Incentives for Market Research: Preemption and Learning Effects*

Peter M. Kort†, Pauli Murto‡, and Grzegorz Pawlina§

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Abstract

This paper is about the optimal entry strategy in a new product market. Some firms enter new markets by committing the sunk cost up-front and immediately investing at full scale. Other companies start out more cautiously by undertaking market research first (e.g. based on a pilot launch). In the latter case, the idea is to gain information on the demand for the offered product. One of the indirect costs of such a strategy is that it can disclose the true demand curve to the firm's competitor(s). This paper provides a theoretical investigation of the incentives to start costly market research before entering a new market. In particular, we analyze the role of uncertainty and the cost of entry in determining the willingness to carry out the market research.

Keywords: *entry deterrence; duopoly; entry under uncertainty; incomplete information*
JEL codes: $C71$, $D21$, $D43$

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†Department of Econometrics & Operations Research, and CentER, Tilburg University, the Netherlands, and Department of Economics, University of Antwerp, Belgium, email: kort@uvt.nl.

‡Department of Economics, Helsinki School of Economics, Finland, email: pauli.murto@hkkk.fi.

§Corresponding author. Department of Accounting and Finance, Lancaster University Management School, UK, email: g.pawlina@lancaster.ac.uk.

1 Introduction

We consider the optimal entry strategy in a new product market. Some firms enter new markets by committing the sunk cost up-front and immediately investing at full scale. Other companies start out more cautiously by undertaking market research first (e.g. based on a pilot launch). In the latter case, the idea is to gain information on the demand for the product. One of the indirect costs of such a strategy is that it can disclose the true demand curve to the firm's competitor(s).

Entry under uncertainty which does not entail the market research costs can be associated with huge losses.[1] There are many situations in which reliable market research is not feasible due to technical limitations or potential threat of competitors copying a non-patentable product offered by the firm. Furthermore, firms often cannot afford waiting due to the threat of competitive entry. In such a case, firms can decide to "jump on the bandwagon" and follow its competitors in the market whose market potential is not fully known.

In many situations it is optimal to incur the costs of undertaking the market research. This allows to make the correct decision about whether to enter the market, and about the size of the market launch. The first-mover advantage is often associated with the knowledge of the true demand level. The potential cost is that the follower learns about the true state of demand and is able to adjust its launch size accordingly (to the Cournot or Stackelberg follower quantity, depending on the ability to commit to quantities). An example of such an adjustment potential is given in the following quote:

> "Boeing thinks that there will be a market for barely 400 very large aircraft (ie, bigger than today's jumbos) over the next 20 years. [...] On the other hand, Boeing's chief executive, Harry Stonecipher, says that, if there turns out to be a far bigger market than it now expects, Boeing will certainly enter it".
>
> The Economist, Jan. 20, 2005

We consider a framework with two firms that both have the option to enter a new market with a homogeneous product and quantity competition. Demand uncertainty is modelled by imposing that demand can have two states: high and low (Smit and Trigeorgis (2001)). In the paper mean preserving spreads are considered in the sense that the difference between high and low demand is varied (see Kulatilaka and Perotti (1998) for an analogous approach with a continuous density function). We study both the cases with information about the demand is public and private. Those two cases correspond to the (informed) Cournot and Stackelberg framework in our model.

[1] The division to research/no market research situations is not dichotomous in real life. In this paper, we assume that (significant) market research is undertaken if it is associated with a material cost and a potential change in the product market structure due to preemption/learning effects.

One firm (Firm 1) is given the option to undertake market research first. If it does so, it gains information on how large the demand for the product will be. Depending on the outcome of this market research the firm considers market entry. If it decides to enter the market, Firm 2 can observe demand of Firm 1 and will make its entry decision based on this observation. In case both firms decide to enter, a Stackelberg quantity game arises with Firm 1 as leader and Firm 2 as follower. Hence, Firm 2 has an advantage since it can free ride by costlessly learning the true demand level, but on the other hand Firm 1 gains the Stackelberg advantage (cf. Thijssen, Huisman, and Kort (2003)). When the results of market research are public good, we have a Cournot game instead. Then, still the advantage of performing market research is the gain of information about the demand but, however, Firm 1 does not have any advantage over free-riding Firm 2. In this paper, we study both the Cournot and Stackelberg framework that correspond to the results of market research being public and private information, respectively.

