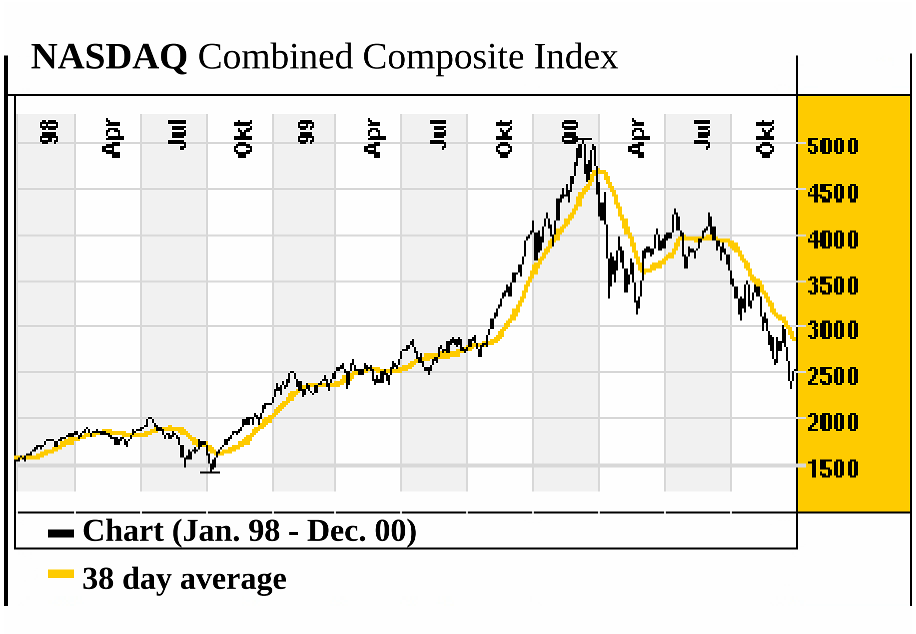
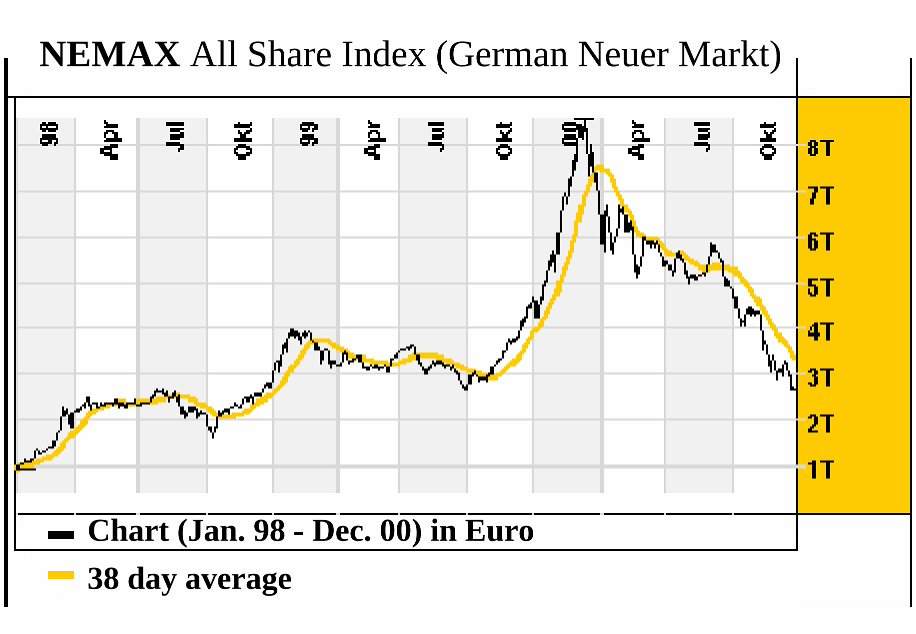
Internet bubble? - 1990's



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?**

Do (rational) professional ride the bubble?

- South Sea Bubble (1710 - 1720)
  - *Isaac Newton*
    - 04/20/1720 sold shares at £7,000 profiting £3,500
    - re-entered the market later - ended 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 the party would end so quickly.
    - "We thought it was the eighth inning, and it was the ninth."
  - *Julian Robertson* of Tiger Fund refused to invest in internet stocks

Pros' dilemma

- "The moral of this story is that irrational market can kill you …
- Julian said 'This is irrational and I won't play' and they carried him out feet first.
- Druckenmiller said 'This is irrational and I will play' and they carried him out feet first."

Quote of a financial analyst, *New York Times*

April, 29 2000

Classical Question

- Suppose behavioral trading leads to mispricing.

- **Can mispricings or bubbles persist in the presence of rational arbitrageurs?**

- What type of information can lead to the bursting of bubbles?

Main Literature

- Keynes (1936) ⇒ 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 ⇒ no bubbles emerge
  - "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
  - Noise trader risk versus Synchronization risk
    Shleifer & Vishny (1997), DSSW (1990 a & b)
- Bubble Literature
  - Symmetric information - Santos & Woodford (1997)
  - Asymmetric information
    Tirole (1982), Allen et al. (1993), Allen & Gorton (1993)

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* !

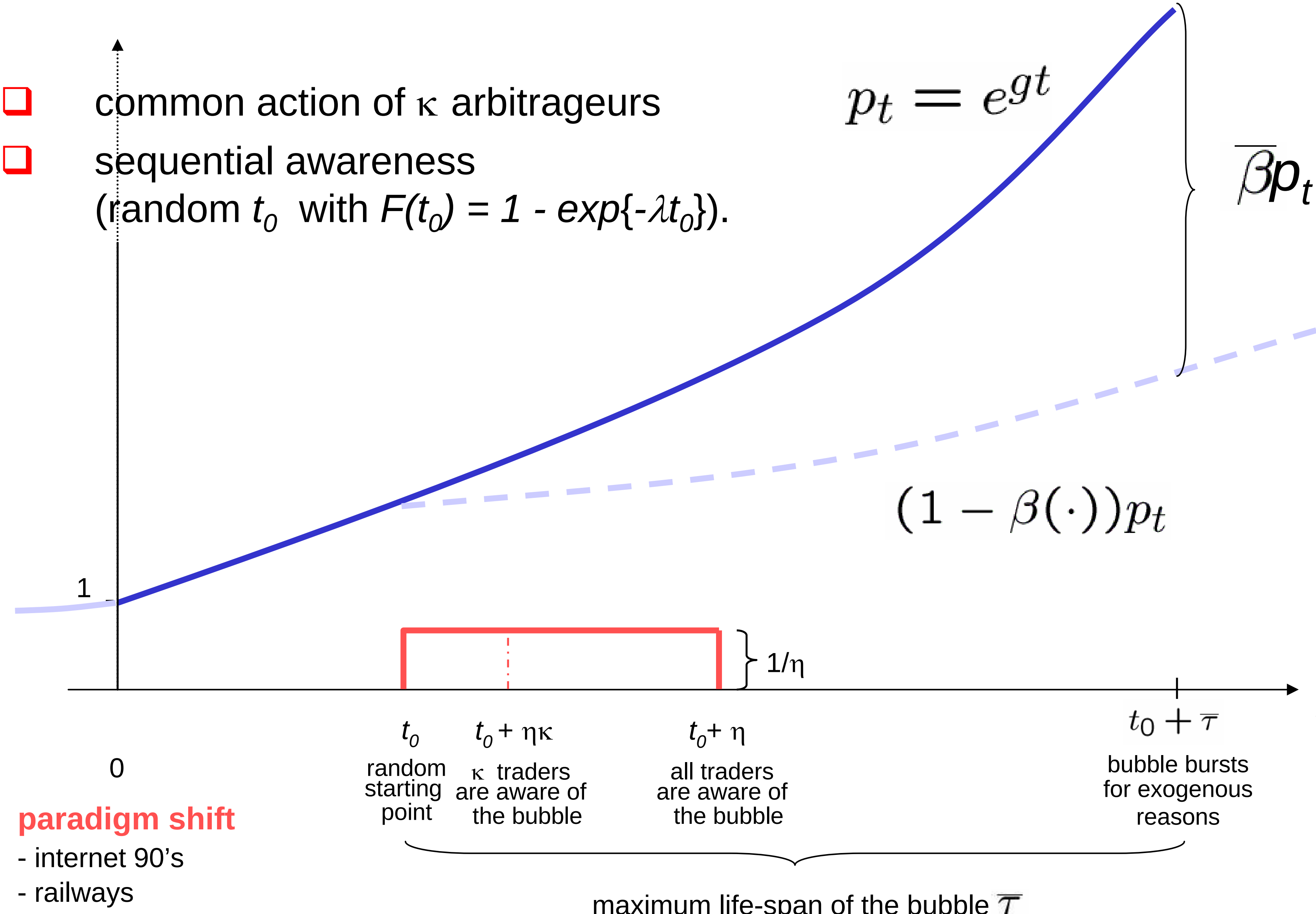
Elements of the Timing Game

- *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 leads to $\Rightarrow$ "delayed arbitrage"
  $\Rightarrow$ persistence of bubble.

- common action of κ arbitrageurs
- sequential awareness
  (random t_0 with $F(t_0) = 1 - exp\{-\lambda t_0\}$).



paradigm shift
- internet 90's
- railways
- etc.

Payoff structure

- Endogenous price path
  - Focus on "when does bubble burst"
  - Only random variable t_0, all other are CK
- Cash Payoffs (difference)
  - Sell 'one share' at $t\text{-}\Delta$ instead of at t.

prior to the crash

after the crash

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

where $p_t = \begin{cases} e^{gt} \\ (1-\beta(t-t_0))e^{gt} \end{cases}$

  - Execution price at the time of bursting

pre crash-price for first random orders up to κ

Payoff structure (ctd.), Trading

- Small transactions 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.

introduction

model setup

Preliminary analysis

preemption motive - trigger strategies

sell out condition

persistence of **bubbles**

public events

price cascades and rebounds

conclusion

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

- sell out at *t* if

appreciation rate

$$\Delta\, h(t|t_i) E_t[\text{bubble}|\bullet] \geq (1-\Delta\, h(t|t_i))\,(g - r) p_t\, \Delta$$

