Carry Trades and Currency Fluctuations

- Eco 554 Lecture 07 -

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Roadmap

- Motivation
  - UIP, Forward Premium Puzzle
  - Conditional Skewness
- Theory
  - "Overshooting/Bubble view"
  - "Undershooting view"
- Empirical evidence

Example of Carry Trade

- Yen-Aussie carry trade
  - Borrow at 0.87 % JPY LIBOR 3 months
    "Funding currency"
  - Invest at 7% AUD LIBOR 3 months
    "Investment currency"
  - Hope that JPY doesn't appreciate too much
- Using currency futures $F_t = S_t e^{i^* - i}$
  - Sell futures if $F_{t,T} > E_t[S_T]$
  - Buy futures if $F_{t,T} < E_t[S_T]$

Empirical: two stylized facts

1. Forward Premium Puzzle – Random Walk
   - UIP (in risk-neutral world)
   - "Fama regression" H_0: $\alpha = 0, \beta = 1$

$$\frac{S_{t+1} - S_t}{S_t} = \alpha + \beta \frac{F_t - S_t}{S_t} + \varepsilon_{t+1}$$

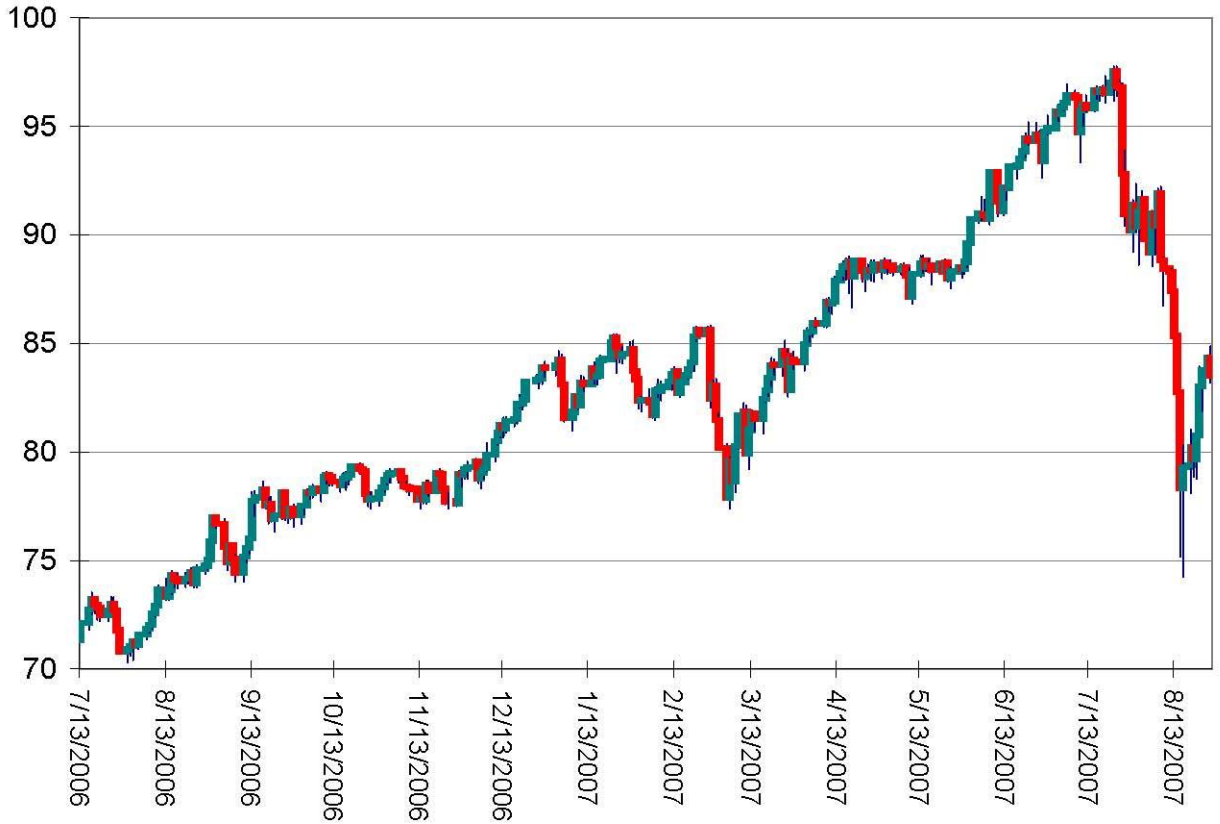
Data (25 major currencies w.r.t. US$ 1976-2007 median)

	$\hat{\alpha}$	$\hat{\beta}$	R^2
	0.0007	-.682	0.012
	(0.0025)	(0.727)	

   - Random Walk - Meese-Rogoff (1983)
     - Carry trade profitability is due to interest rate diff.
   - Difficult to explain high Sharpe ratio as "risk premium"
     - Backus et al. (2001), Burnside et al. (2006)

Empirical: two stylized facts

2. Cond. Skewness of exchange movements
   - "Going up by the stairs and down by the elevator"



Theory: two views

1. Bubble (overshooting) view:
   - Carry trades delay currency adjustments
   - Wile E. Coyote Effect (Abreu-Brunnermeier 2002+03)

Theory: two views united

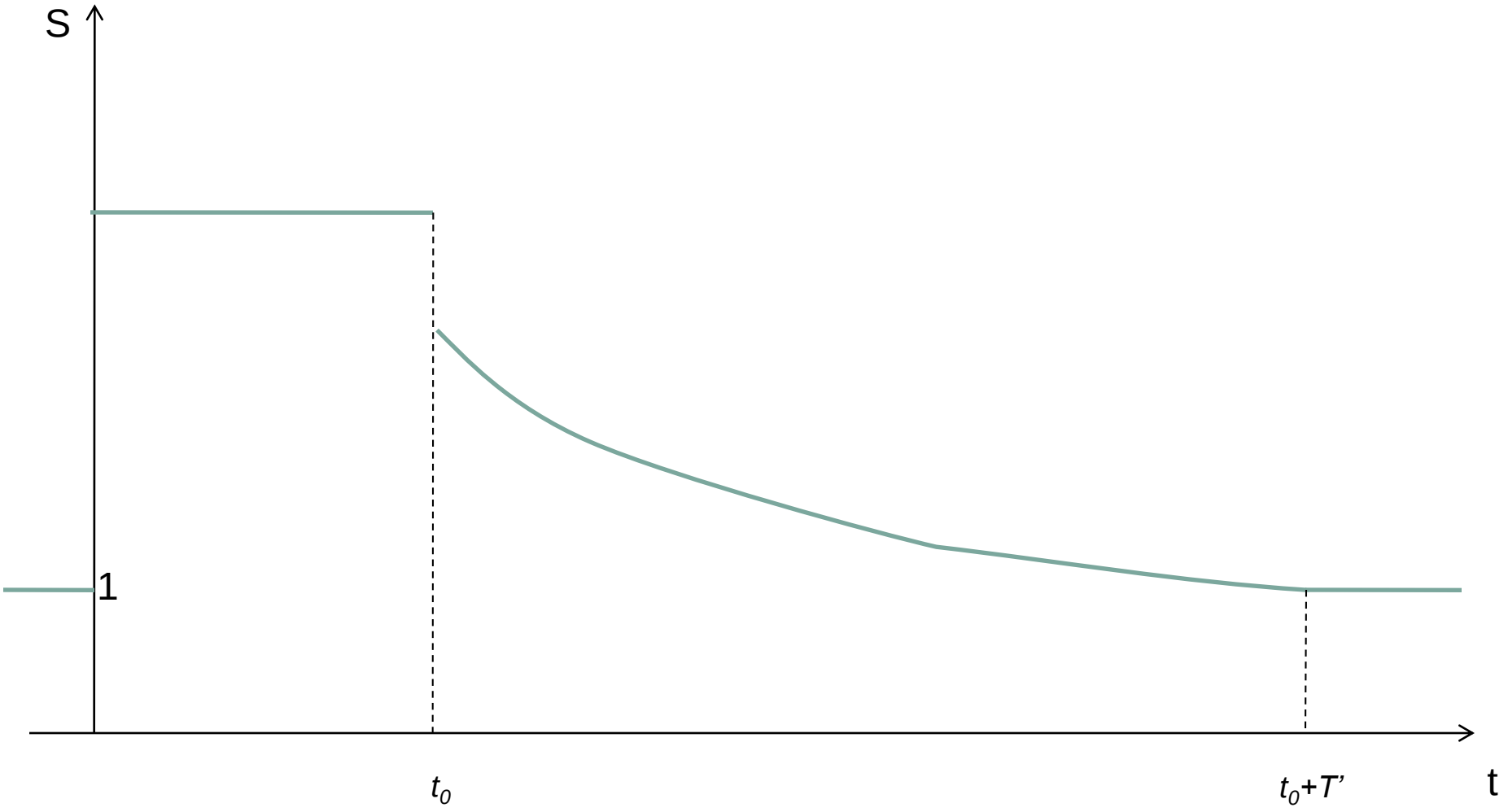
2. Undershooting view:
   - Carry trade activity is limited due to funding liquidity risk
     Brunnermeier-Nagel-Pedersen (2008)
- Both views lead to forward premium puzzle

- Next: United view

Theory: Stylized example

- Positive interest diff for random length
  - $i^*-i > 0$ from $t=0$ to $t = t_0 + T'$, where
    - t_0 is random with
      $F(t_0) = 1 - exp\{-\lambda t_0\})$ with $\lambda > (i^*-i)$
    - T' is "large"
  - $i^*=i$, otherwise
- Exchange rate
  - $S(t_0)= S(t+T')=1$

Theory: frictionless benchmark



Theory: frictionless benchmark

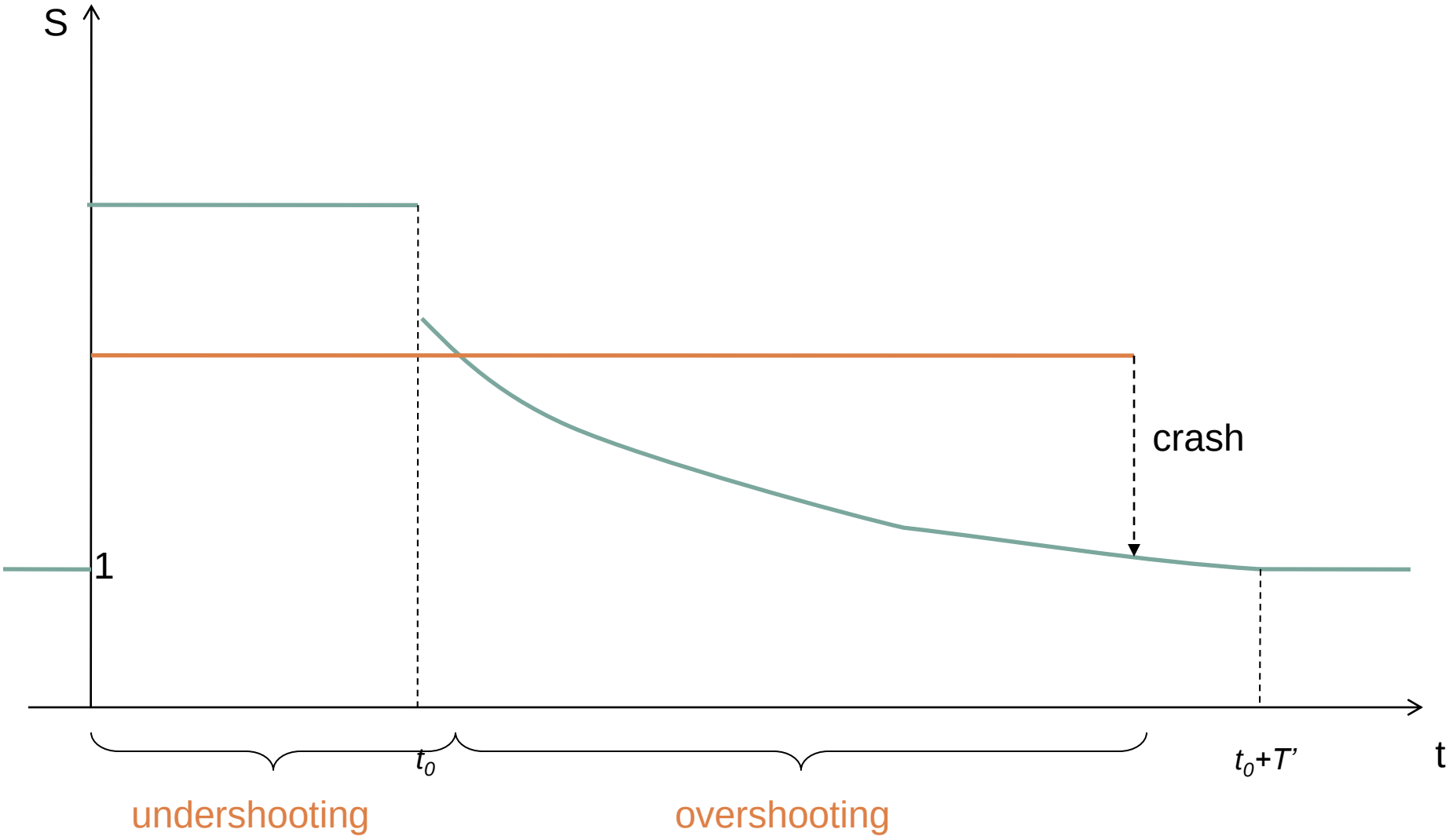
- After knowing t_0
  - UIP implies $S(t \mid t_0) = Ae^{-(i^*-i)t}$ s.t. $S(t_0+T' \mid t_0) = 1$
    Hence, $S(t \mid t_0) = e^{(i^*-i)(t_0 + T' - t)}$
- Before knowing t_0
  - $S(t) = S(0)$ due to exponential structure
  - $S(0)$ is given by UIP

