Employee stock option valuation with an early exercise boundary

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Employee Stock Option Valuation

Black & Scholes model

vs.

Binomial Lattice models

Hull & White (2004, *FAJ*)

Brisley & Anderson (2008, *FAJ*)

ESO valuation: Why do we care?

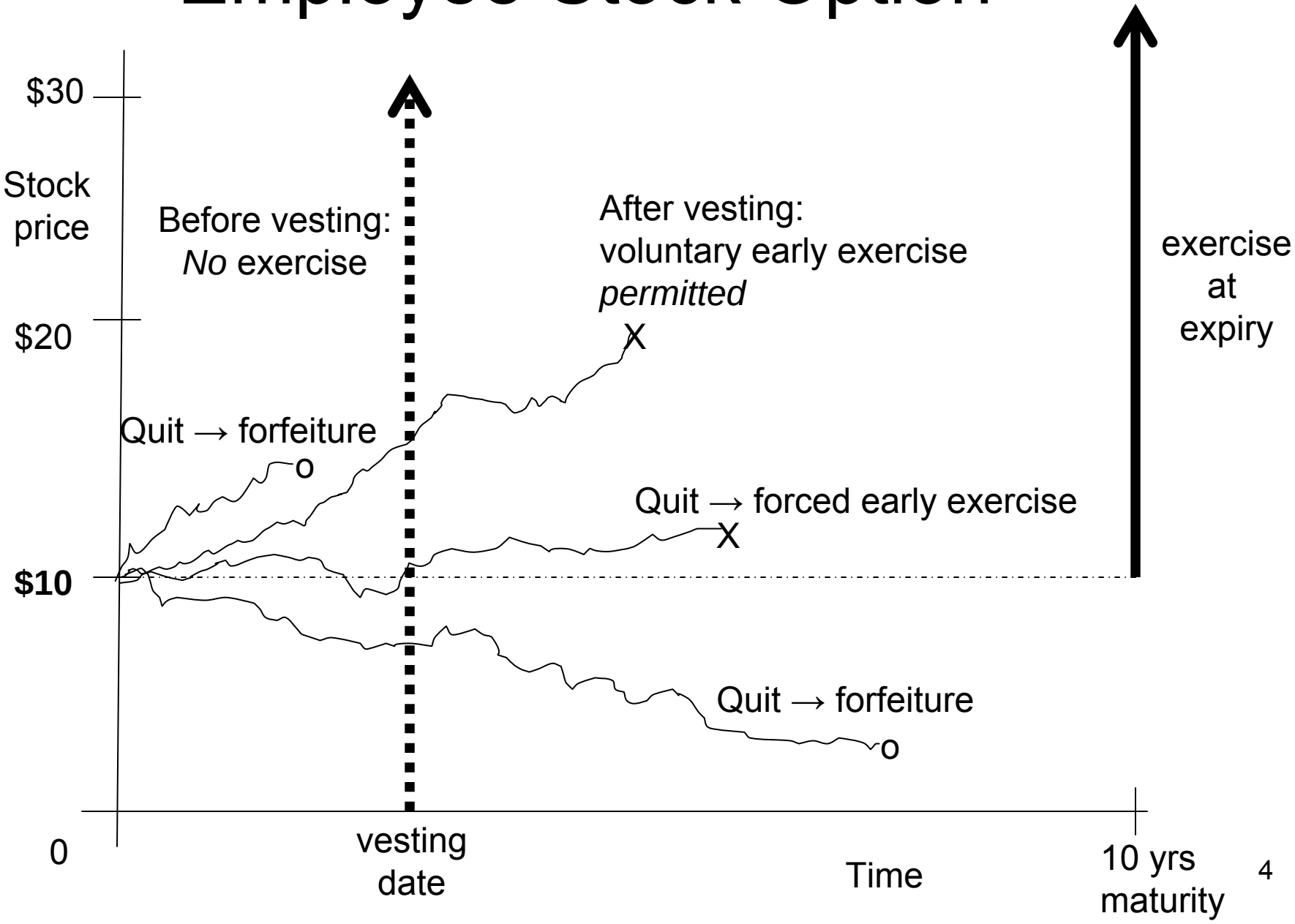
- Accounting profits/disclosures/analyses
  - Black/Scholes permitted, Lattice models *preferred*
- Real compensation decisions
  - Interpreting competitive peer group data
  - Determining option awards
    - '$ per option' estimate may affect 'number granted'

    e.g. "$1 million option award"

