The Economics of Strategic Relationships.

Part Two

2022 - 2023

Moves by Nature

Moves by Nature

- Let us move to more “managerial” situations…
- In all sorts of competitive situations, pure chance can play a part.
- When a firm engages in R&D, it is unclear whether the particular research will pan out.
- From the perspective of the firm considering whether to do the R&D, this is a random event and, unlike the actions of rivals and other players, it is a random event whose outcome is under no one’s particular control.
- How do we model such things?

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Moves by Nature

Imagine two firms, call them A and B, that are separately contemplating entering into the market for a brand new product.

Each is concerned with two things:

- How expensive will the product be to produce?
- And will the other firm enter as well?

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Moves by Nature

In terms of timing, suppose that:

- Firm A must decide whether to enter in the next month;
- Firm B has the luxury of waiting to see what Firm A does.

Firm A, however, is able to decide right now whether to pursue some quick R&D that will tell it whether the production costs will be high or low. (Firm B cannot engage in this R&D.)

That is, in the model we build, costs will be high or low, and doing the R&D will tell Firm A which it is.

Note well: firm A does not need to do this R&D; that is a choice it can make.

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Strategies and the strategic form

- Available strategies for firm A:
  - A1.Don’tdotheR&D.Enterthemarket.
  - A2.Don’tdotheR&D.Don’tenterthemarket.
  - A3. Do the R&D. Enter the market regardless of what is learned about the costs.
  - A4. Do the R&D. Enter the market if costs are low, but don’t enter if they

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are high.

  - A5. Do the R&D. Enter the market if costs are high, but don’t enter if they low.
  - A6.DotheR&D.Don’tenterthemarketregardlessofwhatislearnedabout the costs.
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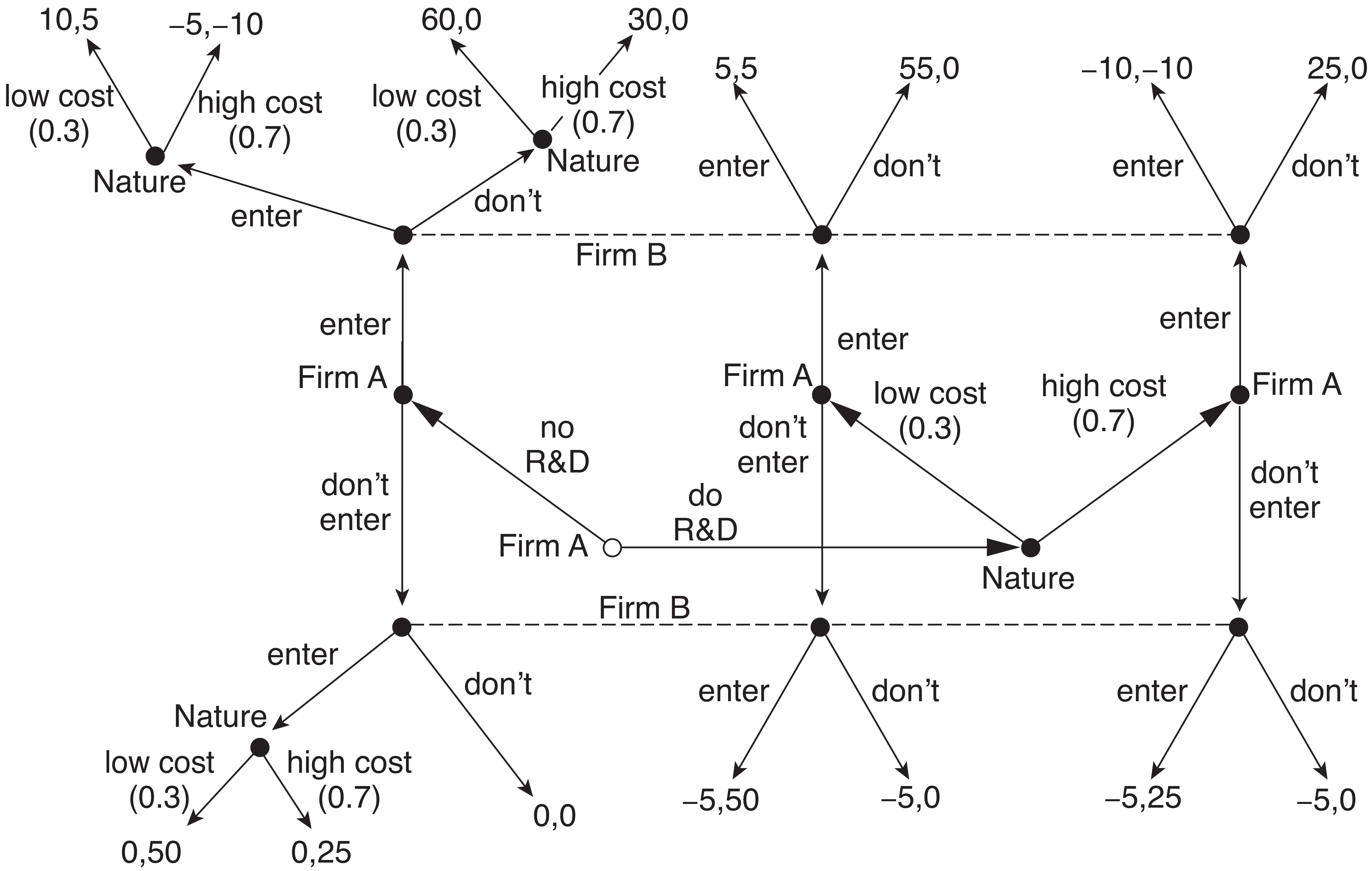