$$\Delta_t \lambda \frac{S(0) - S(t_0 \mid t_0)}{S(0)} S(0) = (1 - \Delta_t \lambda)(i^* - i)\Delta_t S(0)$$

$$S(0) = \frac{\lambda}{\lambda - (i^* - i)} e^{(i^*-i)T'}$$

Note for $\lambda < (i^*-i)$, E(0) goes to infinity

Theory: frictions



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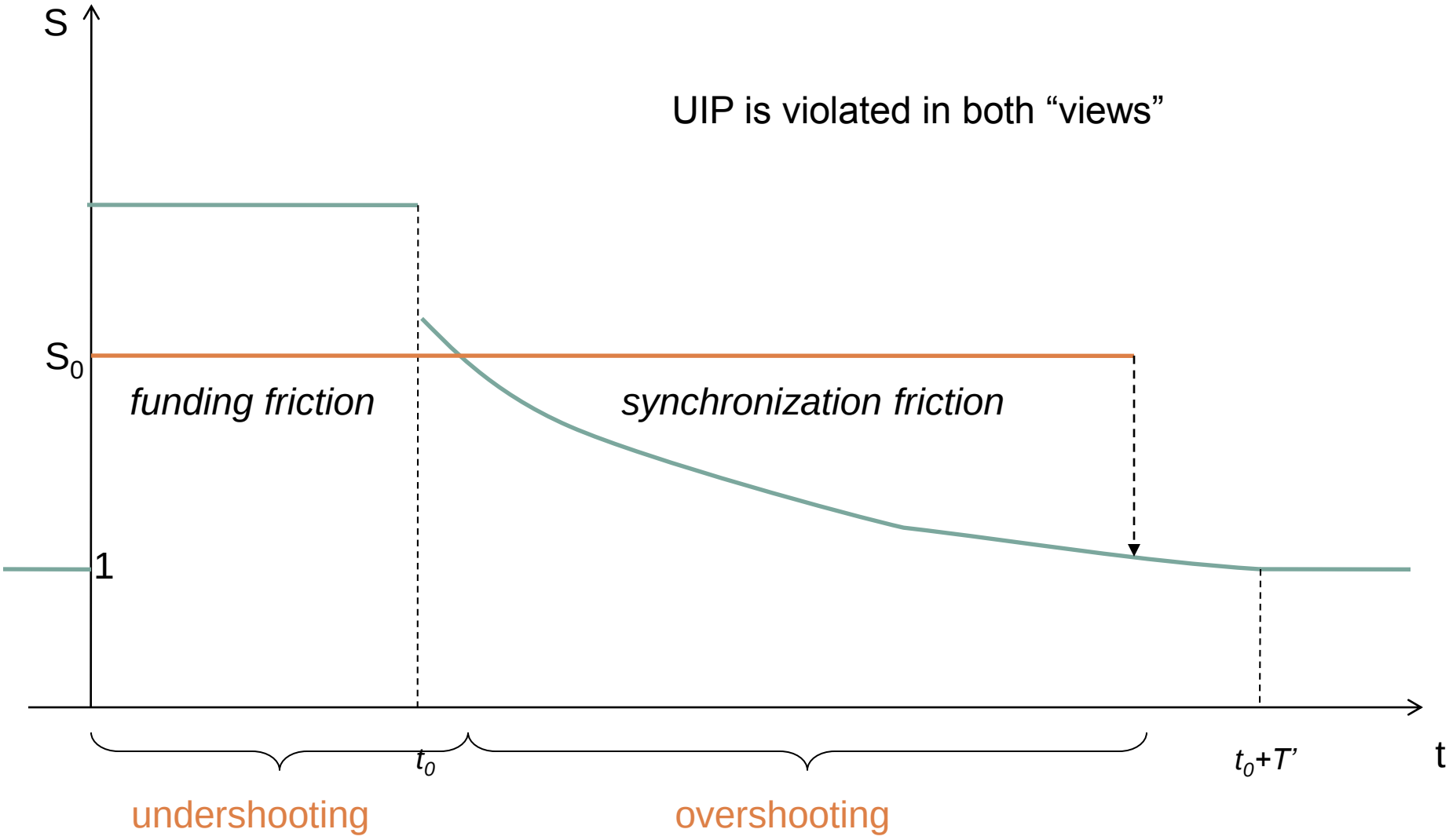
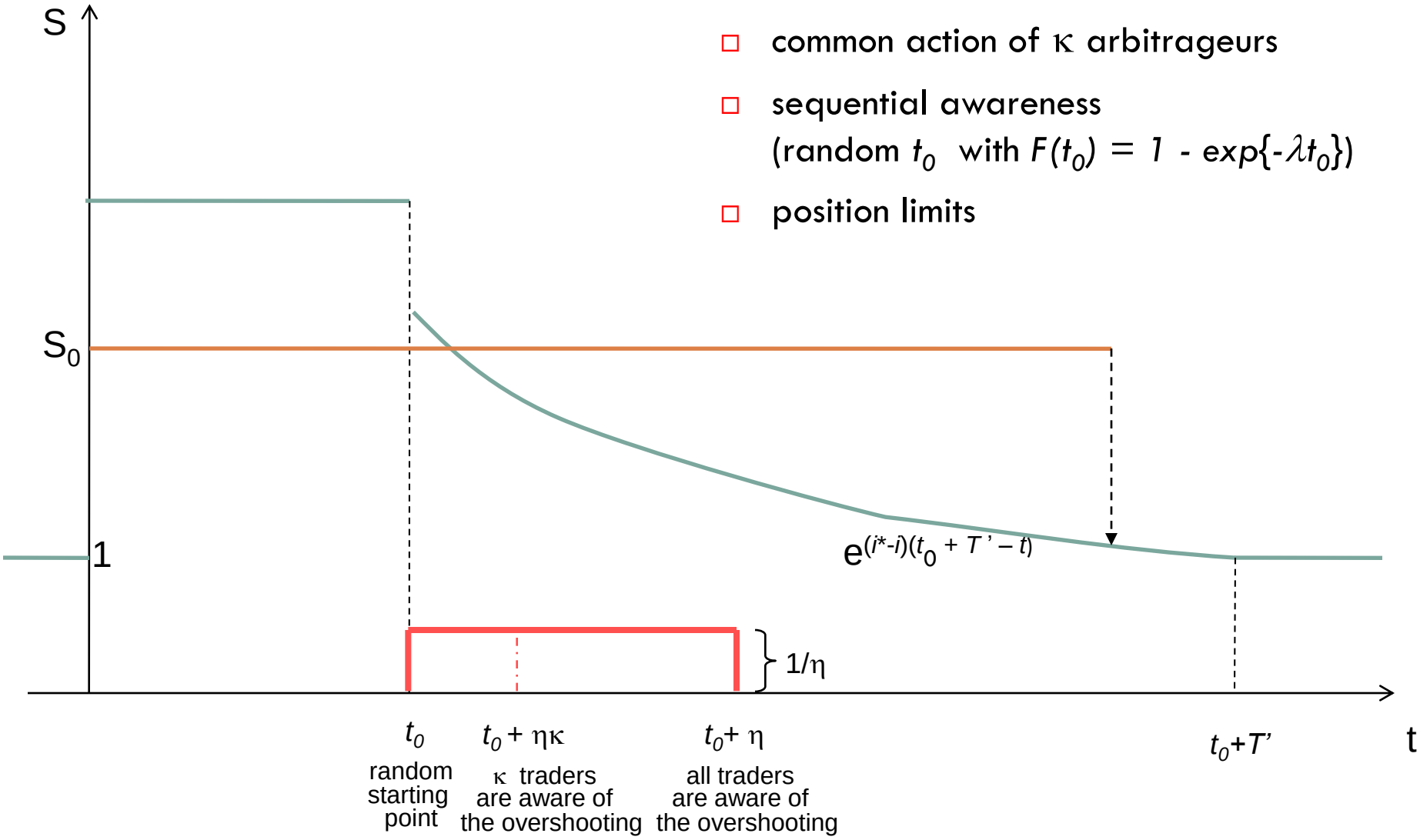


Theory: "bubble view" first



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

Theory: Abreu-Brunnermeier 02

- Focus on
  - "when does currency crash occurs" (carry trade returns are skewed)
  - one random variable t_0, all other variables are CK
- Cash Payoffs (difference)
  - Exit carry trade at $t-\Delta$ instead of at t.

$$S_{t-\Delta}\, e^{r\Delta} - S_t$$

where $S_t = S_0$ prior to crash vs. $e^{(i^*-i)(t_0+T'-t)}$ after crash

- Risk-neutrality but max/min stock position
  - max long position
  - max short position
  - due to capital constraints, margin requirements etc. (more details later)

Theory: exit condition

- Exit carry trade iff

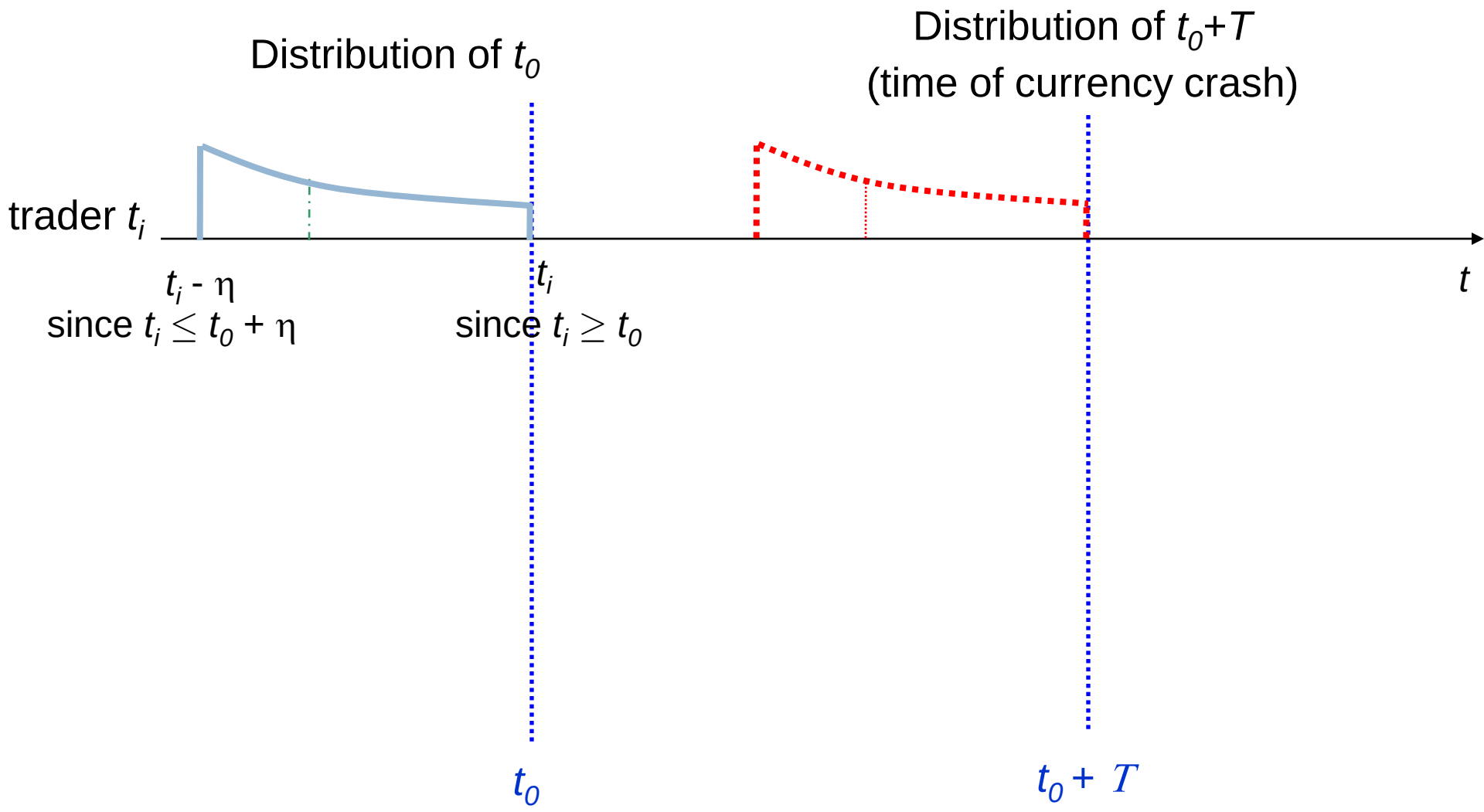
$$\underbrace{\Delta_t h(t \mid t_i)\frac{S_0 - e^{(i^*-i)(t_0+T'-t)}}{S_0} S_0}_{\text{Suffer currency crash}} \geq \underbrace{(1-\Delta_t h(t \mid t_i))(i^*-i)S_0\Delta_t}_{\text{Cash in interest rate differential}}$$