benefit of attacking

cost of attacking

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

bursting date $T^*(t_0) = \min\{T(t_0 + \eta\kappa),\ t_0 + \bar{\tau}\}$

RHS converges to $\to$ $[(g\text{-}r)]$ as $t \to \infty$

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persistence of bubbles

- exogenous crashes
- endogenous crashes
- lack of common knowledge

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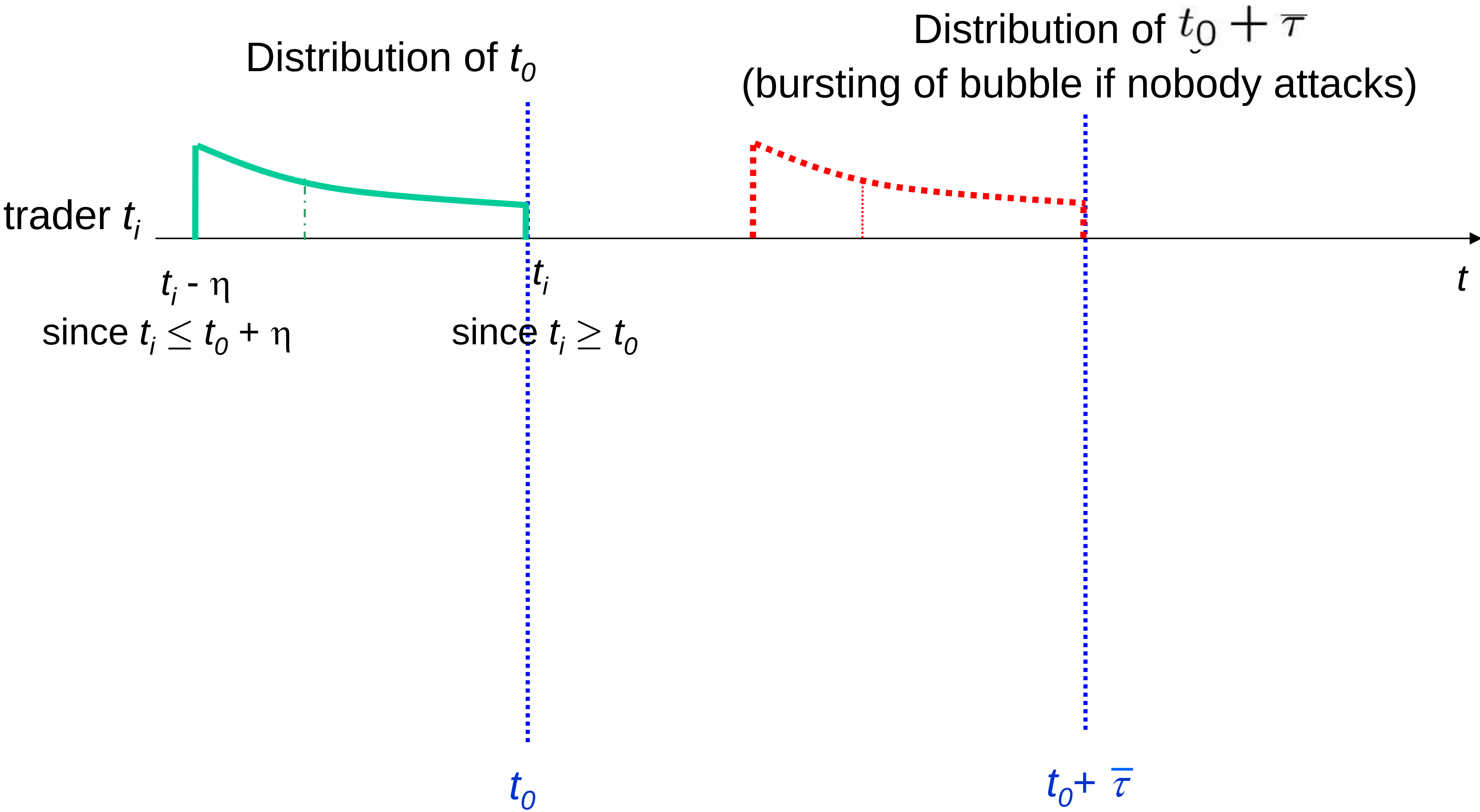
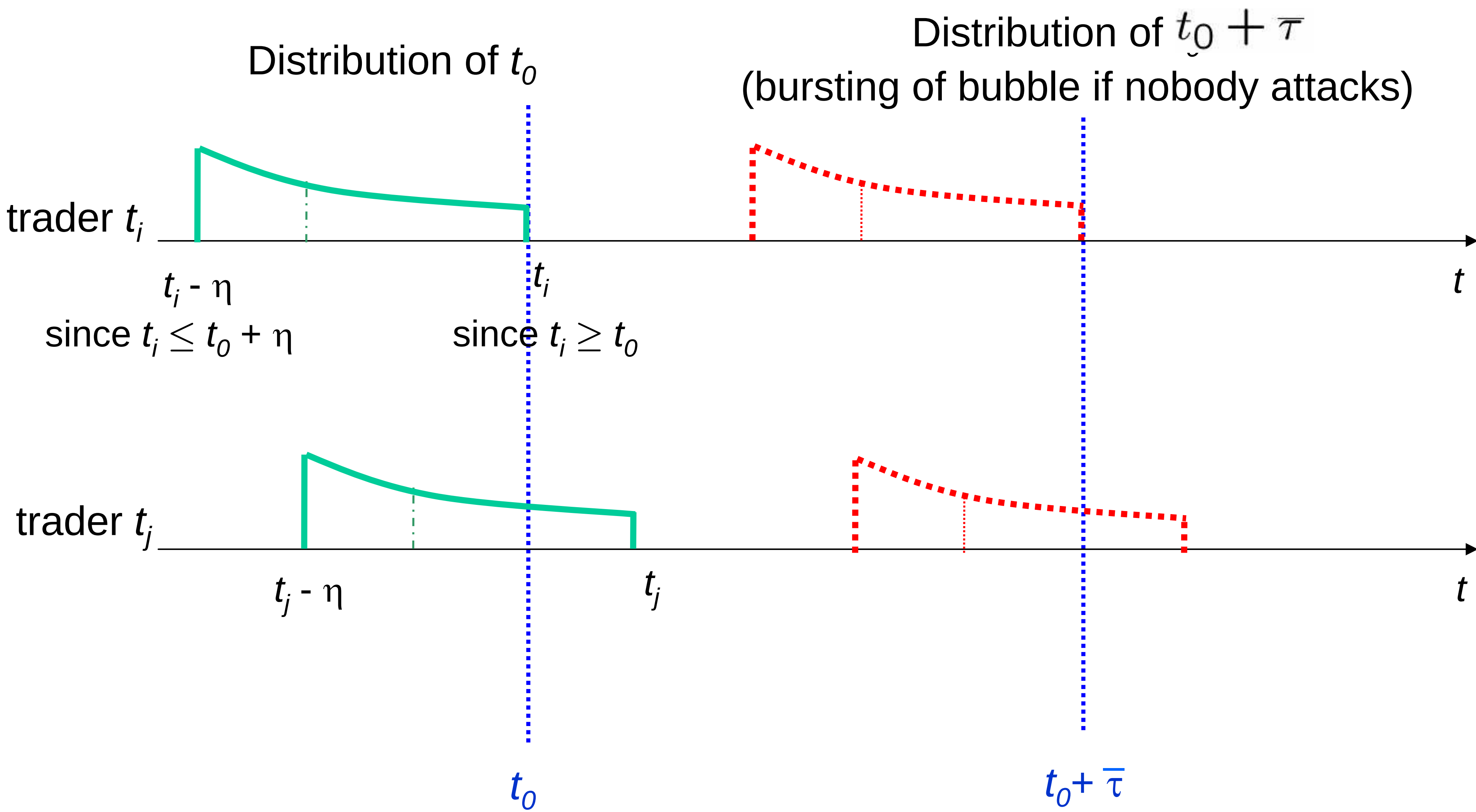
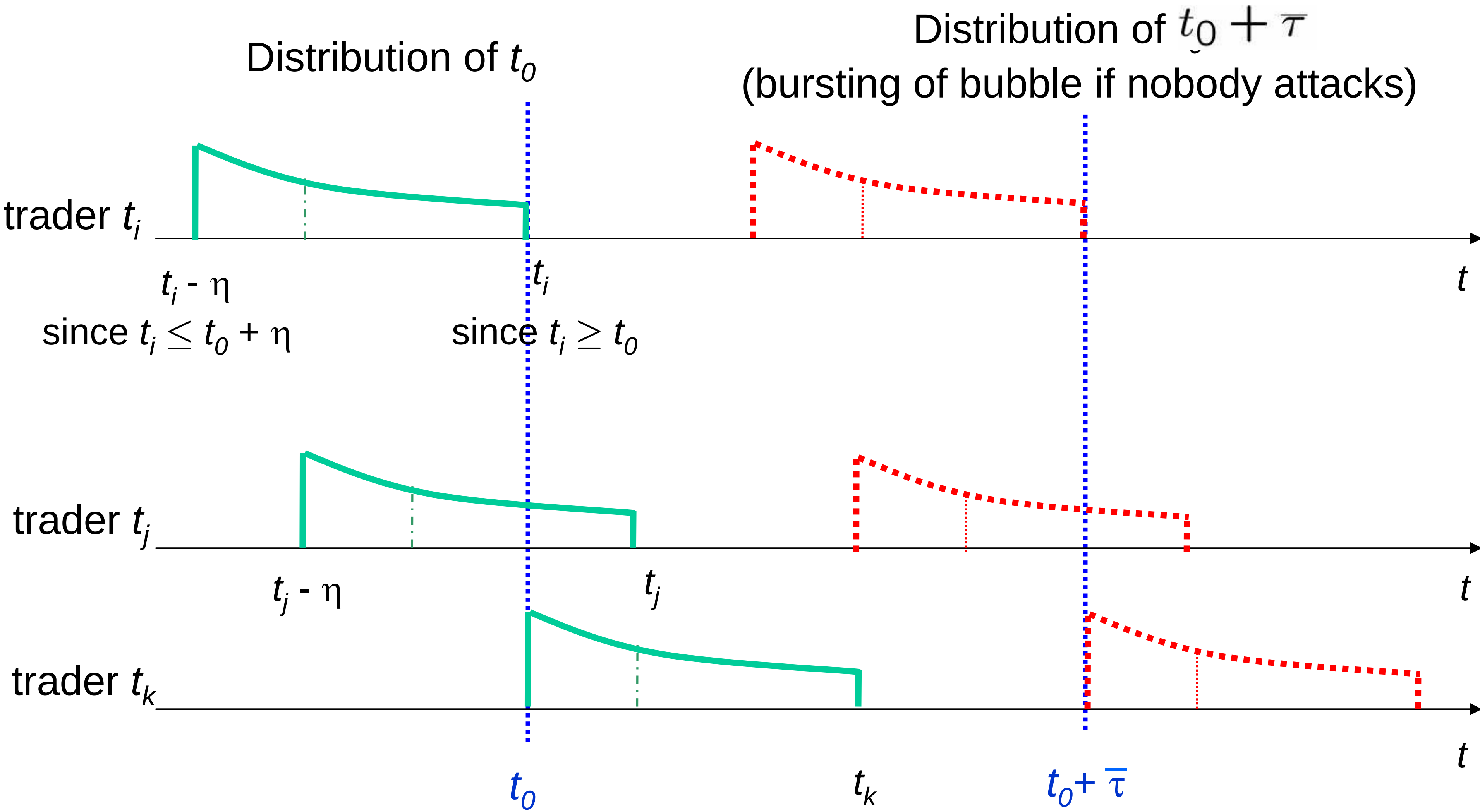
Sequential awareness



