Princeton Initiative: Bubbles

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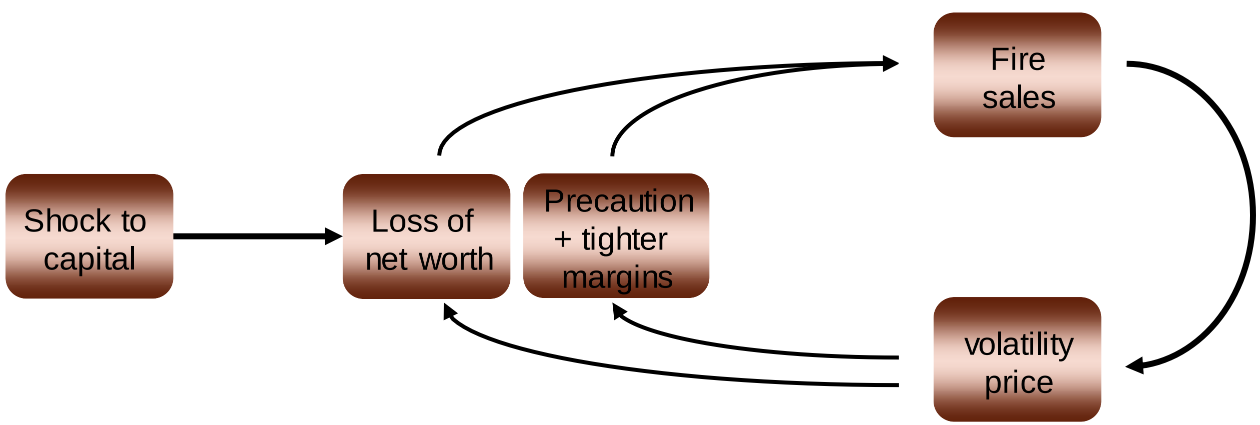
Systemic risk – a broad definition

- Systemic risk build-up during (credit) bubble
  … and materializes in a crisis
  - "Volatility Paradox" → contemp. measures inappropriate
- Spillovers/contagion – externalities
  - Direct contractual: domino effect (interconnectedness)
  - Indirect: price effect (fire-sale externalities)
    credit crunch, liquidity spirals



  - *Adverse GE response* ⇨ amplification, persistence

preventive

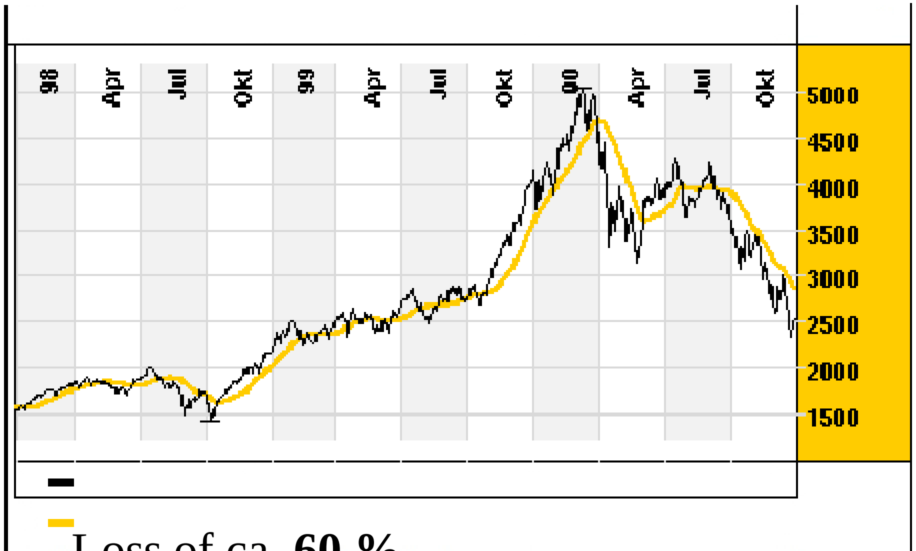
crisis management

Bubbles and Crashes

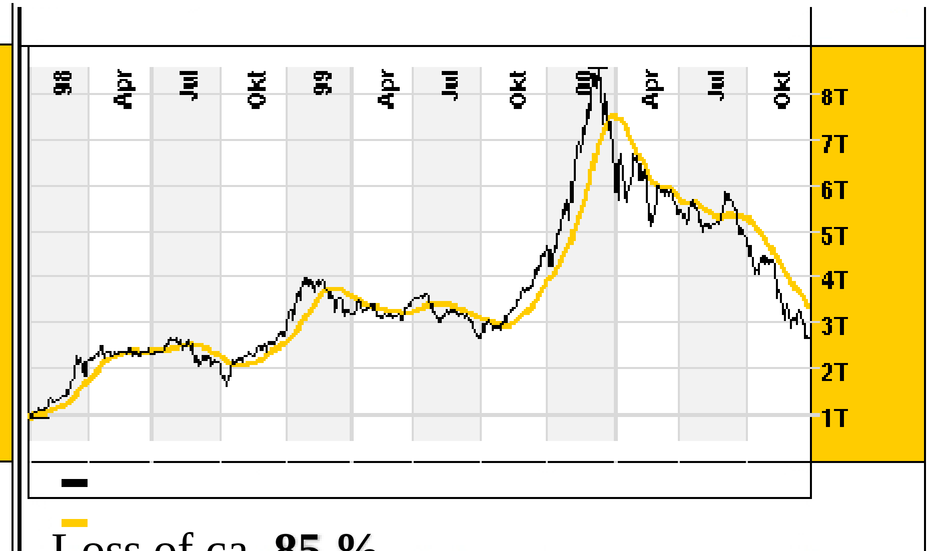
Dilip Abreu and Markus Brunnermeier

Princeton University

Internet bubble - 1990's



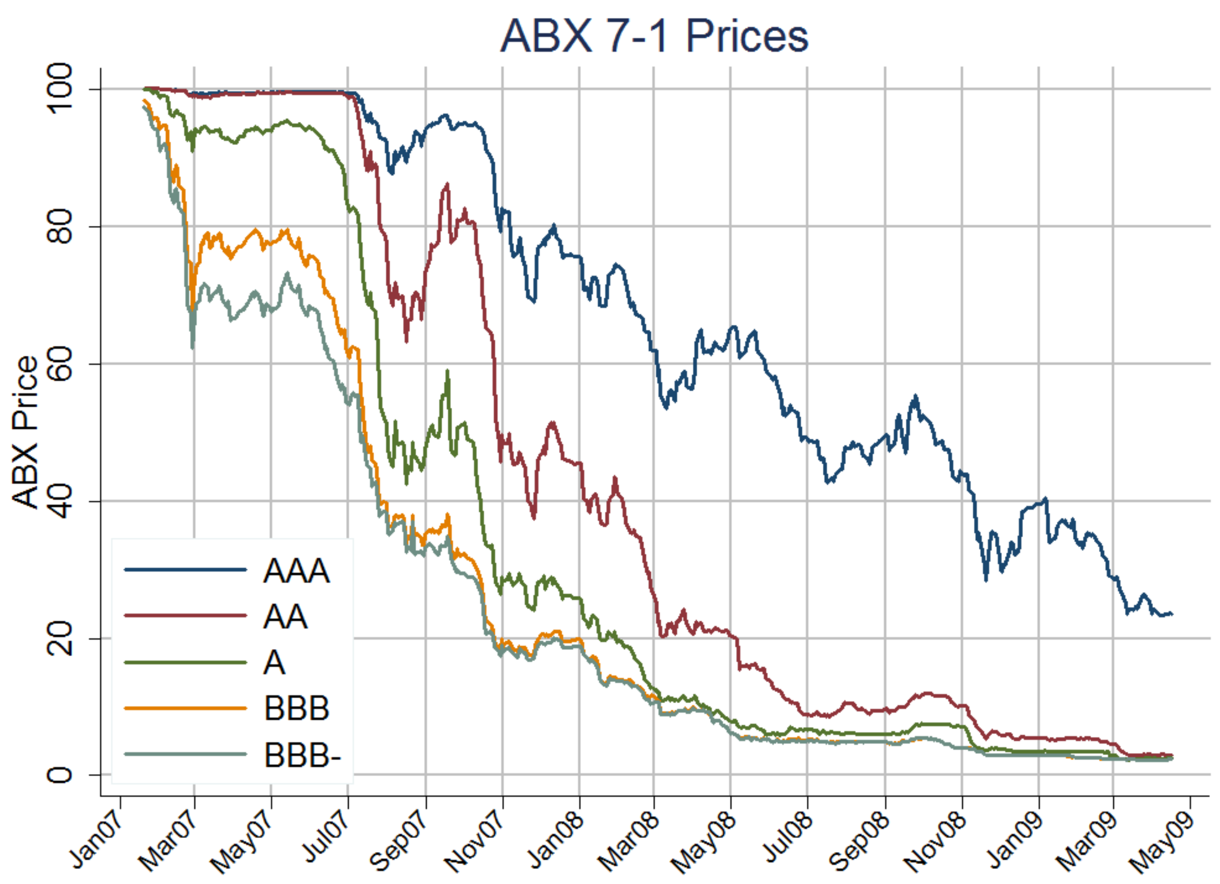
Loss of ca. **60 %**
from high of $ 5,132



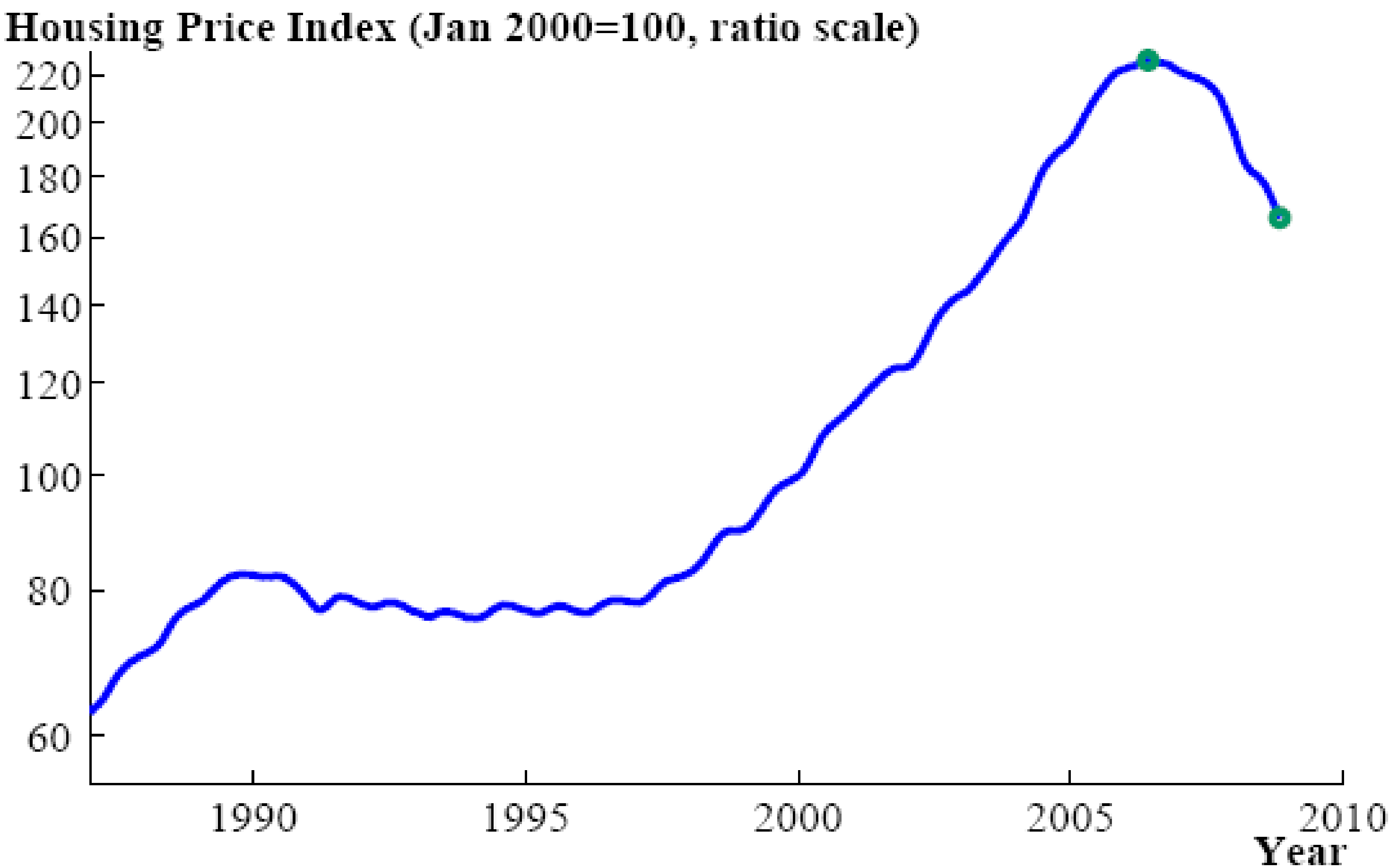
Loss of ca. **85 %**
from high of Euro 8,583