$$h(t \mid t_i) \geq [i^* - i] / [1 - e^{(i^*-i)(T'-T)}/S_0],$$

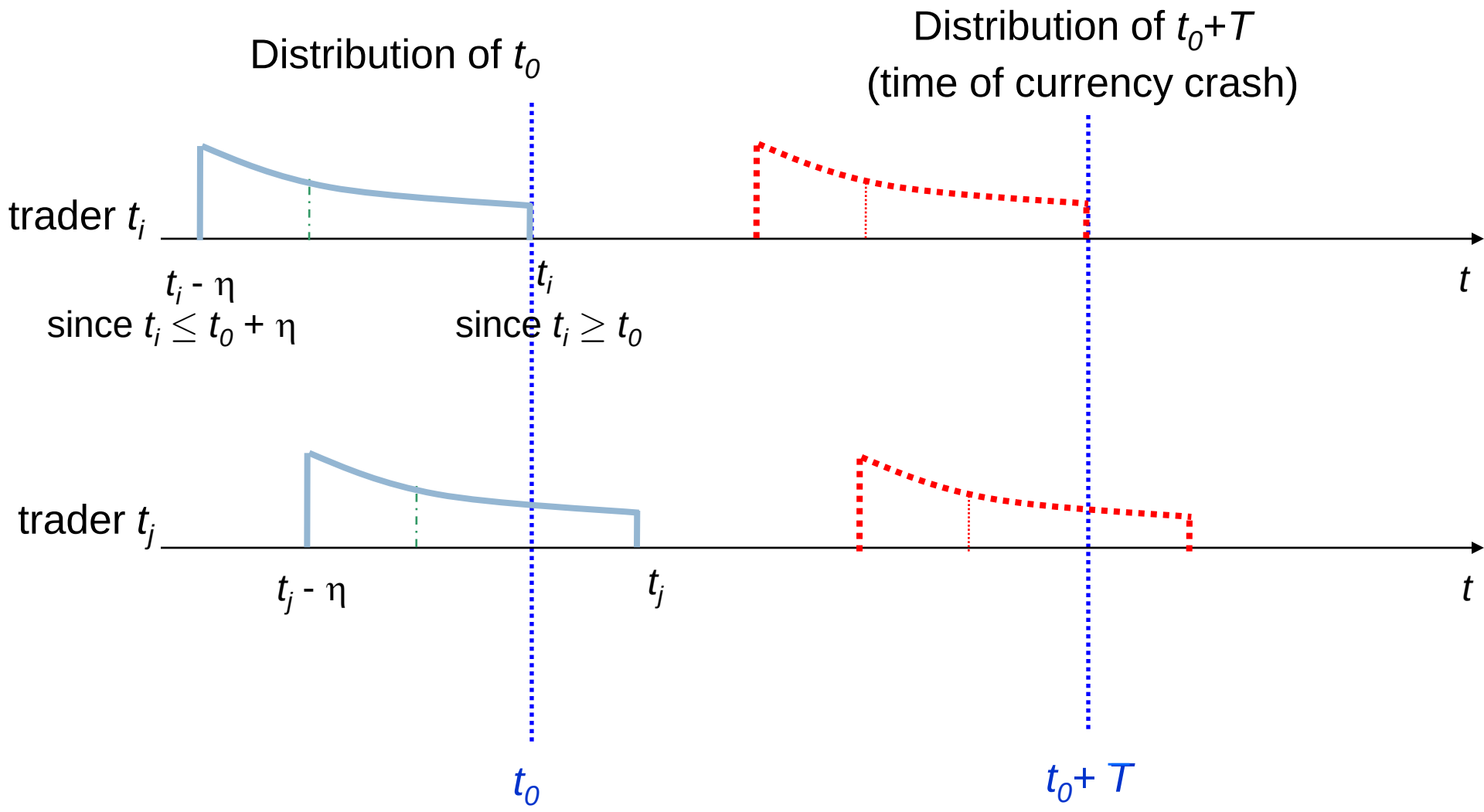
where t_0+T = time of (endogenous) currency crash (T is known in equilibrium)

- RHS is "greed-to-fear ratio"

Sequential Awareness



Sequential Awareness



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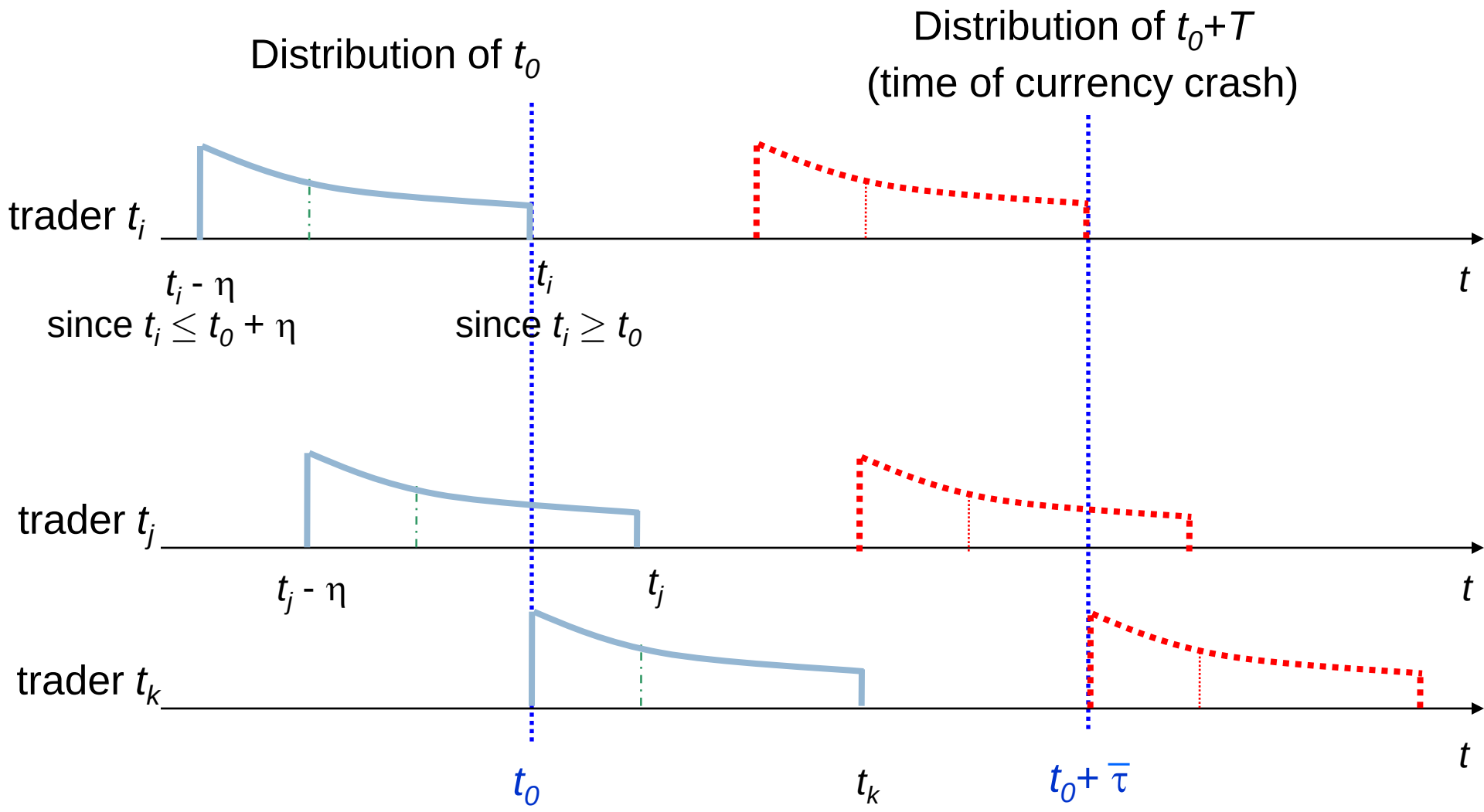
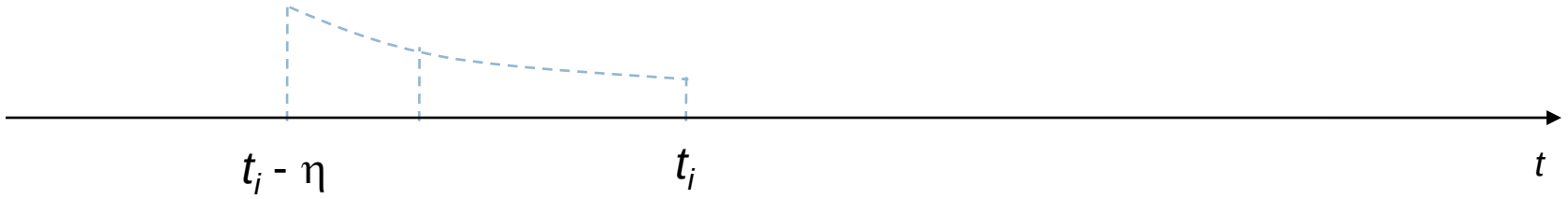


Conjecture: immediate attack

$\Rightarrow$ **Crash at $t_0 + \eta\kappa$**

when κ traders are aware



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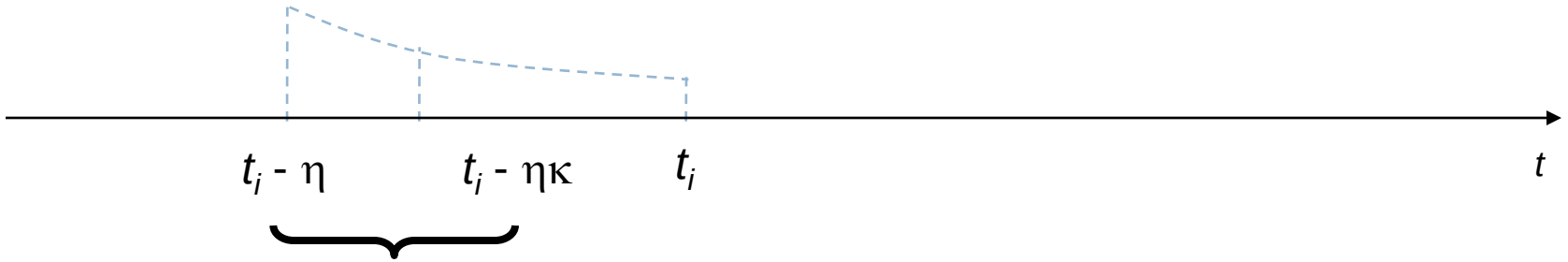

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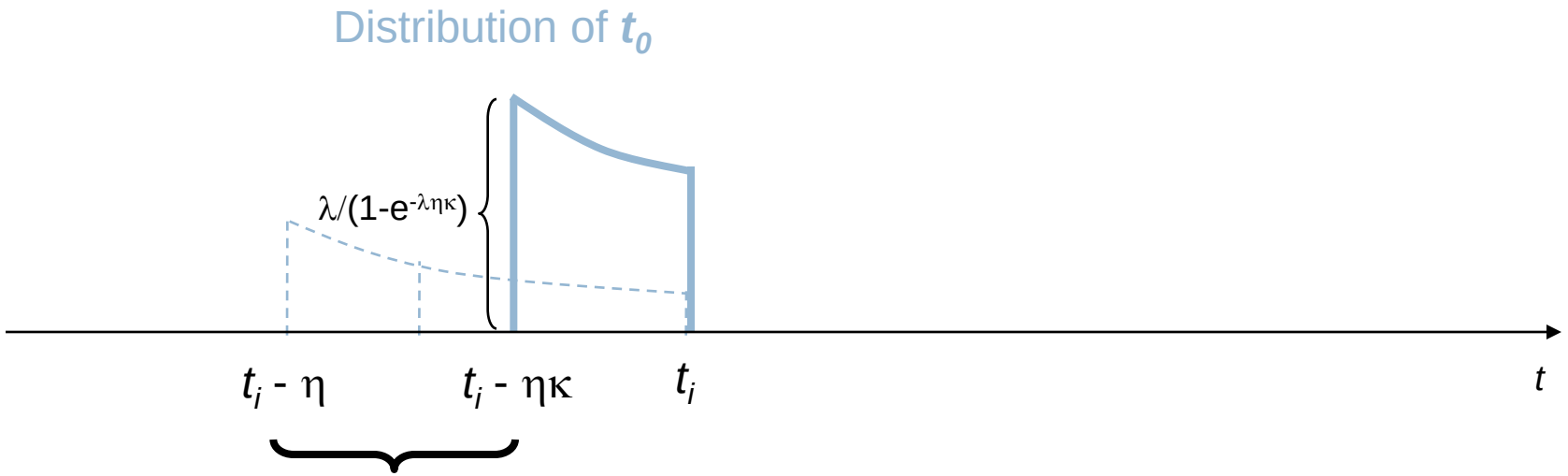