10,5
−5,−10
60,0
30,0
5,5
55,0
−10,−10
25,0
low cost (0.3)
high cost (0.7)
low cost (0.3)
high cost (0.7)
Nature
Nature
enter
don't
enter
don't
enter
don't
Firm B
enter
enter
enter
Firm A
Firm A
Firm A
low cost (0.3)
high cost (0.7)
no R&D
don't enter
do R&D
don't enter
don't enter
Firm A
Nature
Firm B
enter
don't
enter
don't
enter
don't
Nature
low cost (0.3)
high cost (0.7)
0,0
−5,50
−5,0
−5,25
−5,0
0,50
0,25

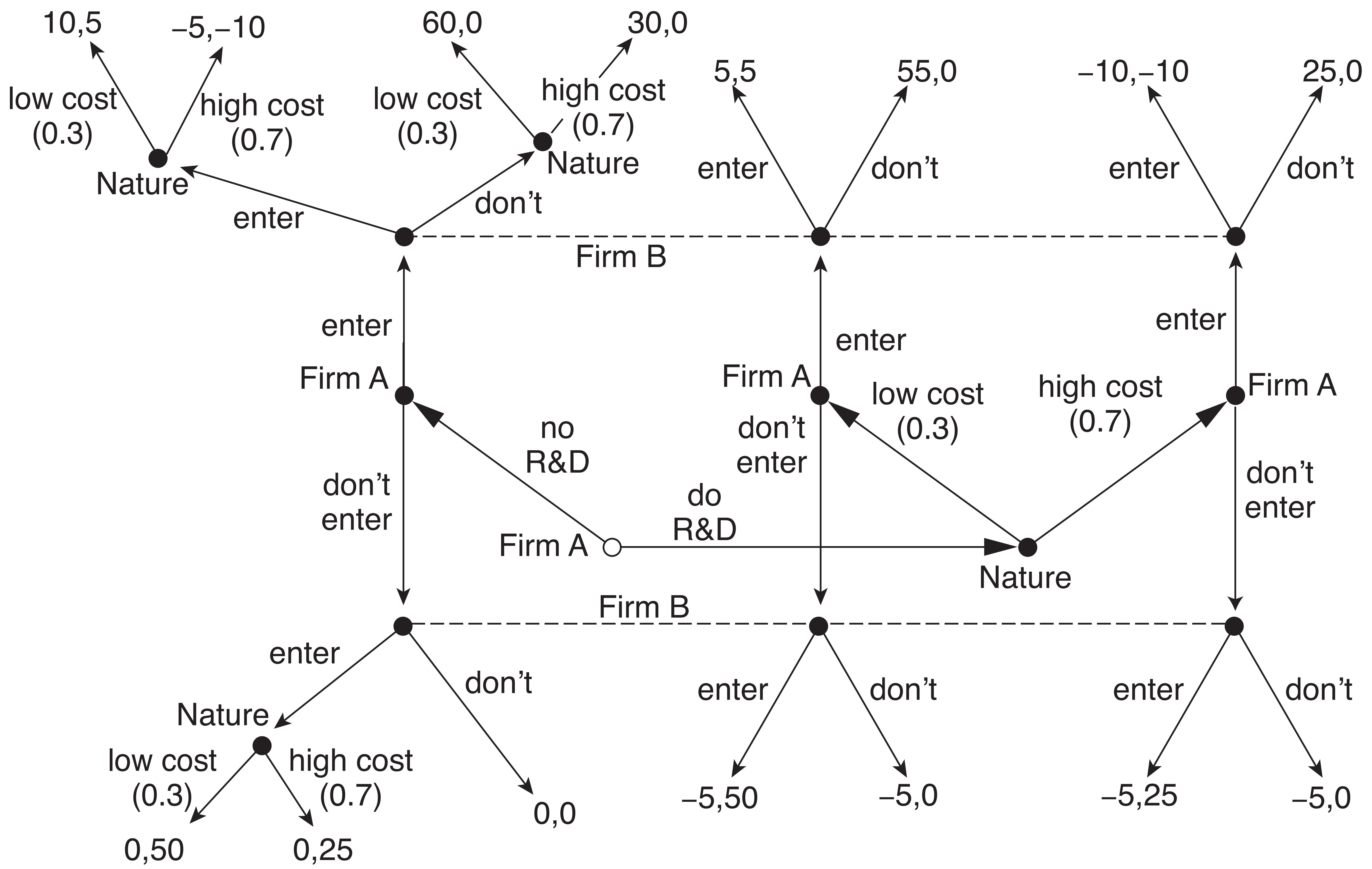
Firm A has the first move: it decides whether to undertake the R&D or not.

If it does not, then it has a second decision, whether to enter the market or not.

On the other hand, if it does undertake the R&D, it learns whether the costs are high or low.