Sequential awareness



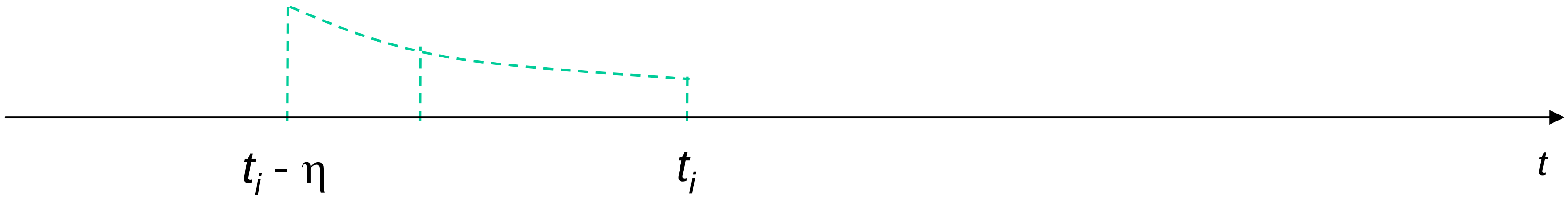
Sequential awareness



Conjecture: Immediate attack

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

when κ traders are aware of the bubble



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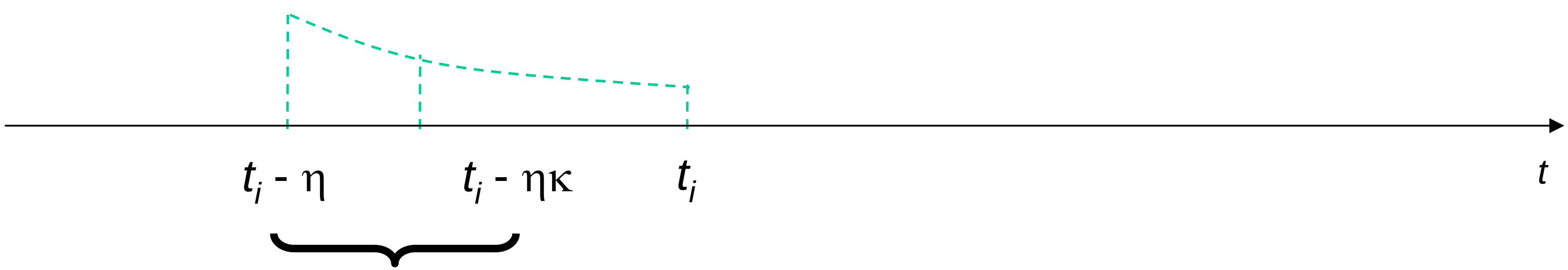
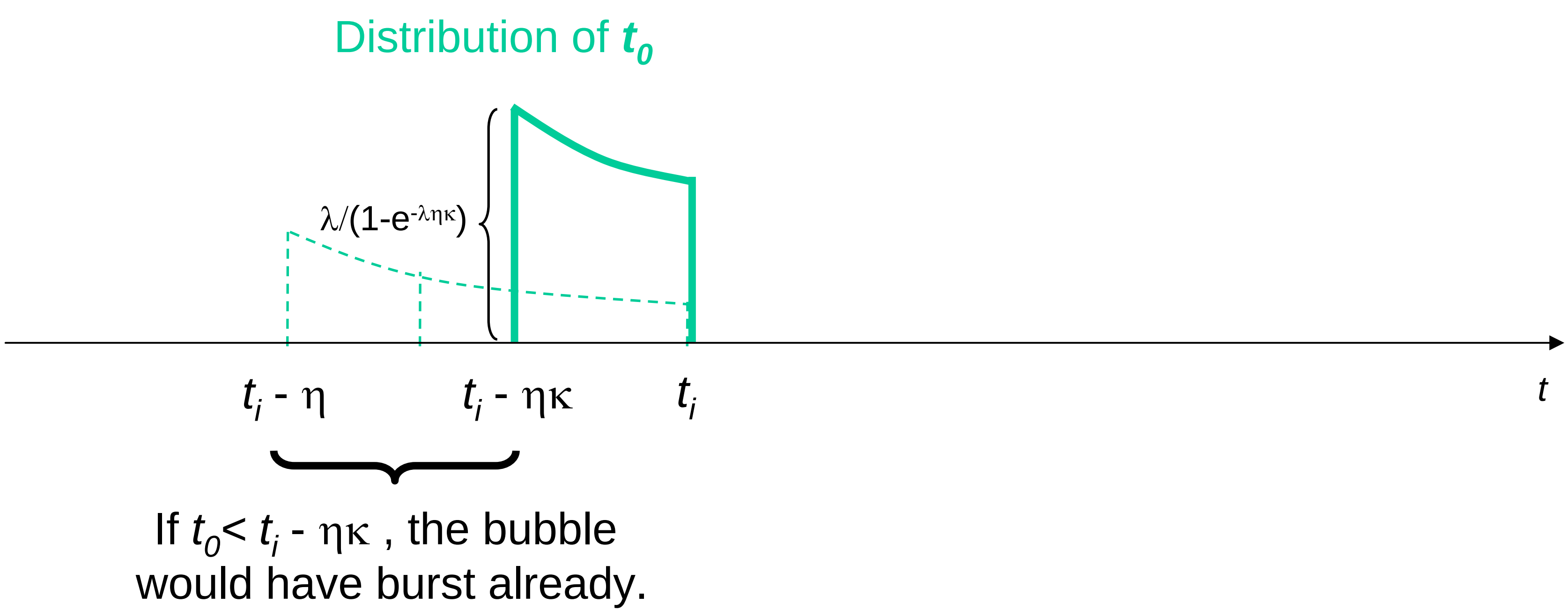


If $t_0 < t_i - \eta\kappa$, the bubble would have burst already.

Conjecture 1: Immediate attack

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

when κ traders are aware of the bubble



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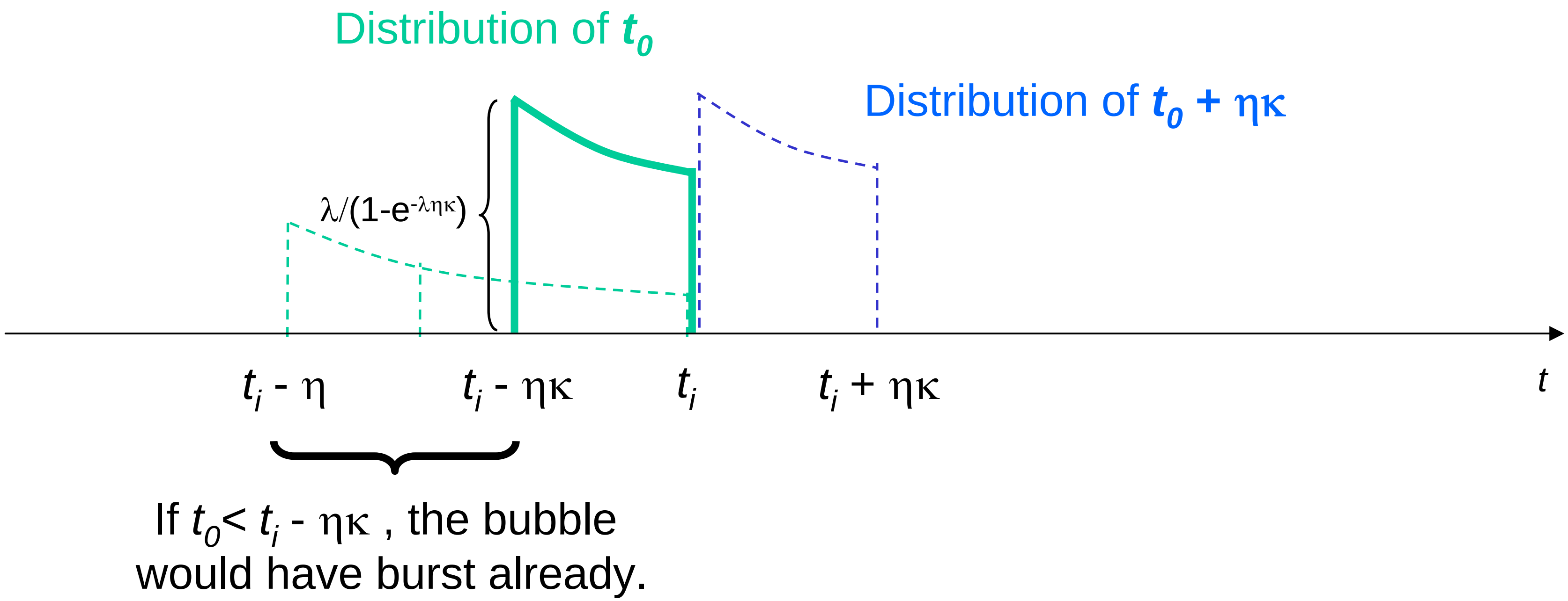
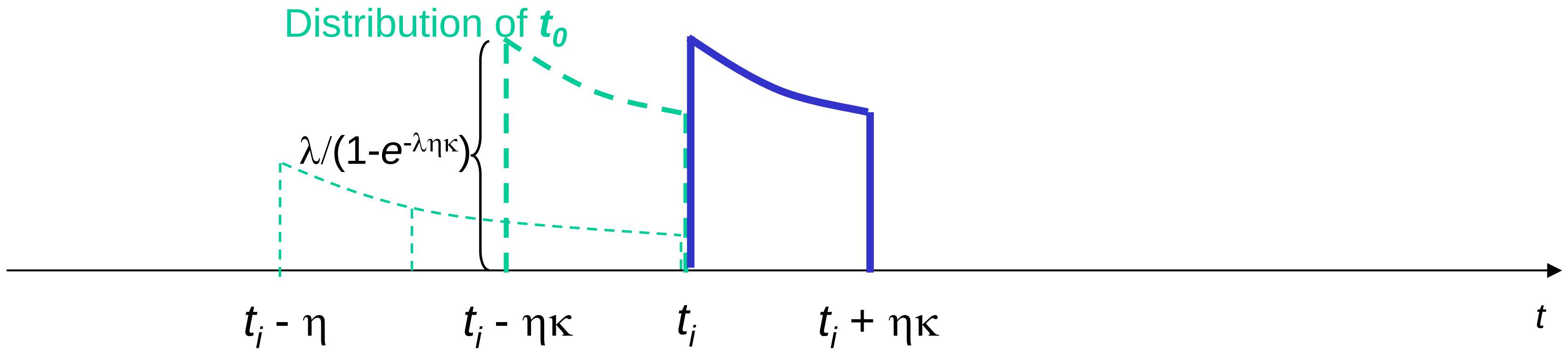