If Firm 1 refrains from doing the market research, both firms end up in a symmetric market entry game, in which the players are uninformed about the true state of demand. Such an outcome also occurs if Firm 2 decides to directly play the entry game with unknown demand (this occurs if its Stackelberg follower payoff under complete information is lower than the expected Cournot payoff with the unknown state of demand).

It turns out that two main scenarios can be distinguished. In the first scenario the market is profitable for two firms when uncertainty is zero. In that case, and with no uncertainty, the firms play a symmetric entry game. Both will enter immediately. One firm cannot prevent the other firm from entering, since the market is simply too profitable.

Now, performing the mean preserving spread raises the profitability in case demand is high but lowers it when demand is low. Eventually, in the latter case, high uncertainty results in the market being profitable for only one firm. Now, an incentive arises to undertake the market research but, on the other hand, Firm 2 may block it because, in expectation, the market is still profitable for two firms. It can be expected that if uncertainty is sufficiently large, it is optimal for Firm 2 to let Firm 1 carry out the market research in order to obtain information about the market for free: if demand is low, only Firm 1 will enter, and if the market is high both firms enter with Firm 2 being the Stackelberg follower. So, compared to blocking market research, Firm 2 avoids the risk of an unprofitable entry in case demand is low, but this goes at the expense of being a Stackelberg follower instead of a symmetric Cournot competitor in case demand is high. However, in the latter case Firm 2 gas to choose quantity based on expected demand instead of true demand. Note that in the framework with market research results being a public good, Firm 2 is a symmetric Cournot player instead of Stackelberg follower. So, in this case it only gains from Firm 1 undertaking market research.

A further increase of uncertainty will make the market unprofitable also in the monopoly case when demand is low. Then market research is fruitful in the sense that the market

research firm learns that entry is not profitable in case of low demand. Note that the other firm gets this information for free, but will be the Stackelberg follower in case demand is high and Firm 1 can commit to quantity. hence, in the decision to allow Firm 1 to do market research first, Firm 2 again has to weight the information free riding advantage against the payoff difference between symmetric Cournot and the Stackelberg disadvantage in case of high demand. However, this payoff difference may be negative since under symmetric Cournot Firm 2 has to choose quantity without knowing demand.

In the second scenario, the market is only profitable for one firm in case uncertainty is absent.[2] This means that in the symmetric entry game the first entrant can set its quantity such that it is not profitable for the other firm to enter[3]. For Firm 2 allowing market research in this case always leads to not entering, because Firm 1 will always be the only one to do so.

Increasing the mean preserving spread even more can eventually result in the market with high demand becoming profitable for two firms. Then, still it may not be optimal to carry out market research, because by playing the symmetric entry game the firms will find this out automatically after the first firm enters. On the other hand, one incentive to undertake market research is to optimally choose quantities.

Yet a further increase in uncertainty makes the case of low demand completely unprofitable. In this situation, market research certainly has value. In the case market research actually is carried out an equilibrium results where both firms exercise their entry options when demand is high, with Firm 1 being the Stackelberg leader in case of commitment, while they refrain from entry when demand is low. It is clear that then the firm that does not perform market research is worse off in case of high demand and commitment but better off in case of not being able to commit and/or low demand, since it does not bear the market research costs. However, aggregate profits are higher in case one of the firms carries out market research, because if different states of demand leads to different actions it is important to know the true state.

