# Innovation And Persistence Effects: Theory And Experimental Evidence

Supplementary Appendix

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## Contents

# 1 A Microfoundation of the Theoretical Model

Here, we provide a microfoundation for the reduced-form model we outlined in the main text. Our model has two periods. In the first period, the duopolists undertake R&D investment, while in the second period, production takes place in a linear duopoly.

## 1.1 The Imperfect Product Differentiation Cournot Stage-Game

In the second period, firms set their output level and, subsequently, prices adjust so that demand equals supply. Each firm $i$ has a marginal production cost $\kappa_i$ and faces demand described by the inverse demand function

$$p_i = b_i - \theta q_j - \gamma q_i,$$

where $p_i$ denotes the price, $q_i$ denotes the output of firm $i$, $b_i$ represents the consumers' highest willingness to pay for the product of firm $i$ (will be referred to as a *quality* parameter), $g_j$ is the rival's output, and $\theta$ is a parameter that captures the substitutability of the two goods in the preferences of the consumers. We assume $\gamma > 0$ and $b_i > 0$, $\gamma > \theta \geq 0$.[1]

Denote $n_i \equiv b_i - \kappa_i$ and refer to it as *cost-adjusted quality*. To fix ideas, let us treat firm $i = 1$ to be the one that is (weakly) more advantaged (i.e. $n_1 \geq n_2$). Assume that

$$b_i > \kappa_i, \tag{1}$$

which ensures that $n_i > 0$ for all $i$.

Firms choose simultaneously and independently their output level to maximize their second-period profits. We refer to these profits as the duopolists' economic rents. Firm $i$'s best-response function is

$$q_i = max\{\frac{b_i - \kappa_i - \theta q_j}{2\gamma}, 0\}. \tag{2}$$

Denote with star the (pure strategy) Nash equilibrium values. The Nash equilibrium is given by the solution to the system of the above best-response functions. The equilibrium economic rents attained by duopolist $i$ equal

$$\Pi_i^* = (b_i - \theta q_j^* - \gamma q_i^* - \kappa_i) q_i^* = \gamma \left(q_i^*\right)^2$$

[1] This environment emerges from price-taking maximization of a linear-quadratic utility function of a numeraire good and the goods produced by the two firms in question, together with the assumption that whenever a firm's good faces zero demand, the price that clears the market is the lowest price from all possible prices that are compatible with zero demand for this good.

(after using the best-response function of firm $i$). In addition, the above best-response function implies that at an interior solution $p_i > 0$ as long as $\gamma q_i^* + \kappa_i > 0$, for all $i$, which is always true for non-negative output. It follows that if $\theta \leq 2\gamma \frac{n_2}{n_1}$, then, the Nash equilibrium is given by $q_i = q_i^*$, where

$$q_i^* = \frac{2\gamma(b_i - \kappa_i) - \theta(b_j - \kappa_j)}{4\gamma^2 - \theta^2},$$

with $q_1^* - q_2^* = \frac{(2\gamma+\theta)(n_1-n_2)}{4\gamma^2-\theta^2} \geq 0$. If, on the other hand, $2\gamma \frac{n_2}{n_1} < \theta < \gamma$ (and hence $n_1 > n_2$), then, the Nash equilibrium is given by $q_2^* = 0, q_1^* = \frac{n_1}{2\gamma} > \frac{n_2}{\theta}$, where the less advantaged firm is at a corner solution. In any case, the more advantaged firm earns higher economic rents.

## 1.2 Capacities and Cost-Adjusted Qualities

Let $k_i$ be the *technology capacity* of firm $i$ that describes its technology in terms of both product-quality and marginal production costs. The technology capacities determine whether the industry is neck-and-neck or unlevelled. In the former case, technology capacities are the same and no firm has an advantage in terms of attained economic rents. In the latter case, technology capacities are not the same and the firm with the higher technology capacity (i.e. the leader) has a relative advantage. To fix ideas, suppose that $k_1 \geq k_2$. We also let, for an arbitrary scalar $n > 1$, the cost-adjusted quality $n_i$ for any firm $i$ to be given by

$$n_i = n + k_i - k_j.$$

Note that $n$ fixes in effect the average cost-adjusted quality in the industry. Moreover, $n > 1$ and $k_1 \geq k_2$ imply that when firms differ by at most one technology capacity level, we have that $n_2 > 0$ as required. Therefore, in a neck-and-neck industry, where $k_1 = k_2$, we have $n_1 = n_2 = n$, whereas in an unlevelled industry where asymmetric firms differ only by one technology capacity level (i.e. $k_1 = k_2 + 1$), we have $n_1 = n + 1 > n > n - 1 = n_2$.