- Why do bubbles persist?
- Do professional traders ride the bubble or attack the bubble (go short)?
- What happened in March 2000?

Credit bubble 2004-2006



US House price index – Case-Shiller



Do (rational) professionals ride the bubble?

- South Sea Bubble (1710-1720)
  - Issac Newton
    - 04/20/1720 sold shares at £ 7,000 profiting £3,500
    - Re-entered the market later – ending up losing £20,000
    - "I can calculate the motions of the heavenly bodies, but not the madness of people"
- Internet Bubble (1992 – 2000)
  - Druckenmiller of Soros' Quantum Fund didn't think that he party would end so quickly.
    - "We thought it was the eighth inning, and it was the ninth."
  - Julian Robertson of Tiger Fund refused internet stocks.
- Housing bubble (2007)
  - Chuck Prince "Dance as long as the music is playing"

Stylized facts

- Initial innovation justifies some price increase
- Momentum leads to price overshooting
  - Extrapolative expectations
- Many market participants seem to be aware that the "price is too high" but keep on holding the asset
  - "Play as long as the music is playing"
- Resell-option is crucial for speculative bubbles
- Minksy moment – triggered by "trivial news"
- Credit bubbles lead to extra amplification effects in downturn (since they can impair financial sector)
  - subprime borrowing was only 4% of US mortgage market

Minsky moment – Wile E. Coyote Effect

Overview of Bubble Literature

- Rational bubbles
  - Difference equation $b_t = E_t^Q[\frac{1}{1+r} b_{t+1}]$
  - No zero-sum argument
- OLG and incompleteness frictions (morning lecture)
  - Samuelson, Triole,… Bewley, …Noise trader risk (DSSW)
- Informational frictions
  - Synchronization Risk (Abreu & Brunnermeier 2003)
- Delegated investment friction
  - Allen & Gorton 1993, Allen & Gale 2000, Shleifer & Vishny 1997
- Heterogeneous beliefs bubbles
  - Harrison & Kreps 1978, Scheinkman & Xiong, Hong & Stein

On Market Efficiency

- Keynes (1936) $\Rightarrow$ bubble can emerge
  - "It might have been supposed that *competition between expert professionals*, possessing judgment and knowledge beyond that of the average private investor, would correct the vagaries of the ignorant individual left to himself."

- Friedman (1953), Fama (1965)

  Efficient Market Hypothesis $\Rightarrow$ no bubble emerges
  - "If there are many sophisticated traders in the market, they may cause these "bubbles" to burst before they really get under way."

Limits to Arbitrage

- Fundamental risk (Campell & Kyle 1993)
  - Risk that fundamental overturns mispricing
- Noise trader risk (DSSW)
  - Risk that irrational traders drive price even further from fundamentals
- Synchronization risk
  - One trader alone cannot correct mispricing (can sustain a trade only for a limited time)
  - Risk that other rational traders do not act against mispricing (in sufficiently close time)
  - Relatively unimportant news can serve as synchronization device and trigger a large price correction

Timing Game - Synchronization

- (When) will behavioral traders be overwhelmed by rational arbitrageurs?
- *Collective* selling pressure of arbitrageurs *more than suffices* to burst the bubble.
- Rational arbitrageurs understand that an *eventual* collapse is inevitable.
  But when?
- Delicate, difficult, dangerous *TIMING GAME !*

Elements of the Timing Game

- *Coordination* at least $\kappa > 0$ arbs have to be 'out of the market'
- *Competition* only *first* $\kappa < 1$ arbs receive pre-crash price.
- *Profitable ride* ride bubble as long as possible.
- *Sequential Awareness*

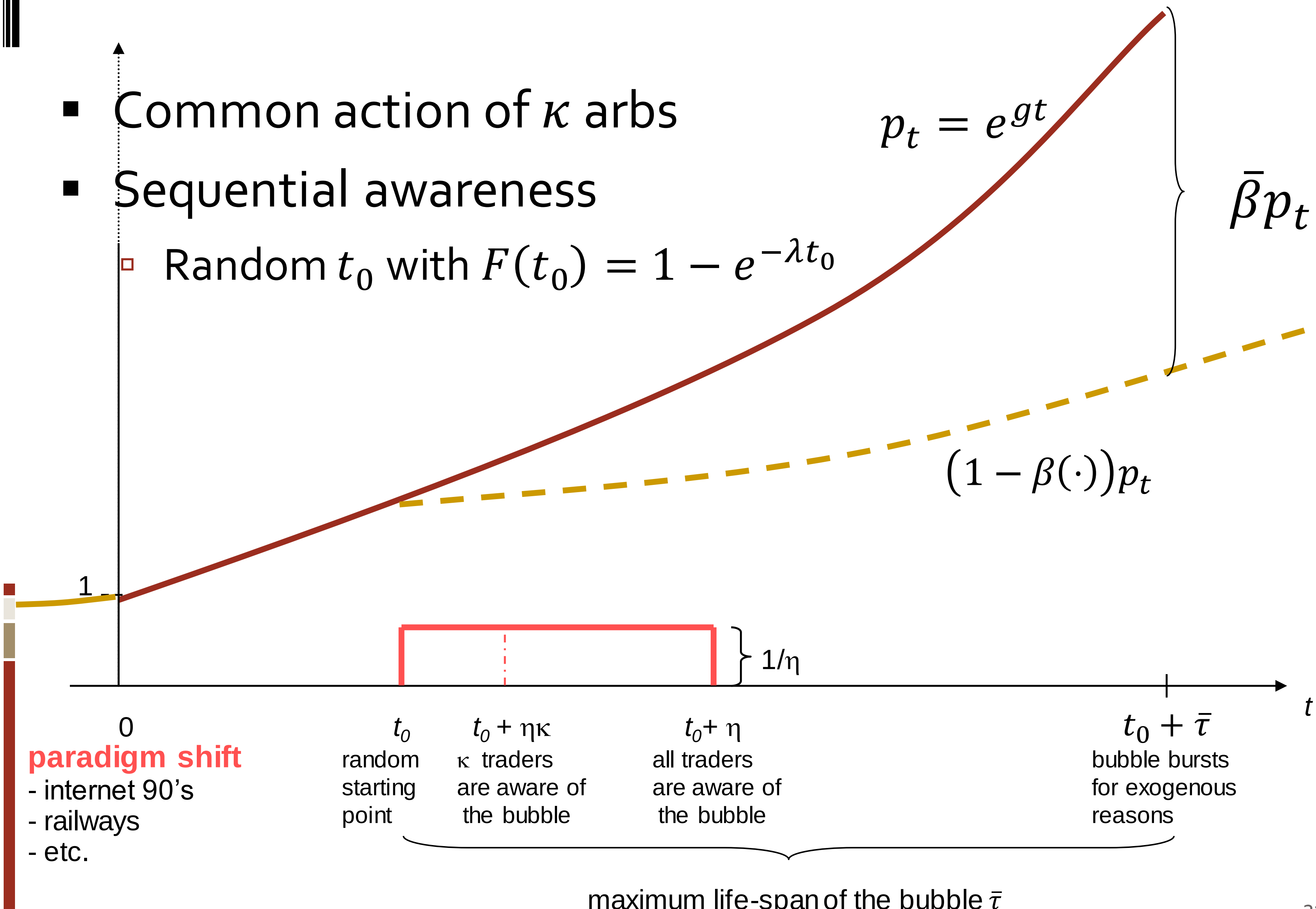
A *Synchronization Problem* arises!

- Absent of sequential awareness competitive element dominates $\Rightarrow$ and bubble burst immediately.
- With sequential awareness incentive to TIME THE MARKET $\Rightarrow$ "delayed arbitrage"
  $\Rightarrow$ persistence of bubble

Overview

- Introduction
- Model setup
- Preliminary analysis
- Persistence of bubbles
- Public events
- Price cascades and rebounds
- Empirical evidence & Hedge funds
  - Brunnermeier & Nagel (2004)

- Common action of κ arbs
- Sequential awareness
  - Random t_0 with $F(t_0) = 1 - e^{-\lambda t_0}$



Payoff structure

- Focus: “when does bubble burst”
- t_0 is only random variables, all other variables are CK
- Cash payoff (difference)
  - Sell one share at $t - \Delta$ instead of at t

$$p_{t-\Delta}e^{r\Delta} - p_t$$

where $p_t = \begin{cases} e^{gt} & \text{prior to crash} \\ \left(1 - \beta(t - t_0)\right)e^{gt} & \text{after the crash} \end{cases}$

  - Price at the time of bursting (tie breaking rule)
    - Pre crash price for first random orders up to κ

Payoff structure, Trading

- Small transaction costs ce^{rt}
- Risk-neutrality but max/min stock position
  - Max long position
  - Max short position
  - Due to capital constraints, margin requirements etc.
- Definition 1: trading equilibrium
  - Perfect Bayesian Nash Equilibrium
  - Belief restriction: trader who attacks at time t believes that all traders who became aware of the bubble prior to her also attack at t.