The (incomplete) list of relevant literature includes contributions on the trade-off between leader superior profits vs. second-mover informational advantage (Hoppe (2000), Décamps and Mariotti (2000), Thijssen, Huisman, and Kort (2003)), on uninformed Cournot competition vs. second-mover informational advantage (Kultti and Niinimäki (1998)), and on entry deterrence in a Cournot model under uncertainty (Maskin (1999)).

[2]Later, we will analyze the third scenario in which market is too small for even one firm in expectation.

[3]Note that this case should be called "entry blockade" if this quantity equals the quantity that would be chosen in the monopoly case without existence of another firm considering entry.

2 The Model

The aim of the paper is to determine the value of information under uncertainty and competition. To do so, our intention is to study the optimality of investing in market research first before entering a market. The outcome of market research is perfect in the sense that full information is obtained so that demand uncertainty is reduced to zero. The market is (i) a market for new products, implying that no incumbent firms are present and gaining information about consumer demand is a relevant issue, and (ii) a potential duopoly which implies that there are two firms having the option to enter this market. The opportunity to undertake market research is given to one firm only: this avoids a situation in which a coordination problem arises about which firm performs the market research. Obviously, from a welfare point of view it would be a deadweight loss when both firms make costs to obtain perfect information about the same market.

We consider both situations where the outcome of the market research is private, thus only known to the market research firm itself, or public, thus known to both firms. The latter case can arise, for instance, in case of a pilot project. The market research firm offers the new product to consumers within the pilot and also the other firm can observe how these people react. Firms compete in quantities which can be chosen only once. Apart from the (initial) state of demand, everything is known to both firms.

The firm performing the market research exploits the perfect information about consumer demand in choosing the quantity. When information gained by market research is public, the other firm can do the same so that a Cournot outcome arises in case the market is big enough for two firms. In this case, the other firm obtains the full information about consumer demand costlessly.

In case the information is private, the other firm first needs to observe the market research firm's quantity and the associated output price, before it obtains perfect full knowledge about consumer demand. Consequently, in case of private information, the firm performing the market research has a first-mover advantage in the sense that it can announce its quantity. The other firm thus free-rides in the sense that it obtains market information at no cost. However, this firm has the disadvantage that it can choose quantity only after the other firm has done so. When the market turns out to be profitable for only one firm, this results in that it is not optimal to enter while the market research firm obtains a monopoly position. Otherwise, the market research firm puts the other firm in a disadvantageous position by performing entry deterrence or Stackelberg leadership strategies.

Without taking into account the opportunity of performing the market research, the firms are otherwise identical. The starting point is a situation where both Firm 1 and 2 have an option to enter the market against an entry cost F. The firms are risk neutral. Let us denote by Firm 1 the firm that has the option to undertake market research first before entering the market. The first decision Firm 1 needs to take is thus whether to enter the market directly

or to undertake market research first. If it decides to enter the market, it depends on the expected profitability of this market whether Firm 2 will enter too. If Firm 2 does enter, an uninformed Cournot game arises in the sense that both firms do not know the exact demand. Consequently, they will choose quantities based on expected demand.

In case Firm 1 undertakes the market research it incurs a sunk cost I. Then Firm 2 has to decide whether it will wait for the results of this research or that it will enter simultaneously with Firm 1. In the latter case, again, a monopoly or an uninformed Cournot game arises. Note that this uninformed Cournot outcome (as selected by Firm 2) is not a subgame perfect equilibrium of the game. (In other words, when Firm 1 knows that Firm 2 would enter before the market research is finished, it would not have started market research in the first place.) The reason is that by entering immediately instead of starting market research, it would have avoided paying the sunk cost I and would have obtained also an uninformed Cournot outcome, or a monopoly outcome instead of not entering. Figure 1 depicts the structure of the game.