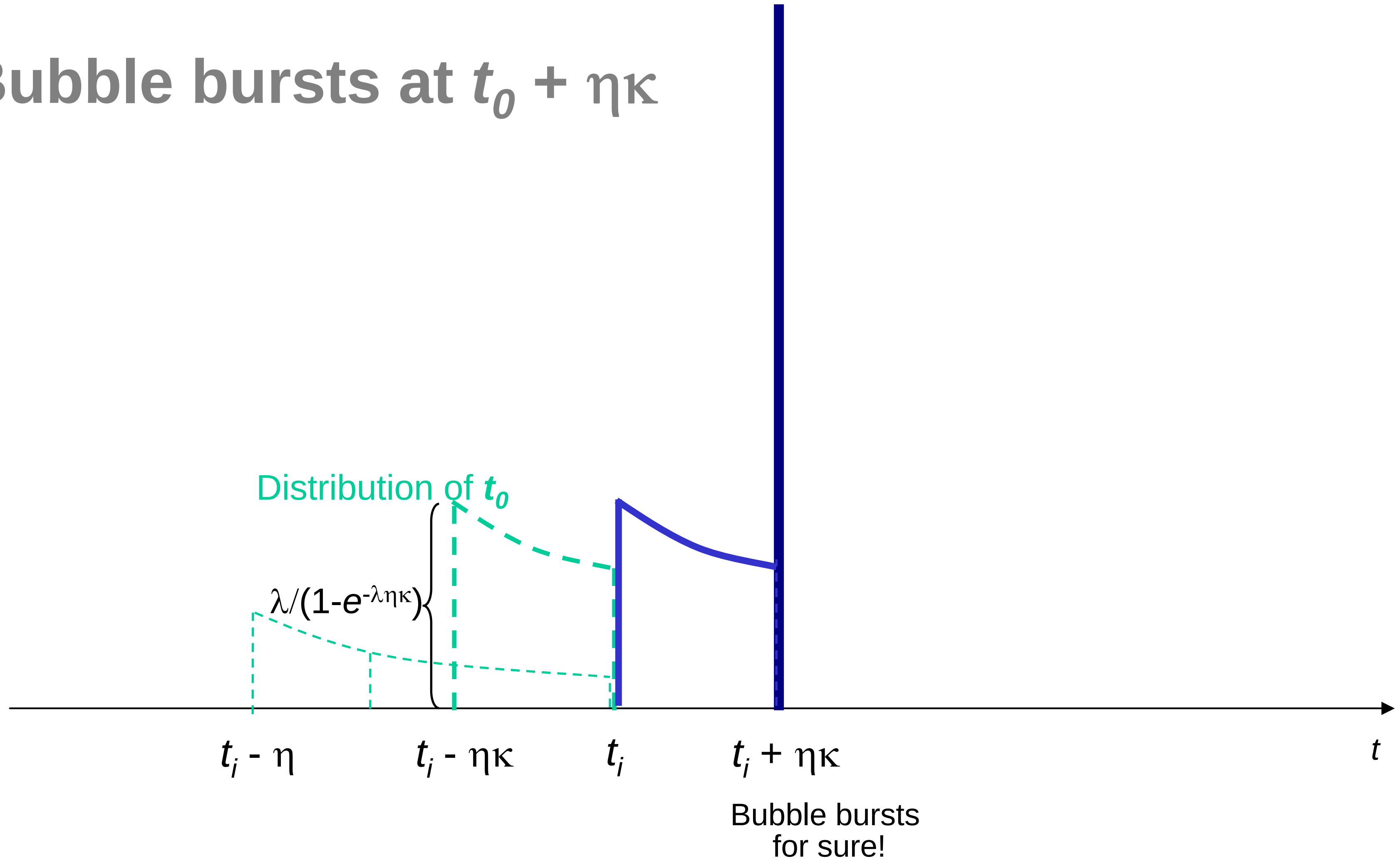
Conj. 1 (ctd.): Immediate attack

⇒ Bubble bursts at $t_0 + \eta\kappa$



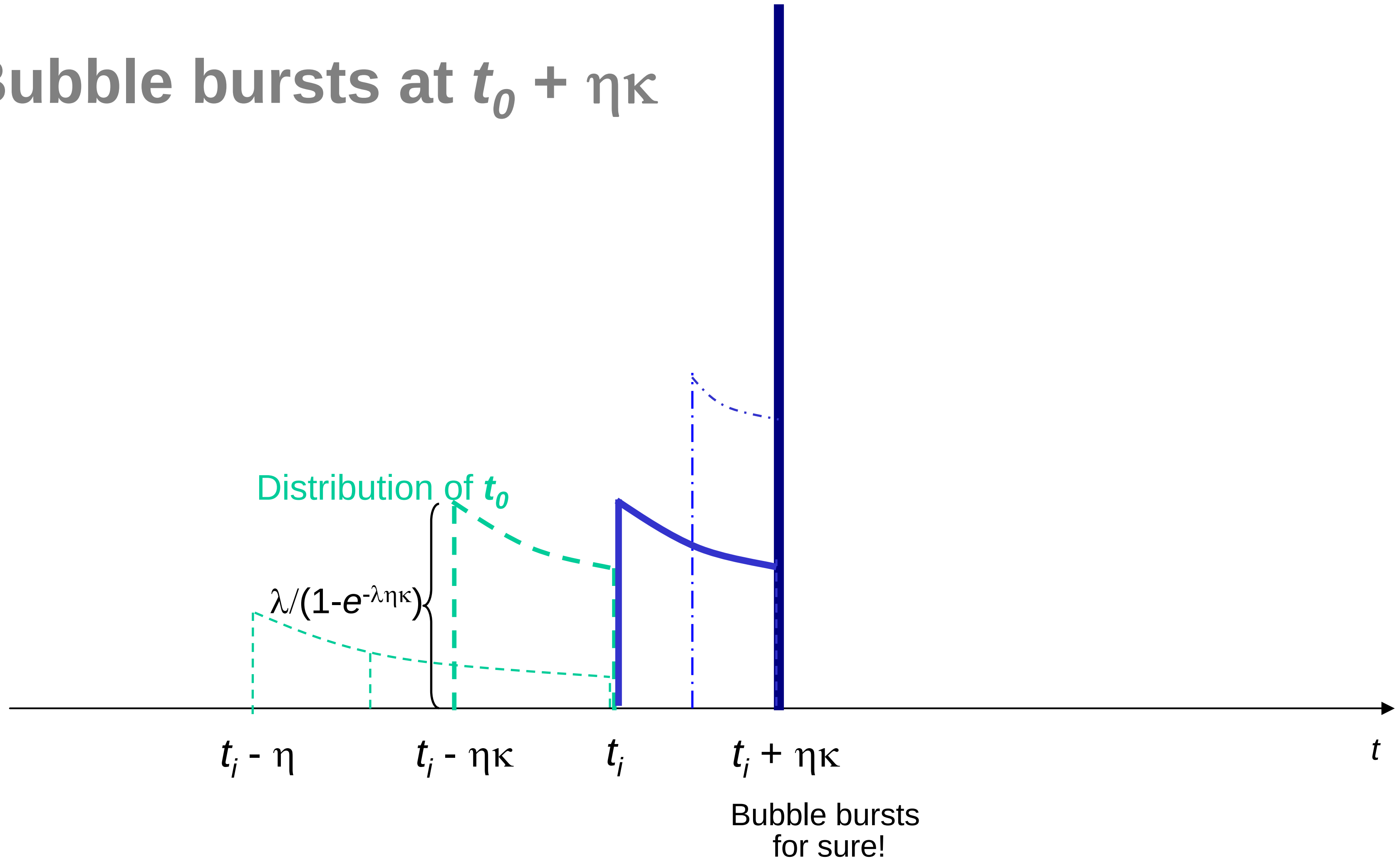
Conj. 1 (ctd.): Immediate attack

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



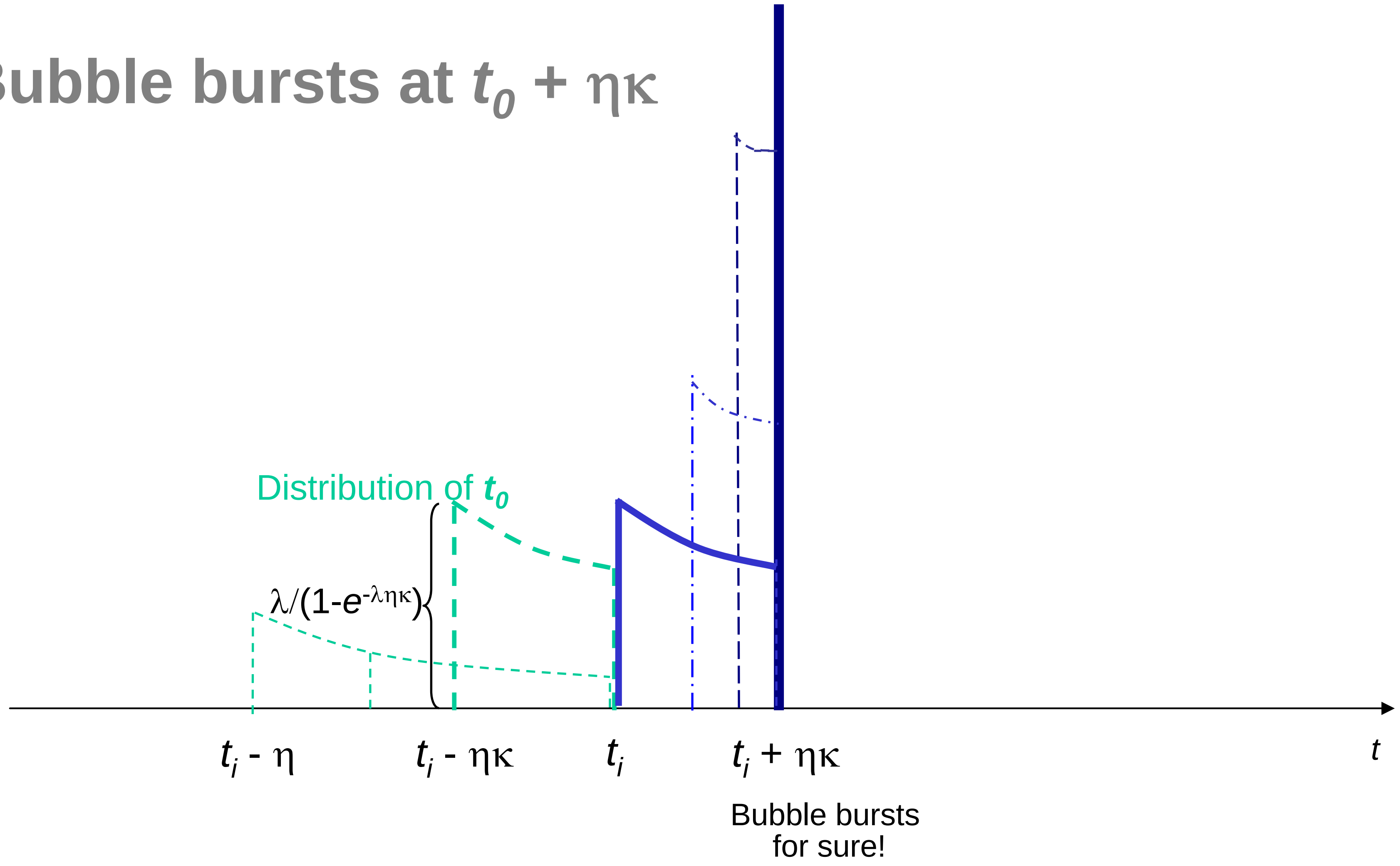
Conj. 1 (ctd.): Immediate attack

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



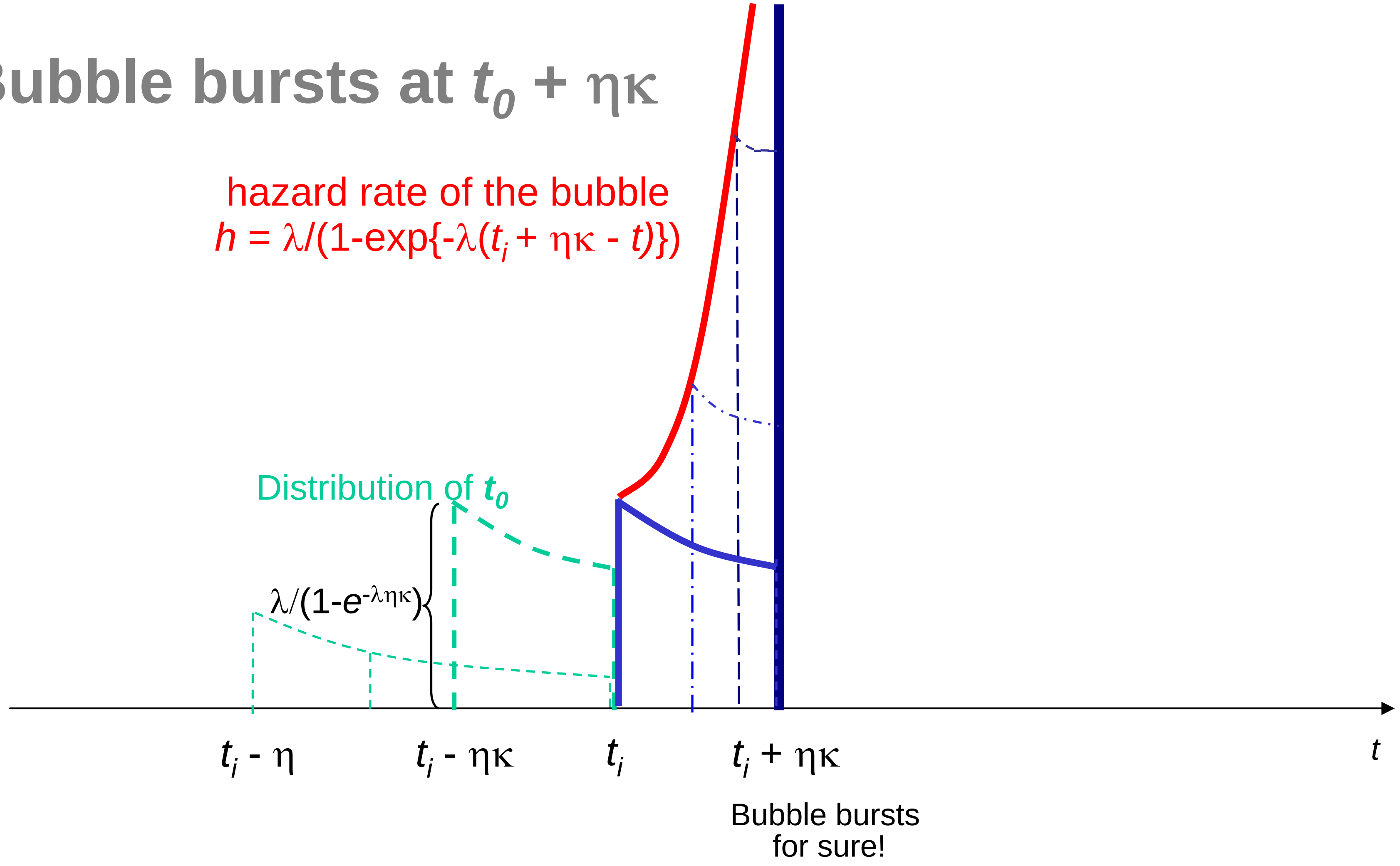
Conj. 1 (ctd.): Immediate attack

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



Conj. 1 (ctd.): Immediate attack

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