Sell out condition for $\Delta \to 0$ periods

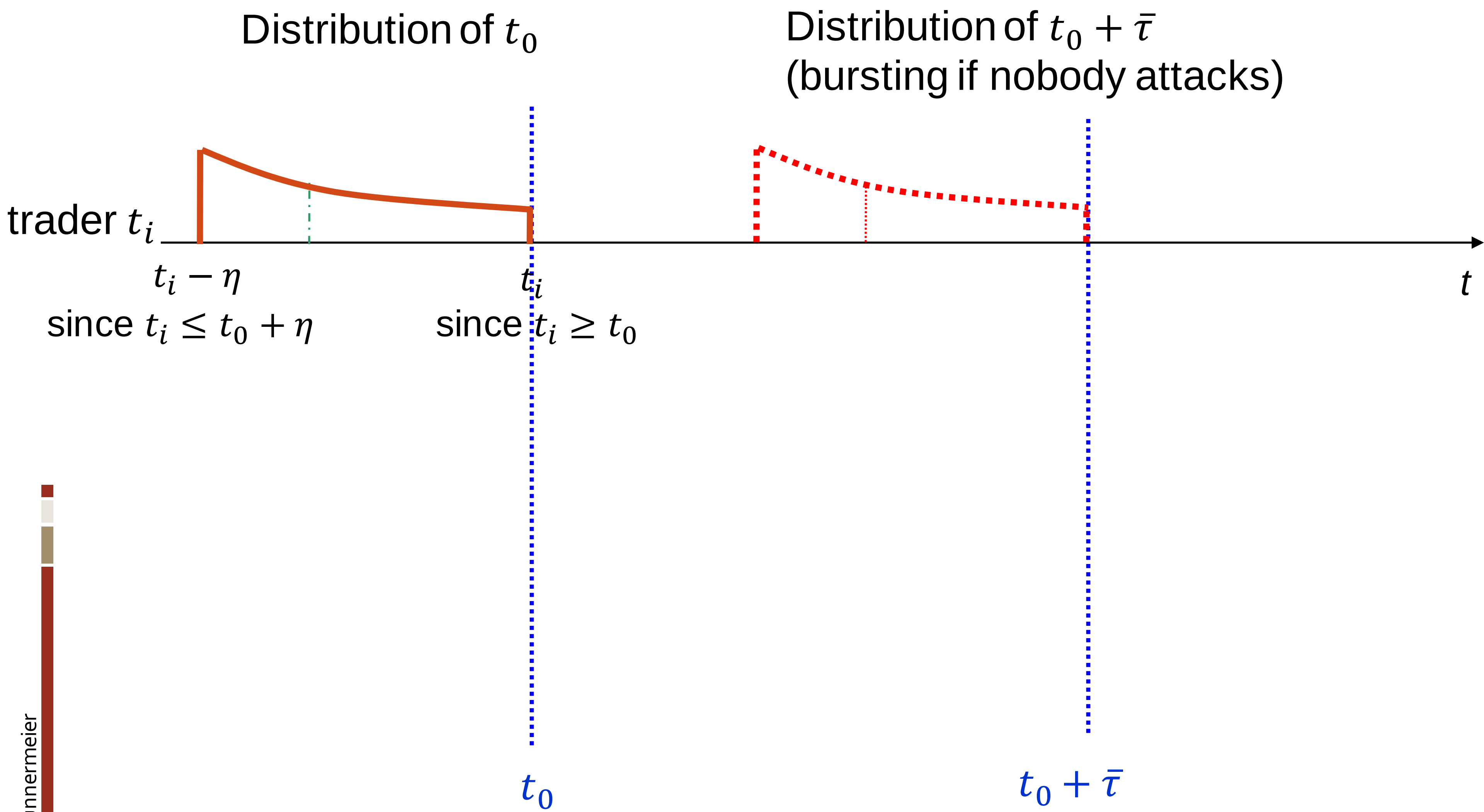
- Sell out at t
  if

$$\Delta h(t|t_i)\underbrace{E_t[\beta p_t|\cdot]}_{\text{benefit of attacking}} \geq (1-\Delta h(t|t_i))\underbrace{\overbrace{(g-r)}^{\text{appreciation rate}}p_t\Delta}_{\text{cost of attacking}}$$

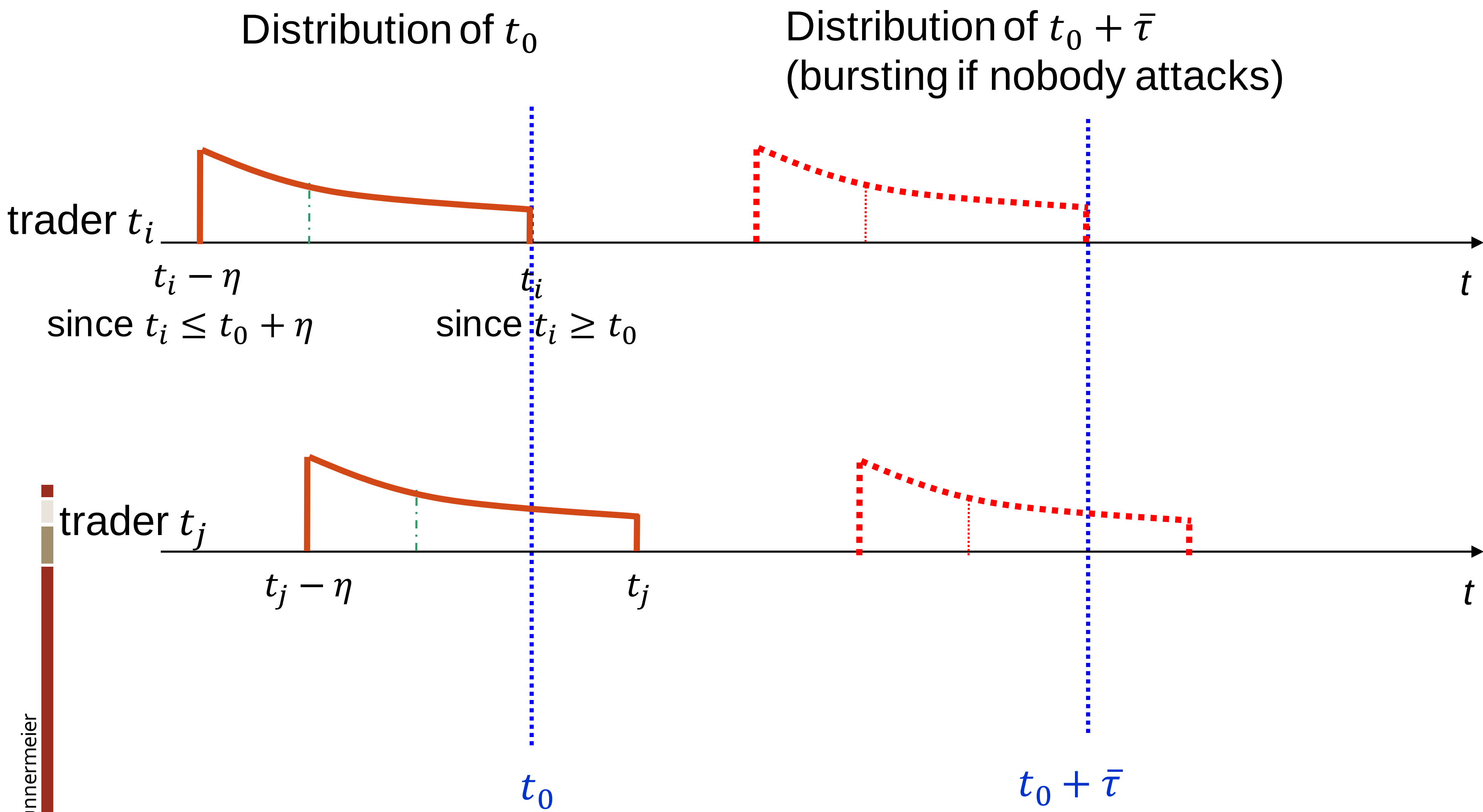
$$h(t|t_i) \geq \frac{g-r}{\beta^*}$$

- RHS $\to (g-r)$ as $t \to \infty$
  - Bursting date: $T^*(t_0) = \min\{T(t_0+\eta\kappa), t_0+\bar{\tau}\}$

Sequential awareness



Sequential awareness



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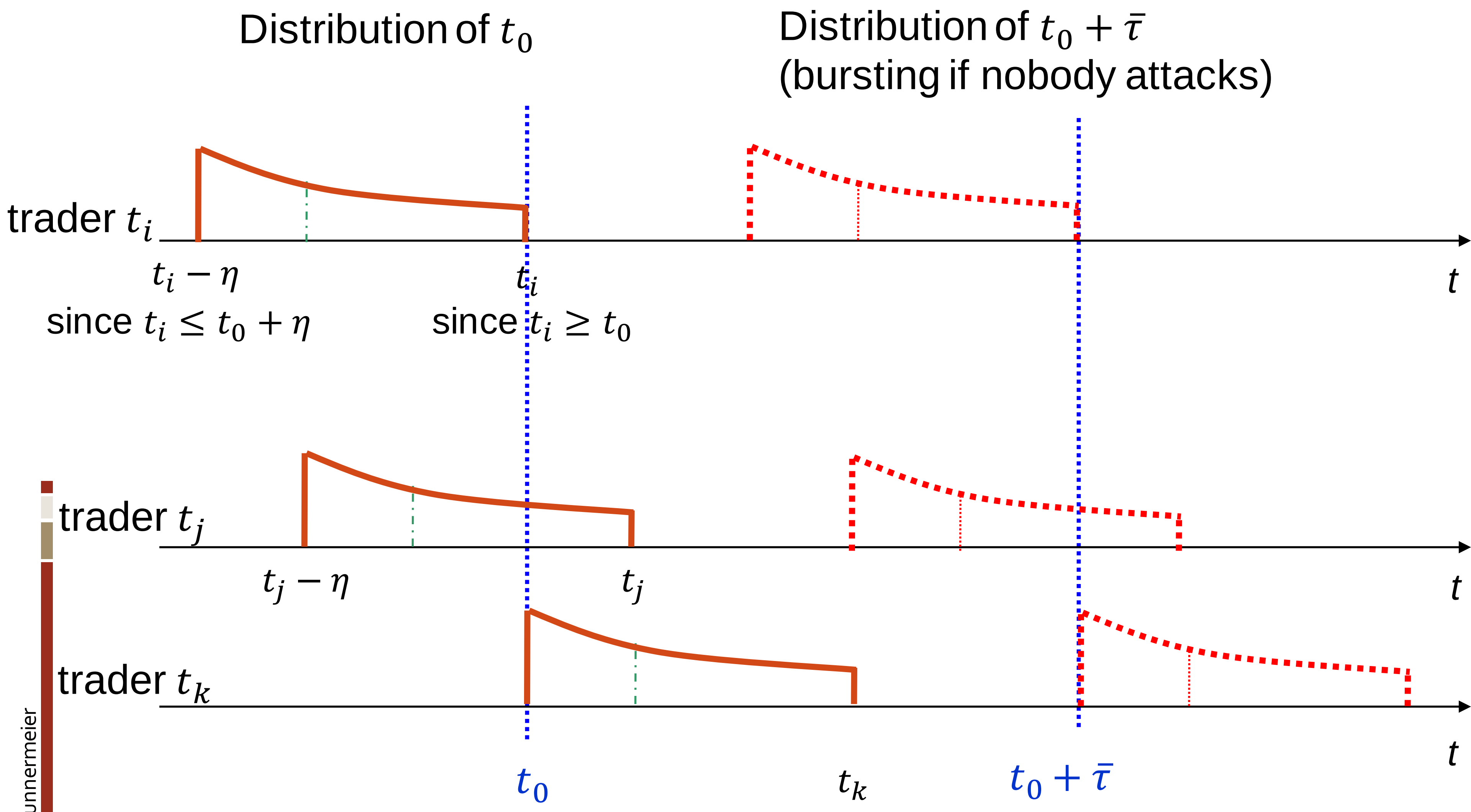
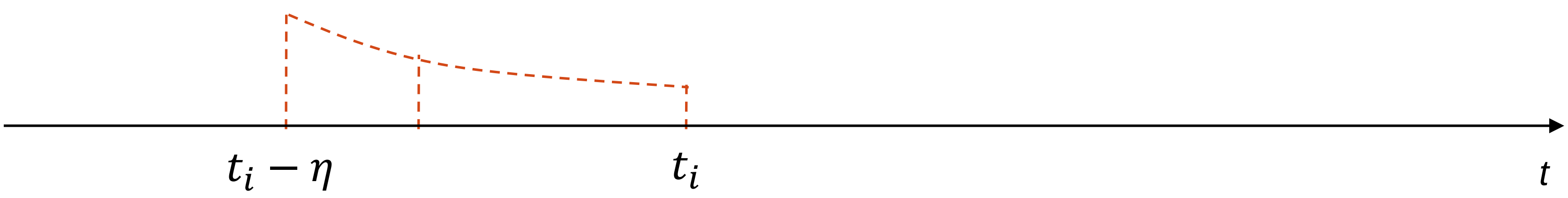
Sequential awareness