    @ estimated $4/option → 250,000 options

    @ estimated $5/option → 200,000 options
  - Managing the optics

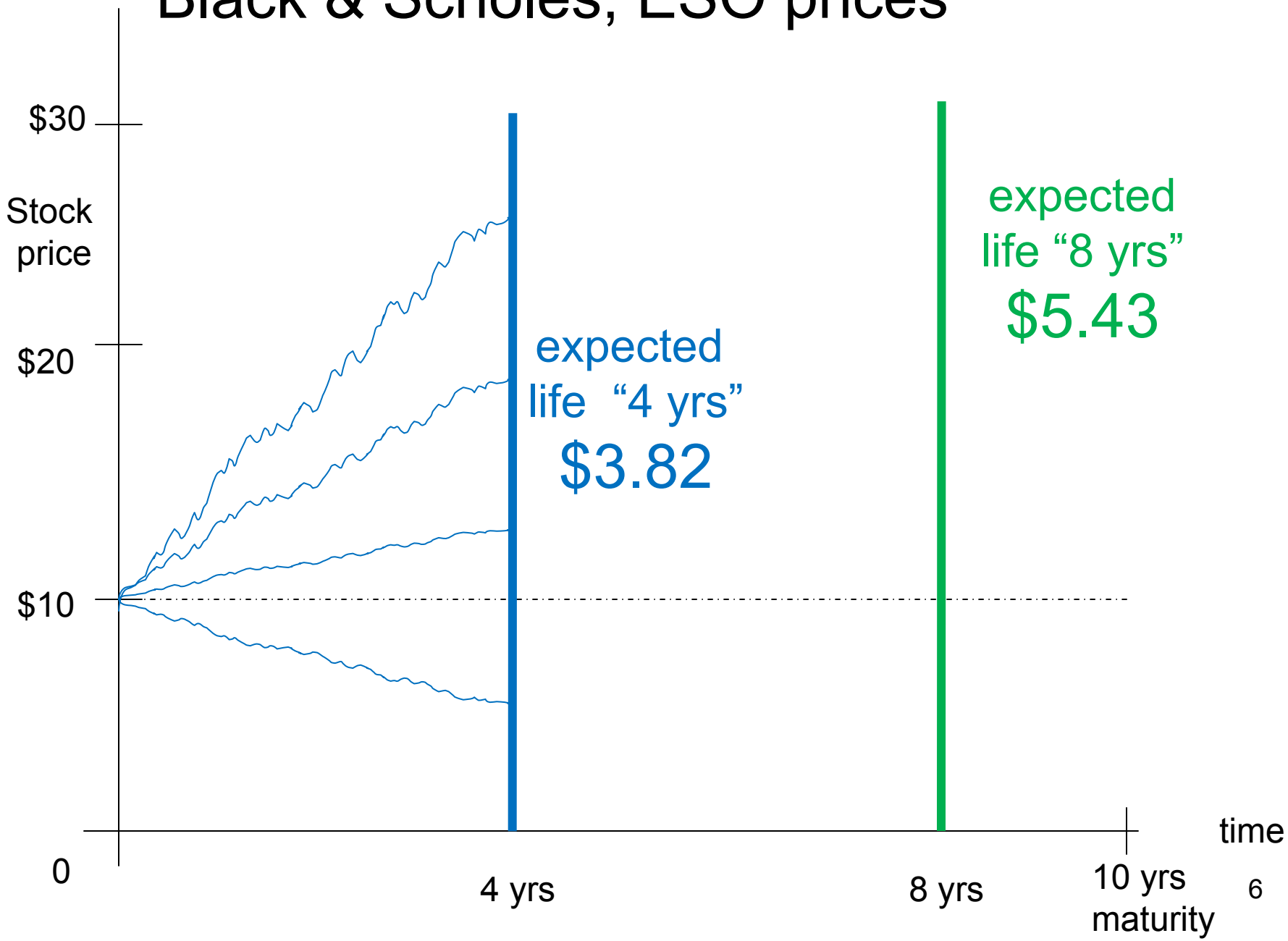
Employee Stock Option



Black/Scholes for ESOs

- *Ignores* all vesting conditions (time & perf.)
- Combines all experience/estimates of quitting and voluntary early exercise into a single estimate of *'Expected Life'* .
- Example:
  - initial stock price $10; strike price $10
  - interest rate 5%p.a.; volatility 40%p.a.
  - maturity ~~10~~ years; expected life?