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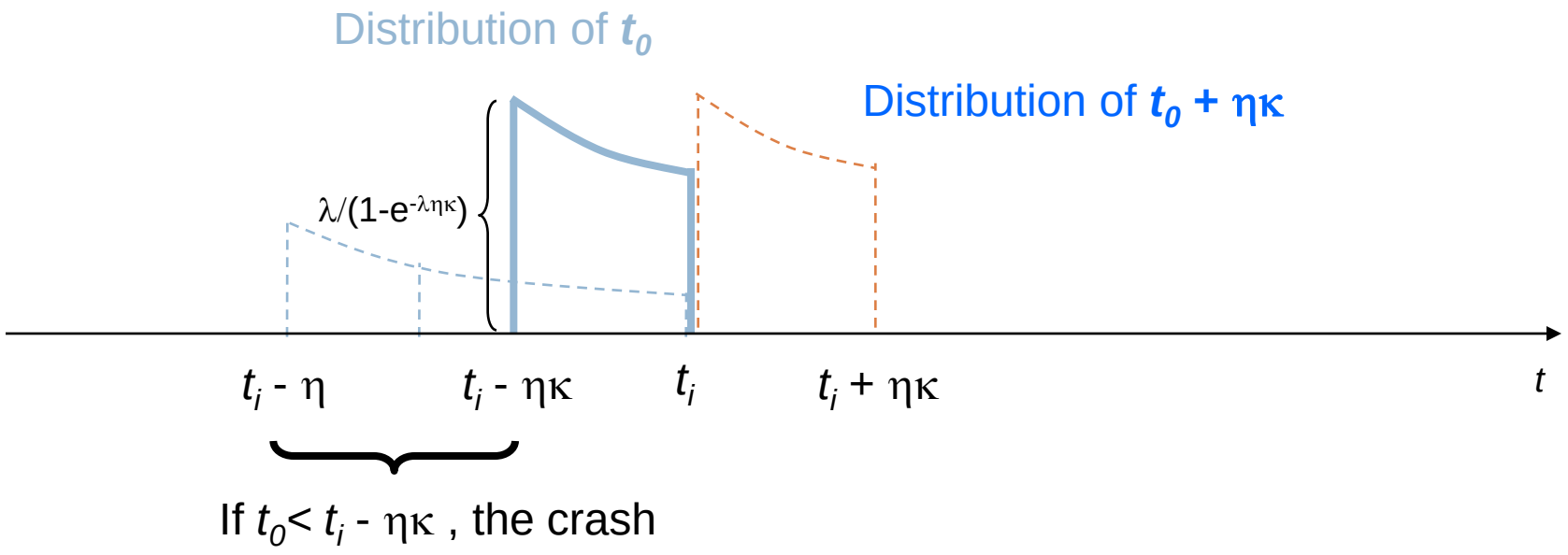

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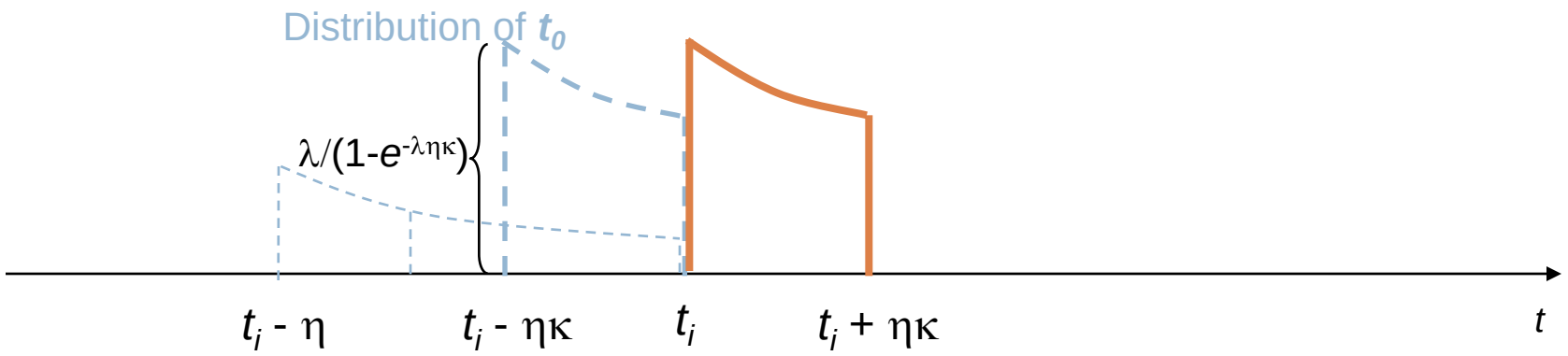
Crash at $t_0 + \eta\kappa$



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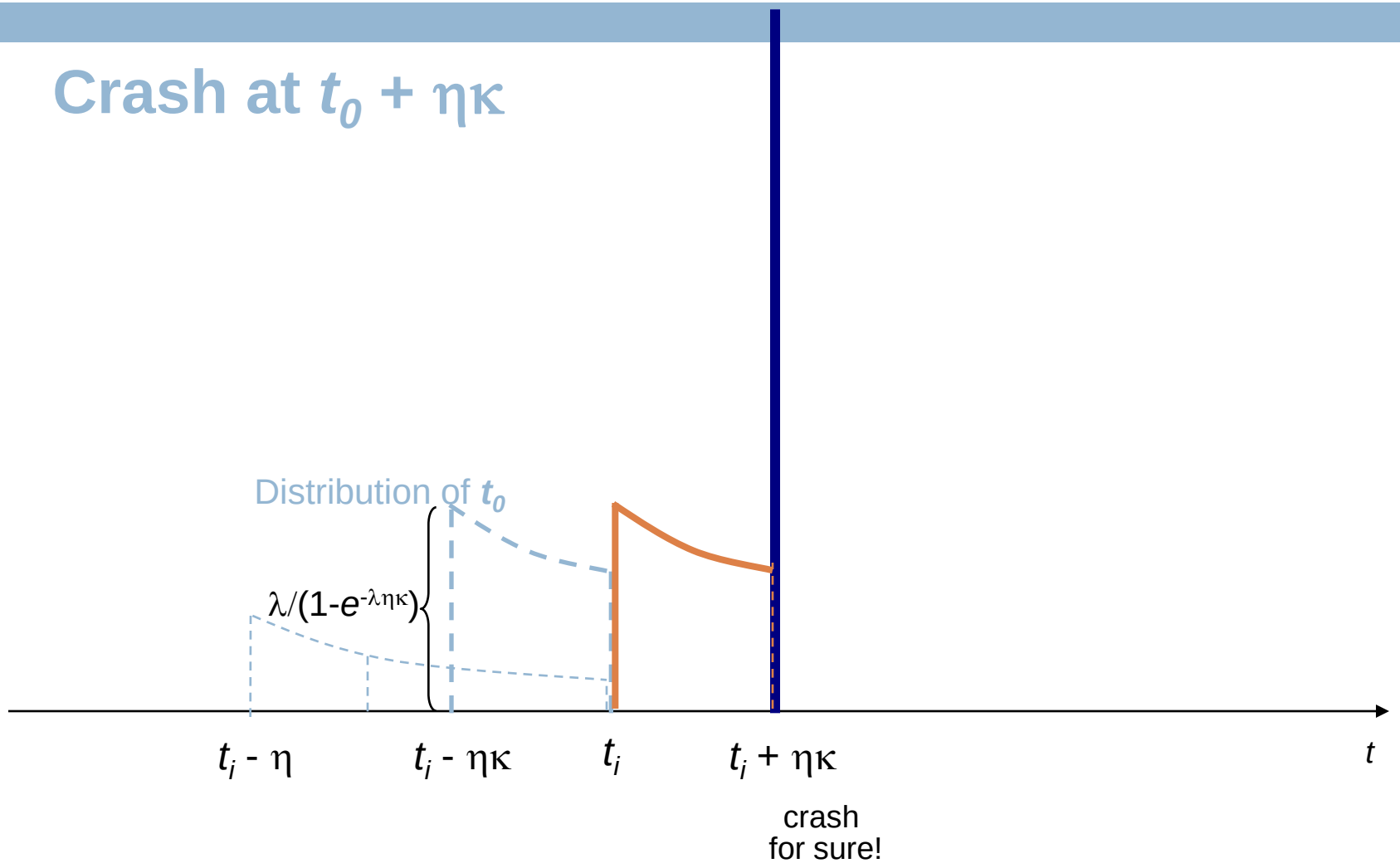

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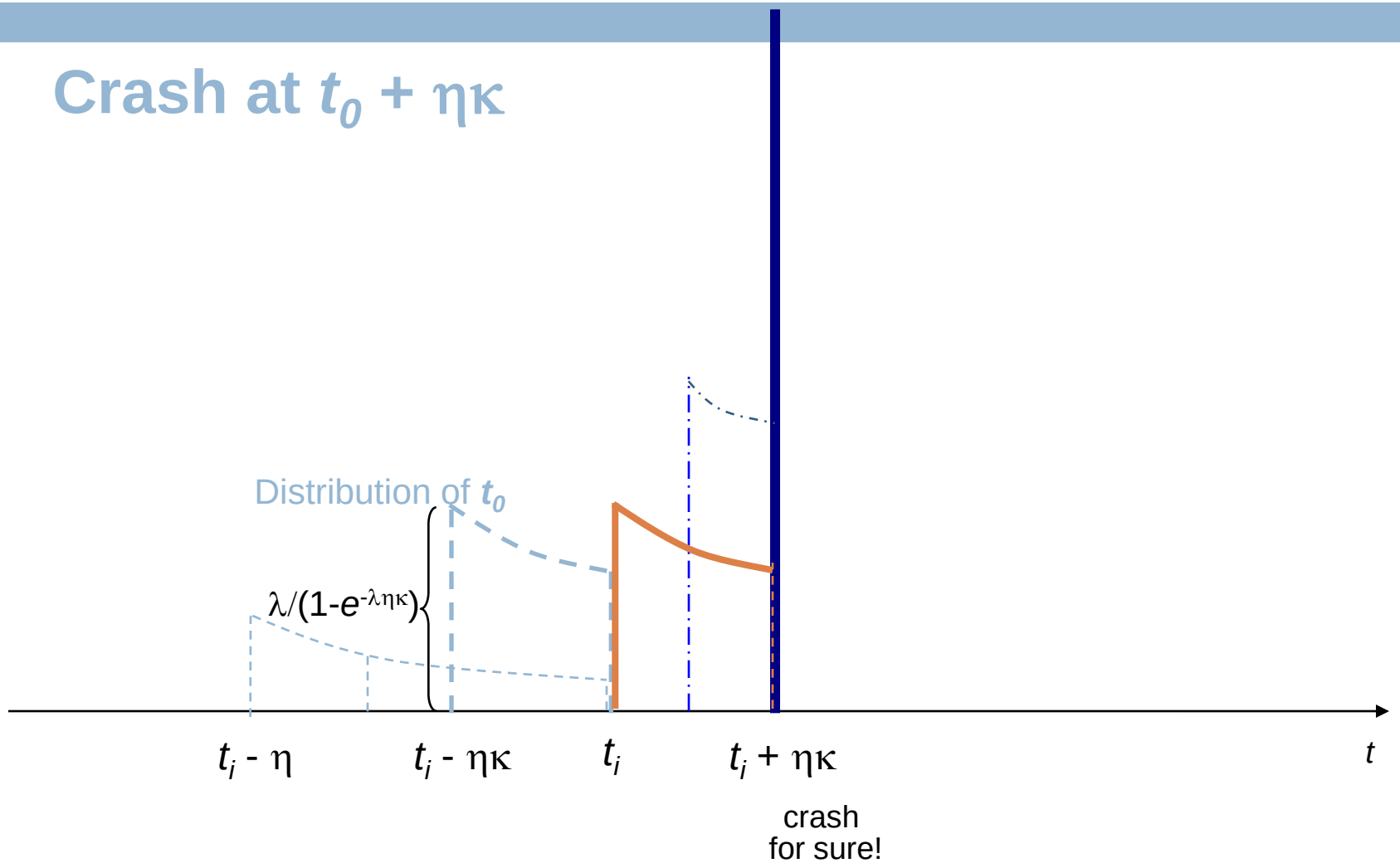