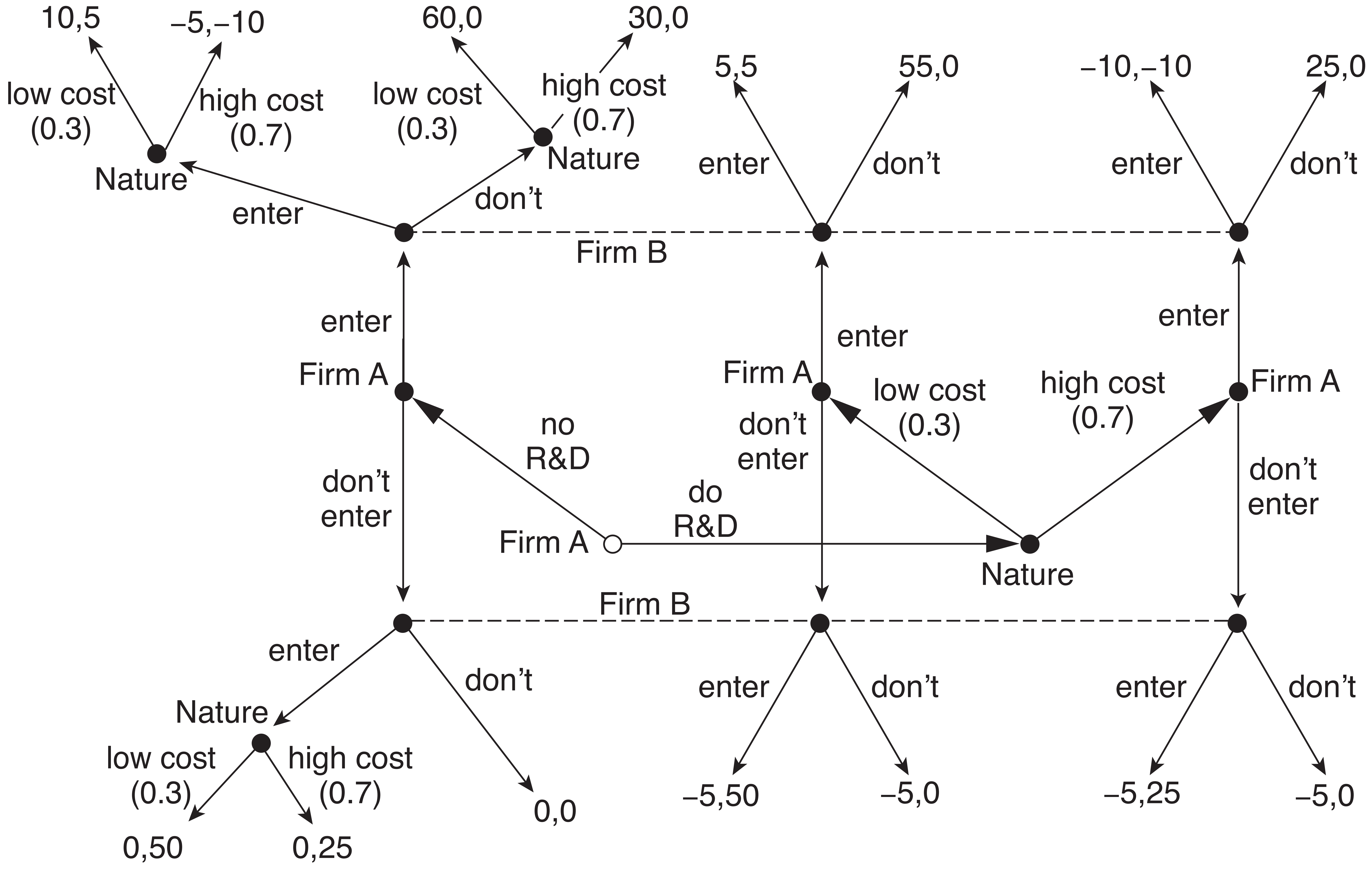
If Firm A decides to do the R&D, we next put in a node belonging to Nature, who (which?) “decides” whether costs are high or low.

We record those odds as probabilities on the branches; in this case, the diagram shows that the odds of high costs are 0.7, while the odds of low costs are 0.3.



And then, Firm A has to decide whether to enter the market or not.

Since we are in the part of the game tree in which Firm A chose to do the R&D, it knows what Nature decided, and we have two different decision nodes for Firm A: one for each of Nature's two choices.



Now it is the turn of Firm B: Does it enter the market or not?

