predictions: Reversion beliefs triggered by
 - Reversion in recent price history
 - Stability in recent price history

Leffler Mutual Insurance Company (stock symbol LPBN) is an Atlanta-based life insurance company.

Here are several recent price quotations for shares in LPBN stock:

Positive / Linear Positive / Reversal Negative / Linear Positive / Reversal

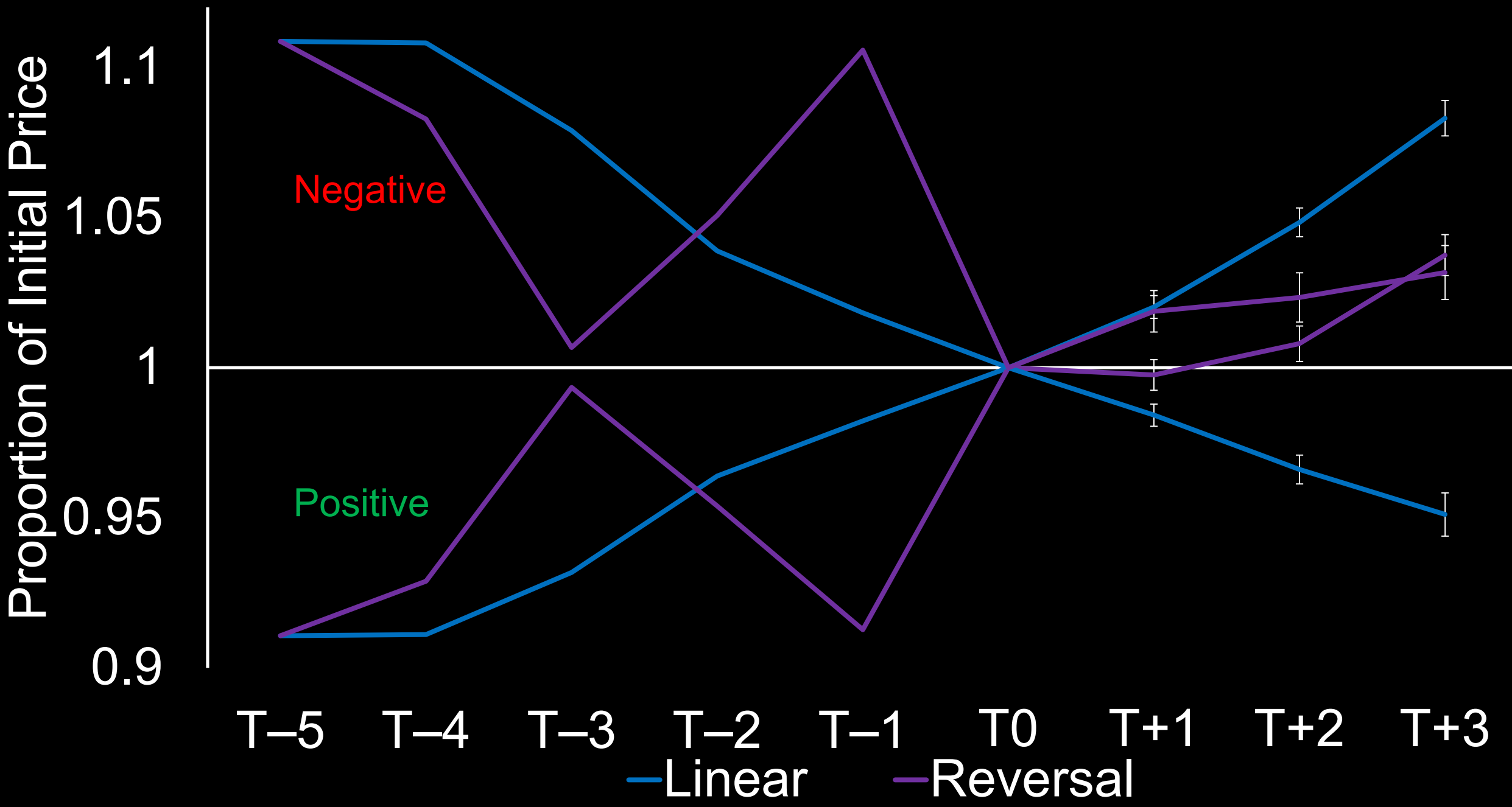
5 months ago:	\$51.00	\$51.00	\$62.09	\$62.09
4 months ago:	\$51.02	\$52.02	\$62.06	\$60.64
3 months ago:	\$52.18	\$55.63	\$60.42	\$56.37
2 months ago:	\$53.98	\$53.42	\$58.18	\$58.84
1 month ago:	\$55.01	\$51.11	\$57.03	\$61.92
Today:	\$56.00	\$56.00	\$56.00	\$56.00

\$28

\$56

\$84

In 1 month:	_____
In 2 months:	_____
In 3 months:	_____



Leffler Mutual Insurance Company (stock symbol LPBN) is an Atlanta-based life insurance company.