## 1.3 Investing in Technology Capacities

In the first period, firms have a given technology capacity level - their stock of knowledge - and they invest towards increasing their technology capacity in the second period. By doing so, they aim at gaining a relative advantage against their rival in terms of achieving a higher cost-adjusted quality and thereby economic rents.

The probability of going up one technology capacity level (referred to as "research capacity") is set to be $p_i = f(a_i)$ where $f(\cdot)$ is an increasing and (weakly) concave function of investment $a_i \in [0, \overline{a}]$ with $f(0) = 0$ and $f(\overline{a}) = 1$. Let also the cost of R&D investment be given by a function $\widehat{C}(a_i, K_i)$ such that $\widehat{C}(\cdot, K_i)$ is increasing and convex with $\widehat{C}(0, K_i) = 0$ and $\lim_{a \to \overline{a}} \widehat{C}(a, K_i) = \infty$, for any $K_i$, and $\widehat{C}(a_i, \cdot)$ is decreasing for any $a_i$.

Observe that in order to implement a research capacity $p_i$, firm $i$ needs to invest $a_i = f'^{-1}(p_i)$. We thus have that the cost from implementing a research capacity $p_i$ is

$$C(p_i, K_i) = \widehat{C}(f'^{-1}(p_i), K_i).$$

As can easily be verified, this function is such that $C(., K_i)$ is increasing and convex with $C(0, K_i) = 0$ and $\lim_{p \to 1} C(p, K_i) = \infty$, for any $K_i$, and $C(a_i, \cdot)$ is decreasing for any $a_i$, as it is assumed in the reduced-form model.

Finally, note that using $p_i = a_i/100$ and $\widehat{C}(a_i, K_i) = \frac{\widetilde{c}}{K_i} \frac{a_i}{100 - a_i}$ gives the cost function $C(p_i, K_i)$ used in the experiments.

## 1.4 Product Differentiation and Competitive Pressure

We associate the inverse of the degree of product differentiation with competitive pressure. So, a higher $\theta$ will be interpreted now as higher competitive pressure.

Recall from the discussion of the Cournot duopoly earlier that firm $i$ earns economic rents

$$\Pi_i^* = \gamma \left[ \frac{2\gamma n_i - \theta n_j}{4\gamma^2 - \theta^2} \right]^2.$$

Therefore, in a neck-and-neck industry, where $n_1 = n_2 = n$, we have that each firm earns economic rents

$$\Pi_0^* \equiv \gamma \left[ \frac{n}{2\gamma + \theta} \right]^2.$$

Moreover, in an unlevelled industry, where $n_1 > n > n_2$, we have

$$\Pi_1^* = \gamma \left[ \frac{2\gamma n_1 - \theta n_2}{4\gamma^2 - \theta^2} \right]^2$$

and

$$\Pi_2^* = \gamma \left[ \frac{2\gamma n_2 - \theta n_1}{4\gamma^2 - \theta^2} \right]^2.$$

In terms of the notation used in the reduced-form model, we have $\pi_h = \Pi_1^*, \pi_l = \Pi_2^*$ and $\pi_s = \Pi_0^*$. Below, we derive the conditions on $\gamma, \theta, n$ that will ensure that these economic rents satisfy the required properties in our reduced-form model.

### 1.4.1 Meeting Conditions on Economic Rents

Given that non-cooperative economic rents are (as we have seen earlier) equal to $\gamma$ times output squared, we have that the required conditions

$$\Pi_2^* < \Pi_0^*$$

$$\Pi_1^* > \Pi_0^*$$

$$\frac{\partial[\Pi_1^* - \Pi_0^*]}{\partial\theta} > 0$$

$$\frac{\partial[\Pi_0^* - \Pi_2^*]}{\partial\theta} < 0$$

are equivalent to

$$\left(\frac{2\gamma n_2 - \theta n_1}{4\gamma^2 - \theta^2}\right)^2 < \left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2$$

$$\left(\frac{2\gamma n_1 - \theta n_2}{4\gamma^2 - \theta^2}\right)^2 > \left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2$$

$$\frac{\partial[\left(\frac{2\gamma n_1 - \theta n_2}{4\gamma^2 - \theta^2}\right)^2 - \left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2]}{\partial\theta} > 0$$

$$\frac{\partial[\left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2 - \left(\frac{2\gamma n_2 - \theta n_1}{4\gamma^2 - \theta^2}\right)^2]}{\partial\theta} < 0.$$