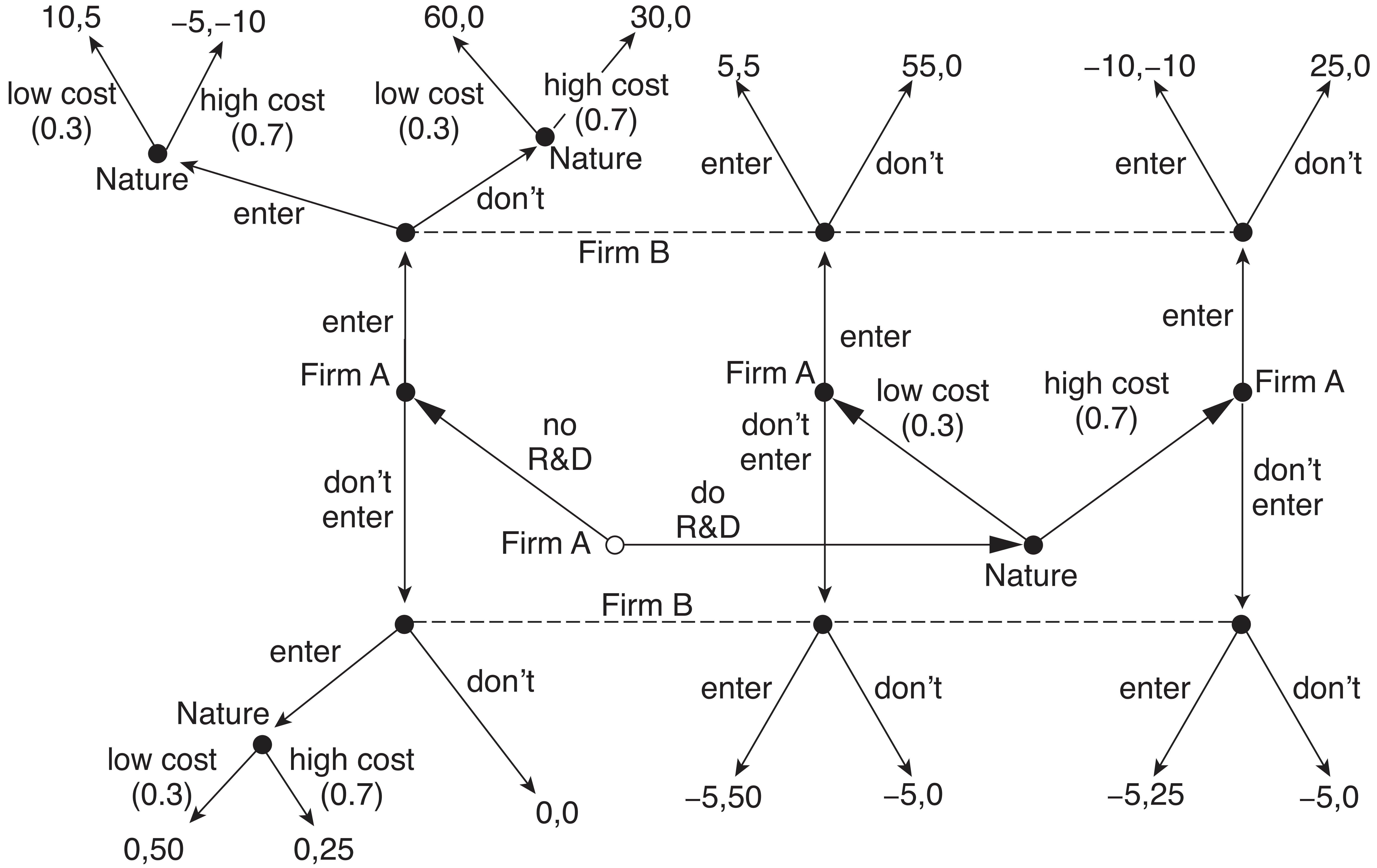
Note the use of information sets here: Clearly, we are supposing that Firm B knows whether Firm A entered or not.

But what have we assumed about Firm B's knowledge of whether Firm A did the R&D?

We could assume that Firm B did see whether Firm A did the R&D, even if Firm B doesn't learn the results.

And we could assume that Firm B only knows if Firm A entered or not.

The diagram models the situation where Firm B doesn't know whether Firm A undertook the R&D.



We need to put into our model the payoffs to the two firms.