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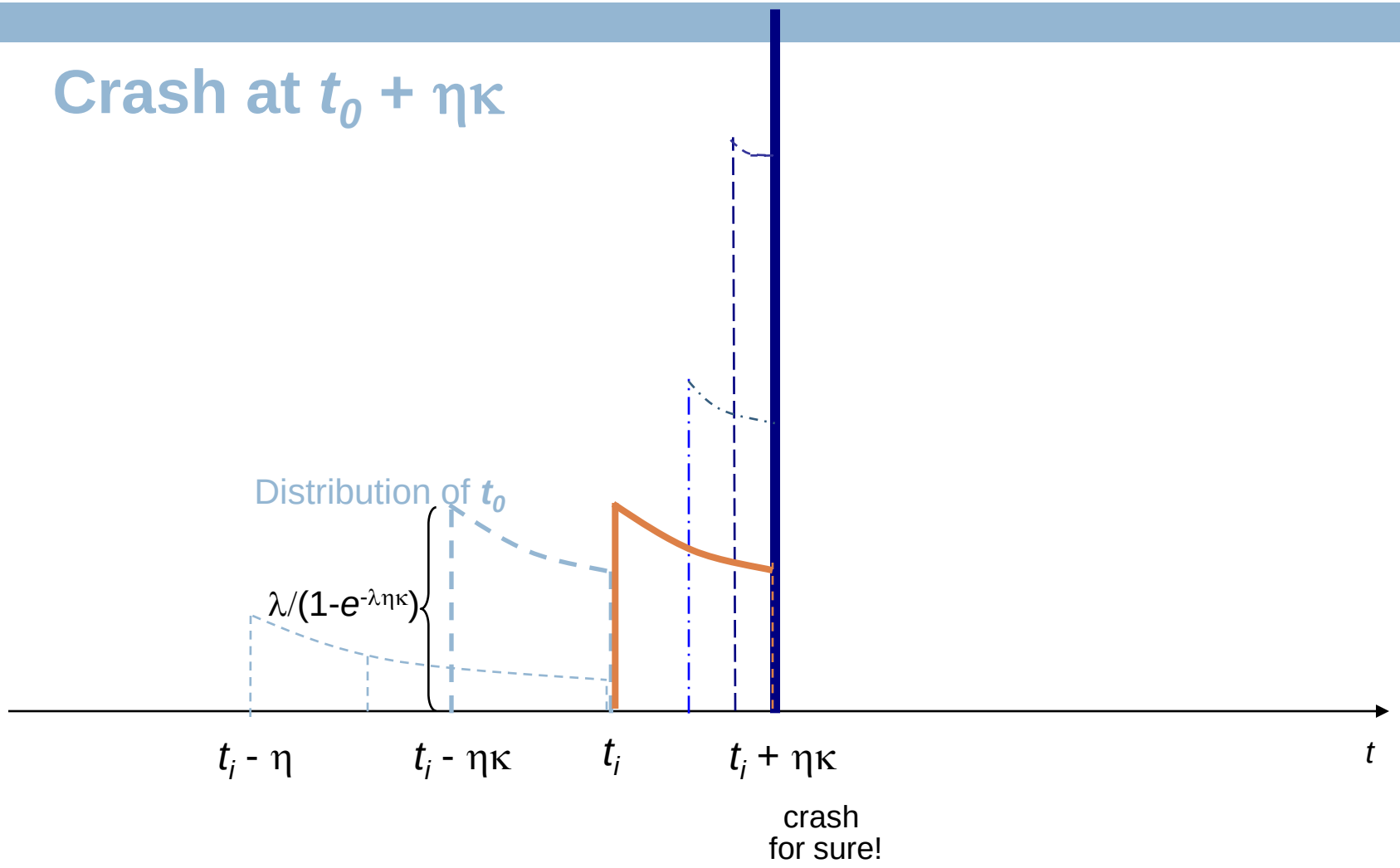

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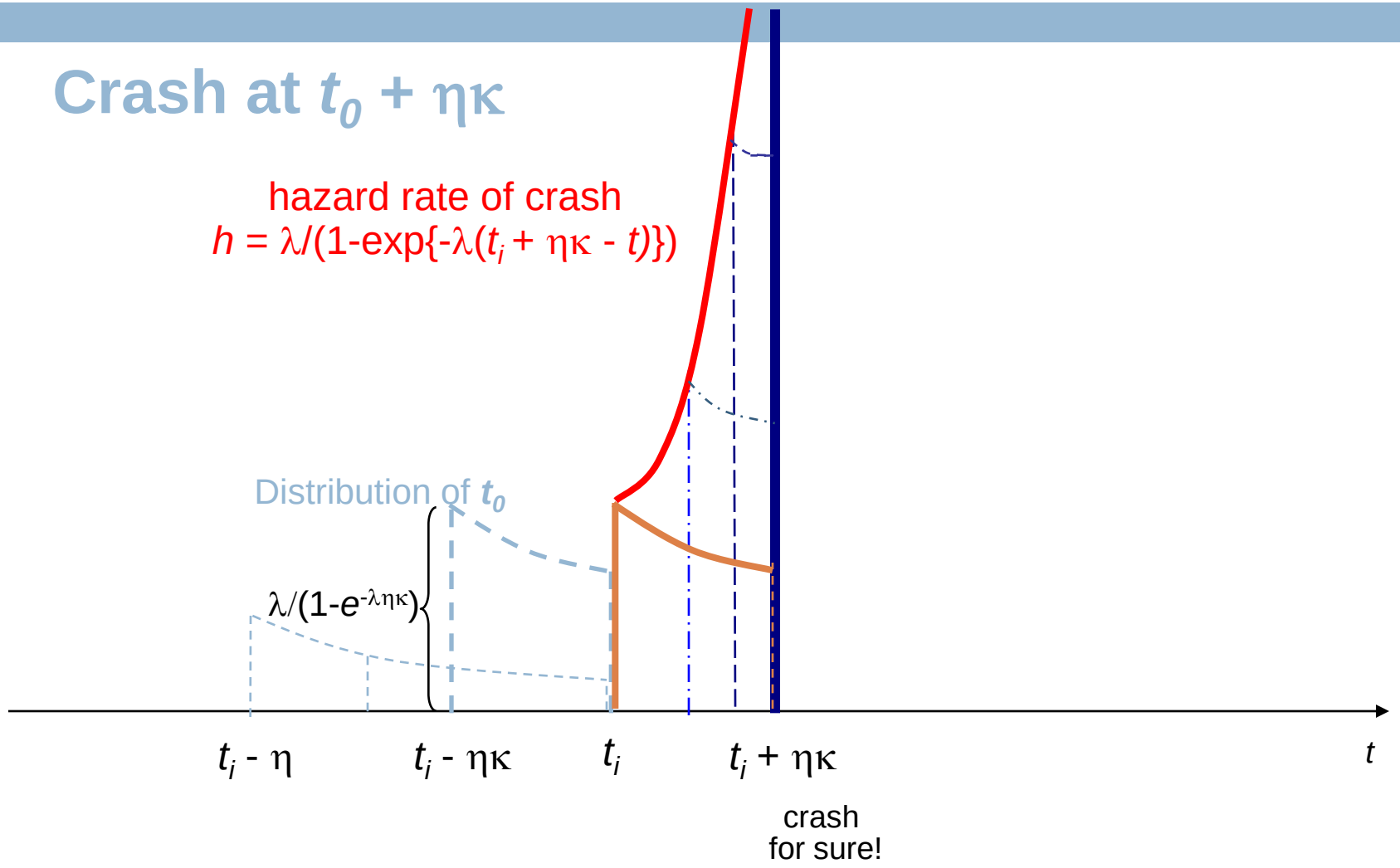

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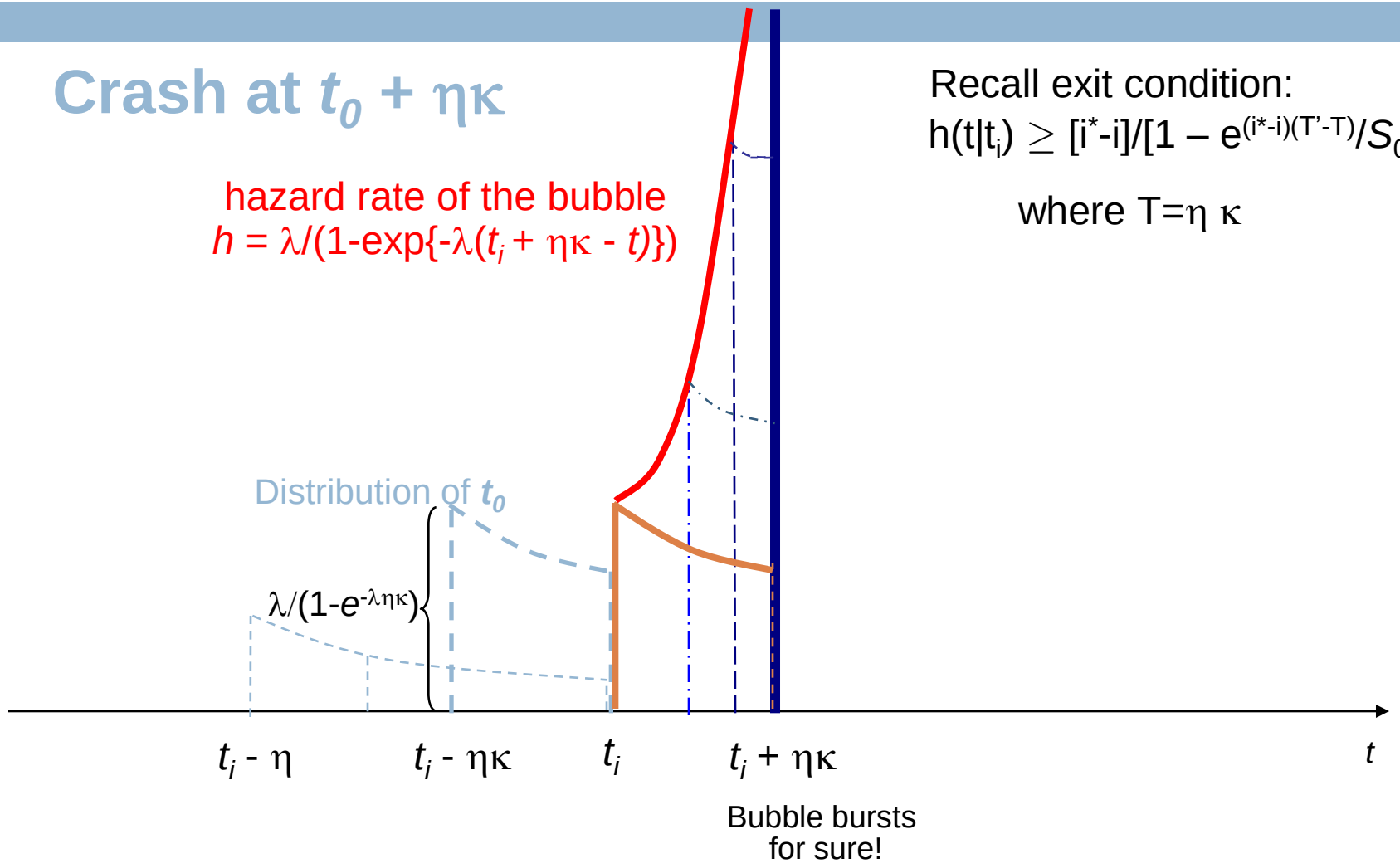