Conjecture 1: Immediate attack

⇒ Bubble bursts at $t_0 + \eta\kappa$

when κ traders are aware of the bubble



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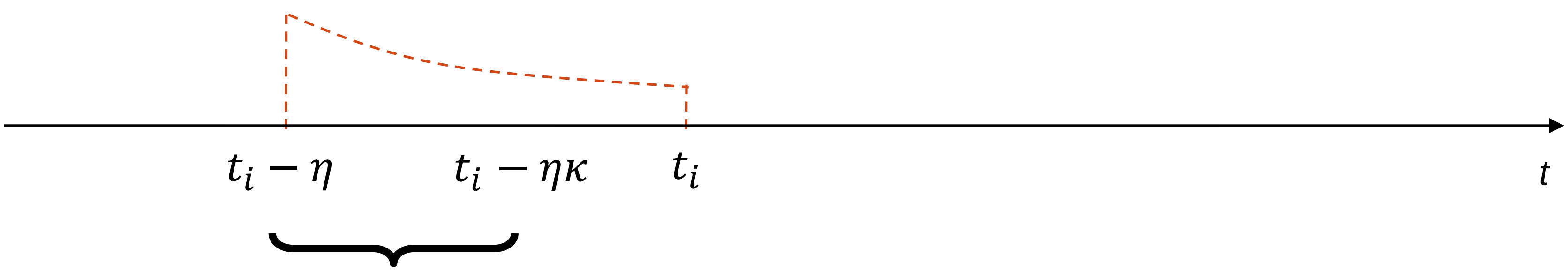
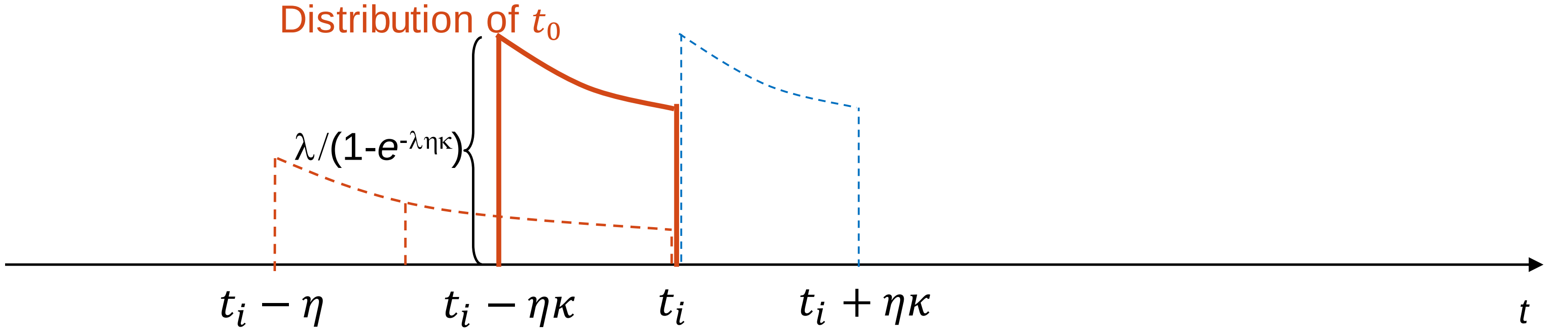


If $t_0 < t_i - \eta\kappa$, the bubble would have burst already.

Conjecture 1: Immediate attack

$\Rightarrow$ **Bubble bursts at $t_0 + \eta\kappa$**

when κ traders are aware of the bubble



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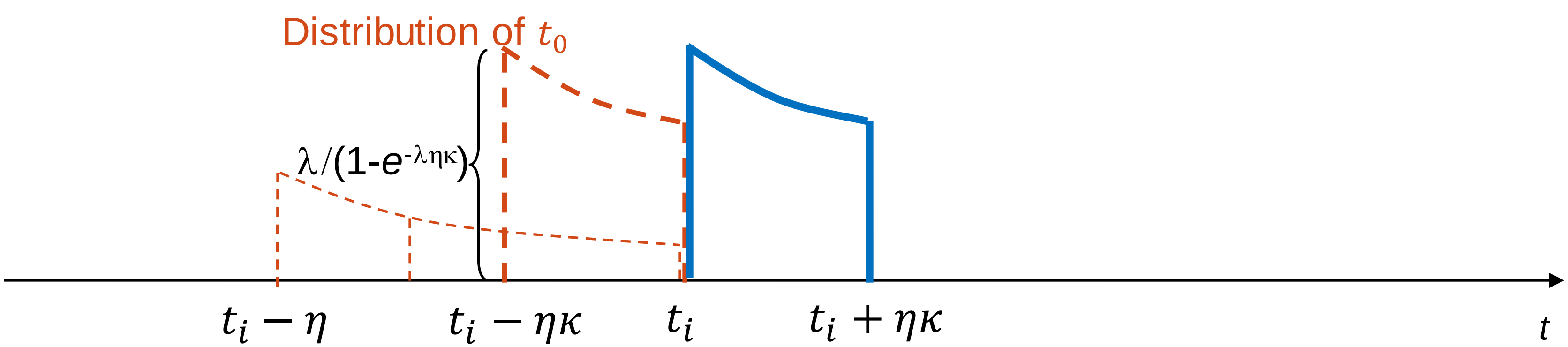

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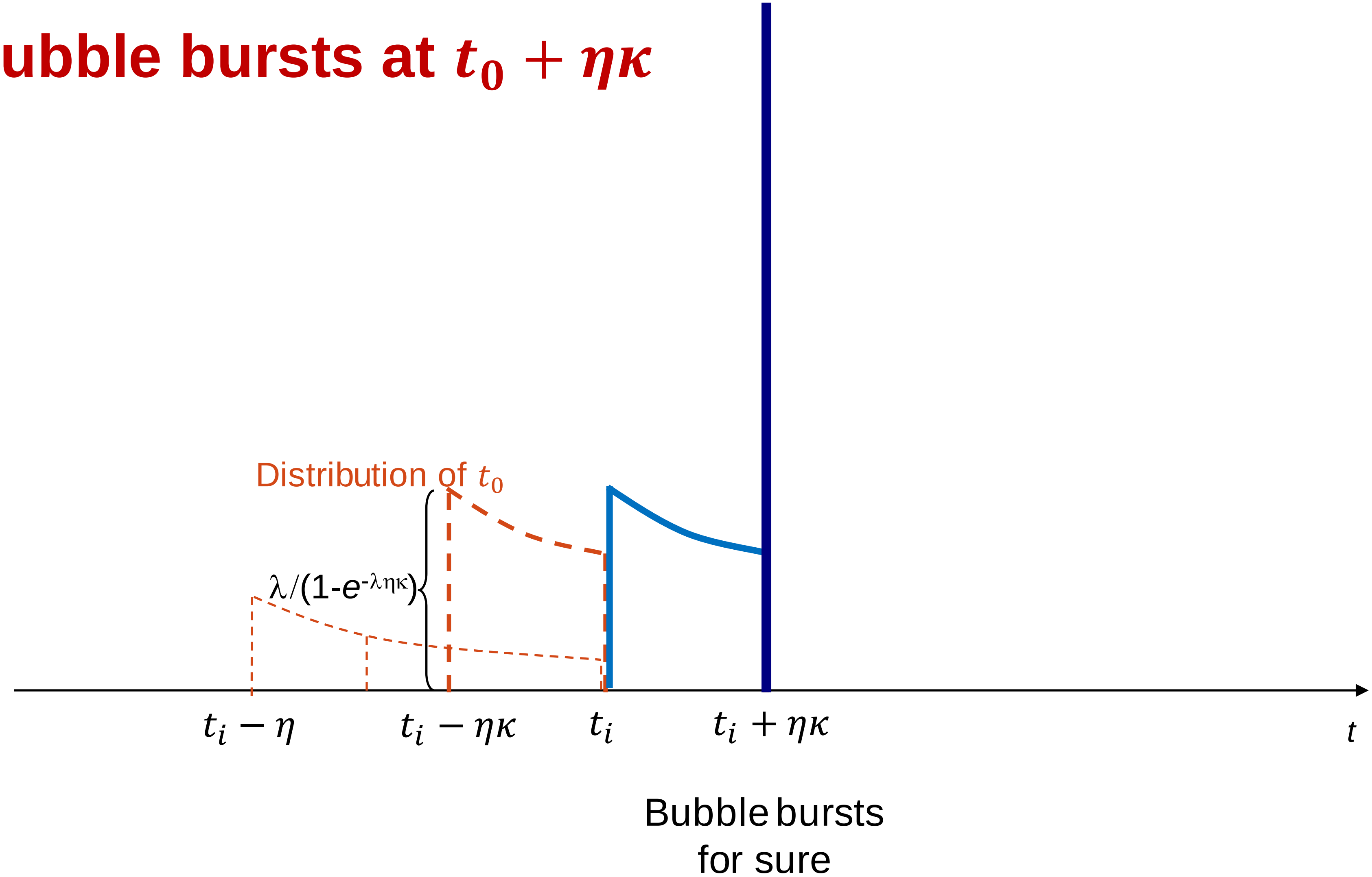