Using that

$$\frac{2\gamma n_1 - \theta n_2}{4\gamma^2 - \theta^2} = \frac{(2\gamma + \theta) + (2\gamma - \theta)n}{4\gamma^2 - \theta^2}$$

$$\frac{2\gamma n_2 - \theta n_1}{4\gamma^2 - \theta^2} = \frac{-(2\gamma + \theta) + (2\gamma - \theta)n}{4\gamma^2 - \theta^2}$$

we have that we need $\gamma, \theta, n$ to be such that

$$\left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2 - \left(\frac{2\gamma n_2 - \theta n_1}{4\gamma^2 - \theta^2}\right)^2 = [\frac{n}{2\gamma + \theta} - (\frac{n}{2\gamma + \theta} - \frac{1}{2\gamma - \theta})][\frac{n}{2\gamma + \theta} + (\frac{n}{2\gamma + \theta} - \frac{1}{2\gamma - \theta})] =$$

$$\frac{1}{2\gamma-\theta}[\frac{2n}{2\gamma+\theta}-\frac{1}{2\gamma-\theta}]>0$$

$$\frac{2\gamma n_1-\theta n_2}{4\gamma^2-\theta^2}-\frac{(2\gamma-\theta)n}{4\gamma^2-\theta^2}=\frac{1}{2\gamma-\theta}>0$$

$$\frac{\partial[\left(\frac{2\gamma n_1-\theta n_2}{4\gamma^2-\theta^2}\right)^2-\left(\frac{(2\gamma-\theta)n}{4\gamma^2-\theta^2}\right)^2]}{\partial\theta}=\frac{\partial[\left(\frac{1}{2\gamma-\theta}\right)^2+2\left(\frac{1}{2\gamma-\theta}\right)\left(\frac{n}{2\gamma+\theta}\right)]}{\partial\theta}=\frac{\partial[\left(\frac{1}{2\gamma-\theta}\right)^2+2\left(\frac{n}{(2\gamma)^2-\theta^2}\right)]}{\partial\theta}>0$$

$$\frac{\partial[\left(\frac{(2\gamma-\theta)n}{4\gamma^2-\theta^2}\right)^2-\left(\frac{2\gamma n_2-\theta n_1}{4\gamma^2-\theta^2}\right)^2]}{\partial\theta}=\frac{\partial[-\left(\frac{1}{2\gamma-\theta}\right)^2+2\left(\frac{1}{2\gamma-\theta}\right)\left(\frac{n}{2\gamma+\theta}\right)]}{\partial\theta}=\frac{\partial[-\left(\frac{1}{2\gamma-\theta}\right)^2+2\left(\frac{n}{(2\gamma)^2-\theta^2}\right)]}{\partial\theta}<0.$$

It follows then directly that $\pi_h^*>\pi_l^*$ and $\frac{\partial[\pi_h^*-\pi_l^*]}{\partial\theta}>0$ are satisfied for any $\gamma>0,\theta<\gamma,n>0$. Turning to the remaining conditions, we clearly have that $\Pi_2^*<\Pi_0^*$ if and only if

$$2(2\gamma-\theta)n>2\gamma+\theta,$$

which can be re-written as

$$\frac{\gamma}{\theta}>\frac{(1+2n)}{2(2n-1)}. \tag{3}$$

Clearly, given $n>1,\gamma>\theta$, the above is satisfied if $1+2n\leq 2(2n-1)$; that is, if $n\geq 3/2$, which is feasible. To derive a condition that ensures that $\frac{\partial[\Pi_0^*-\Pi_2^*]}{\partial\theta}<0$, note that

$$\frac{\partial[-\left(\frac{1}{2\gamma-\theta}\right)^2+2\left(\frac{n}{(2\gamma)^2-\theta^2}\right)]}{\partial\theta}=-2\left(\frac{1}{2\gamma-\theta}\right)^3+4n\theta\left(\frac{1}{(2\gamma)^2-\theta^2}\right)^2=$$

$$-2\left(\frac{1}{2\gamma-\theta}\right)^2\left\{\frac{1}{2\gamma-\theta}-2n\theta\left(\frac{1}{2\gamma+\theta}\right)^2\right\}.$$

This is negative if $\theta=0$. For when $\theta>0$, we need

$$n<\frac{(2\gamma+\theta)^2}{2\theta\,(2\gamma-\theta)}. \tag{4}$$

Note that the right-hand side goes to infinity as $\theta\to 0^+$, while it equals $9/2$ when $\theta\to\gamma^-$. Therefore, by continuity, there is a range of values for $0<\theta<\gamma$ for which the above condition is satisfied for any given $n\geq 3/2$ (which, recall, ensures the previous condition).