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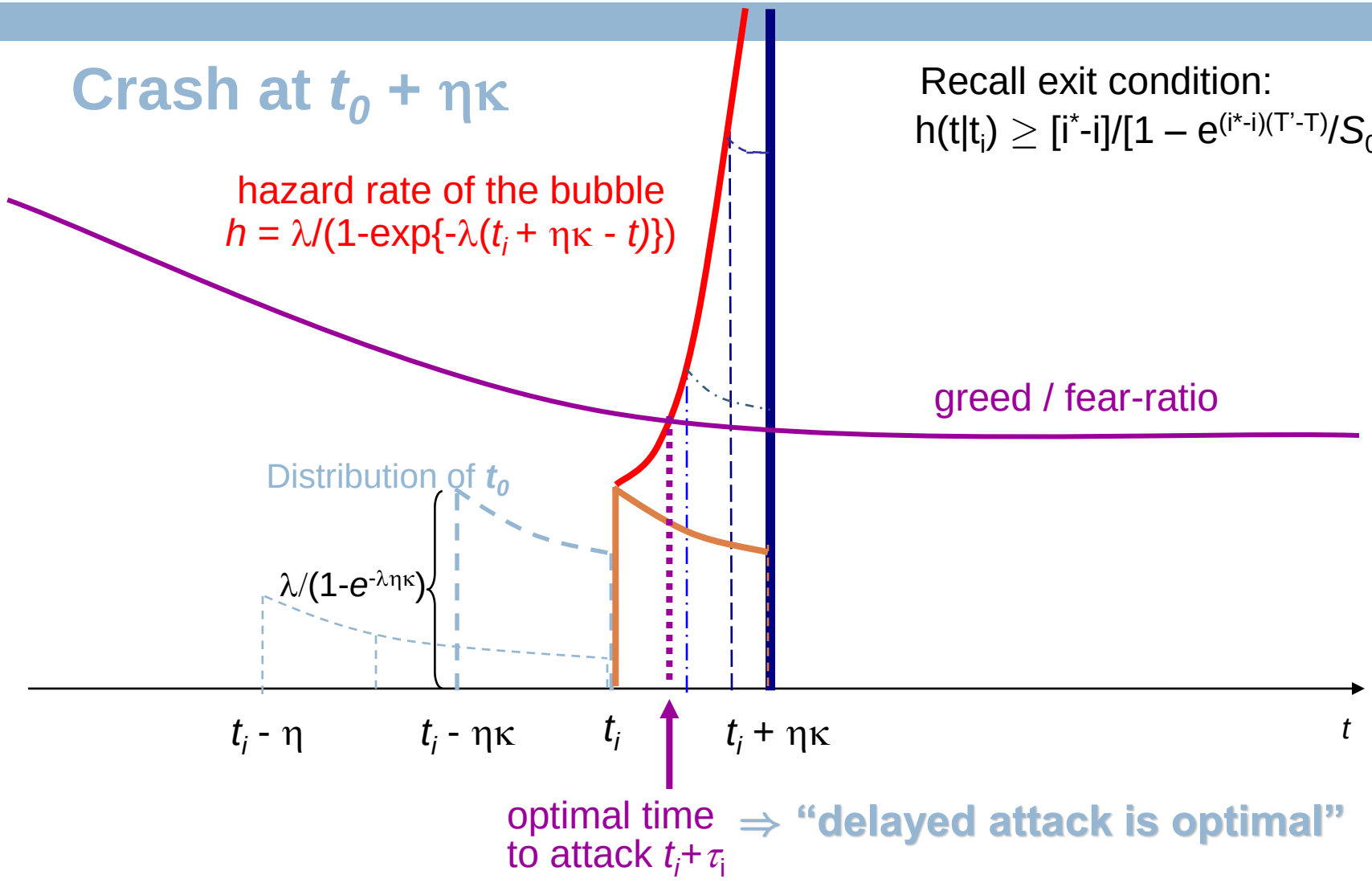
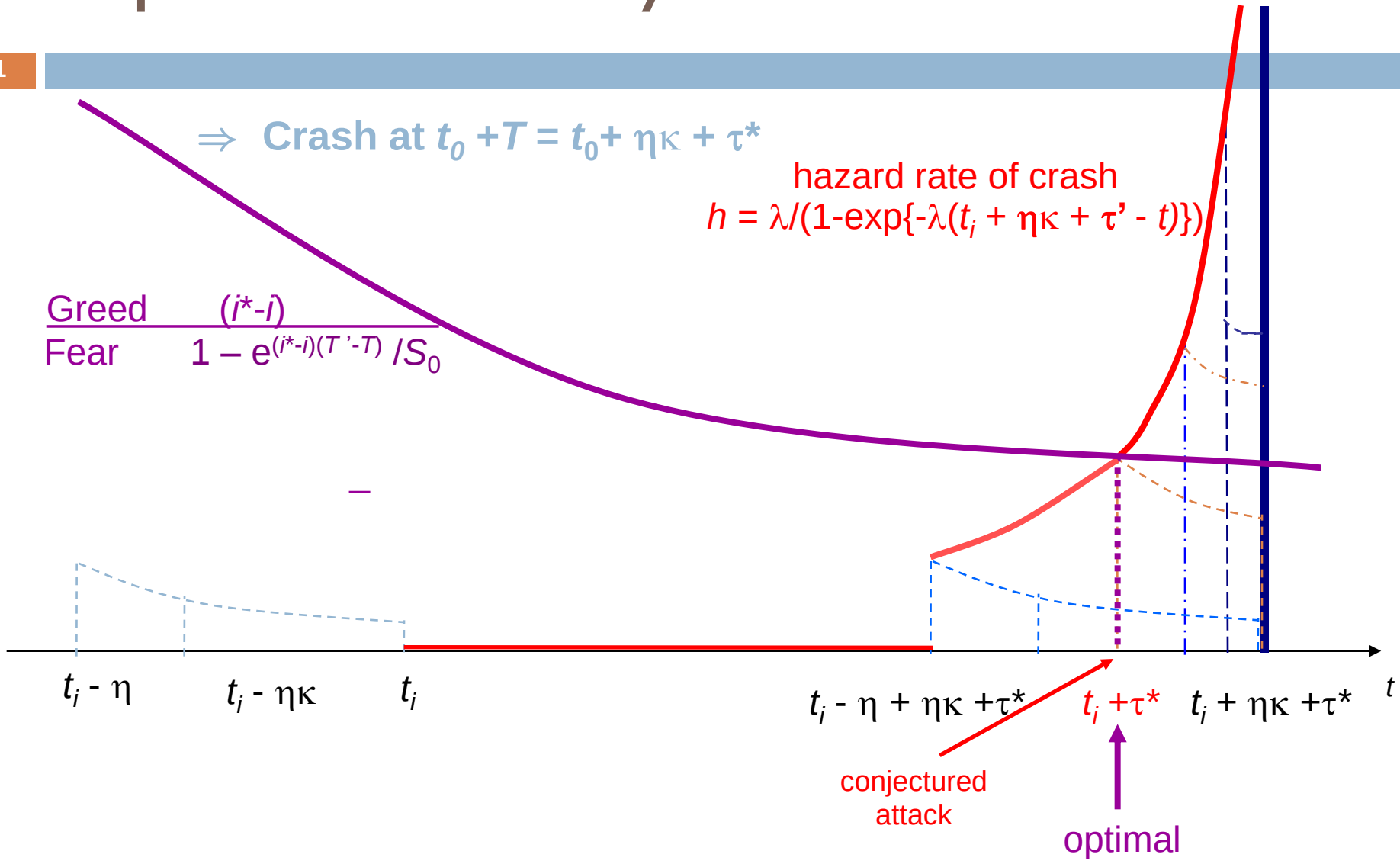


Preliminary results

- Immediate price correction is not an equilibrium
- Mispricing grows over time

Equilibrium delay τ^*

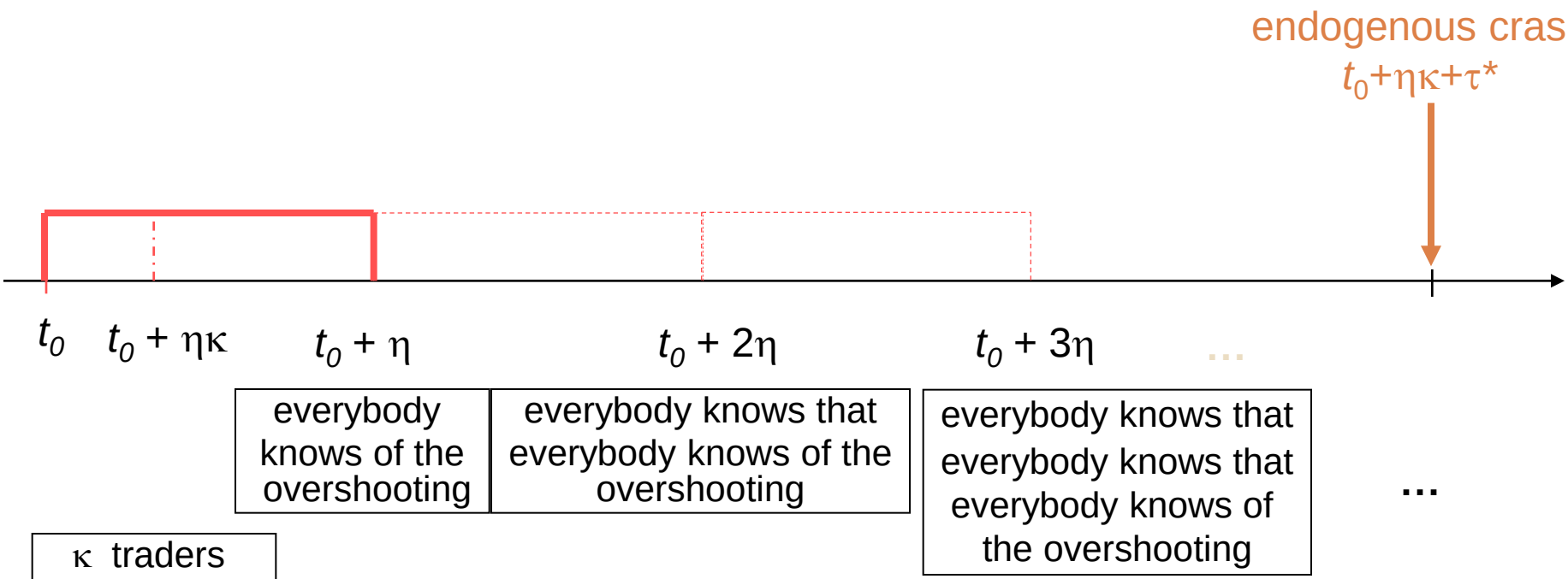


Results: delay τ^* + crash

- Proposition
  - Each speculator only exits its carry trade τ^* periods after learning that the exchange rate is too high, i.e. at $t_i + \tau^*$, where
    $$\tau^* = T' - \frac{1}{i^* - i}\{\ln S_0 + \ln[1 - \frac{1 - e^{-\lambda\eta\kappa}}{\lambda}(i^* - i)]\} - \eta\kappa$$
  - The exchange rate correction occurs at
    $$T = \tau^* + \eta\kappa = T' - \frac{1}{i^* - i}\{\ln S_0 + \ln[1 - \frac{1 - e^{-\lambda\eta\kappa}}{\lambda}(i^* - i)]\}$$
  - Size of crash is
    $$(i^* - i)\frac{1 - e^{-\lambda\eta\kappa}}{\lambda} S_0$$
- Proposition (Comparative Static)
  - Crash size is increasing (i^*-i), η, κ, S_0 (less undershooting, more overshooting)
  - Delay of price correction is increasing in S_0 ambiguous in (i^*-i), since
    - Fear: larger crash size leads to earlier correction
    - Greed: larger (i^*-i) makes carry trades more profitable
- Negative skewness of carry trade returns

Lack of common knowledge

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



(same reasoning applies for κ traders)

Synchronizing events

- Most sharp price movements occur without fundamental news
- Example: Dollar/Yen Oct 7/8, 1998

- Fair (2002): no news on most crashes

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 attack” fails, the crash is even further postponed

Synchronizing events

- Exchange rate drop as a synchronizing event
  - through psychological resistance line
  - by more than, say 5 %
- **Exogenous price drop**
  - after a price drop
    - if mispricing is ripe
      $\Rightarrow$ crash occurs and price drops further
    - if mispricing is not ripe yet
      $\Rightarrow$ exchange rate bounces back and the mispricing is strengthened for some time