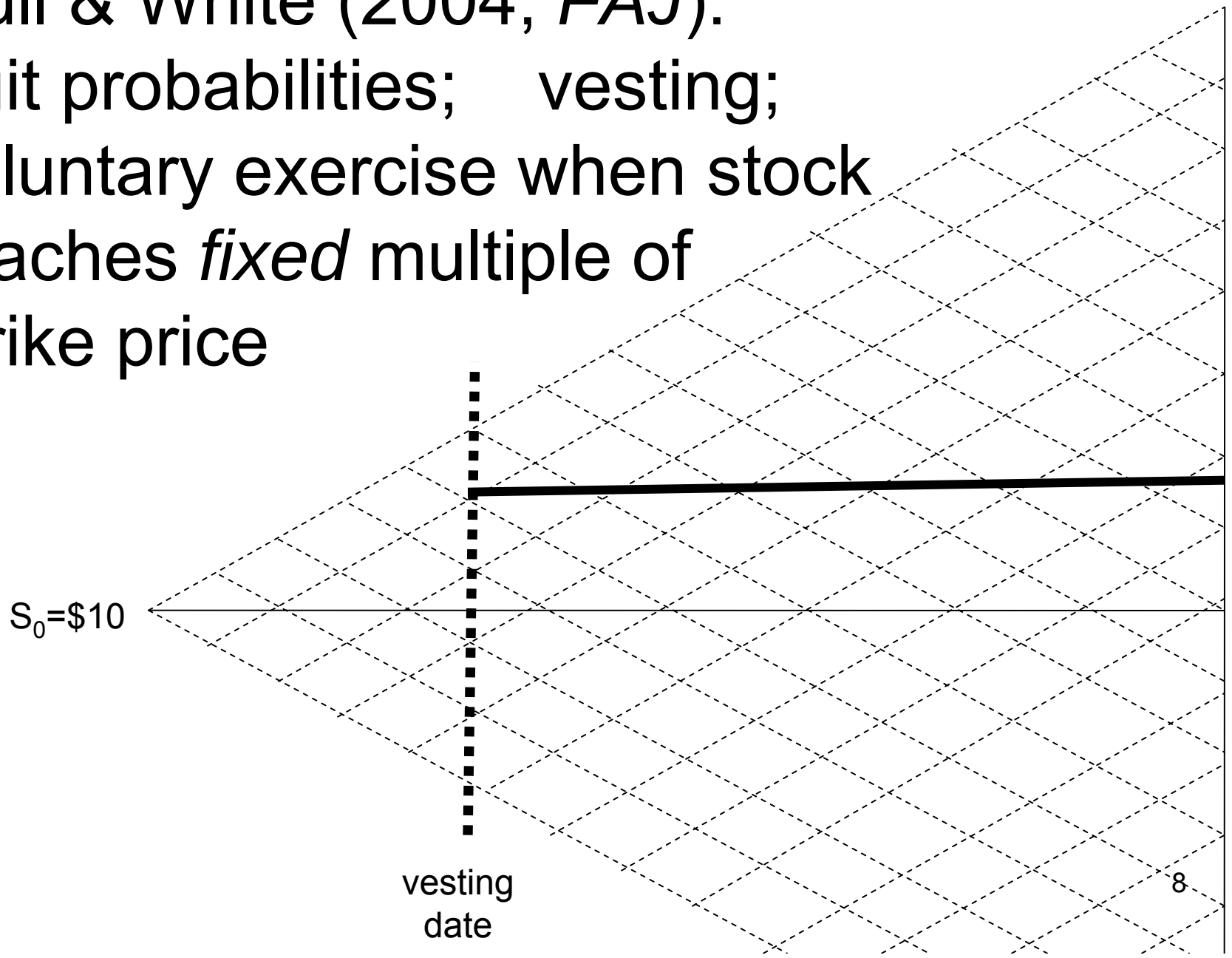
Black & Scholes, ESO prices



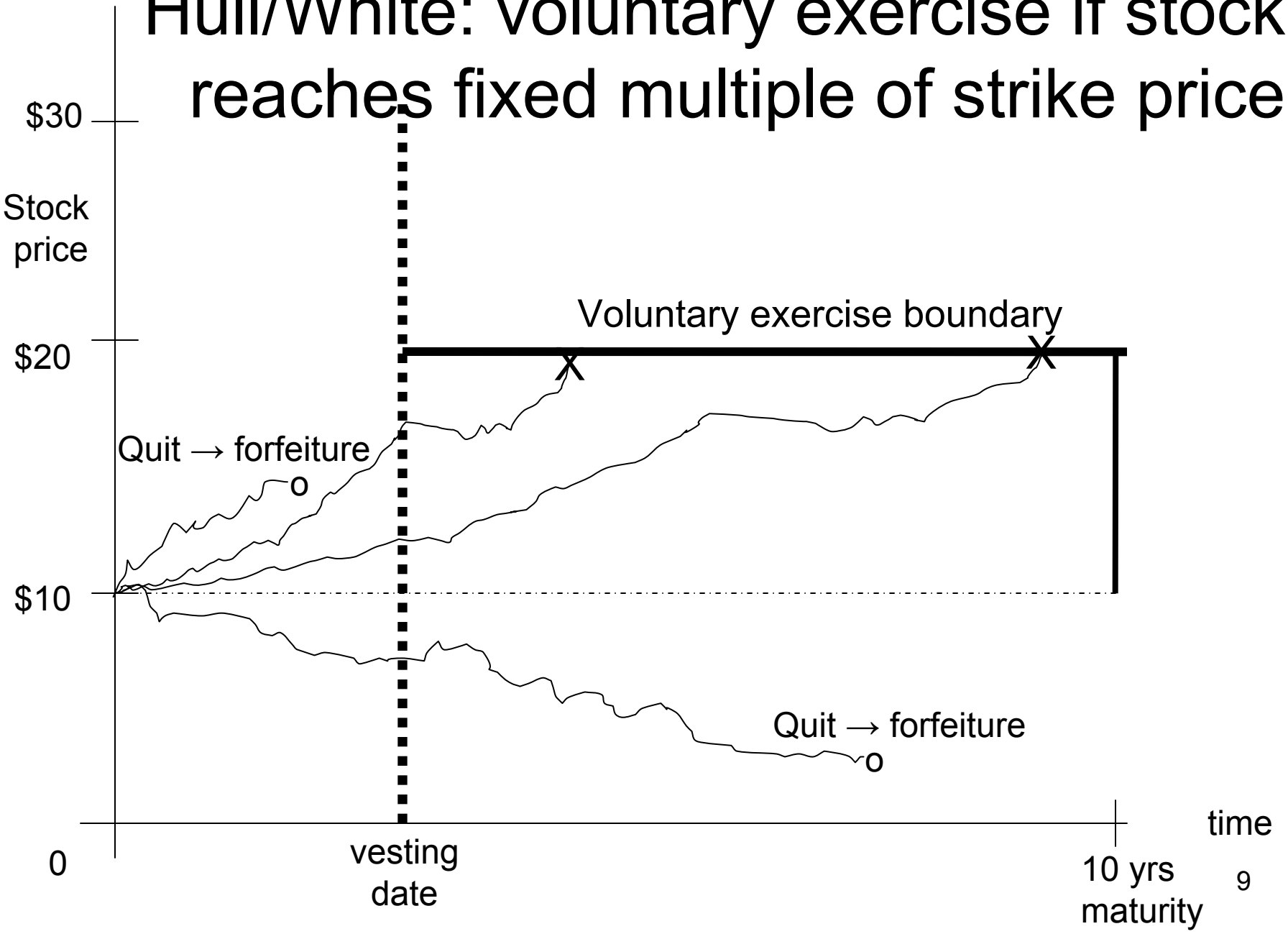
Binomial Lattice (binomial ‘tree’)

- Can handle vesting conditions (time & perf.)
- Can treat separately the estimates of
  - quitting
  - voluntary early exercise
- Example: (maturity 10 years)
  - initial stock price $10; strike price $10;
  - interest rate 5%p.a.; volatility = 40%p.a.
  - Quit rate? Voluntary early exercise policy?

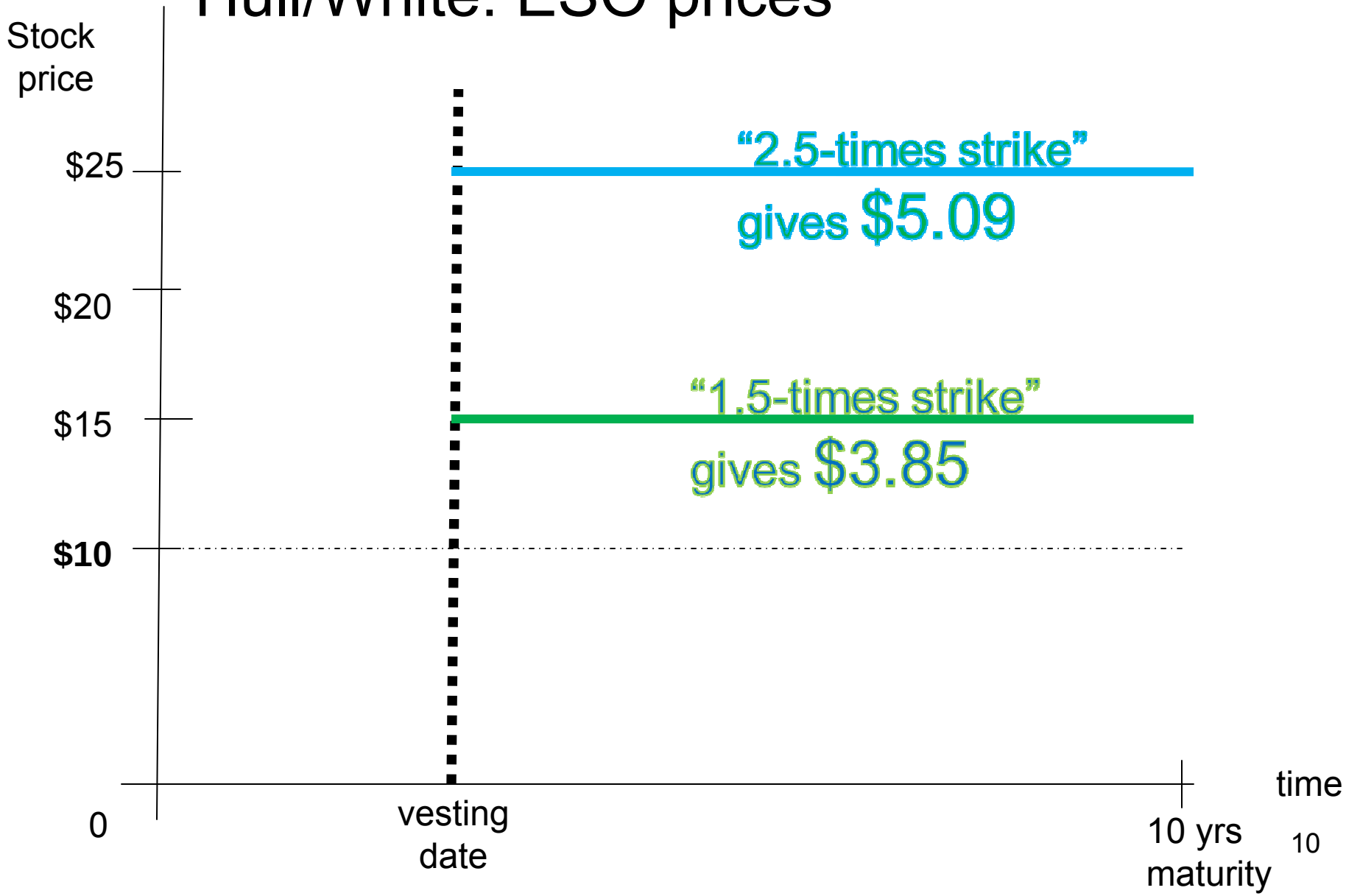
Hull & White (2004, *FAJ*): quit probabilities; vesting; voluntary exercise when stock reaches *fixed* multiple of strike price