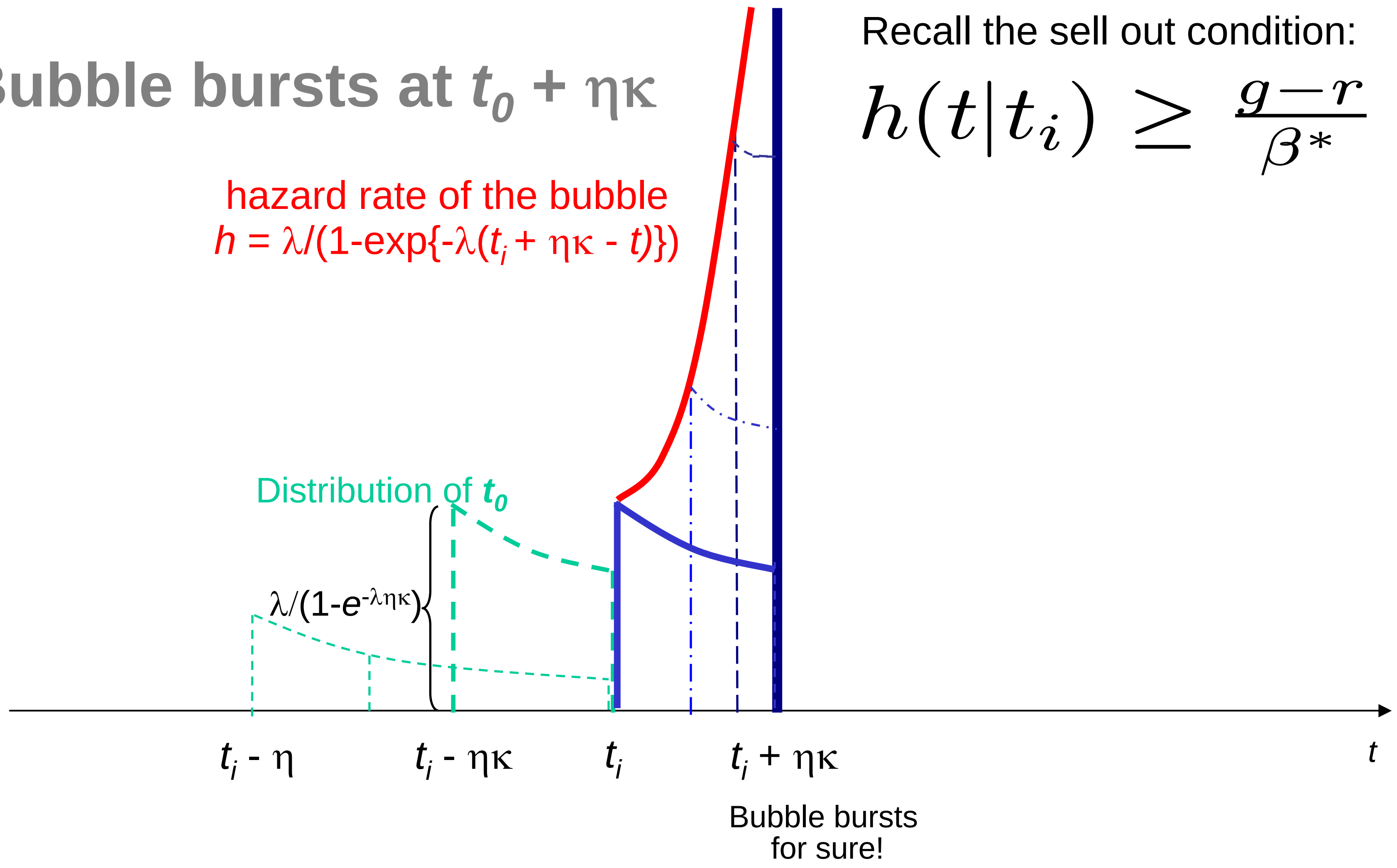


Conj. 1 (ctd.): Immediate attack

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

Recall the sell out condition:

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



Conj. 1 (ctd.): Immediate attack

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

Recall the sell out condition:

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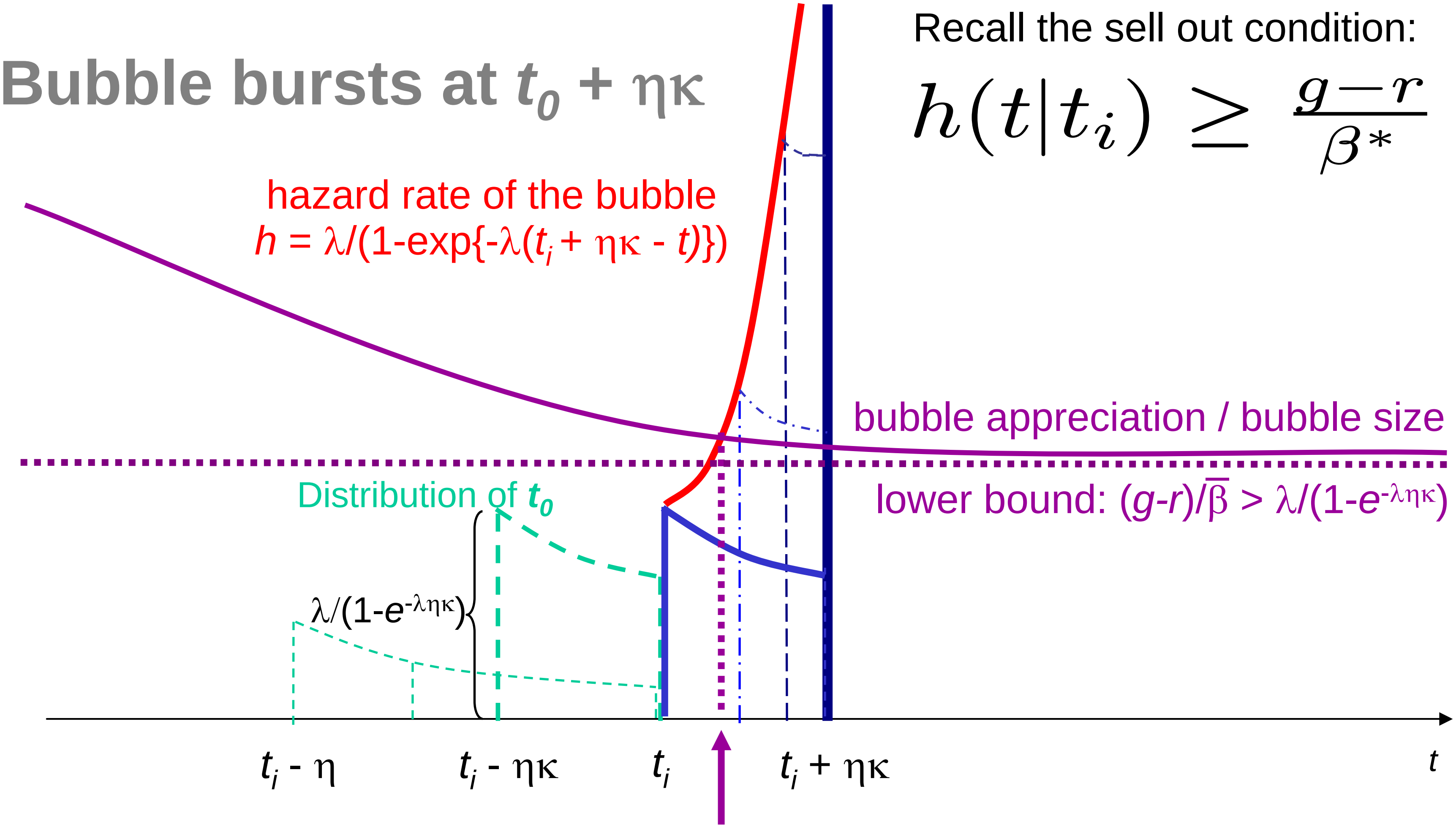


optimal time to attack $t_i + \tau_i$

$\Rightarrow$ **"delayed attack is optimal"**

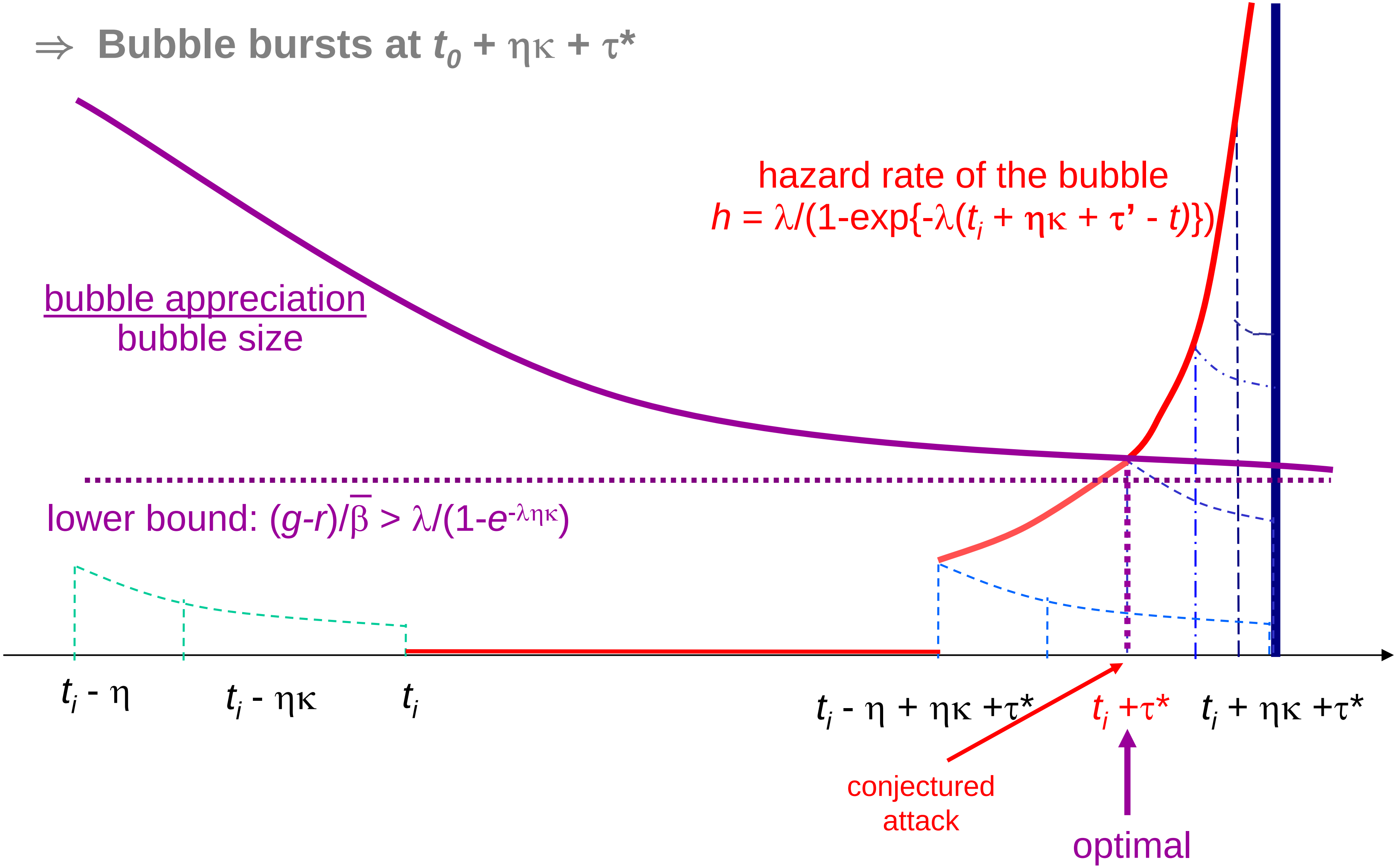
Endogenous crashes for large enough $\bar{\tau}$ (i.e. $\bar{\beta}$)