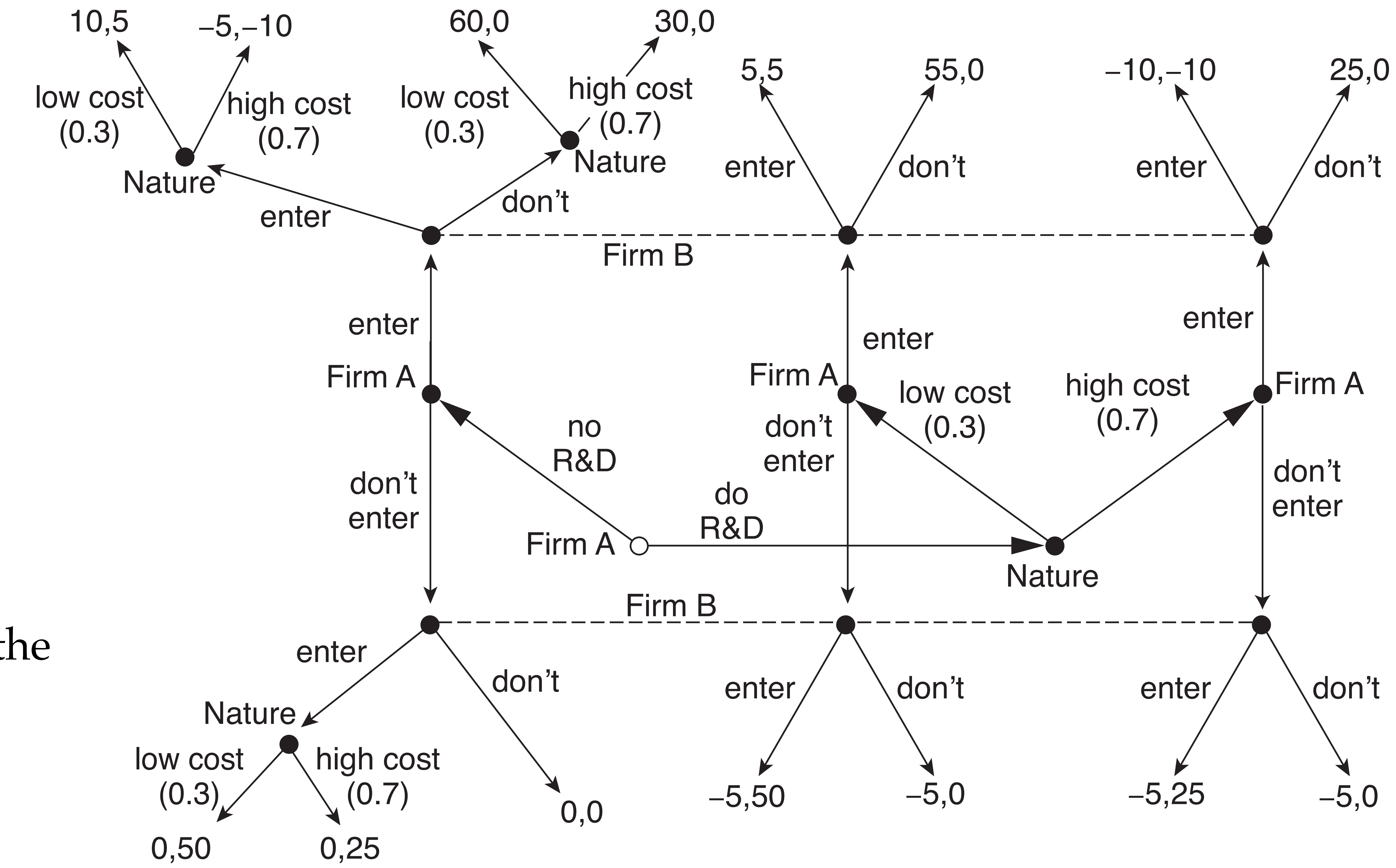
Presumably, these depend on

(a) which firms entered the market,

(b) what are the production costs (high or low),

(c) and for firm A, whether it undertook the R&D (since the R&D probably wasn't free).

If we have all the numbers handy, we can supply those payoffs in the part of the tree where we know the production costs.