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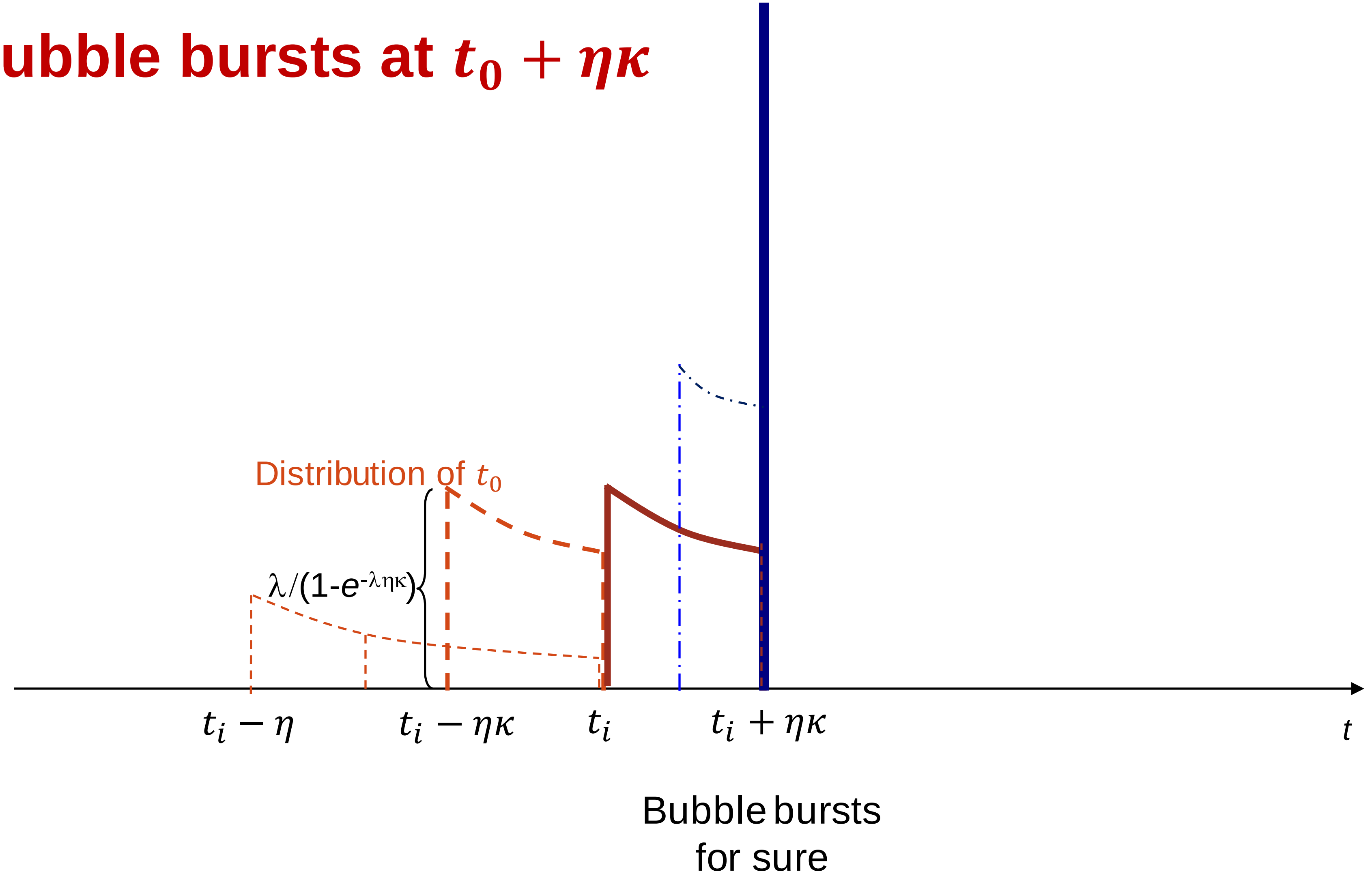

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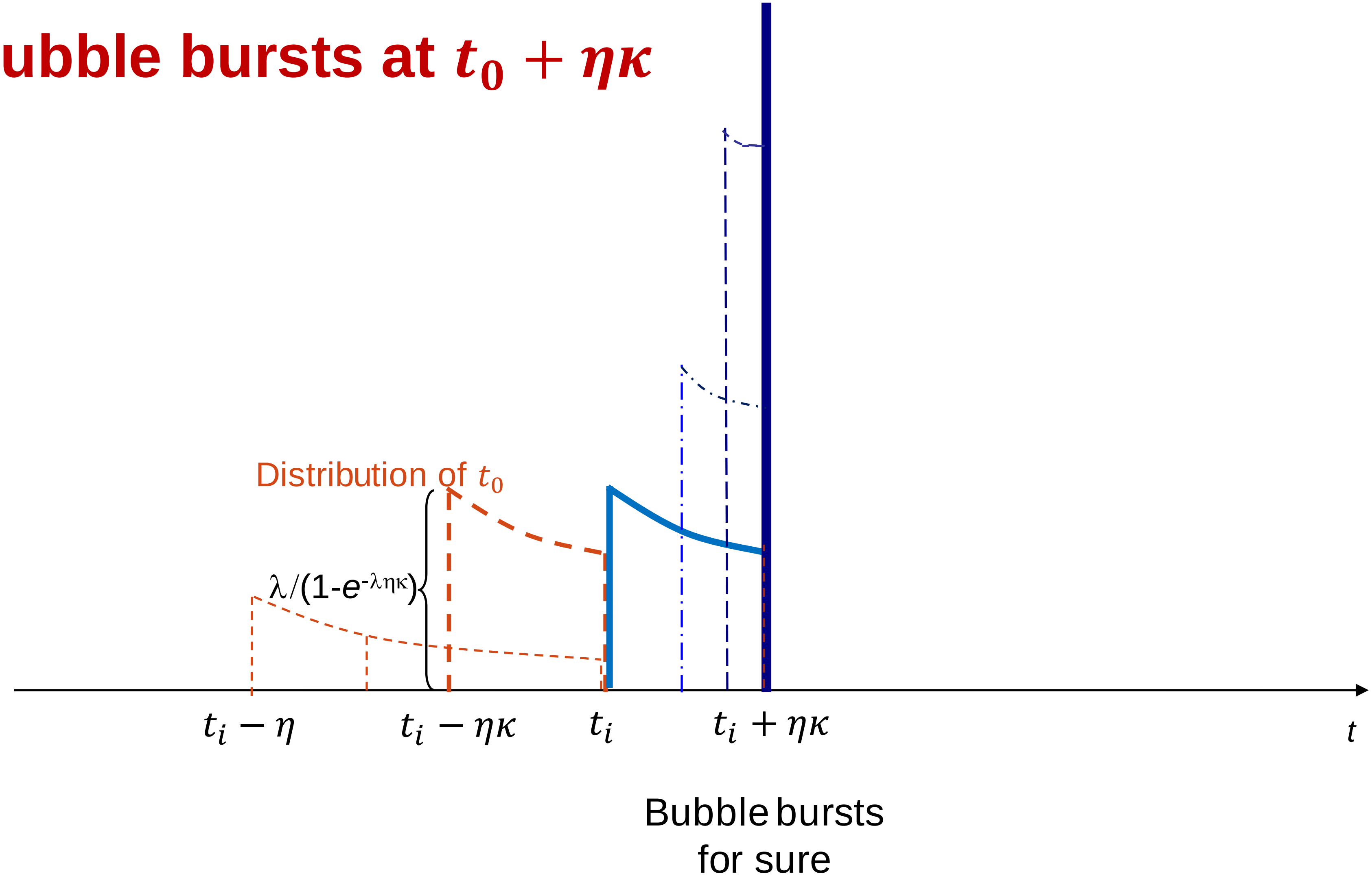

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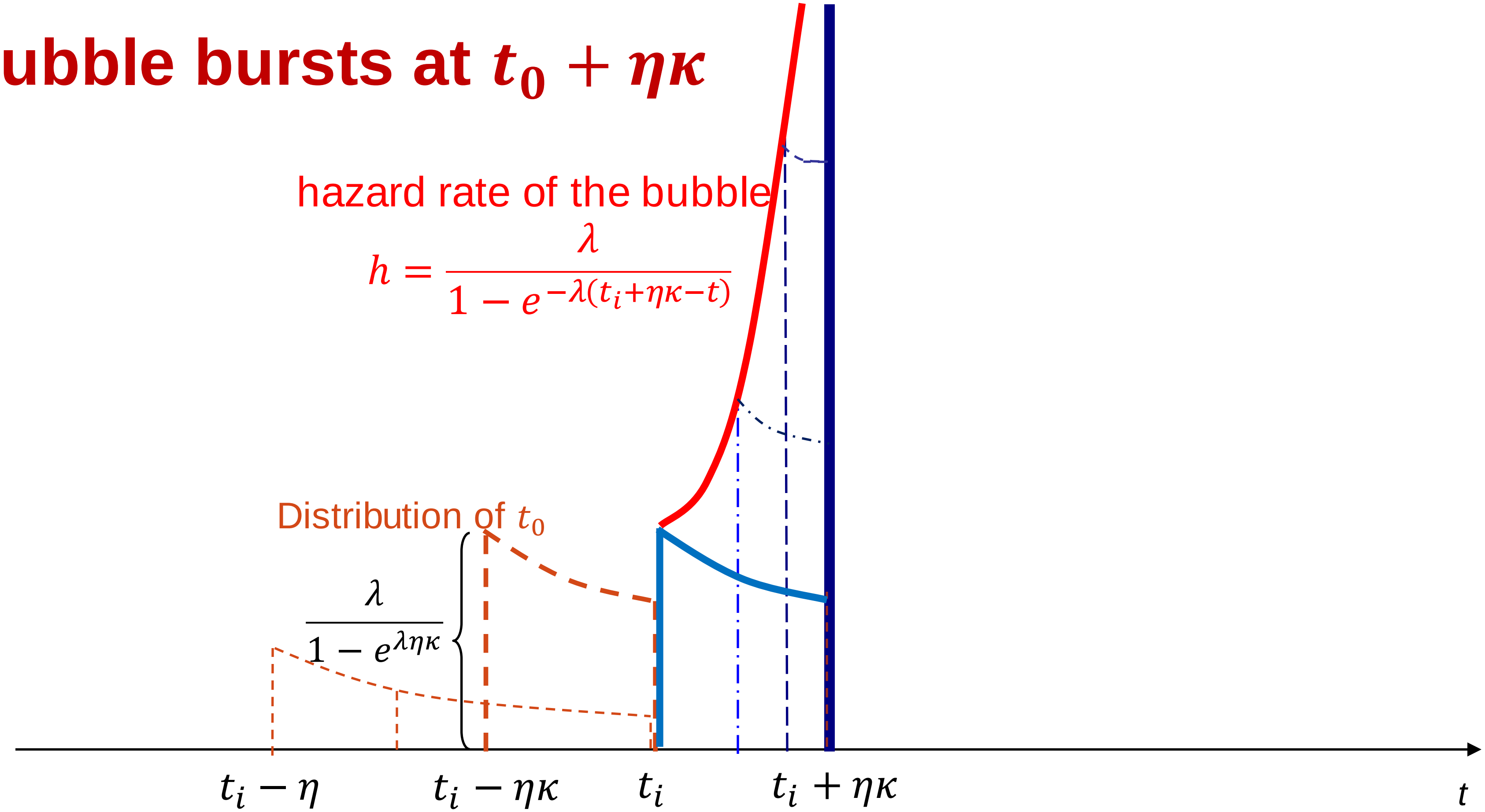
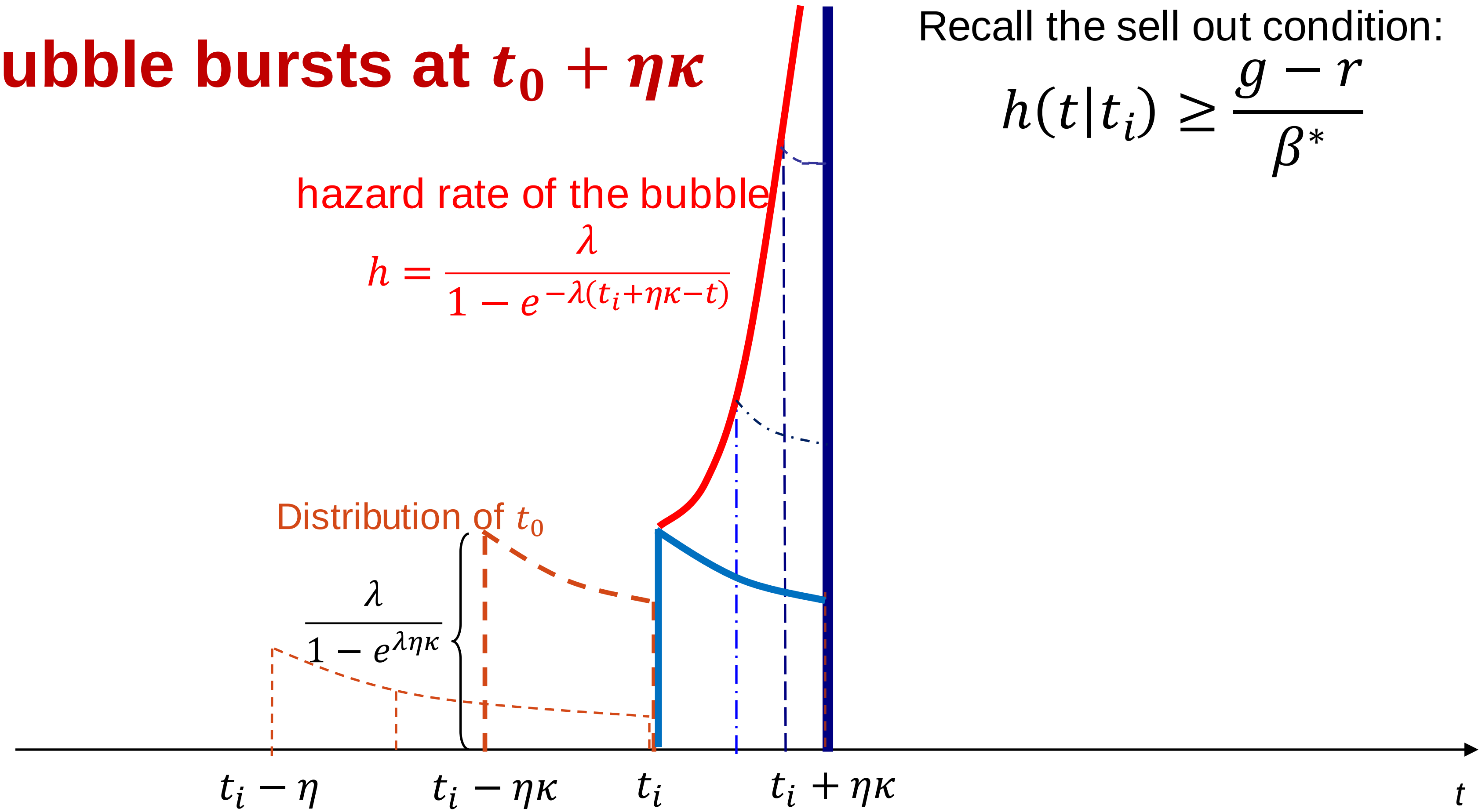