- **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 \tau* periods.
  - bubble ***bursts*** due to endogenous selling pressure at a size of p_t times

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

Endogenous crashes

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

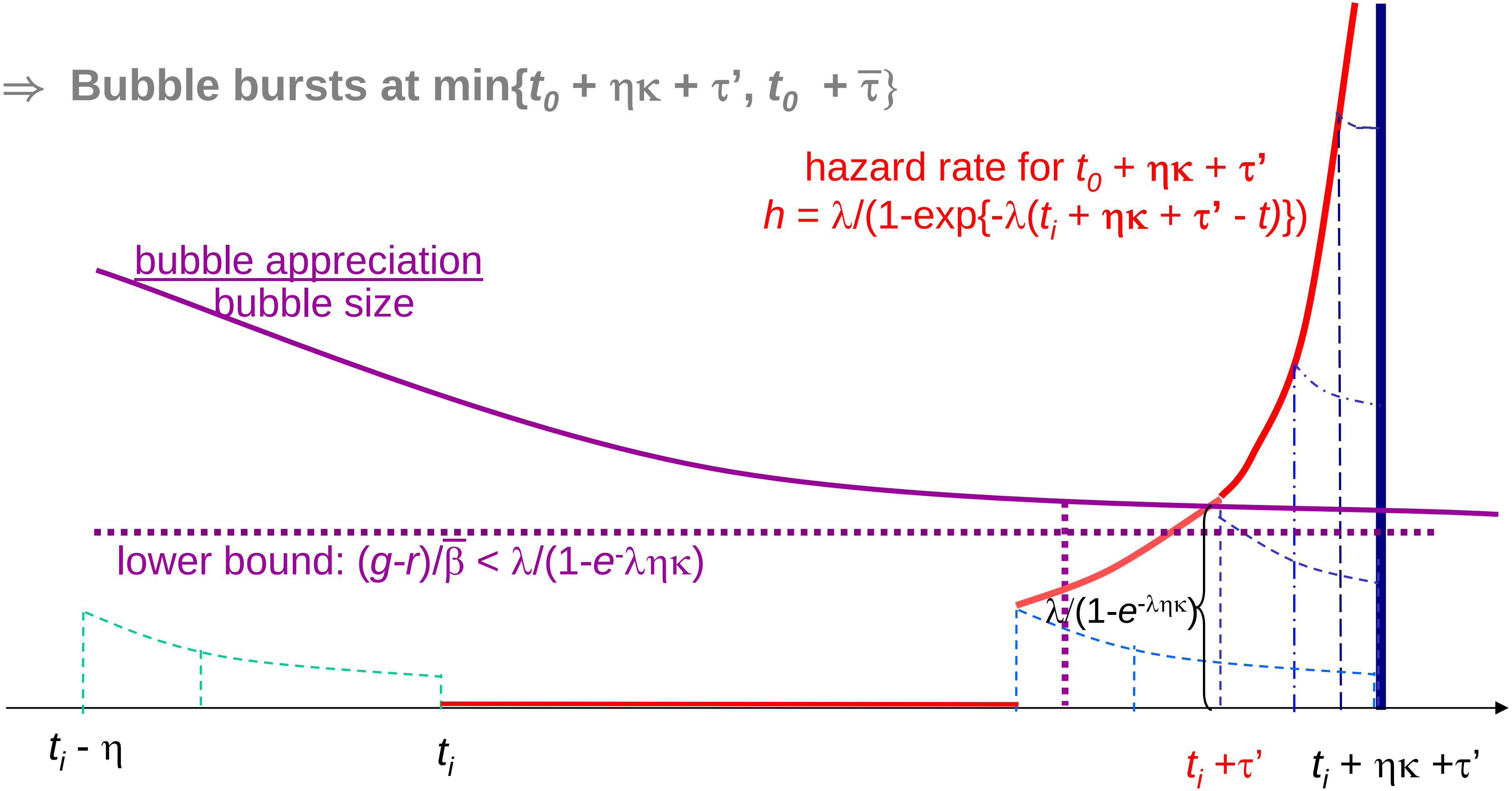


Exogenous crash for low $\bar{\tau}$ (i.e. $\bar{\beta}$)

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

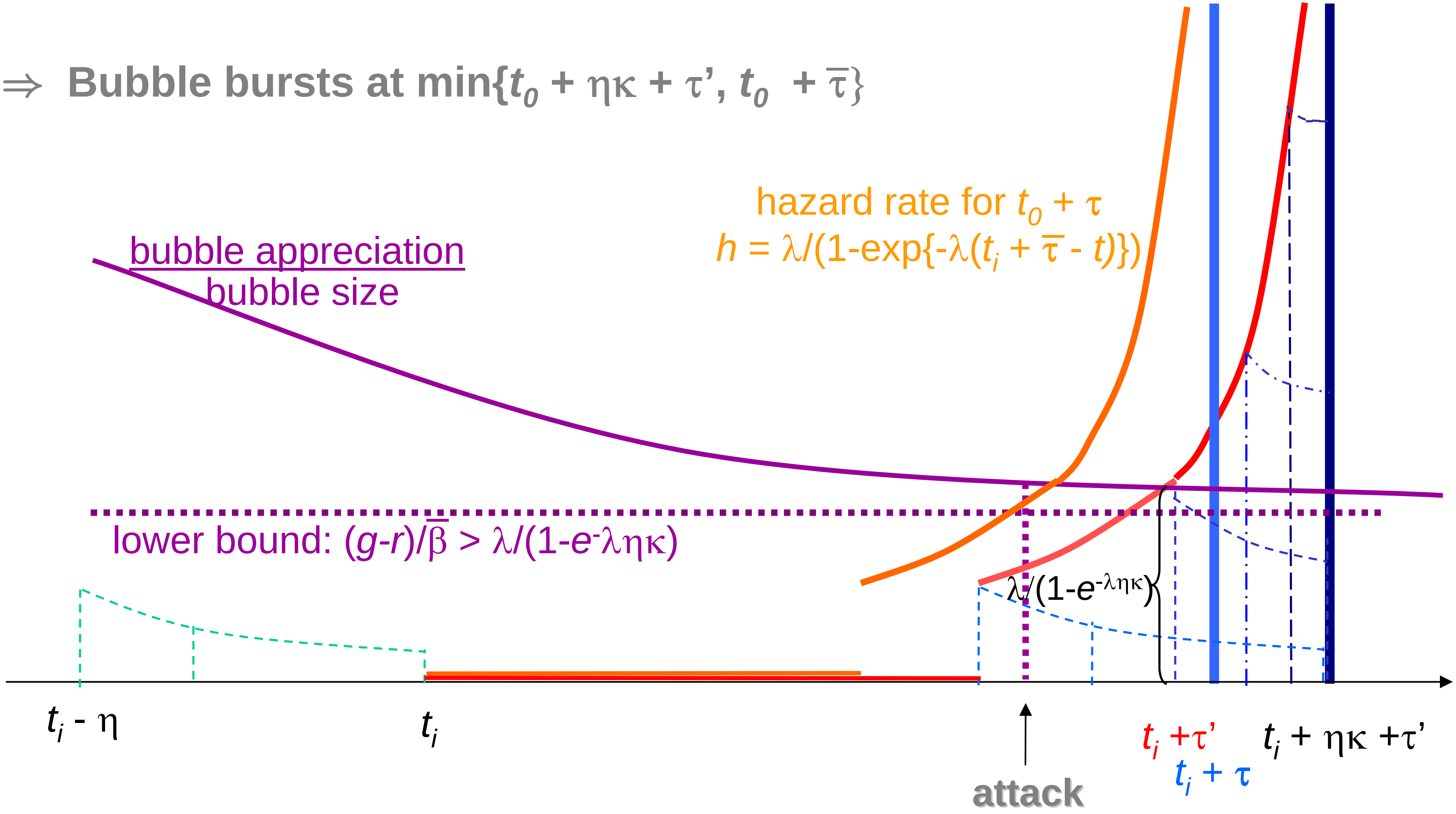
Delayed attack by τ'

⇒ **Bubble bursts at min{t_0 + ηκ + τ', t_0 + $\bar{\tau}$}**



Delayed attack by τ'

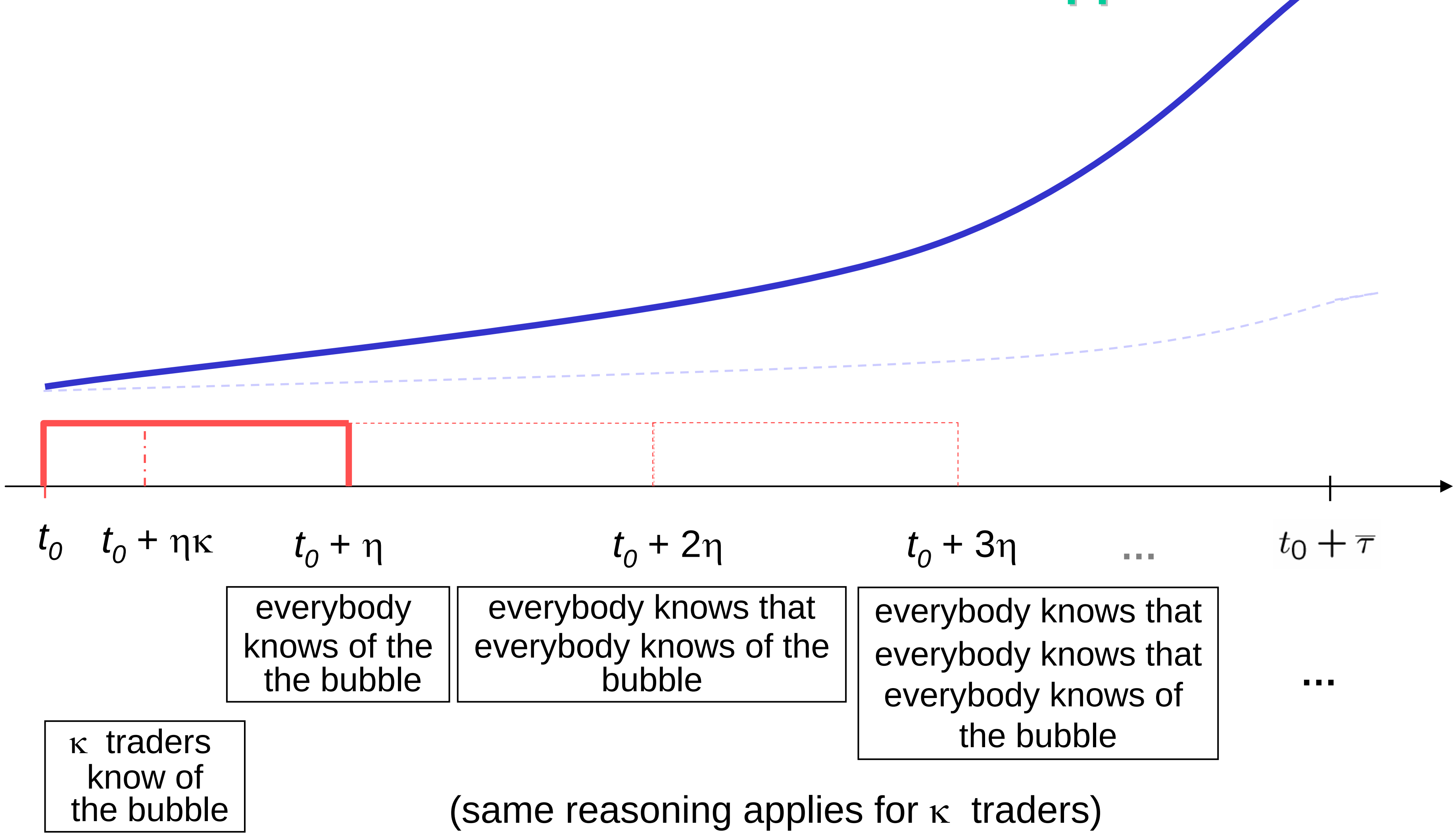
⇒ **Bubble bursts at min{$t_0 + \eta\kappa + \tau'$, $t_0 + \bar{\tau}$}**



⇒ **bubble bursts for exogenous reasons at $t_0 + \bar{\tau}$**

Lack of common knowledge

⇒ **standard backwards induction can't be applied**



Role of synchronizing events (information)

- 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 attack” fails, the bubble is temporarily strengthened.