Finally, notice that $\Pi_1^* - \Pi_0^* \geq \Pi_0^* - \Pi_2^*$, in which case (6) in the main text holds for any convex cost function, if

$$\left(\frac{2\gamma n_1 - \theta n_2}{4\gamma^2 - \theta^2}\right)^2 - \left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2 \geq$$
$$\left(\frac{(2\gamma - \theta)n}{4\gamma^2 - \theta^2}\right)^2 - \left(\frac{2\gamma n_2 - \theta n_1}{4\gamma^2 - \theta^2}\right)^2.$$

This can be rewritten as

$$\frac{1}{2\gamma - \theta}[\frac{2n}{2\gamma + \theta} + \frac{1}{2\gamma - \theta}] \geq$$
$$\frac{1}{2\gamma - \theta}[\frac{2n}{2\gamma + \theta} - \frac{1}{2\gamma - \theta}]$$

which is clearly true for $\gamma > \theta$.

For our experiments, we choose the values $n = 2$ and $\gamma = 1$. For these values, and $\theta \in \{0.1, 0.2, 0.5, 0.6\}$, we have that $n > 3/2$ and equation (4) is satisfied, and $\pi_h, \pi_l, \pi_s$ are as in Table 1 in the main text.

# 2 Experimental Instructions $[\pi_h = £2.19, \pi_s = £0.91, \pi_l = £0.18]$

The purpose of this experimental session is to study how people make decisions in a particular situation. Your earnings will depend upon the decisions you make as well as the decisions that other people make. At the end of the session, you will be paid in cash your total earnings. None of the other participants will be informed of your earnings, and likewise you will not be informed of the earnings of others. Given that nobody will know of each other's identity, all the decisions you make during the experimental session will be anonymous.

**For your participation in the experimental session, you will receive an initial payment of £3.**

The instructions are simple. If you have a question, please raise your hand. Aside from these questions, any communication with other participants or looking at other participants' screens is not permitted and will lead to your immediate exclusion from the experimental session.

**The instructions are identical to all participants.**

You are matched with another participant. Each participant manages a firm. Thus, there are 2 firms within the industry. **Both your firm and the other firm will make an investment decision in each of 3 starting situations.** The 3 starting situations differ in the relative ranking of the two firms in the point score as follows:

i) Your firm is one point ahead in the point score from the other firm.

ii) The other firm is one point ahead in the point score from your firm.

iii) Both firms have the same number of points in the point score.

To help you decide on the level of investment to undertake in each of the 3 starting situations, some information will be provided. This information pertains to the available investment levels and their respective probabilities of success and costs. The higher your investment choice, the more likely it is that your firm's investment will be successful and that you will earn one point in the point score. At the same time, a higher investment also leads to higher costs.

The Table displays the investment levels and their respective probabilities of success as well as the costs at each investment level.

| Investment Level | Probability of Success (%) | Cost (£) |
|---|---|---|
| 0 | 0 | 0.00 |
| 2 | 2 | 0.01 |
| 4 | 4 | 0.02 |
| 6 | 6 | 0.02 |
| 8 | 8 | 0.03 |
| 10 | 10 | 0.04 |
| 12 | 12 | 0.05 |
| 14 | 14 | 0.06 |
| 16 | 16 | 0.07 |
| 18 | 18 | 0.08 |
| 20 | 20 | 0.10 |

| | | |
|---|---|---|
| 22 | 22 | 0.11 |
| 24 | 24 | 0.12 |
| 26 | 26 | 0.13 |
| 28 | 28 | 0.15 |
| 30 | 30 | 0.16 |
| 32 | 32 | 0.18 |
| 34 | 34 | 0.20 |
| 36 | 36 | 0.21 |
| 38 | 38 | 0.23 |
| 40 | 40 | 0.25 |
| 42 | 42 | 0.28 |
| 44 | 44 | 0.30 |
| 46 | 46 | 0.32 |
| 48 | 48 | 0.35 |
| 50 | 50 | 0.38 |
| 52 | 52 | 0.41 |
| 54 | 54 | 0.45 |
| 56 | 56 | 0.48 |
| 58 | 58 | 0.52 |
| 60 | 60 | 0.57 |
| 62 | 62 | 0.62 |
| 64 | 64 | 0.68 |
| 66 | 66 | 0.74 |
| 68 | 68 | 0.81 |
| 70 | 70 | 0.89 |
| 72 | 72 | 0.98 |
| 74 | 74 | 1.08 |
| 76 | 76 | 1.20 |
| 78 | 78 | 1.35 |
| 80 | 80 | 1.52 |

Take starting situation i) where your firm is one point ahead in the point score from the other firm. If your investment is successful, regardless of whether or not the investment of the other firm turns out to be successful, you will again be ahead in the point score by one point. If your investment is unsuccessful and so is the other firm's investment, then again you will be ahead in the point score by one point. If your investment is unsuccessful and the other firm's investment is successful, then you will be tied in the point score. Thus, unless your investment is unsuccessful and the other firm's investment is successful, you will be ahead of the other firm in the point score by one point.