Hull/White: voluntary exercise if stock reaches fixed multiple of strike price



Hull/White: ESO prices



Early exercise ‘policy’

- Black/Scholes assumes employees exercise at some target *date* (whether in-the-money by $0.01 or by $100.00...) .
  - ‘Vertical’ exercise boundary
  - Assumes employees ignore option time value...
- Hull / White assumes employees exercise at some target *stock price* (whether achieved very early in option life or very late).
  - ‘Horizontal’ exercise boundary.
  - Assumes employees ignore option time value...

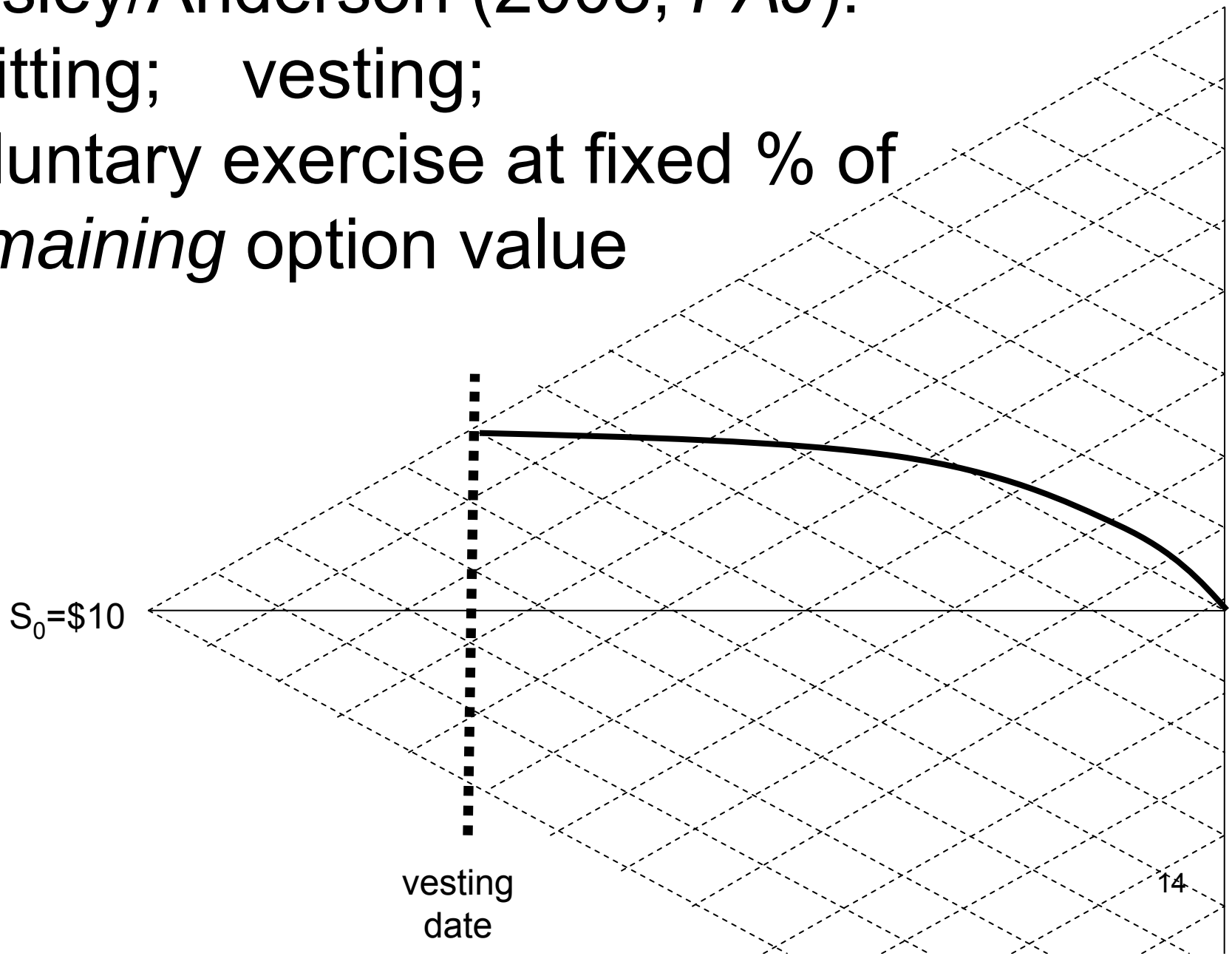
Bettis et al. (2005):

- Employees require *high* stock price to induce exercise *early* in option life.
- But willing to exercise at *lower* stock prices *later* in option life
- Employees exercising early typically capture 80%-90% of the *remaining* option value. And this statistic is relatively stable whether stock prices grew fast or slow.