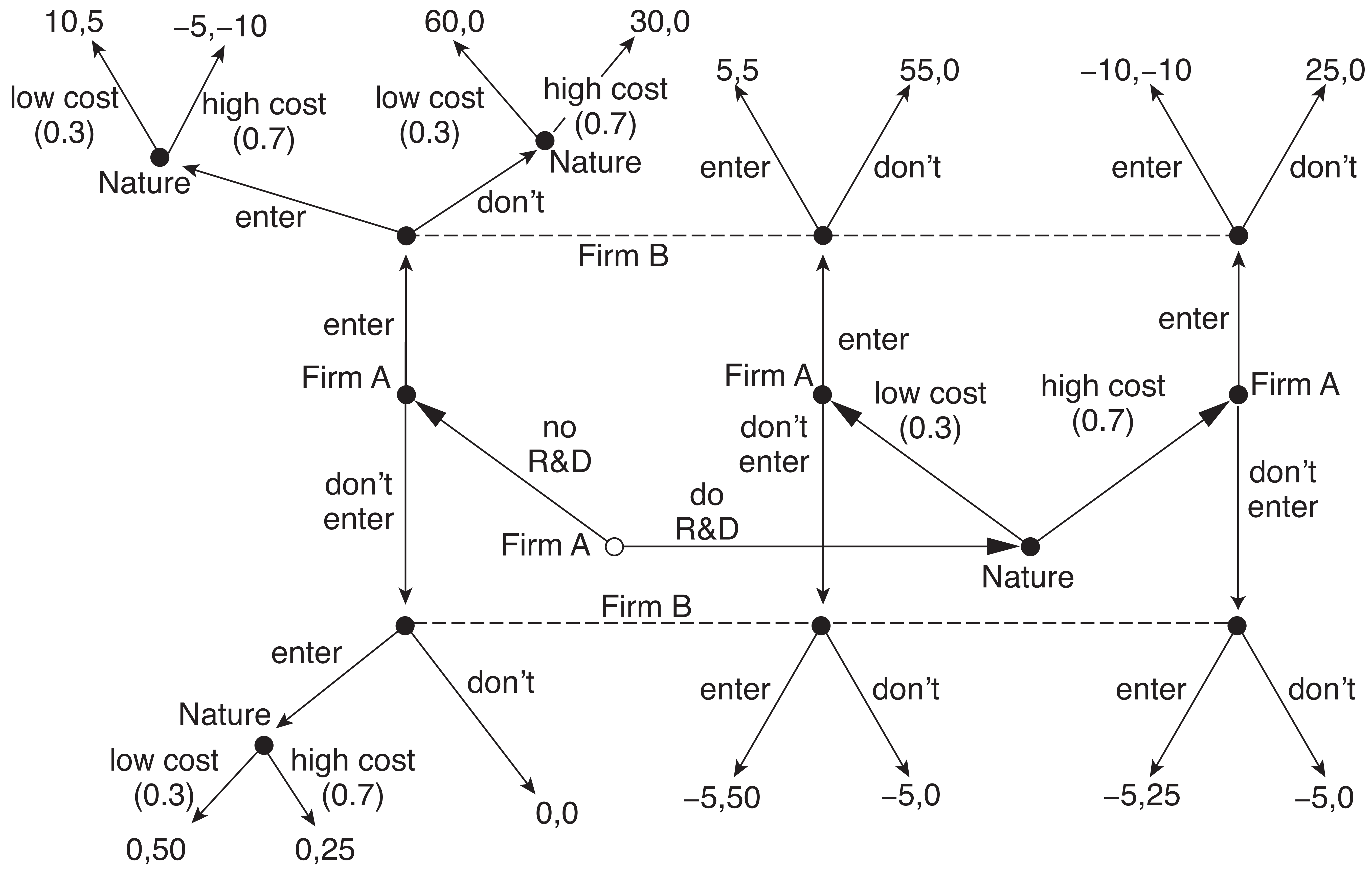


But if Firm A did not undertake the R&D but did enter, or if A did not undertake the R&D and chose not to enter but Firm B did enter, we need to know what are those costs.

So, in the part of the tree where A has chosen not to do the R&D—the left-hand side of the diagram—and after A and B have made their entry choices, we need nodes for Nature's moves, determining the costs and, then, at the end of each complete path or branch, the payoffs.

That gives us the game tree in the diagram.

How did we determine those payoffs?



Strategies and the strategic form

Strategies for firm A

A1.Don't do the R&D. Enter the market.

A2.Don't do the R&D. Don't enter the market.

A3. Do the R&D. Enter the market regardless of what is learned about the costs.

A4. Do the R&D. Enter the market if costs are low, but don't enter if they

are high.

A5. Do the R&D. Enter the market if costs are high, but don't enter if they low.

A6.Do the R&D. Don't enter the market regardless of what is learned about the costs.

Strategies and the strategic form

Strategies for firm B

B1: Enter regardless of what Firm A does.

B2: Enter if Firm A does enter. Do not enter if Firm A does not enter.

B3: Don’t enter if Firm A enters. Enter if Firm A does not enter.

B4: Do not enter, regardless of what Firm A does.