Take starting situation ii) where the other firm is one point ahead in the point score from your firm. If the other firm's investment is successful, regardless of whether or not your investment turns out to be successful, the other firm will again be ahead in the point score by one point. If the other firm's investment is unsuccessful and so is your firm's investment, then again the other firm will be ahead in the point score by one point. If the other firm's investment is unsuccessful and your firm's investment is successful, then you will be tied in the point score. Thus, unless the other firm's investment is unsuccessful and your firm's investment is successful, the other firm will be ahead of your firm in the point score by one point.

Take starting situation iii) where both firms have the same number of points in the point score. If the two firms' investments are both successful or both unsuccessful, then the two firms will still be tied in the point score. The only way for one firm to be ahead in the point score from the other firm is for that firm's investment choice to turn out successful and for the other firm's investment choice to turn out unsuccessful.

**Determination of Payoffs**

No feedback will be provided until both of you have made all your investment choices in the three starting situations. To determine your payoffs, one starting situation will be selected at random (i.e. each starting situation is equally likely to be drawn). In addition, there will be a separate draw for each firm to determine whether the firm's investment in the selected starting situation is successful. Specifically, the computer will draw an integer from 1 to 100 (all inclusive), where each integer has the same probability of being drawn. If the firm's investment choice in the selected starting situation is x, hence the probability of success is x%, and the computer draws a number above x, then the firm's investment in the selected starting situation is unsuccessful. However, if the computer draws a number below or equal to x, then the firm's investment in the selected starting situation is successful.

Should the starting situation i) get chosen (i.e. your firm is one point ahead in the point score from the other firm), your payoffs will be determined based on your investment choice in i), the other participant's investment choice in ii), and the respective outcomes of the two firms' investment decisions, which will determine the **final** relative standing in the point score.

Should the starting situation ii) get chosen (i.e. the other firm is one point ahead in the point score from your firm), your payoffs will be determined based on your investment choice in ii), the other participant's investment choice in i), and the respective outcomes of the two firms' investment decisions, which will determine the **final** relative standing in the point score.

Should the starting situation iii) get chosen (i.e. both firms have the same number of points in the point score), your payoffs will be determined based on your investment choice in iii), the other participant's investment choice in iii), and the respective outcomes of the two firms' investment decisions, which will determine the **final** relative standing in the point score.

The payoffs of each firm depend on their **final** relative standing in the point score after the computer draw about the success (or not) of their investment and the cost of their chosen investment level.

- If your firm is ahead in the point score, then your firm will receive £2.19 minus the cost of your chosen investment level, and the other firm will receive £0.18 minus the cost of its chosen investment level.

- If the other firm is ahead in the point score, then the other firm will receive £2.19 minus the cost of its chosen investment level, and your firm will receive £0.18 minus the cost of your chosen investment level.

- If both firms have the same number of points in the point score, then both your firm and the other firm will receive £0.91 minus the cost of the chosen investment level of each firm.

Your total earnings right now are set at £3. Should you make a loss, this will be deducted from your total earnings of £3.

**Examples**

1. Suppose your firm is one point ahead in the point score from the other firm, and you choose an investment level of 4. What is your probability of success? 4% What is your cost? £0.02 Suppose that the other firm, which is one point behind in the point score, chooses an investment level of 20. What is its probability of success? 20% What is its cost? £0.10 Suppose your investment turns out to be successful and so does the other firm's investment. What are your payoffs? £2.19 - £0.02 = £2.17 What are your total earnings? £3 + £2.17 = £5.17 What are the payoffs of the other firm? £0.18 - £0.10 = £0.08 What are the total earnings of the other firm? £3 + £0.08 = £3.08

2. Suppose your firm is one point ahead in the point score from the other firm, and you choose an investment level of 26. What is your probability of success? 26% What is your cost? £0.13 Suppose that the other firm, which is one point behind in the point score, chooses an investment level of 32. What is its probability of success? 32% What is its cost? £0.18 Suppose your investment turns out to be unsuccessful, whereas the other firm's investment turns out to be successful. What are your payoffs? £0.91 - £0.13 = £0.78 What are your total earnings? £3 + £0.78 = £3.78 What are the payoffs of the other firm? £0.91 - £0.18 = £0.73 What are the total earnings of the other firm? £3 + £0.73 = £3.73