Conjecture 1: Immediate attack

⇒ Bubble bursts at $t_0 + \eta\kappa$

Recall the sell out condition:

$$h(t|t_i) \geq \frac{g - r}{\beta^*}$$



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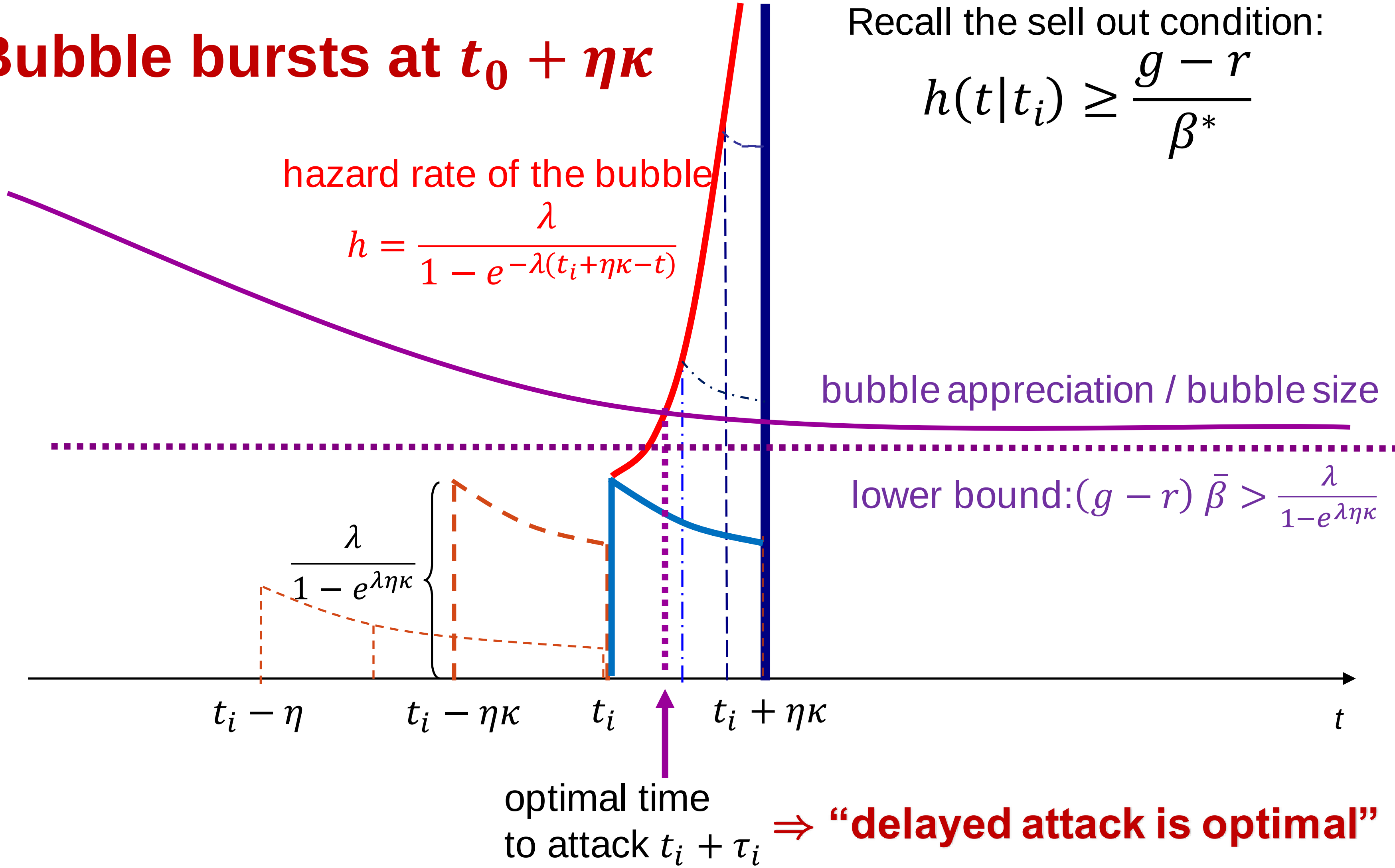

⇒ "delayed attack is optimal"

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Endogenous Crash for large enough $\bar{\tau}$ (i.e. $\bar{\beta}$)

- Proposition 3: Suppose $\frac{\lambda}{1-e^{-\lambda\eta\kappa}} > \frac{g-r}{\bar{\beta}}$
  - Unique trading equilibrium
  - Traders begin attacking after a delay of τ^* periods
  - Bubble bursts due to endogenous selling pressure at a size of p_t times

$$\beta^* = \frac{1-e^{-\lambda\eta\kappa}}{\lambda}(g-r)$$

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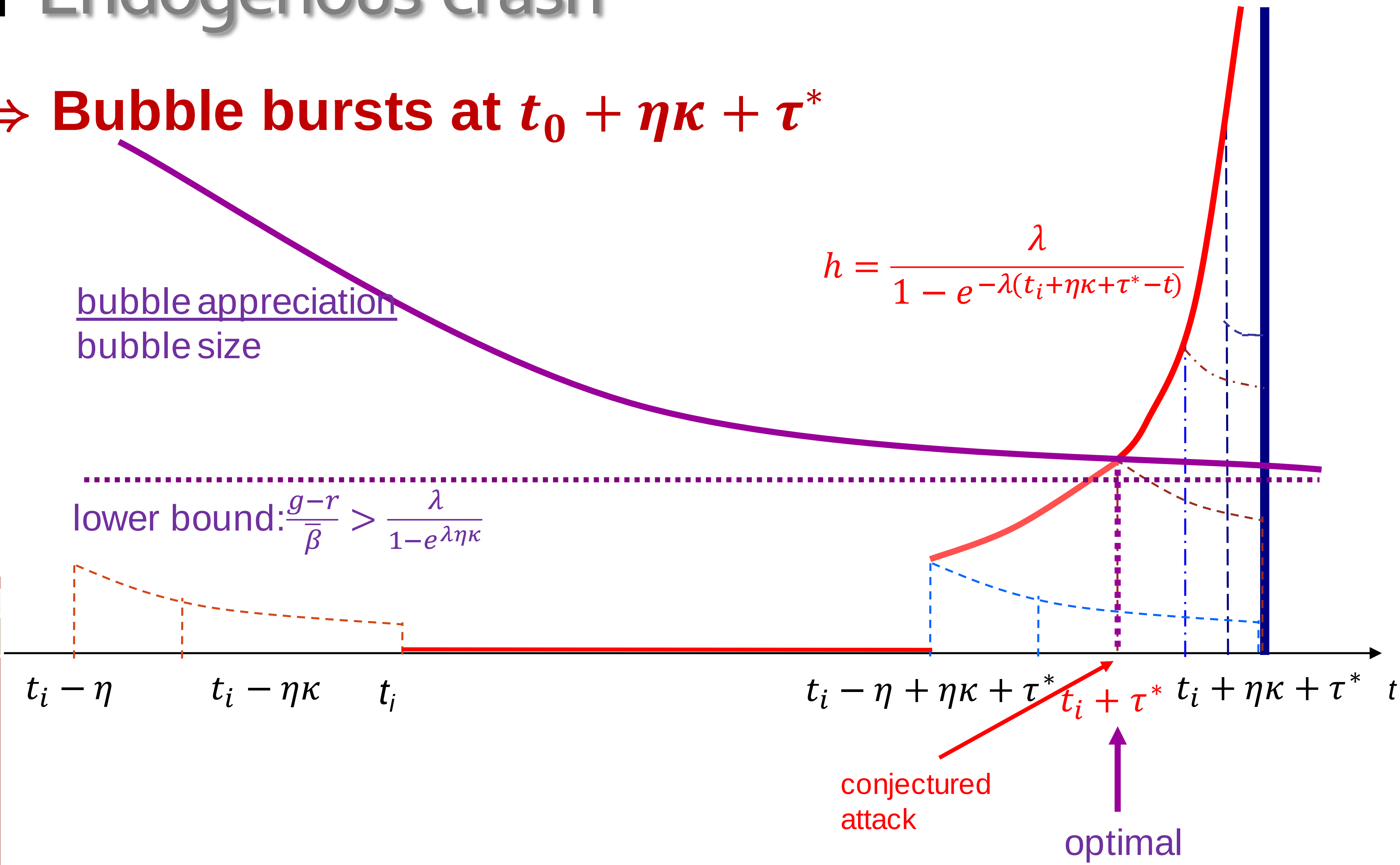
Endogenous crash