Strategies and the strategic form

- Diagram says that costs will be low with probability 0.3 and high with probability 0.7
- so the payoffs for A and B, respectively, in the cell A4–B1 are
- (0.3)(5) + (0.7)(5) = 2 for A
- and (0.3)(5) + (0.7)(25) = 19 for B.
- If you carry this out for each of the 6 x 4 = 24 cells, you get the strategic-form representation of the situation that is shown in the diagram.

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Firm A's strategy	Firm B's strategy: Enter regardless of what A does	Enter if A enters. Don't enter if A doesn't	Don't enter if A enters. Enter if A does not	Don't enter regardless of what A does
Don't do R&D, enter	–0.5, –5.5	–0.5, –5.5	39, 0	39, 0
Don't do R&D, don't enter	0, 32.5	0, 0	0, 32.5	0, 0
Do R&D, enter regardless of results	–5.5, –5.5	–5.5, –5.5	34, 0	34, 0
Do R&D, enter if costs low (only)	**–2, 19**	–2, 1.5	13, 17.5	13, 0
Do R&D, enter if costs high (only)	–8.5, 8	–8.5, –7	16, 15	16, 0
Do R&D, don't enter regardless	–5, 32.5	–5, 0	–5, 32.5	–5, 0

Dominance

- We now try and see if we can actually make predictions.
- For games in strategic form, one form of analysis is directed at the question: Can we confidently predict that certain strategies **will not** be employed by the players involved?
- Affirmative answers to this questions involve **dominance** arguments.

Have a look at the following game…

		Bob chooses the column		
		column 1	column 2	column 3
Alice chooses the row	row 1	7, 3	3, 1	0, 5
	row 2	5, 1	5, 3	2, 2

Dominance

Can we rule out any of Bob's three strategies?

Column1 is dominated by column 3

We predict that Bob is not going to choose column 1.

		Bob chooses the column		
		column 1	column 2	column 3
Alice chooses the row	row 1	7, 3	3, 1	0, 5
	row 2	5, 1	5, 3	2, 2

Dominance

Suppose that Alice is smart enough to replicate our argument that Bob will not choose column 1.

Whether Bob chooses column 2 or column 3, Alice is better off with row 2 than with row 1.

Therefore, row 2 *iteratively* dominates row 1, following the first dominance argument that eliminated column 1.

Based on an argument of *iterated dominance*, the prediction is that Alice will not choose row 1.

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Bob chooses the column

Alice chooses the row	column 1	column 2	column 3
row 1	7, 3	3, 1	0, 5
row 2	5, 1	5, 3	2, 2

Dominance

Having eliminated row 1 from consideration, *column 2 iteratively dominates column 3*.

After removing column 1 and then row 1 from consideration, column 2 is Bob's clear best choice.

Column 2 and row 2 are all that remain.

By iterated dominance, the prediction is that Alice chooses row 2 and Bob chooses column 2.

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Bob chooses the column

Alice chooses the row		column 1	column 2	column 3
	row 1	7, 3	3, 1	0, 5
	row 2	5, 1	5, 3	2, 2

Dominance

Dominance solvability is not always available;

If you go back to the Sam and Jan game you'll see that! (try it as an exercise)

Dominance

- Note worthy: do we sometimes play dominated strategies?
- Surprisingly enough, the answer is “yes, sometimes we do”.
- There is a huge empirical literature on this issue. Just ask and I’ll give you some references.

Weak dominance

- Have a look at this game:

	column 1	column 2
row 1	3, 0	2, 1
row 2	3, 4	0, 0

- Row 1 *weakly dominates* row 2: Against column 2, row 1 does strictly better than row 2, while against column 1, row 1 does just as well as row 2.
- Can we therefore conclude that row 2, which is weakly dominated, will not be chosen?
- Can we iterate on this and say that, once the column-selecting player concludes that row 2 will not be chosen (hence row 1 must be), column 2 will be the choice of the column player?

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Weak dominance

- The answer to this question must be settled empirically;
- However weak dominance does not do nearly as well as strict dominance, and iterated weak dominance can do quite poorly.
- Be wary of analyses you see that invoke weak dominance.