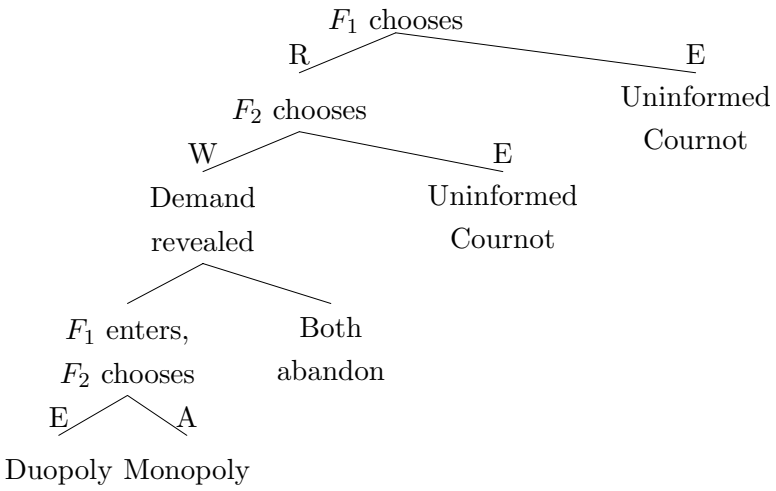

Figure 1: Game tree. 'A' stands for 'abandon', 'E' for 'enter', 'R' for 'do market research', and 'W' for 'wait'.

As described above, the disadvantage of waiting is that in case of private information Firm 1 can announce quantity, which can make the entry investment for Firm 2. unprofitable in case entry is blockaded or deterred. Otherwise, Firm 2 will be put in a Stackelberg follower position. However, if information is public and the outcome is that it is profitable for both firms to enter, a Cournot game arises where both firms know demand. Then, it is also in the interest of Firm 2 to let Firm 1 perform the market research. Here Firm 2 is in the advantageous position since it gets the market research information for free, while Firm 1 had to incur a sunk cost.

Now, we present the main assumptions and the framework of the model. There are two

equiprobable states: H and L. Inverse demand function in case of high demand (H) is

$$p^H = 1 + h - Q.$$

Demand in case of low demand (L) equals

$$p^L = 1 - h - Q,$$

$Q = q_1 + q_2$, where $q_i, i \in \{1, 2\}$ is the quantity chosen by Firm i. p^S is the price prevailing in state $S \in \{H, L\}$. Furthermore, F is the fixed entry costs of each firm and the production costs are zero.[4]

3 Benchmark case: Monopoly

The uninformed monopolistic firm will invest as long as F does not exceed $\frac{1}{4}$, i.e. the monopolistic expected (gross) profit. When Firm 1 has the information about the true state of demand, three scenarios are possible: no entry, entry in state H, and entry in both states.

The value of market research depends on the outcome region. When entry is never optimal, so is the market research. The value of market research positively depends on the uncertainty in the region of entry in both states. Finally, when entry is optimal only in state H, the value of market research depends both on uncertainty and entry cost. The latter dependence is due to the fact that investment occurs in different states when market research is (i.e., H) and is not (i.e., both or none) undertaken. Consequently, if uninformed investment occurs in both states, the value of market research increases with F (since market research allows for saving cost F in state L). On the other hand, if there is no uninformed investment, the value of market research decreases with F (since now it is going to be incurred with a positive probability ($\frac{1}{2}$)). Figure 2 illustrates the prevailing market outcomes in the (h, F)-space.

4 General case

In this section, we determine the prevailing market outcomes in the (h, F)-space when both firms have an option to enter the new market.

4.1 Entry under uncertainty without market research possibility

When it is not feasible for firms to undertake market research, no firm will ever enter when investment cost F exceeds monopolistic expected profit, 1/4. When entry costs is lower, two

[4]For the moment, we assume that $I = 0$ and we interpret the difference in Firm 1's payoffs with and without market research as the willingness to pay for it.