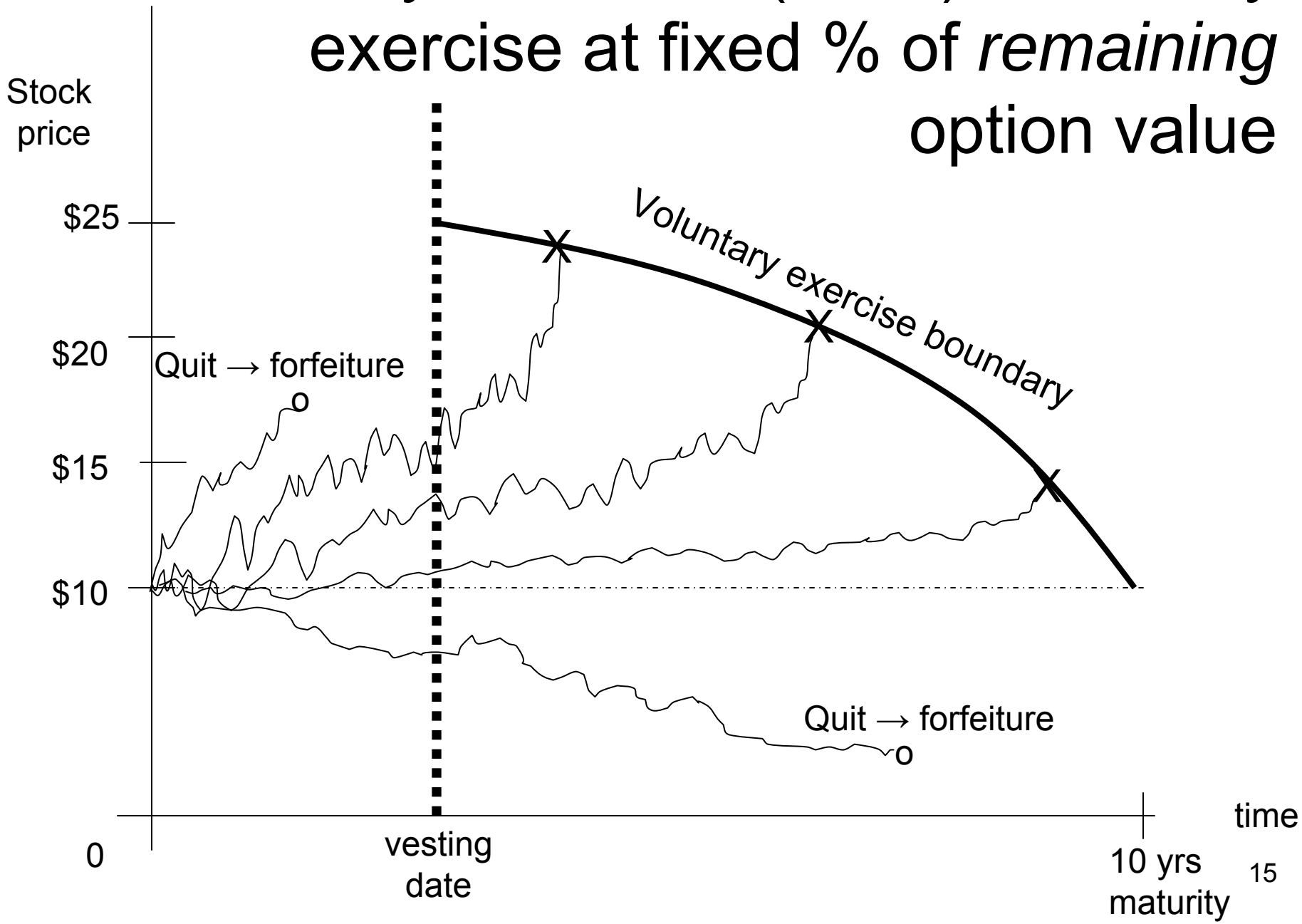
Early exercise ‘policy’

- Brisley/Anderson assumes employees exercise early when they can achieve some target *fixed percentage* of the *remaining* option value.
  - Assumes employees trade-off *intrinsic value* (moneyness) captured vs. *time value* forgone
  - Gives ‘Downward sloping’ exercise boundary