Setting with synchronizing events

- Focus on news with no informational content (sunspots)
- Synchronizing events occur with Poisson arrival rate η.
  - Note that the 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 a public event t_e,
  b) after $t_i + \tau^{**}$ (where $\tau^{**} < \tau^{*}$) ,
  except after a failed attack at t_p , **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 $t_e + \tau_e - \tau^{**}$.
    - the existence of bubble at t reveals that $t_0 > t - \tau^{**} - \eta\kappa$
    - that is, no additional information is revealed till $t_e - \tau_e + \tau^{**}$
    - density that bubble bursts for endogenous reasons is zero.

Price cascades and rebounds

- Price drop as a synchronizing event.
  - through psychological resistance line
  - by more than, say 5 %
- **Exogenous price drop**
  - after a price drop
    - if bubble is ripe
      $\Rightarrow$ bubble bursts and price drops further.
    - if bubble is not ripe yet
      $\Rightarrow$ price bounces back and the bubble is strengthened for some time.

Price cascades and rebounds (ctd.)

- **Proposition 6:**

Sell out a) after a price drop if $\tau_i \leq \tau_p(H_p)$

b) after $t_i + \tau^{***}$ (where $\tau^{***} < \tau^*$) ,

re-enter the market after a rebound at t_p

for $t \in (t_p, t_p - \tau_p + \tau^{***})$.

- attack is costly, since price might jump back $\Rightarrow$ only arbitrageurs who became aware of the bubble more than τ_p periods ago attack bubble.
- after a rebound, an endogenous crash can be temporarily ruled out and hence, arbitrageurs re-enter the market.
- Even sell out after another price drop is less likely.

Conclusion of Bubbles and Crashes

- Bubbles
  - Dispersion of opinion among arbitrageurs causes a synchronization problem which makes coordinated price corrections 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 a synchronization device.
- Rebound
  - can occur after a failed attack, which temporarily strengthens the bubble.

Hedge Funds and the Technology Bubble

- Markus K. Brunnermeier
  Princeton University
- Stefan Nagel
  London Business School

http://www.princeton.edu/~markus

reasons for persistence

data

empirical results

conclusion

Why Did Rational Speculation Fail to Prevent the Bubble ?

1. Unawareness of Bubble
   ⇒ Rational speculators perform as badly as others when market collapses.
2. Limits to Arbitrage
   - Fundamental risk
   - Noise trader risk
   - Synchronization risk
   - Short-sale constraint

   ⇒ Rational speculators may be *reluctant to go short* overpriced stocks.
3. Predictable Investor Sentiment
   - AB (2003), DSSW (JF 1990)

   ⇒ Rational speculators may want to *go long* overpriced stock and try to go short prior to collapse.

reasons for persistence

data

empirical results

conclusion

Data

- Hedge fund stock holdings
  - Quarterly 13 F filings to SEC
  - mandatory for all institutional investors
    - with holdings in U.S. stocks of more than $ 100 million
    - domestic and foreign
    - at manager level
  - *Caveats:* No short positions
- 53 managers with CDA/Spectrum data
  - excludes 18 managers b/c mutual business dominates
  - incl. Soros, Tiger, Tudor, D.E. Shaw etc.
- Hedge fund performance data
  - HFR hedge fund style indexes

reasons for persistence

data

empirical results

- did hedge funds ride bubble?
- did hedge funds’ timing pay off?

conclusion

Did hedge funds ride the bubble?

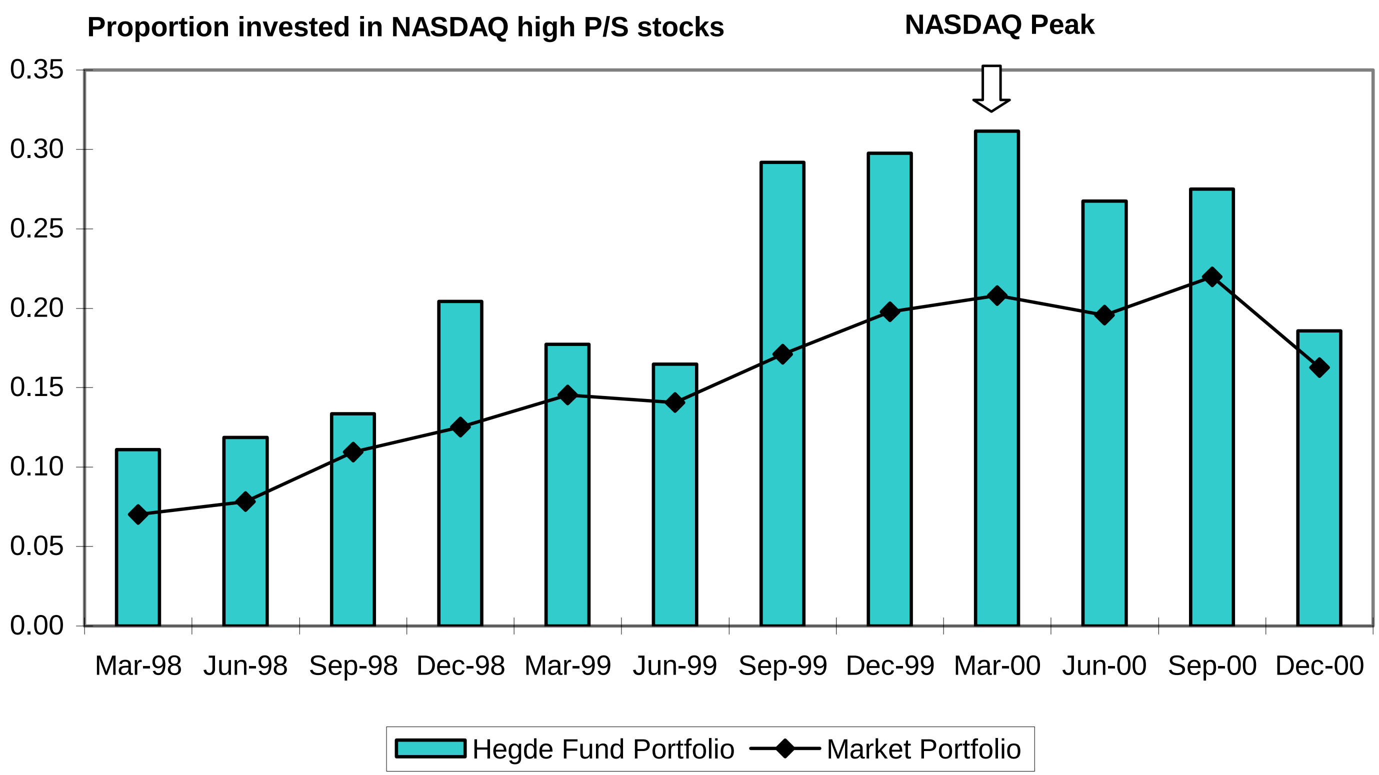


Fig. 2: Weight of NASDAQ technology stocks (high P/S) in aggregate hedge fund portfolio versus weight in market portfolio.

Did Soros etc. ride the bubble?

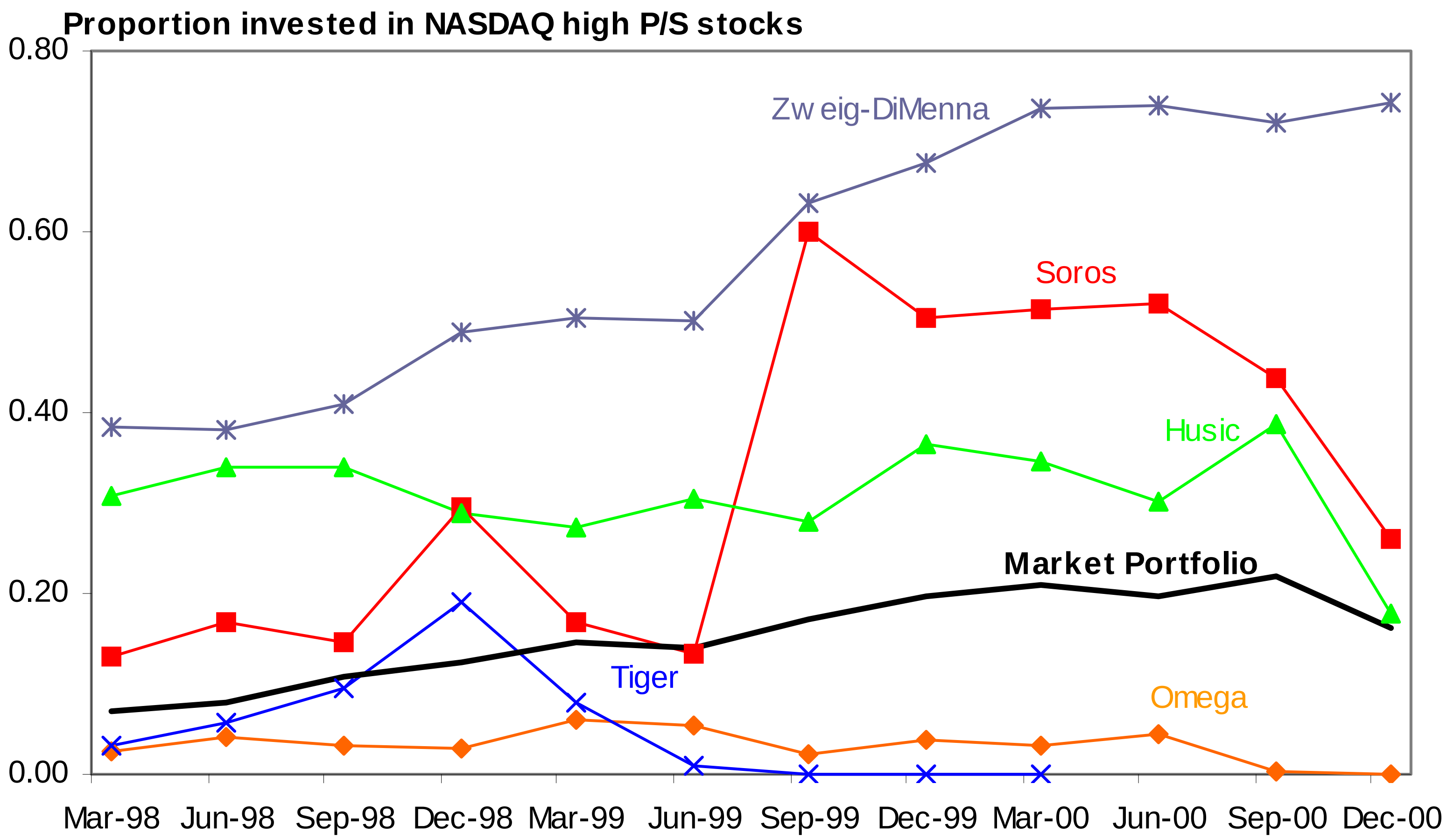
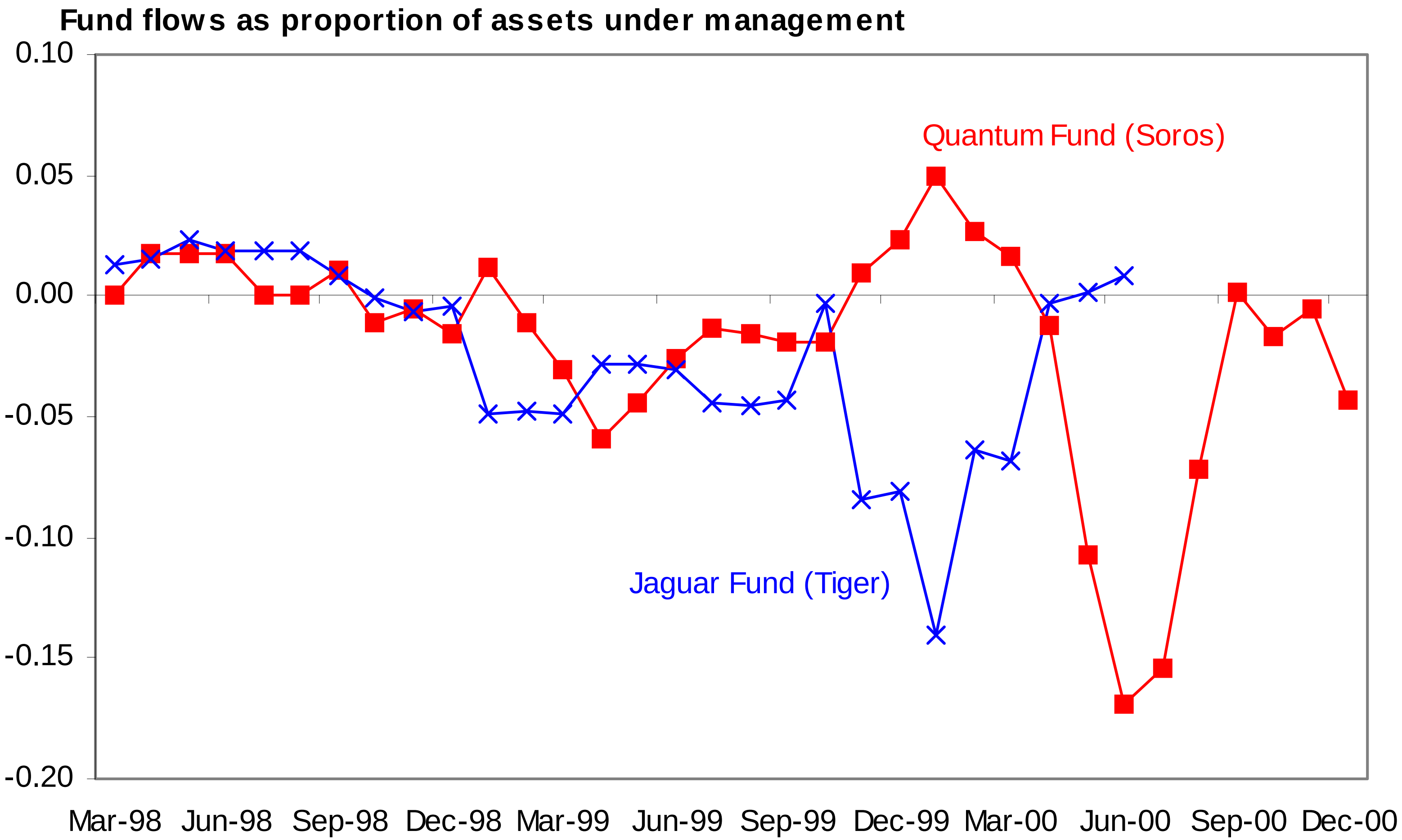