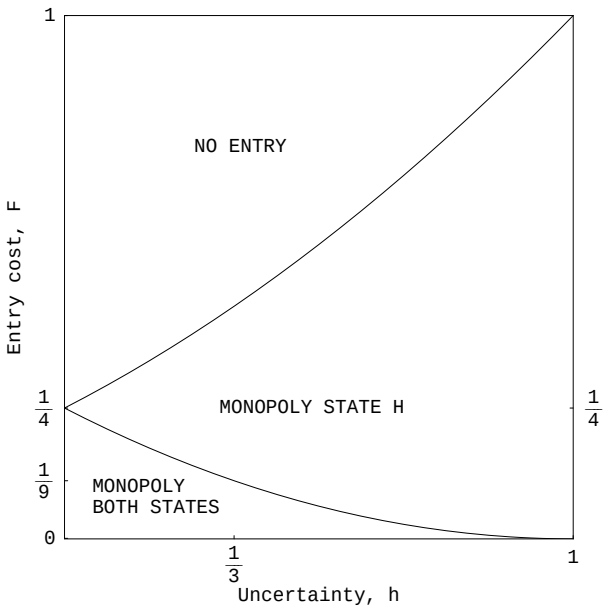

Figure 2: Prevailing market outcomes: The monopoly case.

situations are possible: entry is still profitable for a single firm, or the market is sufficiently large for both firms to enter.

When $F > \frac{1}{9}$, the expected profit of a duopolistic firm is not sufficient to cover the cost of entry. As a consequence, only Firm 1 will enter the market. The firm will serve the market in both states of nature (the sunk cost of entry has been committed anyway) and the expected profit that it will generate amounts to

$$\pi_1 = \frac{1}{4} - F. \tag{1}$$

Finally, when the cost of entry is sufficiently low, both firms will have an incentive to enter the uncertain market. In such a case, their expected profits will be equal to

$$\pi_i = \frac{1}{9} - F, i \in \{1, 2\}. \tag{2}$$

Consequently, when there is no opportunity to undertake the market research, the firms' entry decisions will be solely based upon the relation between the entry cost and the expected profit and will not depend on the level of market uncertainty.

4.2 Entry when market research results are public information

If one of the firms have complete information about the state of demand, entry is possible even if the sunk cost exceeds 1/4, provided that uncertainty is sufficiently high. In such a case, Firm 1 will enter if the state of demand is H.

For $F > 1/4$, Firm 1 does not enter unless the state is H and $h > 2\sqrt{F} - 1$. Firm 1 enters in state H as the monopolist if demand uncertainty h^2 is between $2\sqrt{F} - 1$ and $3\sqrt{F} - 1$. In such a scenario, the expected profit of Firm 1 is

$$\pi_1 = \frac{(1+h)^2}{8} - \frac{F}{2}. \tag{3}$$

For $h > 3\sqrt{F} - 1$, both firms enter in state H and realize expected profit

$$\pi_i = \frac{1}{18}(1+h)^2 - \frac{F}{2}, i \in \{1, 2\}. \tag{4}$$

For a moderate entry cost, i.e. for $1/9 < F < 1/4$, three outcomes are possible.

For $1/9 < F < 1/4$, Firm 1 always enters for demand uncertainty h^2 lower than $1 - 2\sqrt{F}$, and enters in state H only is uncertainty is between $1 - 2\sqrt{F}$ and $4\sqrt{F} - 1$. For uncertainty levels higher than $3\sqrt{F} - 1$, both Firms enter as (informed) Cournot competitors in state H and both refrain from entering in state L. In the first case, the expected profit of Firm 1 will equal $(1 + h^2)/4 - F$, and (3) in the second case. In a situation where both of the firms invest in state H, their expected profits are given by (4).

For low level entry costs, i.e. for $F < 1/4$, two outcomes are possible.

For low uncertainty levels, firms enter in both states and realize expected profits equal to:

$$\pi_i = \frac{1}{9}\left(1 + h^2\right) - F, i \in \{1, 2\}. \tag{5}$$

If uncertainty exceeds $1 - 3\sqrt{F}$, firms invest only in state H and realize expected payoffs (4).

The equilibrium outcomes for the results of the market research being public information are depicted in Figure 3.