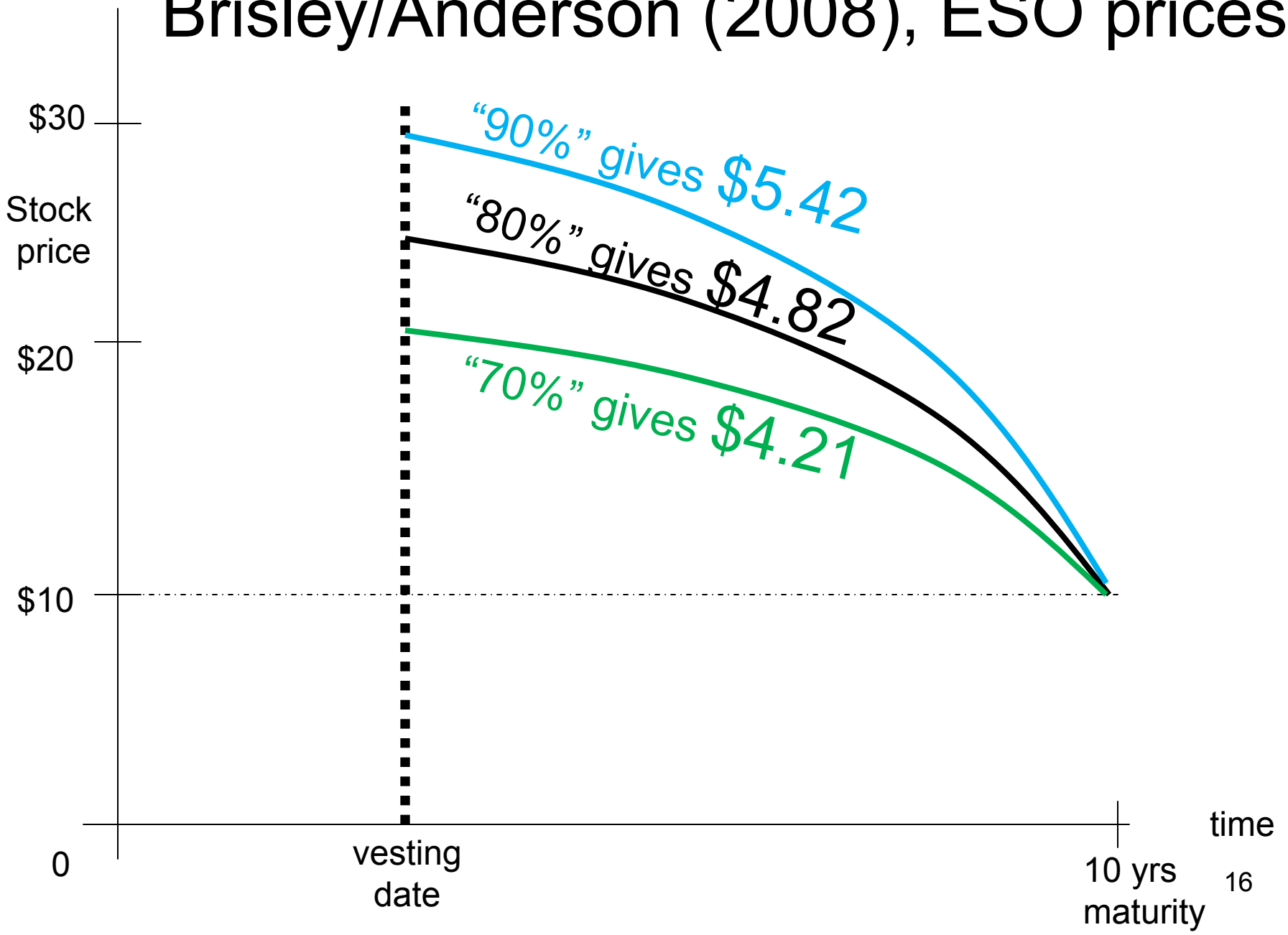
Brisley/Anderson (2008, *FAJ*): quitting; vesting; voluntary exercise at fixed % of *remaining* option value



Brisley/Anderson (2008): voluntary exercise at fixed % of *remaining* option value



Brisley/Anderson (2008), ESO prices



Brisley/Anderson (2008 *FAJ*)

- We offer a new lattice model for valuing ESOs
  - Straightforward and intuitive
  - Approximates better the real exercise decisions of employees
- B/A option prices can be lower or higher than B/S or H/W prices. But we show why our model is more ‘stable’ – the $ price outputs are *less sensitive* or vulnerable to unusual historical exercise data from firms with atypical stock price histories.

Estimating the inputs

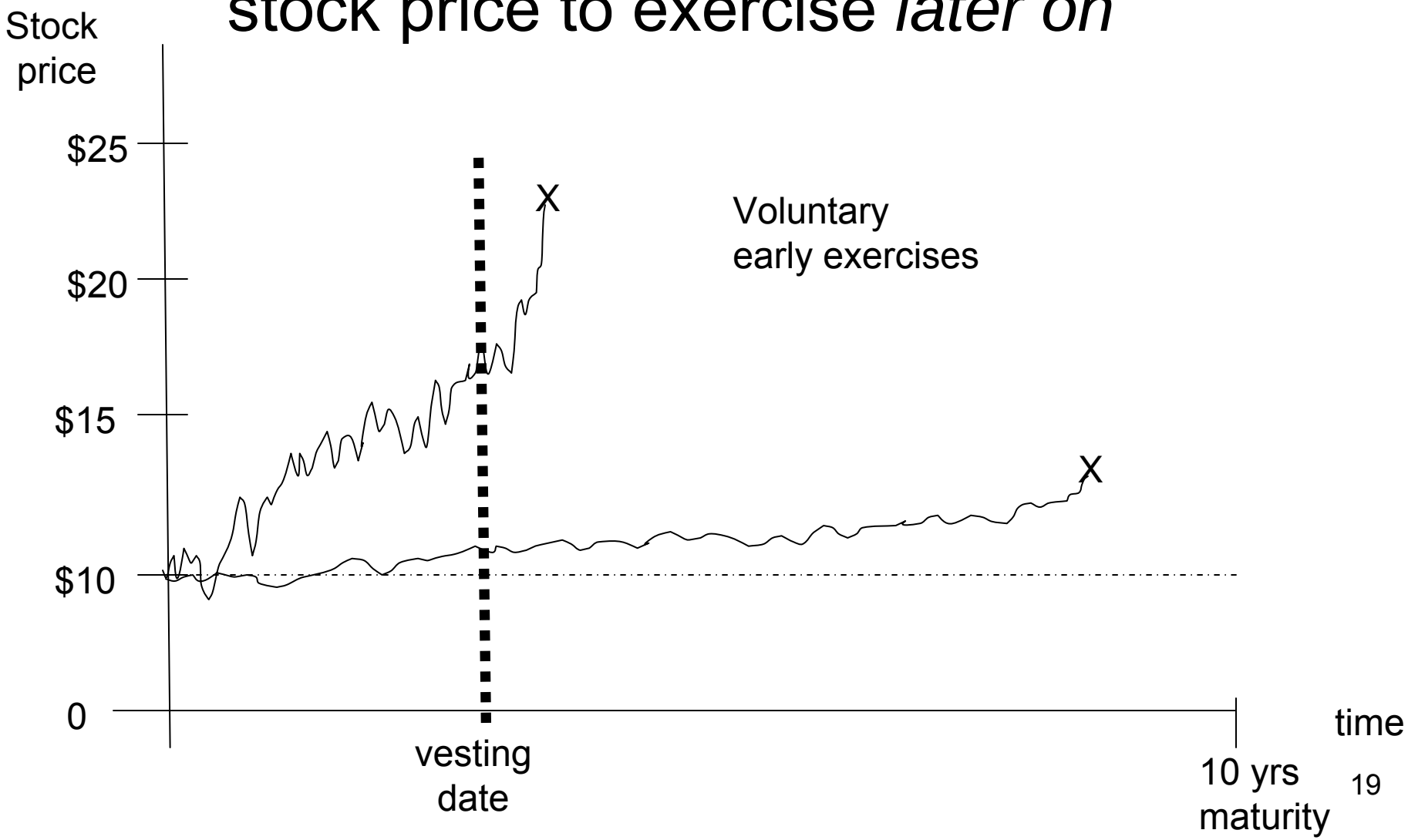
- *"…assumptions, such as the employees' expected exercise behavior, may be derived from the entity's own historical experience…"* [FAS123R]