$\Rightarrow$ **Bubble bursts at $t_0 + \eta\kappa + \tau^*$**

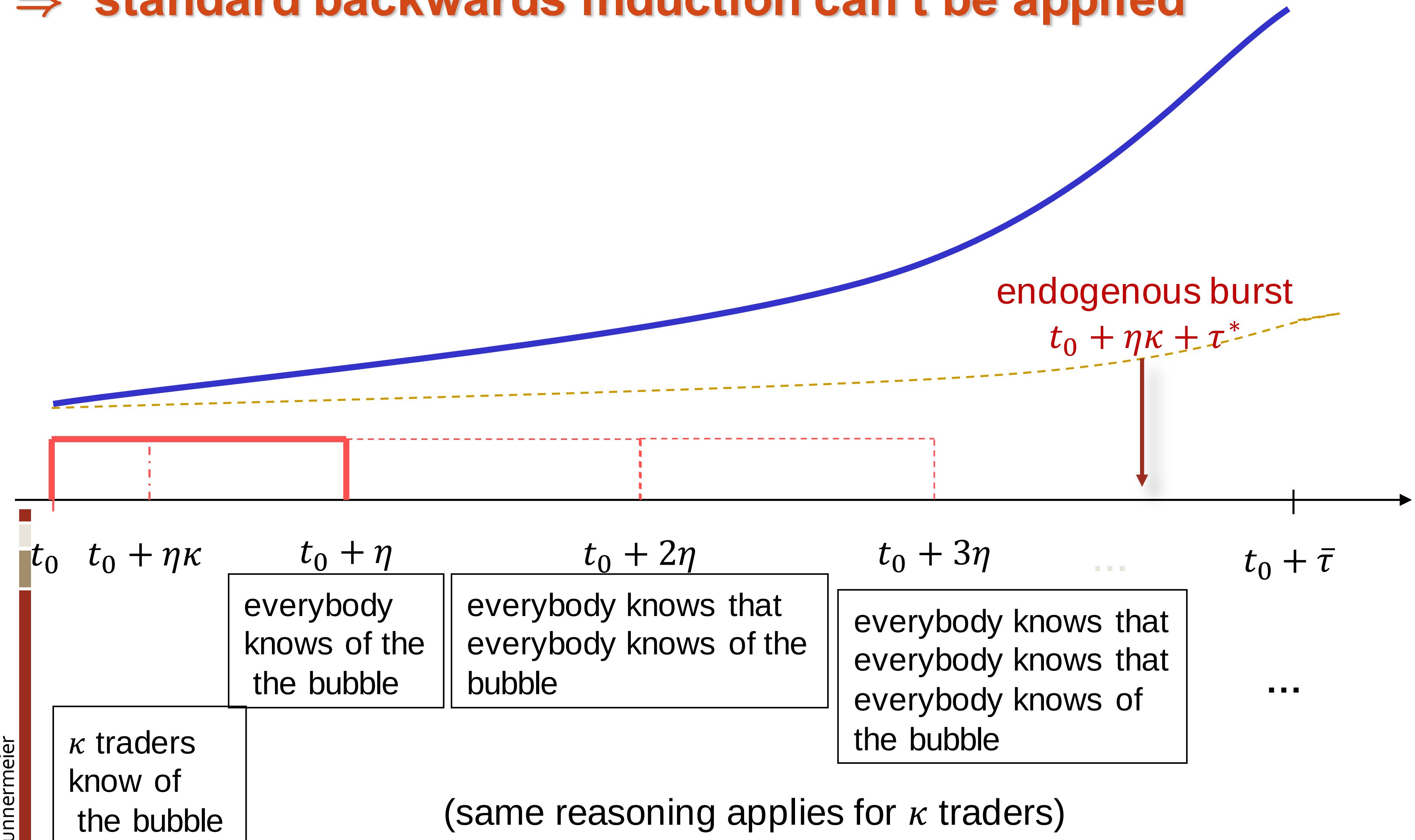


Exogenous crash for low $\bar{\tau}$ (i.e. low $\bar{\beta}$)

- Proposition 2: Suppose $\frac{\lambda}{1-e^{-\lambda\eta\kappa}} \leq \frac{g-r}{\bar{\beta}}$.
  - Unique trading equilibrium
  - Traders begin attacking after a delay of $\tau^1 < \bar{\tau}$ periods.
  - Bubble does not burst due to endogenous selling pressure prior to $t_0 + \bar{\tau}$.

Lack of common knowledge

⇒ standard backwards induction can't be applied



(same reasoning applies for κ traders)

Role of synchronizing events

- News may have an impact disproportionate to any intrinsic informational (fundamental) content
  - News can serve as a synchronization device
- Fads & fashion in information
  - Which news should traders coordinate on?
- When "synchronized attach" fails, then the bubble is temporarily strengthened

Setting with synchronizing events

- Focus on news with no info content (sunspots)
- Synchronizing events occur with Poisson arrival rate
  - Note that pre-emption argument does not apply since event occurs with zero probability
- Arbitrageurs who are aware of the bubble become increasingly worried about it over time.
  - Only traders who became aware of the bubble more than τ_e periods ago observe (look out for) this synchronizing event.

Synchronizing events – market rebounds

- Proposition 5: In 'responsive equilibrium'
  Sell out a) always at the time of the public event t_e,
  b) after $t_i + \tau^{**}$ (where $\tau^{**} < \tau^*$)
  except after a failed attack at , re-enter the market
  for $t \in (t_e, t_e - \tau_e + \tau^{**})$.

- Intuition for re-entering the market
  - For $t_e < t_0 + \eta\kappa + \tau_e$ attack fails, agents learn $t_0 > t_e - \tau_e - \eta\kappa$
  - Without public event, they would have learnt this only at $t_e + \tau_e - \tau^{**}$
  - Density that bubble burst for endogenous reasons is zero

Conclusion of Bubbles and Crashes

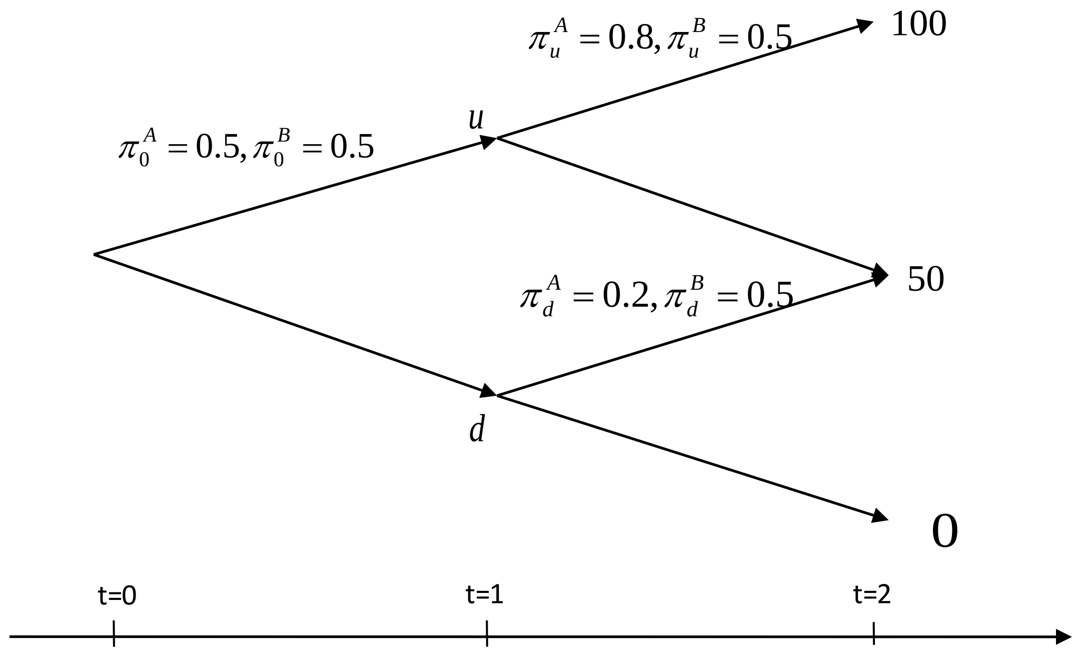
- Bubbles
  - Dispersion of opinion among arbs causes a synchronization problem which makes coordinated price correction difficult.
  - Arbitrageurs time the market and ride the bubble
    $\Rightarrow$ Bubbles persist
- Crashes
  - Can be triggered by unanticipated news without any fundamental content, since
  - It might serve as synchronization device.
- Rebound
  - Can occur after a failed attack which temporarily strengthens the bubble

Heterogeneous Beliefs Bubbles

Harrison and Kreps, Scheinkman and Xiong

Bubbles with Trading Cost – simplified example

- Two risk-neutral agents: A and B.
  - An asset with fixed supply, 1 unit equally divided bw A & B.
  - Heterogeneous beliefs; short-sales prohibited.
  - Harrison and Kreps (1978), Morris (1996), Scheinkman and Xiong (2003).



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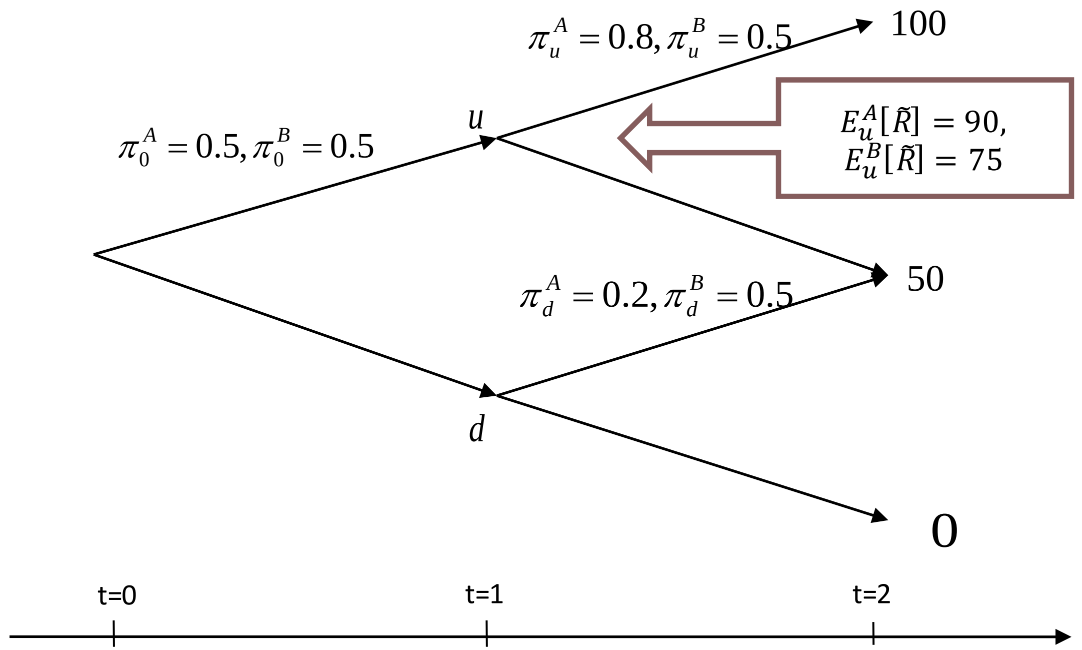