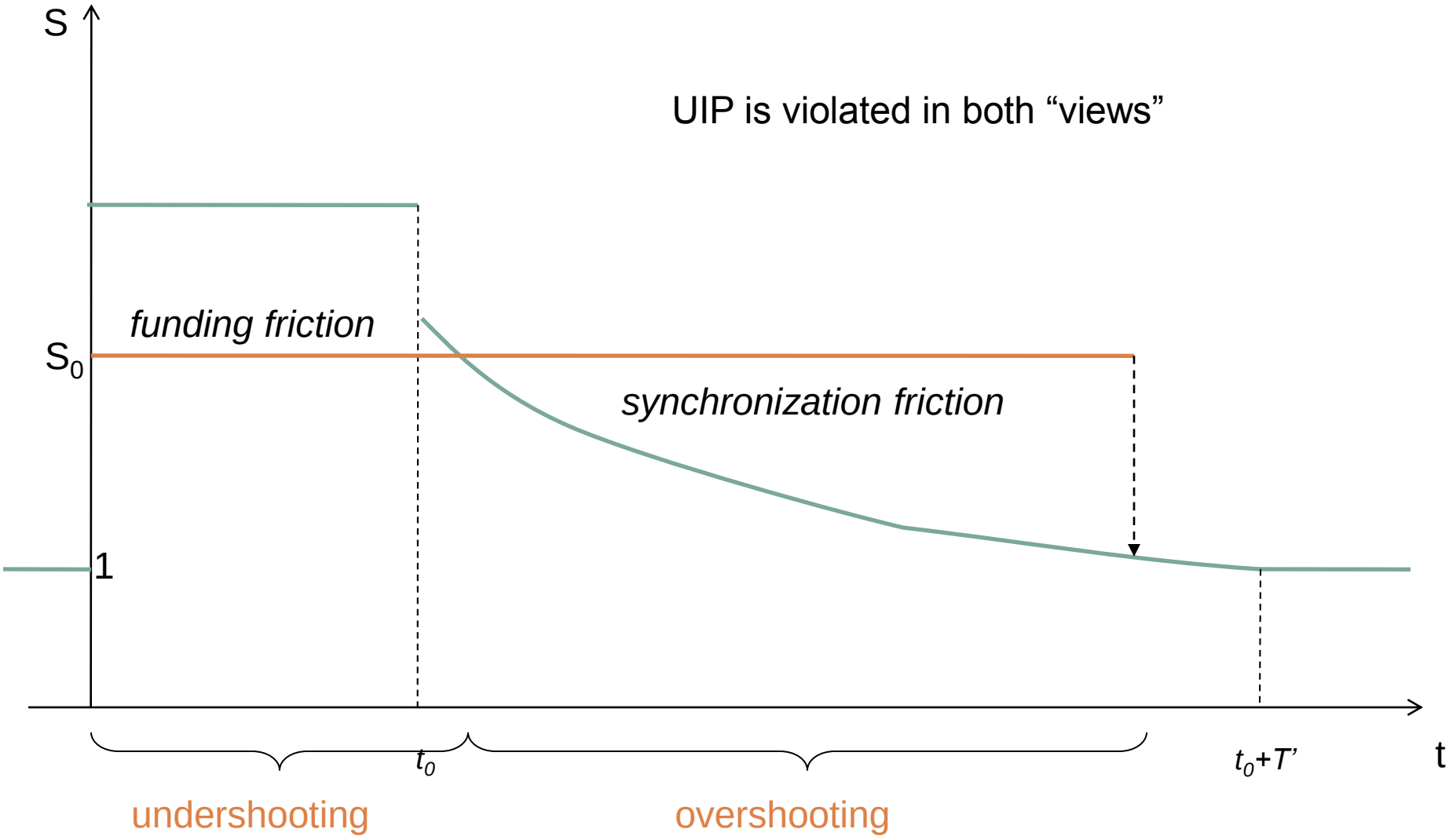
“Bubble view” – take aways

- Bubbles
  - Dispersion of opinion among arbitrageurs causes a synchronization problem which makes coordinated price corrections difficult
  - Arbitrageurs time the market and continue carry trades
  - Exchange rate distortions persist and crashes are larger
    - Wile E. Coyote effect
    - Sknewness
- Crashes
  - can be triggered by unanticipated news without any fundamental content, since
  - it might serve as a synchronization device.
- Crash is larger for larger interest rate differential
- Even more extreme view:
  “Carry trades CAUSE bubbles”

Roadmap

- Motivation
  - UIP, Forward Premium Puzzle
  - Skewness
- Theory
  - "Overshooting/Bubble view"
  - "Undershooting view"
- Empirical evidence

“Underreaction view”



Funding Liquidity Frictions

- Illiquidity arises due to frictions which
  - prevent fund flows to investors with expertise
  - limits optimal risk sharing
- Causes of frictions
  - asymmetric information
    - market breakdowns/credit rationing, market for lemons
  - non-verifiable info - incomplete contracts/markets
- Funding liquidity frictions = limits to arbitrage
- Speed of arbitrage (dynamic)
  - experts only build up capital slowly …

Flavors of Funding Liquidity

- Margin funding risk — *Prime broker*
  - Margin has to be covered by HF's own capital
  - Margins increase at times of crisis
- Rollover risk — *CP*
  - Inability to roll over short-term commercial paper
- Redemption risk — *Depositors, HF-investors*
  - Outflow of funds for HFs and banks

Funding constraint

- So far, simple position limits
  - to ensure that not a single market participant alone can cause crash
- Now, more specific
  - Margins
    - Buy AUS on margins $m^{AUS+} = VaR(AUS)$
    - Borrow JPY on margins $m^{JPY-} = VaR(JPY)$

$$\sum_j x_t^{j+} m_t^{j+} + x_t^{j-} m_t^{j-} \leq W_t$$

  - With cross-margining (portfolio margining)

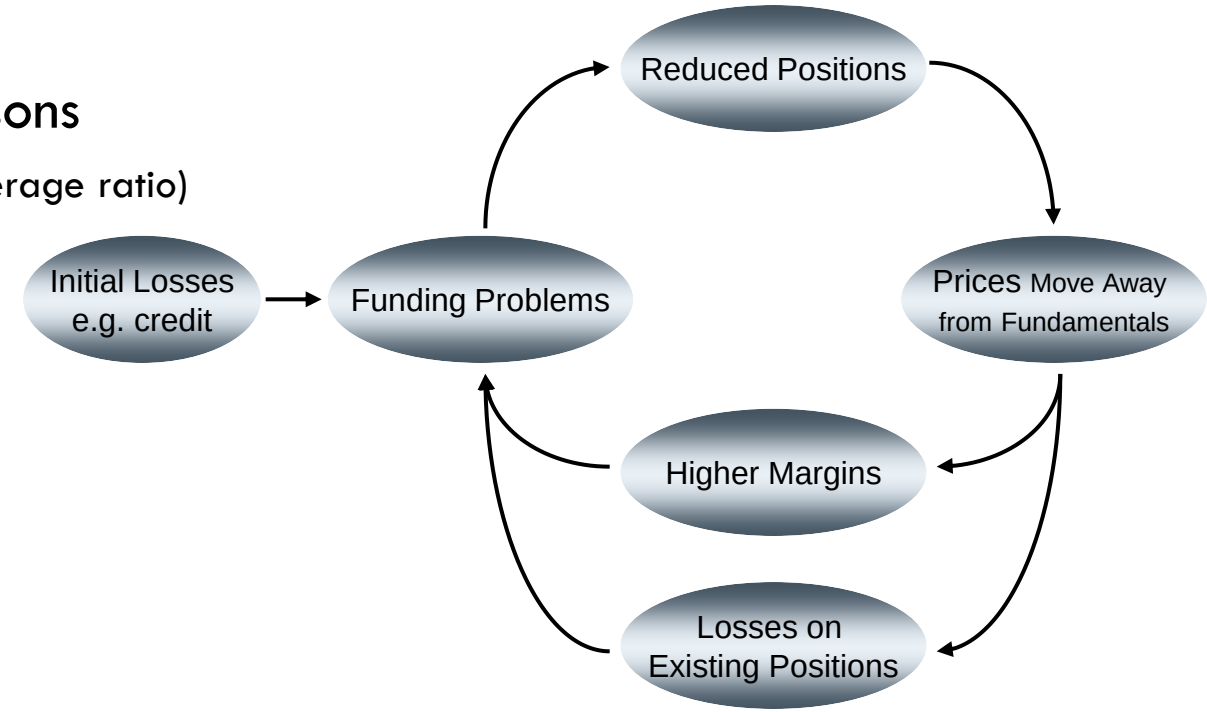
$$M(x_t^1, \ldots, x_t^J) \leq W_t$$

Funding constraint

- Exchange margins
- Regulatory Capital Requirements
  - Basel accord: banks
  - SEC Net Capital Rule: brokers
  - Regulation T: costumers of brokers

Balance Sheet Channel

- Borrowers' balance sheet – Brunnermeier-Pedersen (2008)
  - Loss spiral
    - Net wealth > α x for asym. info reasons
      - (constant or increasing leverage ratio)
      - Bernanke-Gertler, …
  - Margin spiral
    - (forces to deleverage)



Source: Brunnermeier & Pedersen (2008)

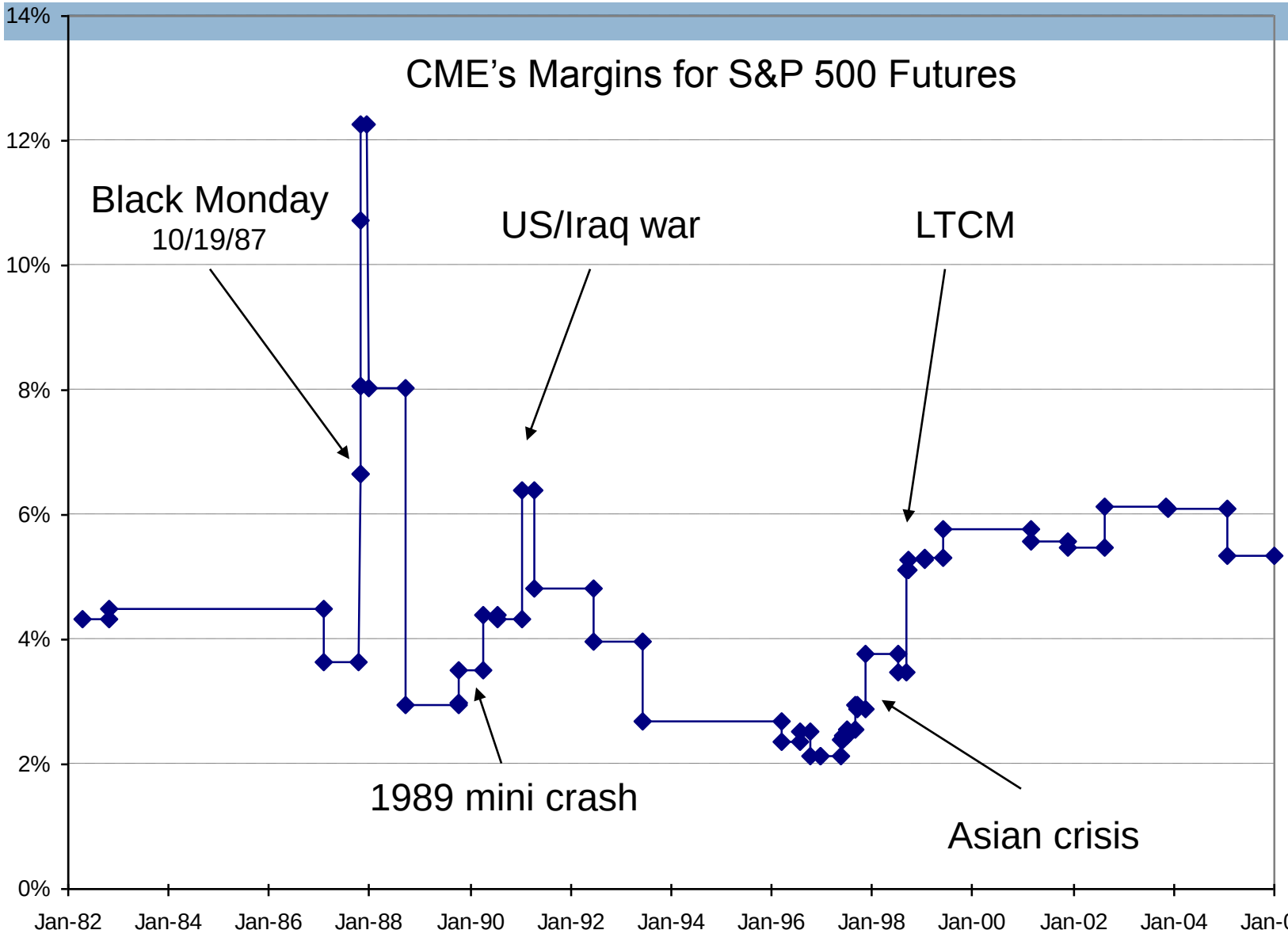
• Both spirals reinforce each other

Margin spirals

Margins/Haircuts:

Rating	Jan-May 2007	July-Aug 2007
	Bond	
Investment grade	0-3	3-7
High yield	0-5	10+
	Leveraged Loan	
Senior	10-12	15-20
2nd lien	15-20	20-30
Mezzanine	18-25	30+
	ABS and CDO	
AAA	2-4	8-10
AA	4-7	20
A	8-15	30
BBB	10-20	50
Equity	50	100
Source: Citigroup, IMF Stability report 2007		