Black/Scholes: time to exercise

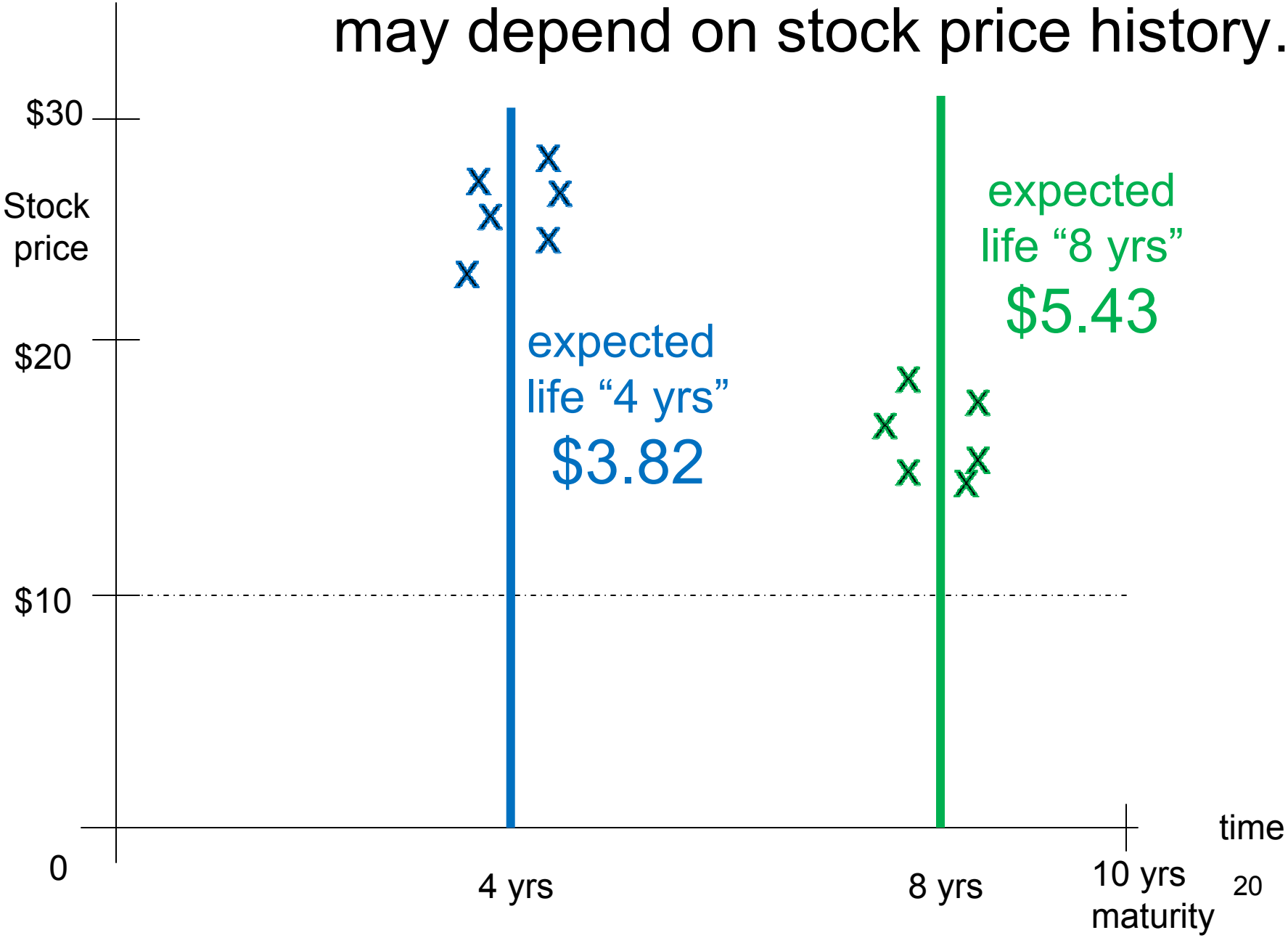
Hull/White: stock price (multiple of strike) at exercise

Brisley/Anderson: percentage of remaining option value captured at exercise

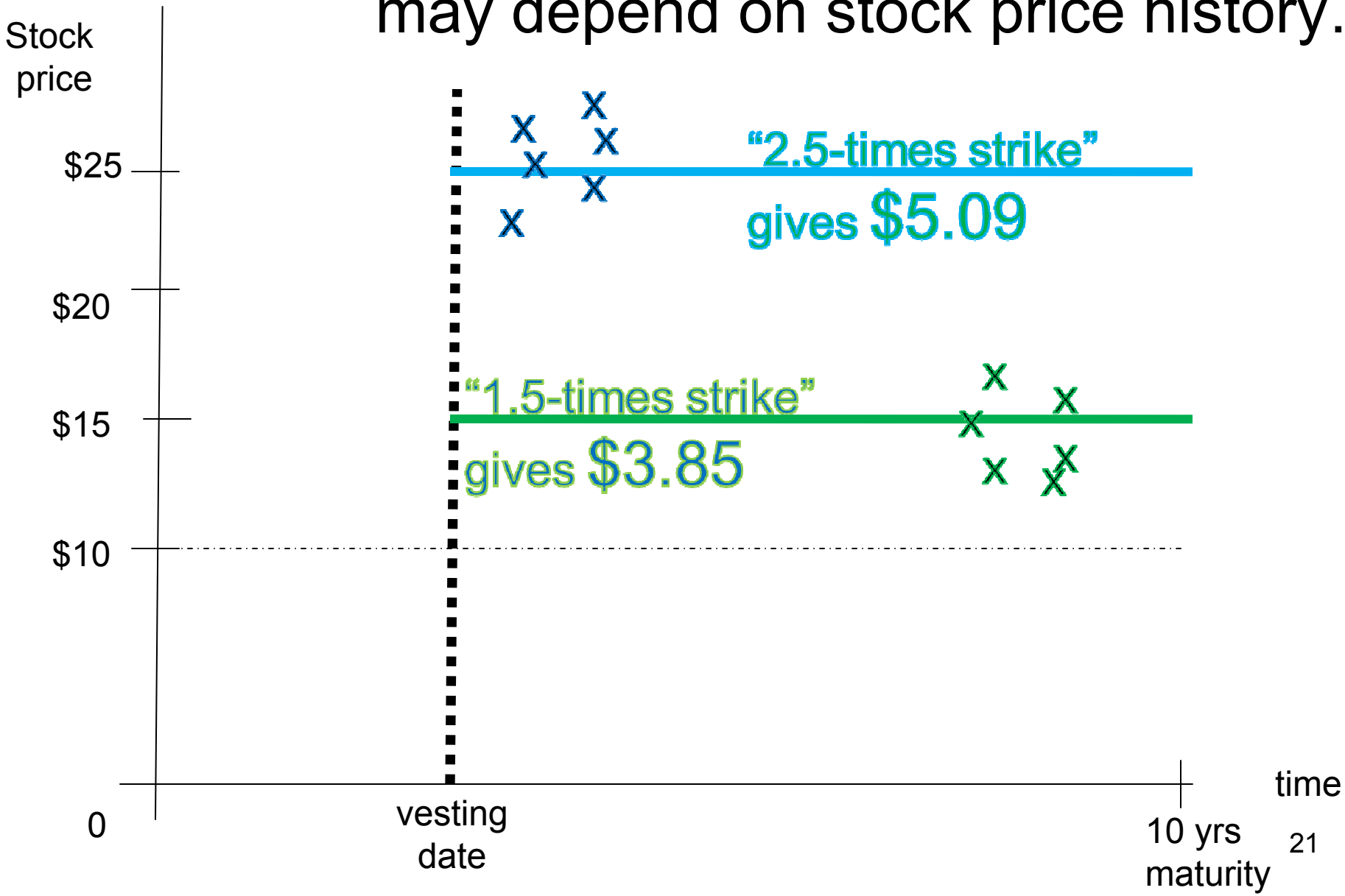
Employees require *high* stock price to induce exercise *early* in the life, but *lower* stock price to exercise *later on*