4.3 Entry when market research results are private information

When entry cost exceeds 1/4, the resulting outcomes are the same as with market research being public information. When entry cost is moderate, i.e. when $1/9 < F < 1/4$, three outcomes are possible.

For $1/9 < F < 1/4$, Firm 1 always enters for demand uncertainty h^2 lower than $1 - 2\sqrt{F}$, and enters in state H only is uncertainty is between $1 - 2\sqrt{F}$ and $4\sqrt{F} - 1$. For uncertainty levels higher than $4\sqrt{F} - 1$, both Firm 1 deters entry of Firm 2 by setting quantity above it monopoly level in state H and both firms refrain from entering in state L. In the first case, the expected profit of Firm 1 will equal $(1 + h^2)/4 - F$, and (3) in the second case. In a situation where both of the firms invest in state H, their expected profits are

$$\pi_1 = (1+h)\sqrt{F} - \frac{5F}{2}, \tag{6}$$

$$\pi_2 = 0. \tag{7}$$

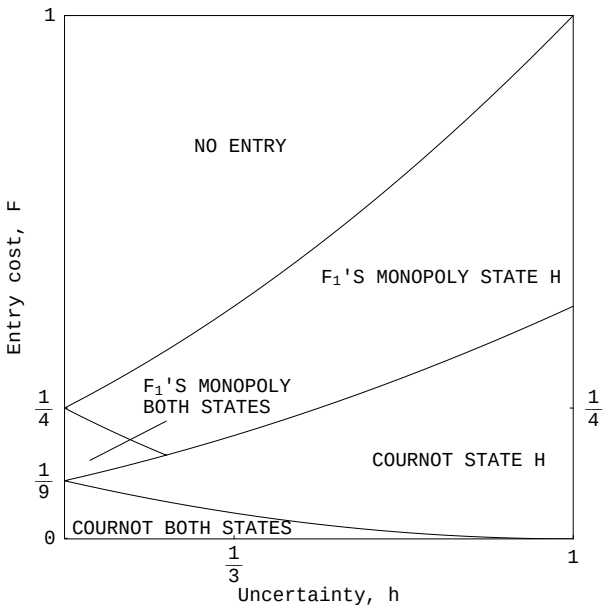

Figure 3: Prevailing market outcomes: Market research results being public information.

For low level entry costs, i.e. for $F < 1/4$, the prevailing market structure strongly depends on the level of uncertainty. For low uncertainty levels, Firm 2 prefers to play a Cournot game under incomplete information to being the Stackelberg follower once Firm 1 performs the market research. As a consequence, firms compete à la Cournot and realize expected profits given by Eq. (2). It holds that, in general, Firm 1 always prefers being the Stackelberg leader and it is Firm 2 that ultimately influences the prevailing type of equilibrium.

When uncertainty exceeds

$$\min\left\{\frac{\sqrt{7}}{3}, 4\sqrt{2}\sqrt{\frac{1}{9}-\frac{F}{2}}\right\}, \tag{8}$$

Firm 2 does not any longer have an incentive to compete in a Cournot game and prefers the wait-and-see strategy. Following the observation of demand on the basis of Firm 1's market study, the decision of Firm 2 (and, ultimately, of Firm 1) depends on the relative levels of uncertainty and the cost of entry. For uncertainty levels between $\sqrt{7}/3$ and $1-4\sqrt{F}$, both firms always enter but their quantities are in both cases based on the observed realization of demand (unless entry deterrence in state L occurs). For uncertainty levels exceeding $1-4\sqrt{F}$ but lower than $1-2\sqrt{F}$, Firm 2 enters only in state H whereas Firm 1 always enters. Finally, for uncertainty levels exceeding $1-2\sqrt{F}$, both Firms enter in state H and refrain from investing in state L.

