How much does the development of a pharmaceutical cost?

• Accounting data: at least $800m

• What does the accounting data include?
  – Failed R&D programs
  – Failure to get there first (another drug company won)
  – Any inefficiencies or lobbying efforts

• What is the economists’ notion of cost?
  – Opportunity cost
  – Minimum cost (the least that must be spent)
Thought experiment 1

• Suppose that
  – each firm could develop each drug for $200m for sure.
  – the value of the patent is $800m
  – Each firm is involved in many drug development efforts

• For social efficiency, how many firms should invest?
• How many firms will invest? Is this efficient?
• What percentage of a firm’s drug efforts (on average) result in a patent?
• If the firm adds failures to its accounting data, what is the accounting cost of a drug?
Thought experiment 2

• Suppose that
  – each firm must pay $400m in R&D
  – the probability of finding the drug is 1/2
  – Private value of the drug patent is $800m
  – Social value of the drug is twice private value, namely $1.6b

• Social welfare: To maximize social value net of cost, how many firms should invest? Calculate marginal social value provided by each entrant.
  – What is the (expected, or average) social value provided the first firm?
    • $0.5 \times 1.6b = $800m
  – What is the (expected, or average) social value provided by the second?
    • $(3/4 - 1/2) \times 1.6b = $400m
  – What is the (expected, or average) social value provided by the third?
    • $(7/8 - 3/4) \times 1.6b = $200m

• Answer: two firms should invest. The marginal social value provided by the 2\textsuperscript{nd} entrant is at least its cost, and the marginal social value provided by 3\textsuperscript{rd} entrant is less than its cost.
Thought experiment 2 cont.

• How many firms will invest?
• With one firm, the probability of success is \( \frac{1}{2} \), so the expected profit of a single firm is \( \frac{1}{2} \times 800 = 400 \). Cost equals expected profit.

• With two firms, the probability of success by at least one firm is
  \[ 1 - (\frac{1}{2})(\frac{1}{2}) = \frac{3}{4}. \]
  The firms have equal chances to get the patent, so each gets it with probability \( \frac{3}{8} \). Expected profit is \( \frac{3}{8} \times 800 = 300 \), which is less than the cost of investing. The second firm will not enter.

• Answer: one firm (too few)
Thought experiment 2 cont.

• Suppose the firms argue to congress that they underinvest because they make too little profit. They want the whole social value as profit.

• Suppose Congress increases the value of patent to the whole social value, $1.6b. Will investment be socially efficient?

• Third firm will enter because probability at least one succeeds is 1-(1/2)³ = 7/8
  It could be any firm, so each firm receives in expectation (1/3) {(7/8) X 1.6} – 400 >0

• Fourth firm will not enter because probability at least one succeeds is 1-(1/2)⁴ = 15/16.
  Each firm receives in expectation (1/4) {(15/16) X 1.6} -400 < 0

• Answer: three firms will enter, which is too many

• Basic problem: each firm receives the *average* expected profit (social value), not the *marginal* expected profit (social value).