3. Suppose your firm is one point behind in the point score from the other firm, and you choose an investment level of 28. What is your probability of success? 28% What is your cost? £0.15 Suppose that the other firm, which is one point ahead in the point score, chooses an investment level of 40. What is its probability of success? 40% What is its cost? £0.25 Suppose your investment turns out to be successful and so does the other firm's investment. What are your payoffs? £0.18 - £0.15 = £0.03 What are your total earnings? £3 + £0.03 = £3.03 What are the payoffs of the other firm? £2.19 - £0.25 = £1.94 What are the total earnings of the other firm? £3 + £1.94 = £4.94

4. Suppose your firm is one point behind in the point score from the other firm, and you choose an investment level of 42. What is your probability of success? 42% What is your cost? £0.28 Suppose that the other firm, which is one point ahead in the point score, chooses an investment level of 48. What is its probability of success? 48% What is its cost? £0.35 Suppose your investment turns out to be unsuccessful, whereas the other firm's investment turns out to be successful. What are your payoffs? £0.18 - £0.28 = -£0.10 What are your total earnings? £3 - £0.10 = £2.90 What are the payoffs of the other firm? £2.19 - £0.35 = £1.84 What are the total earnings of the other firm? £3 + £1.84 = £4.84

5. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 54. What is your probability of success? 54% What is your cost? £0.45 Suppose that the other firm chooses an investment level of 40. What is its probability of success? 40% What is its cost? £0.25 Suppose your investment turns out to be successful and so does the other firm's investment. What are your payoffs? £0.91 - £0.45 = £0.46 What are your total earnings? £3 + £0.46 = £3.46 What are the payoffs of the other firm? £0.91 - £0.25 = £0.66 What are the total earnings of the other firm? £3 + £0.66 = £3.66

6. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 68. What is your probability of success? 68% What is your cost? £0.81 Suppose that the other firm, which also has the same number of points, chooses an investment level of 52. What is its probability of success? 52% What is its cost? £0.41 Suppose your investment turns out to be unsuccessful, whereas the other firm's investment turns out to be successful. What are your payoffs? £0.18 - £0.81 = -£0.63 What are your total earnings? £3 - £0.63 = £2.37 What are the payoffs of the other firm? £2.19 - £0.41 = £1.78 What are the total earnings of the other firm? £3 + £1.78 = £4.78

7. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 56. What is your probability of success? 56% What is your cost? £0.48 Suppose that the other firm, which also has the same number of points, chooses an investment level of 8. What is its probability of success? 8% What is its cost? £0.03 Suppose your investment turns out to be unsuccessful and so does the other firm's investment. What are your payoffs? £0.91 - £0.48 = £0.43 What are your total earnings? £3 + £0.43 = £3.43 What are the payoffs of the other firm? £0.91 - £0.03 = £0.88 What are the total earnings of the other firm? £3 + £0.88 = £3.88

**Quiz**

1. How many firms are within an industry? 2

2. What are your total earnings right now? £3

3. How many investment decisions you need to make? 3

4. If your investment is successful, how many points in the point score do you earn? 1

5. If you choose an investment level of 12, what is your probability of success? 12%

6. If you choose an investment level of 20, what is your cost? £0.10

7. Suppose you chose an investment level of 20 in the selected starting situation. To determine whether the firm's investment in the selected starting situation is successful the computer draws integer 27. Is the firm's investment in the selected starting situation successful? No

8. Suppose you chose an investment level of 20 in the selected starting situation. To determine whether the firm's investment in the selected starting situation is successful the computer draws integer 17. Is the firm's investment in the selected starting situation successful? Yes

9. Suppose you chose an investment level of 20 in the selected starting situation. To determine whether the firm's investment in the selected starting situation is successful the computer draws integer 20. Is the firm's investment in the selected starting situation successful? Yes

10. Suppose your firm is one point ahead in the point score from the other firm, and you choose an investment level of 30. Your investment turns out to be successful. What are your payoffs? £2.03

11. Suppose your firm is one point ahead in the point score from the other firm, and you choose an investment level of 40. Your investment turns out to be unsuccessful. The other firm's investment turns out to be successful. What are your payoffs? £0.66

12. Suppose the other firm is one point ahead in the point score from your firm, and you choose an investment level of 56. Your investment turns out to be successful. The other firm's investment turns out to be also successful. What are your payoffs? -£0.30

13. Suppose the other firm is one point ahead in the point score from your firm, and you choose an investment level of 26. Your investment turns out to be unsuccessful. What are your payoffs? £0.05

14. Suppose the other firm is one point ahead in the point score from your firm, and you choose an investment level of 26. Your investment turns out to be unsuccessful. What are your total earnings? £3.05

15. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 36. Your investment turns out to be unsuccessful. The other firm's investment turns out to be successful. What are your payoffs? -£0.03

16. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 70. Your investment turns out to be unsuccessful. The other firm's investment turns out to be also unsuccessful. What are your payoffs? £0.02

17. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 44. Your investment turns out to be unsuccessful. The other firm's investment turns out to be also unsuccessful. What are your payoffs? £0.61

18. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 20. Your investment turns out to be successful. The other firm's investment turns out to be also successful. What are your payoffs? £0.81

19. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 40. Your investment turns out to be successful. The other firm's investment turns out to be unsuccessful. What are your payoffs? £1.94

20. Suppose both your firm and the other firm have the same number of points in the point score, and you choose an investment level of 40. Your investment turns out to be successful. The other firm's investment turns out to be unsuccessful. What are your total earnings? £4.94

**Game-Play Stage**

You will be asked next to make an investment decision in **each** of 3 starting situations. Remember that the 3 starting situations differ in the relative ranking of the two firms in the point score as follows:

i) Your firm is one point ahead in the point score from the other firm.

ii) The other firm is one point ahead in the point score from your firm.

iii) Both firms have the same number of points in the point score.

The starting situations will be shown to you in no particular order. Recall that once you make all three investment decisions, one starting situation will be selected at random (i.e. each starting situation is equally likely to be drawn).

Once you enter your investment choice, you will be asked to confirm it. Please note that once you confirm your investment choice, you will not be allowed to change it; that is, your investment choice will be final.

Assume this is starting situation i) where you are asked to make an investment decision knowing that:

i) Your firm is one point ahead in the point score from the other firm.

The investment choices and their accompanied costs are displayed.

| Investment Level | Probability of Success (%) | Cost (£) |
|---|---|---|
| 0 | 0 | 0.00 |
| 2 | 2 | 0.01 |
| 4 | 4 | 0.02 |
| 6 | 6 | 0.02 |
| 8 | 8 | 0.03 |
| 10 | 10 | 0.04 |
| 12 | 12 | 0.05 |
| 14 | 14 | 0.06 |
| 16 | 16 | 0.07 |
| 18 | 18 | 0.08 |
| 20 | 20 | 0.10 |
| 22 | 22 | 0.11 |
| 24 | 24 | 0.12 |
| 26 | 26 | 0.13 |
| 28 | 28 | 0.15 |
| 30 | 30 | 0.16 |
| 32 | 32 | 0.18 |
| 34 | 34 | 0.20 |
| 36 | 36 | 0.21 |
| 38 | 38 | 0.23 |
| 40 | 40 | 0.25 |
| 42 | 42 | 0.28 |
| 44 | 44 | 0.30 |
| 46 | 46 | 0.32 |
| 48 | 48 | 0.35 |
| 50 | 50 | 0.38 |
| 52 | 52 | 0.41 |
| 54 | 54 | 0.45 |
| 56 | 56 | 0.48 |
| 58 | 58 | 0.52 |
| 60 | 60 | 0.57 |
| 62 | 62 | 0.62 |
| 64 | 64 | 0.68 |
| 66 | 66 | 0.74 |

| | | |
|---|---|---|
| 68 | 68 | 0.81 |
| 70 | 70 | 0.89 |
| 72 | 72 | 0.98 |
| 74 | 74 | 1.08 |
| 76 | 76 | 1.20 |
| 78 | 78 | 1.35 |
| 80 | 80 | 1.52 |

Remember that:

The payoffs of each firm depend on their **final** relative standing in the point score after the computer draw about the success (or not) of their investment and the cost of their chosen investment level.

If your firm is ahead in the point score, then your firm will receive £2.19 minus the cost of your chosen investment level, and the other firm will receive £0.18 minus the cost of its chosen investment level.

If both firms have the same number of points in the point score, then both your firm and the other firm will receive £0.91 minus the cost of the chosen investment level of each firm.

Once you enter your investment choice, you will be asked to confirm it. Please note that once you confirm your investment choice, you will not be allowed to change it; that is, your investment choice will be final.

Your firm is one point ahead in the point score from the other firm. What is your investment level?

Assume this is starting situation ii) where you are asked to make an investment decision knowing that:

ii) The other firm is one point ahead in the point score from your firm.