In a situation where firms invest in both states of nature but after learning the true

demand, their Stackelberg profits are equal to:

$$\pi_1 = \frac{1}{8}\left(1+h^2\right) - F, \tag{9}$$

$$\pi_2 = \frac{1}{16}\left(1+h^2\right) - F. \tag{10}$$

For h lower than $1-4\sqrt{F}$ but exceeding $1-4(2+\sqrt{2})\sqrt{F}$, Firm 1 deters the entry of Firm 2 in state L. In such a case, the profit of Firm 1 equals

$$\pi_1 = (1-h)\sqrt{F} - \frac{5F}{2}. \tag{11}$$

If uncertainty becomes sufficiently high, it is no longer optimal for Firm 2 to (attempt to) invest in state L. In such a case, the expected profit of the firms in the scenario where Firm 1 undertakes the pilot project equals:

$$\pi_1 = \frac{1}{16}(1+h)^2 + \frac{1}{8}(1-h)^2 - F, \tag{12}$$

$$\pi_2 = \frac{1}{32}(1+h)^2 - \frac{F}{2}. \tag{13}$$

Finally, after performing market survey and discovering the bad state, Firm 1 may still refrain from investing. This happens when $\frac{1}{4}(1-h)^2 - F < 0$, which corresponds to $h > 1-2\sqrt{F}$. In this case the expected profit of Firm 1 equals

$$\pi_1 = \frac{1}{16}(1+h)^2 - \frac{F}{2}, \tag{14}$$

However, when uncertainty is lower than $4(2+\sqrt{2})\sqrt{F}-1$, Firm 2 faces the threat of entry deterrence and chooses uninformed Cournot outcome.

It is worth mentioning that apart from the entry-deterrence type of outcome, it is Firm 2 that ultimately decides about the type of the equilibrium (Firm 1 always prefers being the Stackelberg leader). Whenever Firm 2 considers entry, the prevailing outcome: uninformed Cournot, Stackelberg in state H, and Stackelberg in both states, is solely determined by its action. Figure 4 shows the prevailing market outcomes in the (h, F)-space.

5 Conclusions

We investigate the value of conducting the market research for different levels of uncertainty and of the sunk cost that has to be incurred to enter the new market. Two main situations are considered. In the first case, the entry cost is sufficiently low so the entry is profitable for both firms. In the second case, a high entry case makes Cournot competition infeasible at any uncertainty level. We show [the description still to be included] that the value of market research is non-monotonic in the level of the entry cost and the shape of this relationship critically depends on the level of market uncertainty.

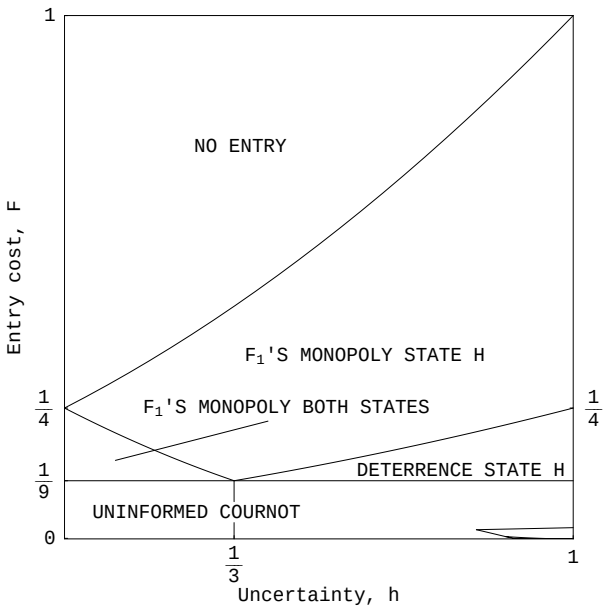

Figure 4: Prevailing market outcomes: Market research results being private information.

Strategic interactions influence the incentives for market research. The value of market research is non-monotonic in the cost of entry and it is piecewise increasing with uncertainty. The non-monotonicity of the value of market research in uncertainty is solely due to the competitive entry threat. The value of market research is negatively affected by both *i*) preemption considerations (via the threat of simultaneous competitive entry), and *ii*) learning effects (due to the follower observing the true demand and adjusting its output accordingly).

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