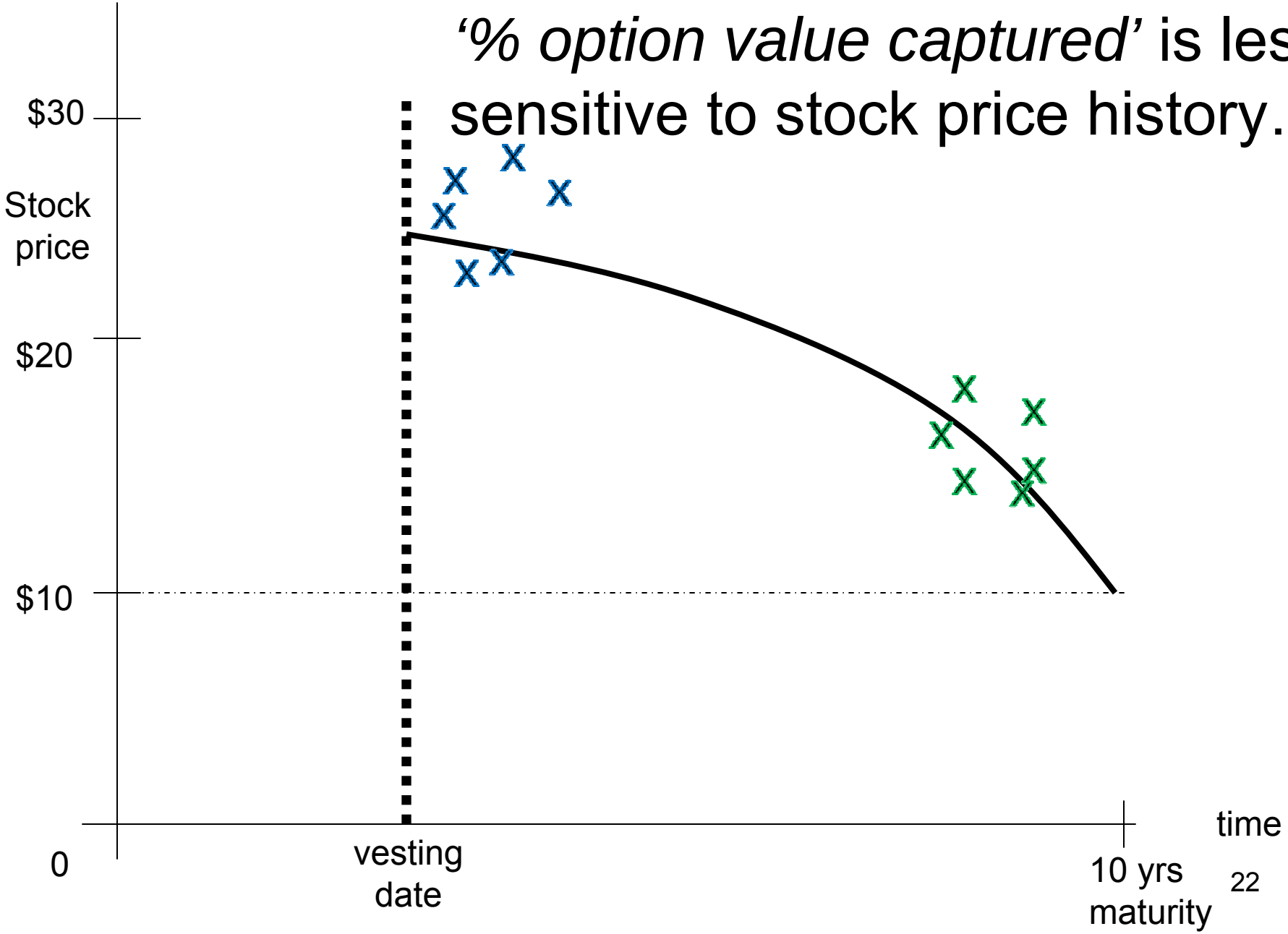
Black/Scholes: prior experience of option lives may depend on stock price history…



Hull/White: prior experience of 'exercise multiple' may depend on stock price history…



Brisley/Anderson (2008), prior experience of *'% option value captured'* is less sensitive to stock price history…



Takeaway on ESO valuation:
vesting + quitting + voluntary early exercise

Black/Scholes model, 'expected life'

vs.

Binomial Lattice models

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Brisley & Anderson (2008, *FAJ*)

- stock price histories affect past early exercise behaviours. Affects $$-valuations…
- choice of model affects $$-valuations...