The investment choices and their accompanied costs are displayed.

| Investment Level | Probability of Success (%) | Cost (£) |
|---|---|---|
| 0 | 0 | 0.00 |
| 2 | 2 | 0.01 |
| 4 | 4 | 0.02 |
| 6 | 6 | 0.02 |
| 8 | 8 | 0.03 |
| 10 | 10 | 0.04 |
| 12 | 12 | 0.05 |
| 14 | 14 | 0.06 |
| 16 | 16 | 0.07 |
| 18 | 18 | 0.08 |
| 20 | 20 | 0.10 |
| 22 | 22 | 0.11 |
| 24 | 24 | 0.12 |
| 26 | 26 | 0.13 |
| 28 | 28 | 0.15 |
| 30 | 30 | 0.16 |
| 32 | 32 | 0.18 |
| 34 | 34 | 0.20 |
| 36 | 36 | 0.21 |
| 38 | 38 | 0.23 |
| 40 | 40 | 0.25 |
| 42 | 42 | 0.28 |
| 44 | 44 | 0.30 |
| 46 | 46 | 0.32 |
| 48 | 48 | 0.35 |
| 50 | 50 | 0.38 |
| 52 | 52 | 0.41 |
| 54 | 54 | 0.45 |
| 56 | 56 | 0.48 |
| 58 | 58 | 0.52 |
| 60 | 60 | 0.57 |
| 62 | 62 | 0.62 |
| 64 | 64 | 0.68 |
| 66 | 66 | 0.74 |

| | | |
|---|---|---|
| 68 | 68 | 0.81 |
| 70 | 70 | 0.89 |
| 72 | 72 | 0.98 |
| 74 | 74 | 1.08 |
| 76 | 76 | 1.20 |
| 78 | 78 | 1.35 |
| 80 | 80 | 1.52 |

Remember that:

The payoffs of each firm depend on their final relative standing in the point score after the computer draw about the success (or not) of their investment and the cost of their chosen investment level.

If the other firm is ahead in the point score, then the other firm will receive £2.19 minus the cost of its chosen investment level, and your firm will receive £0.18 minus the cost of your chosen investment level.

If both firms have the same number of points in the point score, then both your firm and the other firm will receive £0.91 minus the cost of the chosen investment level of each firm.

Once you enter your investment choice, you will be asked to confirm it. Please note that once you confirm your investment choice, you will not be allowed to change it; that is, your investment choice will be final.

The other firm is one point ahead in the point score from your firm. What is your investment level?

Assume this is starting situation iii) where you are asked to make an investment decision knowing that:

iii) Both firms have the same number of points in the point score.

The investment choices and their accompanied costs are displayed.

| Investment Level | Probability of Success (%) | Cost (£) |
|---|---|---|
| 0 | 0 | 0.00 |
| 2 | 2 | 0.01 |
| 4 | 4 | 0.02 |
| 6 | 6 | 0.02 |
| 8 | 8 | 0.03 |
| 10 | 10 | 0.04 |
| 12 | 12 | 0.05 |
| 14 | 14 | 0.06 |
| 16 | 16 | 0.07 |
| 18 | 18 | 0.08 |
| 20 | 20 | 0.10 |
| 22 | 22 | 0.11 |
| 24 | 24 | 0.12 |
| 26 | 26 | 0.13 |
| 28 | 28 | 0.15 |
| 30 | 30 | 0.16 |
| 32 | 32 | 0.18 |
| 34 | 34 | 0.20 |
| 36 | 36 | 0.21 |
| 38 | 38 | 0.23 |
| 40 | 40 | 0.25 |
| 42 | 42 | 0.28 |
| 44 | 44 | 0.30 |
| 46 | 46 | 0.32 |
| 48 | 48 | 0.35 |
| 50 | 50 | 0.38 |
| 52 | 52 | 0.41 |
| 54 | 54 | 0.45 |
| 56 | 56 | 0.48 |
| 58 | 58 | 0.52 |
| 60 | 60 | 0.57 |
| 62 | 62 | 0.62 |
| 64 | 64 | 0.68 |
| 66 | 66 | 0.74 |

| | | |
|---|---|---|
| 68 | 68 | 0.81 |
| 70 | 70 | 0.89 |
| 72 | 72 | 0.98 |
| 74 | 74 | 1.08 |
| 76 | 76 | 1.20 |
| 78 | 78 | 1.35 |
| 80 | 80 | 1.52 |

Remember that:

The payoffs of each firm depend on their final relative standing in the point score after the computer draw about the success (or not) of their investment and the cost of their chosen investment level.

If your firm is ahead in the point score, then your firm will receive £2.19 minus the cost of your chosen investment level, and the other firm will receive £0.18 minus the cost of its chosen investment level.

If the other firm is ahead in the point score, then the other firm will receive £2.19 minus the cost of its chosen investment level, and your firm will receive £0.18 minus the cost of your chosen investment level.

If both firms have the same number of points in the point score, then both your firm and the other firm will receive £0.91 minus the cost of the chosen investment level of each firm.

Once you enter your investment choice, you will be asked to confirm it. Please note that once you confirm your investment choice, you will not be allowed to change it; that is, your investment choice will be final.

Both firms are tied in the point score. What is your investment level?