Fig. 4a: Weight of technology stocks in hedge fund portfolios versus weight in market portfolio

Fund in- and outflows



Did hedge funds time stocks?

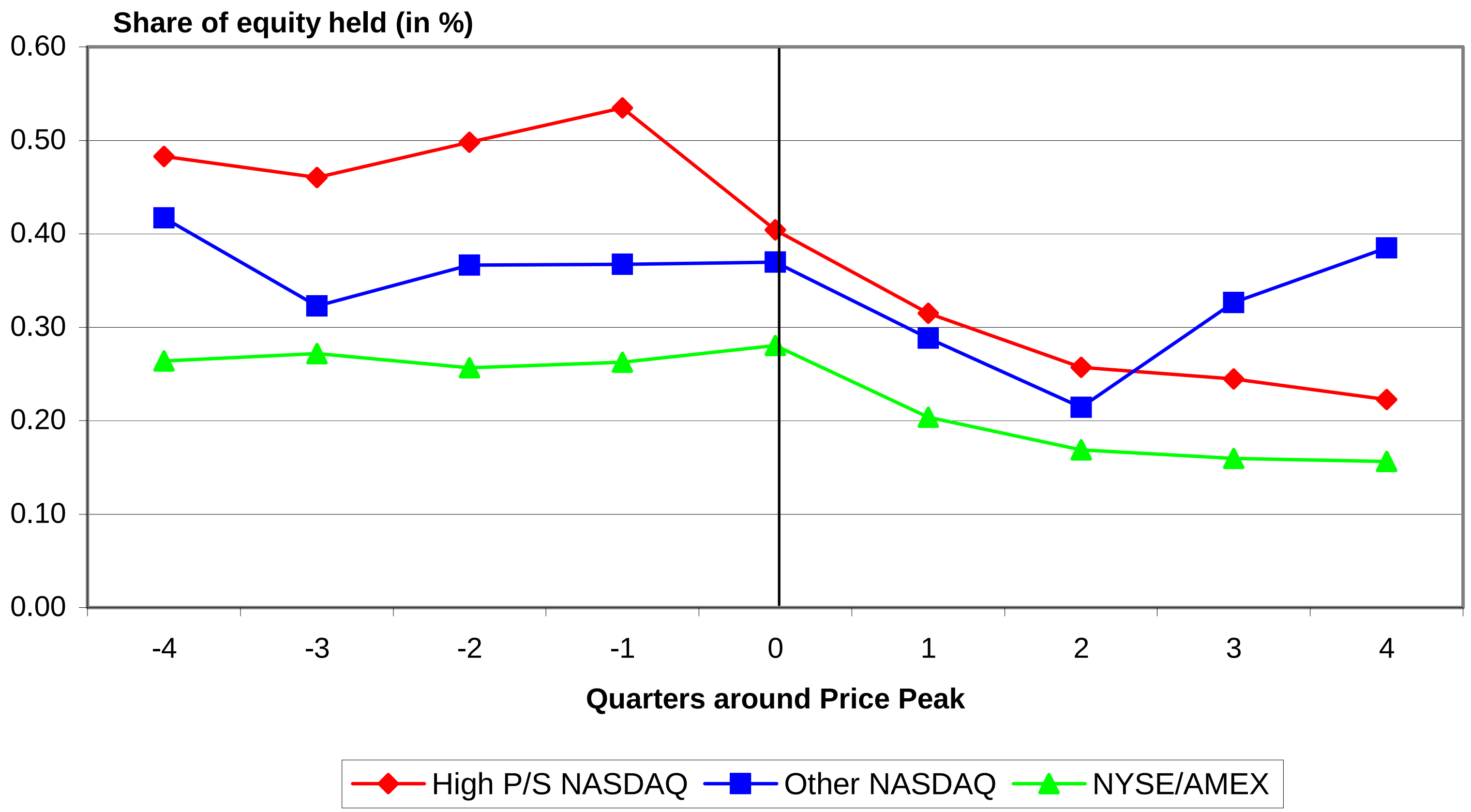


Figure 5. Average share of outstanding equity held by hedge funds around price peaks of individual stocks

Did hedge funds' timing pay off?

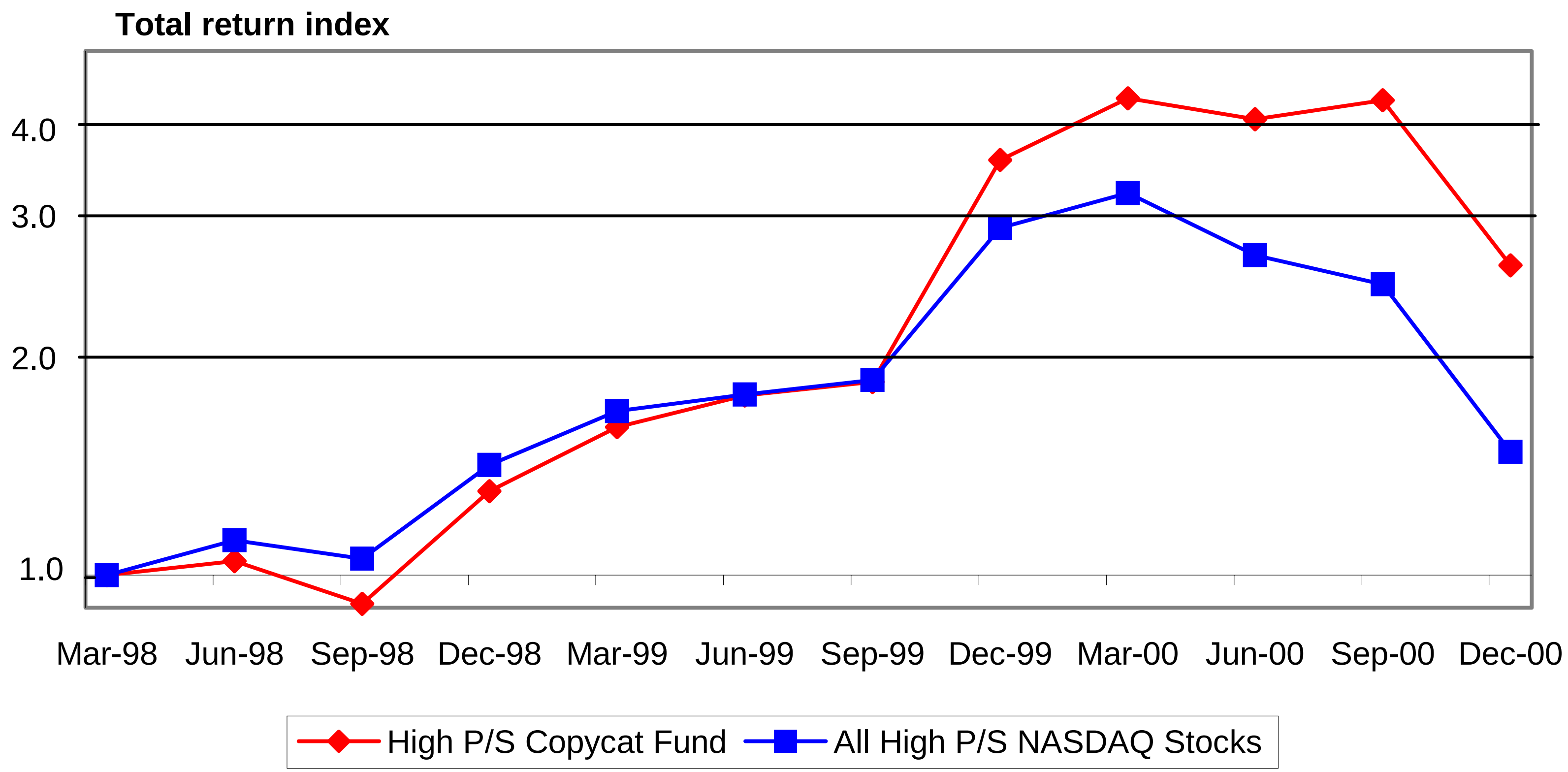


Figure 6: Performance of a copycat fund that replicates hedge fund holdings in the NASDAQ high P/S segment

Conclusion

- Hedge funds were riding the bubble
  - Short sales constraints and “arbitrage” risk are not sufficient to explain this behavior.
- Timing bets of hedge funds were well placed. Outperformance!
  - Rules out unawareness of bubble.
  - Suggests predictable investor sentiment. Riding the bubble for a while may have been a rational strategy.

$\Rightarrow$ Supports ‘bubble-timing’ models

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