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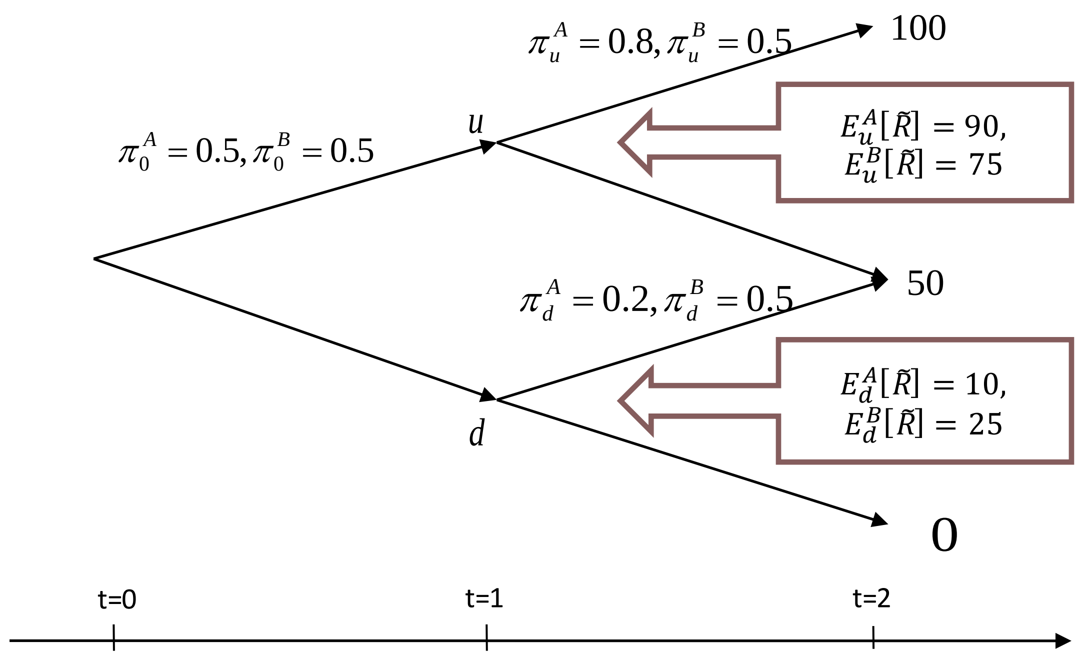

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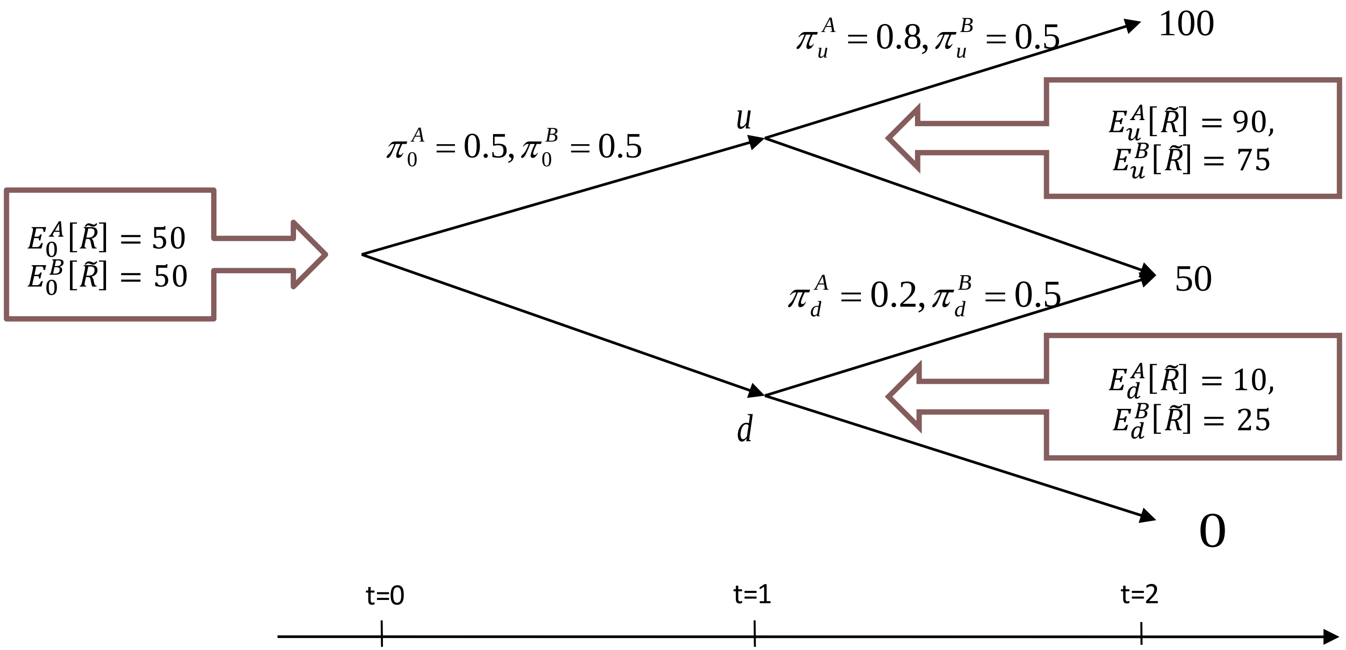

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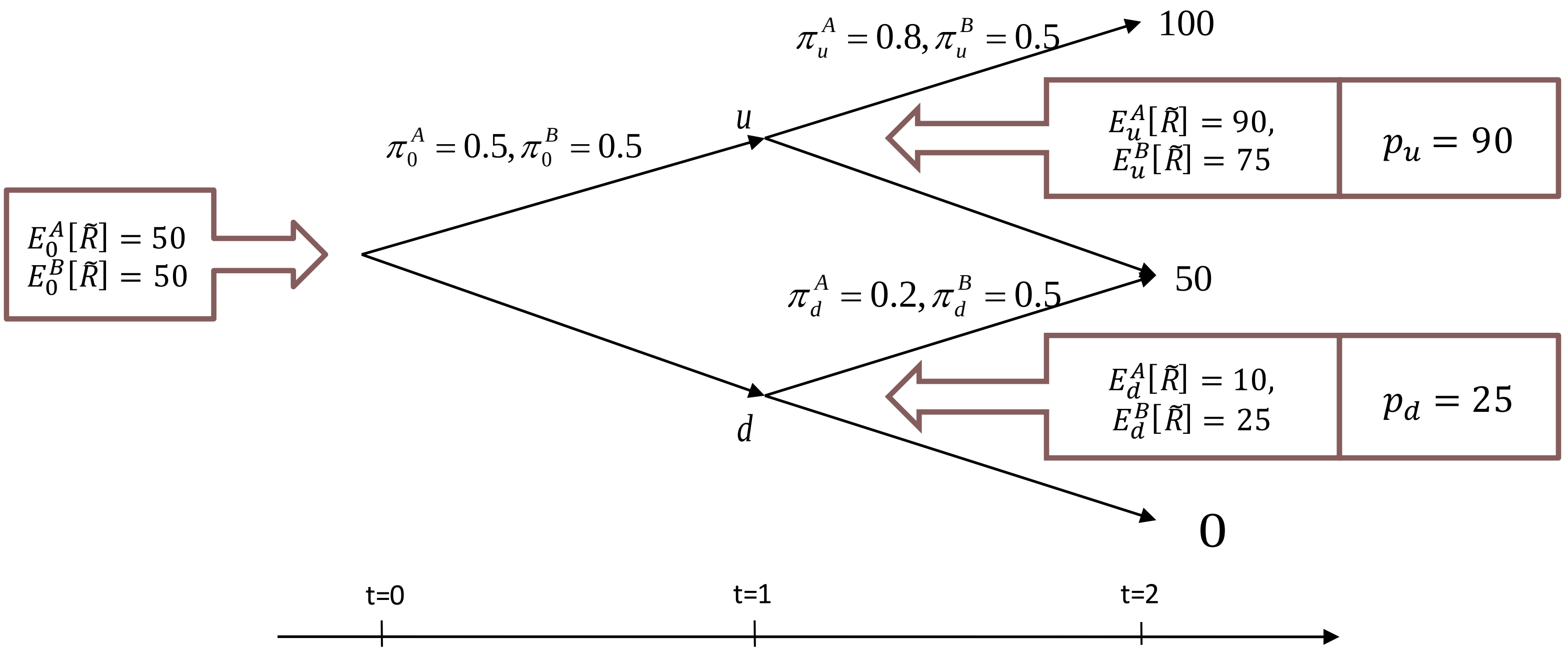

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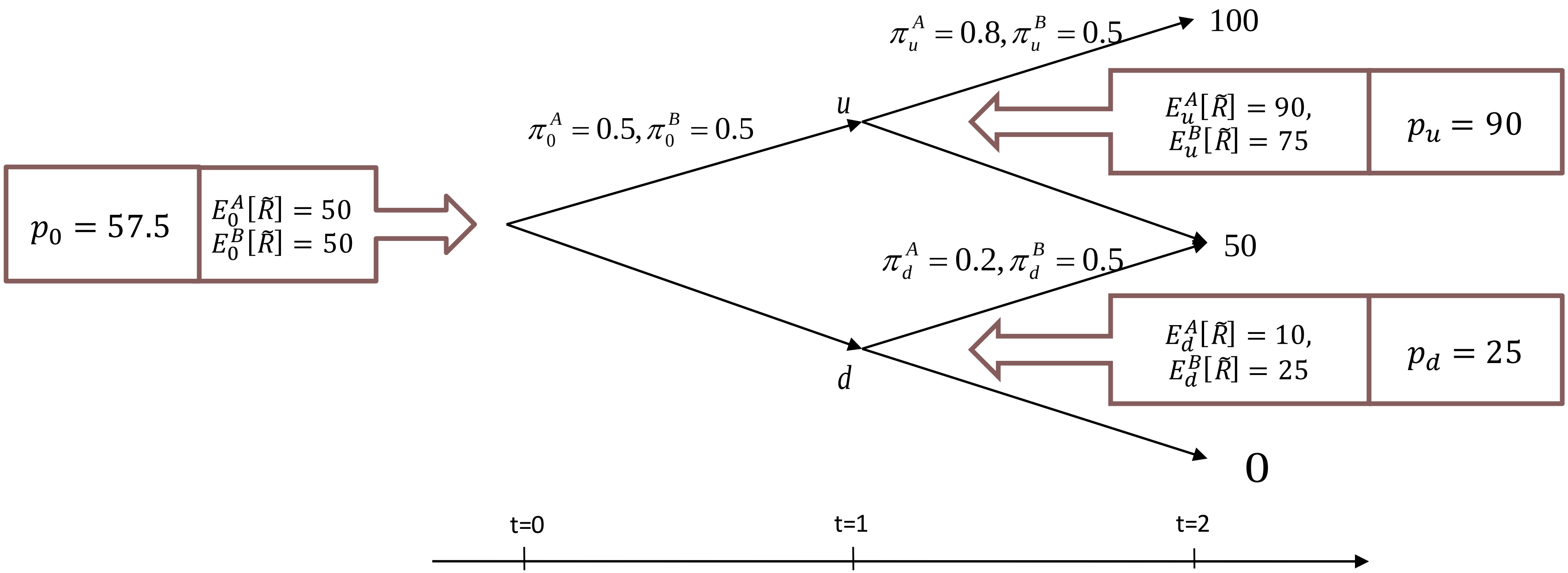

Welfare criterions heterogeneous beliefs

Brunnermeier & Xiong 2011

- Given a social welfare function W, allocation $x \succcurlyeq_W x'$ if
  - $E^A[W(u^A(x), u^B(x))] \geq E^A[W(u^A(x'), u^B(x'))]$ AND
  - $E^B[W(u^A(x), u^B(x))] \geq E^B[W(u^A(x'), u^B(x'))]$
- Back to Bubble example
  - Assume linear and symmetric social welfare function:
    $$W(u_A, u_B) = u(c_A) + u(c_B) = c_A + c_B.$$
  - At the status quo:
    $$E_0^j[W(u_A, u_B)] = E_0^j[\tilde{R}] = 50, \forall j \in \{A, B\}.$$
  - Suppose that trading costs k per share.
    - $k < 15$ so that trading occurs.
  - In the equilibrium:
    $$E_0^j[W(u_A, u_B)] = E_0^j[\tilde{R}] - \frac{k}{2} = 50 - \frac{k}{2}, \forall j \in \{A, B\}.$$

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