Here are several recent price quotations for shares in LPBN stock:

Positive / Linear

Positive / Stable

Negative / Linear

Positive / Stable

5 months ago:

\$51.00

\$52.55

\$62.09

\$59.93

4 months ago:

\$51.02

\$53.01

\$62.06

\$59.35

3 months ago:

\$52.18

\$52.36

\$60.42

\$60.18

2 months ago:

\$53.98

\$52.86

\$58.18

\$59.54

1 month ago:

\$55.01

\$52.42

\$57.03

\$60.10

Today:

\$56.00

\$56.00

\$56.00

\$56.00

\$28

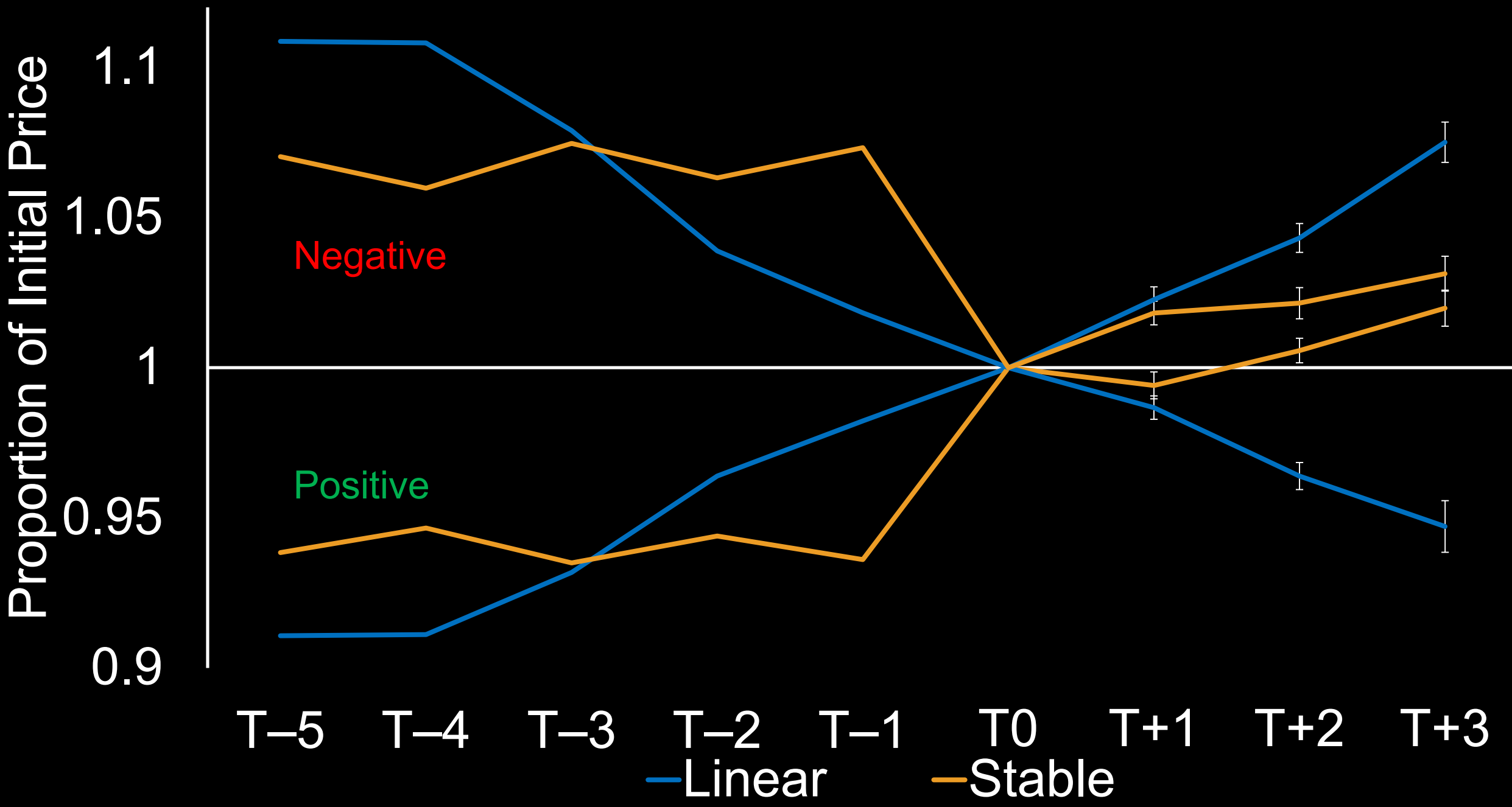
\$56

\$84

In 1 month:

In 2 months:

In 3 months:



Further Evidence

- Similar results...
 - for other kinds of prices (financial and consumer goods)
 - for real stock prices
 - in an incentivized task
- Effects of expertise?
 - Not within sample of laypeople
 - Possibly similar effects among finance experts (preliminary)

Implications

- *In behavioral economics*
 - Indicates possibility of framing effects in expectations
 - Empirical inadequacy of rational expectations and extrapolation models
- *In cognitive science*
 - People think beyond the linear – we are narrative creatures
 - A good strategy in many domains – but misleading in finance

Today

- Two case studies on sense-making and expectations
 - Grey Swans
 - Price Patterns
- Why behavioral economics needs cognitive science

Cognitive Science

- Studies internal states
- Develops a rich conception of human nature
- Attends equally to success and failure
- Respects intellectual and methodological pluralism
- Has different blind spots compared to economics

Thank you!



Faith Hill



Tamri Matiashvili



David Tuckett

Funding:

*American Psychological Association
Institute for New Economic Thinking*