Margin Spiral



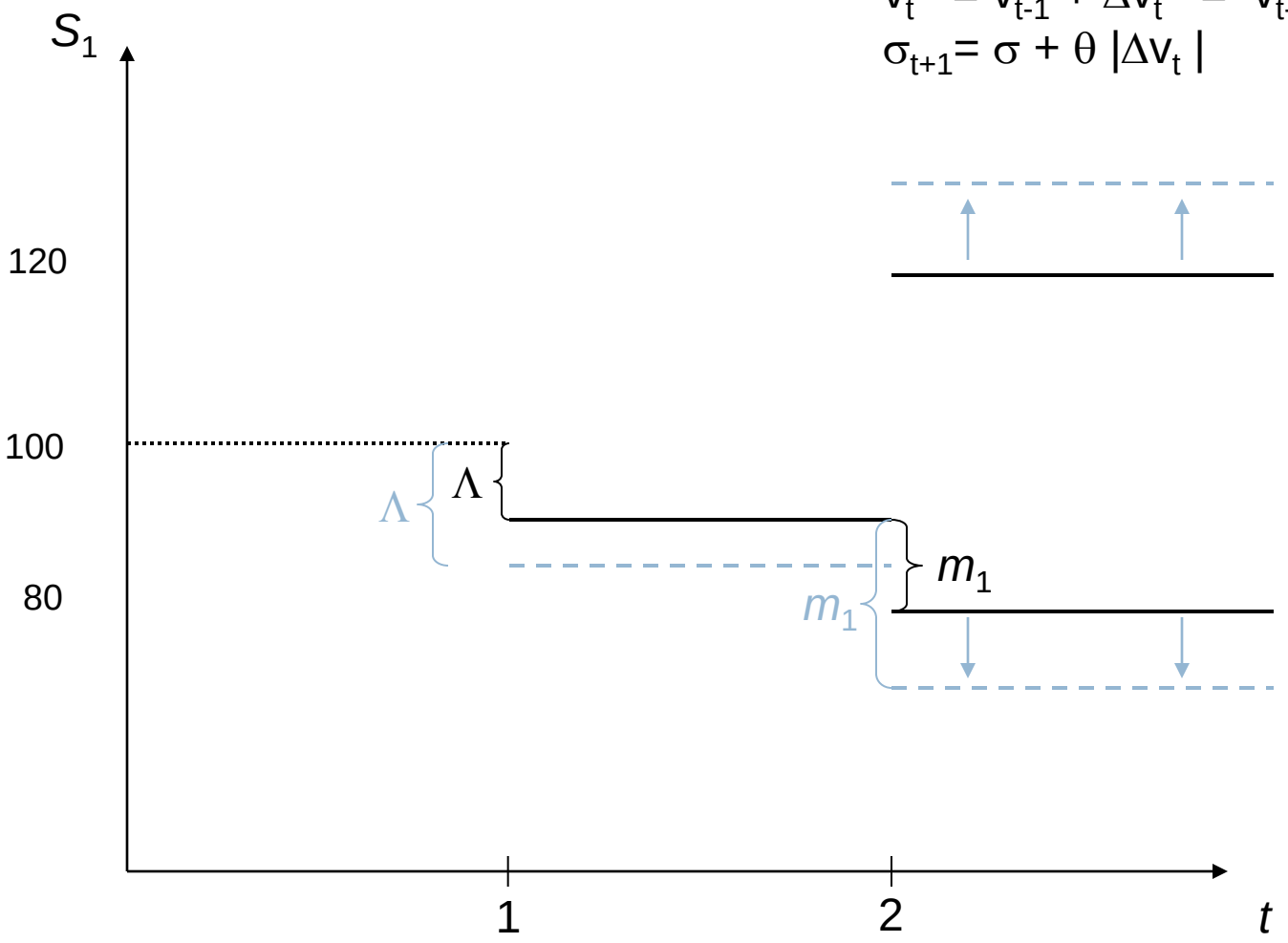
Margin Spiral – Why?

1. Volatility of collateral increases
   - Permanent price shock is accompanied by higher future volatility (e.g. ARCH)
     - Realization how difficult it is to value structured products
   - Value-at-Risk shoots up
   - Margins/haircuts increase = collateral value declines
   - Funding liquidity dries up
   - Note: all "expert buyers" are hit at the same time, SV 92
2. Adverse selection of collateral
   - As margins/ABCP rate increase, selection of collateral worsens

Margin Spiral – Increased Vol.

$v_t = v_{t-1} + \Delta v_t = v_{t-1} + \sigma_t \varepsilon_t$

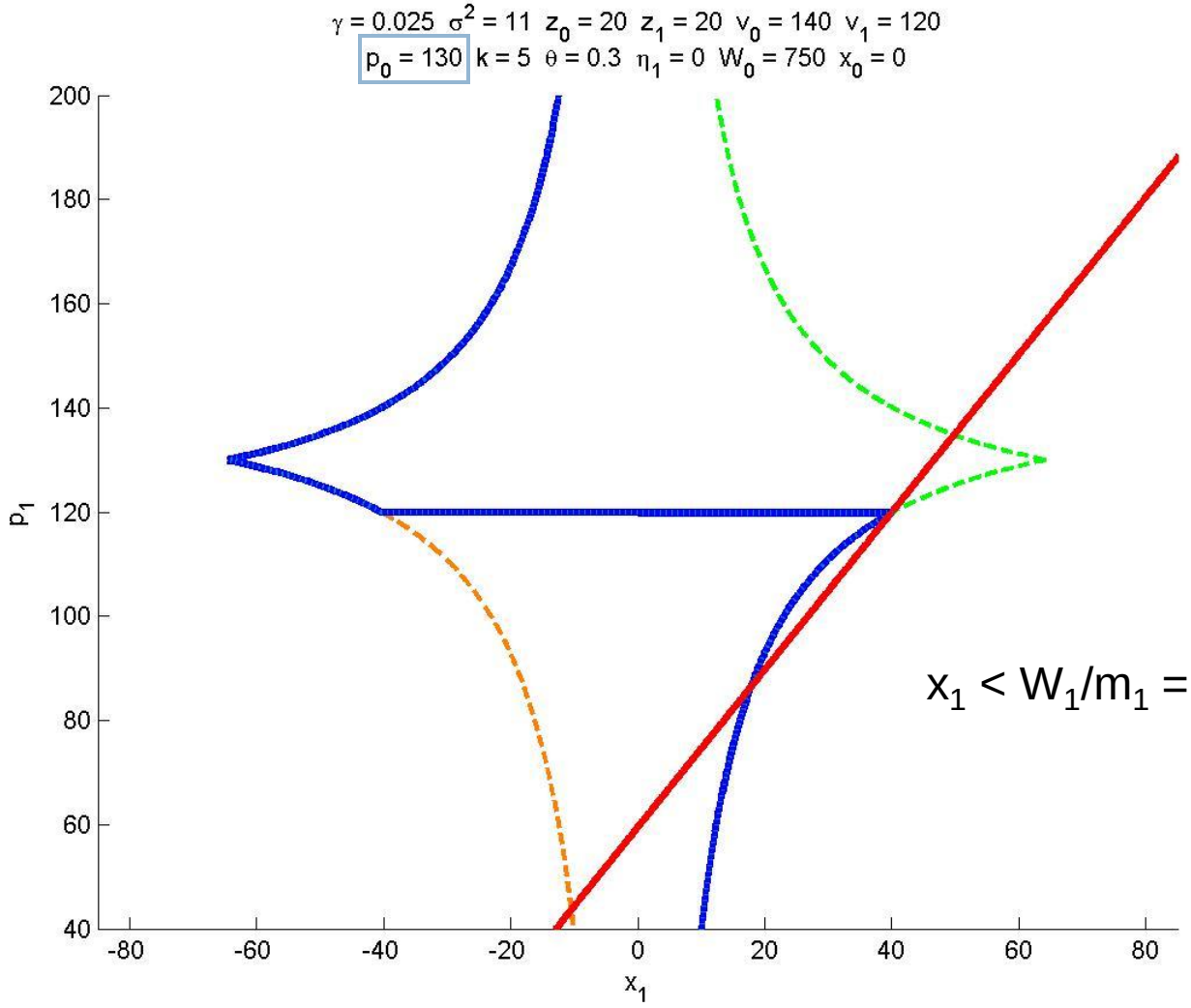
$\sigma_{t+1} = \sigma + \theta |\Delta v_t|$



Margin - VaR

- $\pi = \Pr(-\Delta S_{t+1} \leq m_t) = 1 - \Phi(m_t / \sigma_{t+1})$
- $m_t = \sigma_{t+1} \Phi^{-1}(1-\pi)$
- Recall that due to ARCH effect
  - $\sigma_{t+1} = \sigma + \theta |\Delta v_t|$
  - if financiers (margin setters)
    - Do not observe liquidity shocks
    - Liquidity shocks are rare then
    - $\sigma_{t+1} = \sigma + \theta |\Delta S_t|$
- Positions $x^+_t \leq W_t / m^+_t$

Margin Spiral – Increased Vol.



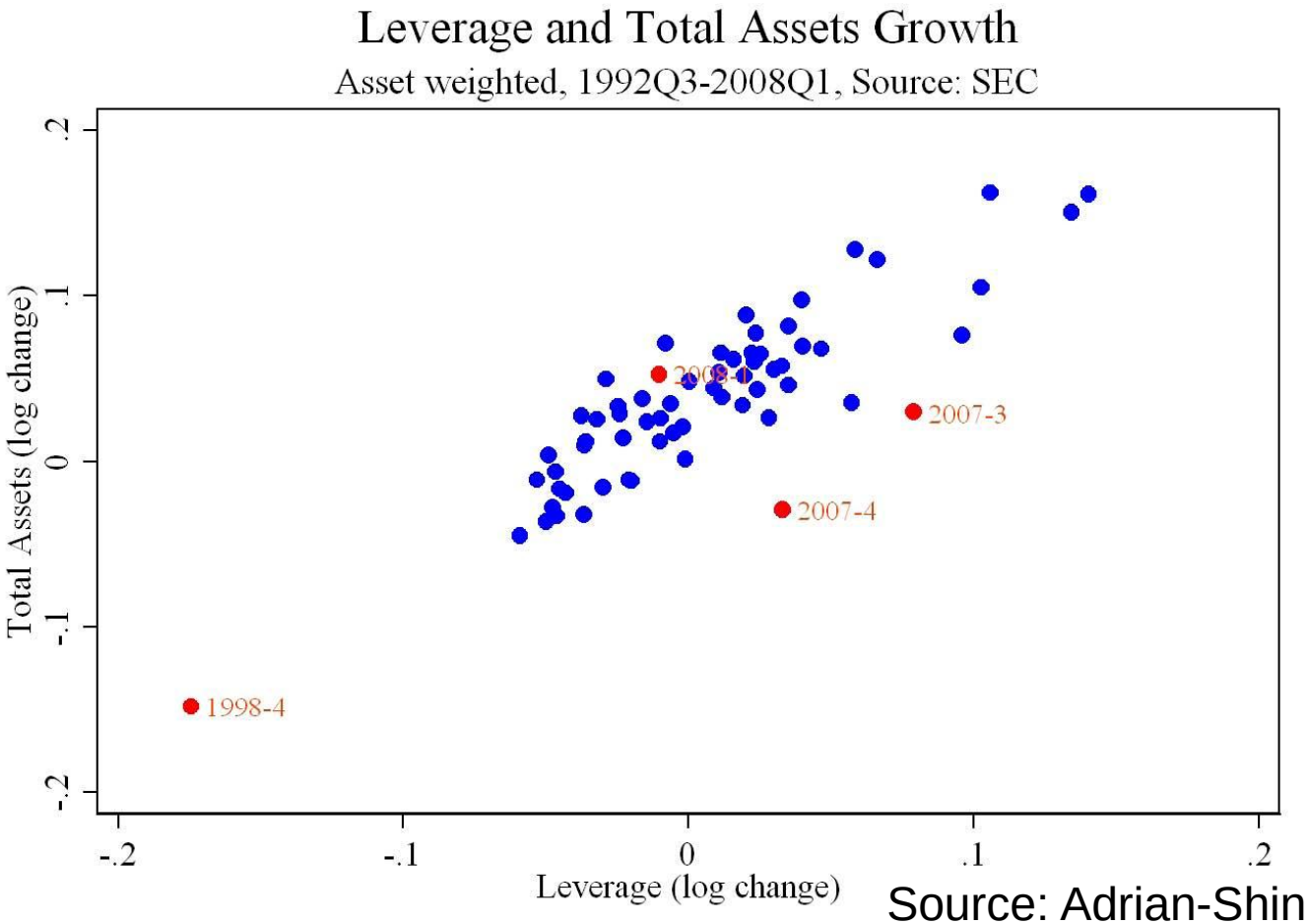
customers' supply

$x_1 < W_1/m_1 = W_1/(\sigma + \bar{\theta}|\Delta p_1|)$

Results

- Backward bending demand curves
  - Due to forced deleveraging
- Discontinuous prices – fragility
- Amplification - spiral

Deleveraging of I-Banks



Source: Adrian-Shin (2008)

Evidence for margin spiral

Skewness: unwinding of carry trades

- Early unwinding of carry trades
  - since funding constraint binds
  - crowded trades
- Adverse fundamental movement
  - good news on funding currency
  - losses for carry trade speculators on other trades (VIX)
- Funding liquidity tightens – forces unwinding of carry trades
- Note asymmetry: good news for investment currency relaxes constraint
- Conditional skewness of exchange rate

- Ex-ante: funding liquidity risk
  - Pricing kernel is given by shadow cost of binding funding constraint (not risk aversion given by utility function)

Undershooting view - takeaways

- Skewness is due to forced unwinding of carry trades (sign of congestion)
  - Note carry trades are leveraged positions
- Undershooting is due to danger of potential future unwinding of carry trades
  - Limits to arbitrage – funding liquidity risk
  - Pricing kernel is given by shadow costs of funding liquidity (Lagrange multiplier $\phi_{t+1} = 1 +$ expected profit from extra \$)

$$S_t = E[\frac{\phi_{t+1}}{E[\phi_{t+1}]} S_{t+1}] \qquad \text{for } \phi_t = 1$$

    - **Not** by risk aversion – curvature of utility function
    - Hint: difference hedging demand – since adverse shocks lead to unwinding, cautious ex-ante

More related theoretical research

- Afonso (2007)
  - AB framework applied to currency attacks
- Plantin-Shin (2008)
  - Carry trades cause bubble
  - Margin spiral a la BP(2008) needed
  - Strategic complements + trading friction
  - Assumes no exchange rate jumps
    – assumed underreaction
- Farhi-Gabaix (2008)
  - Skewness is due to rare (fundamental) events

Empirical Analysis is next

- …. New set of slides …