

Being a Naive or a Strategic Entrant?

Abstract

Both through empirical research and laboratory experiments it has been shown that managers are heterogeneous in strategic thinking-i.e., not all the managers can accurately conjecture their competitors' behavior. In this paper, we adapt Cognitive Hierarchy model to model this heterogeneity among the managers and investigate whether it is more advantageous to be a naive or a strategic entrant when a market is at the very immature stage. We specifically focus on when a market is at the very early stage of its development because as suggested by the extant literature as time passes the markets become more sophisticated and players show more rationality. Our results show that if the future prospects of the market and the entry barriers to the market are high it is more profitable to be a naive entrant. The naive entrant's profit advantage over the strategic one has a non-monotonic relationship with the category growth rate and the competitiveness of the market.

(Cognitive Hierarchy; Competitive Signaling; Entry)

1 Introduction

Both through empirical research and laboratory experiments it has been shown that managers are heterogeneous in strategic thinking. The results of various laboratory experiments that require the players to involve in strategic interaction suggest that in many cases Nash Equilibrium does not explain the actual outcome (Camerer, 2003; Ho et al., 2006). These experiments show that not all the players have the necessary cognitive capacity/high degree of rationality so that the outcome of their interaction leads to NE. There exist alternative models which relax one of the three strong assumptions of NE (i.e., strategic thinking, optimization, and mutual consistency) and perform better than NE in experimental games. One of these alternative models which is called as Cognitive Hierarchy (CH) relaxes the assumption of mutual consistency (Camerer et al., 2004; Stahl and Haruvy, 2008; Amaldoss and Jain, 2010; Hossain and Morgan, 2011; Goldfarb et al., 2012). CH model allows the heterogeneity among the players' accurately conjecture competitors' behavior. This limited rationality makes the beliefs of the players regarding what their opponents will do inconsistent with each other. CH model assumes that in a game some players use zero-steps of thinking-i.e., they ignore the competition and just randomize equally among all available strategies. Some players are one-step thinkers- i.e., they best respond believing that all the other players are zero-step thinkers. In other words, one-step thinkers consider the competition, but do not consider that the competition will consider them. By iteration, some players are k-step thinkers and they best respond believing that all others are zero to (k-1) step thinkers.

There exists empirical evidence supporting CH model. Brown et al. (2012) compare a standard equilibrium model with CH model and show that the latter model fits their data better. In their experiments the authors find that opposite of what movie studios think, moviegoers are not fully strategic (i.e., do not play a Bayesian-Nash strategy) when making inference about the quality of movie depending on whether the movie has been shown to critics prior to opening. Thus, movie studios can make higher profits if they do not best respond as if consumers use the fully iterative process. By using the data from US local telephone markets shortly after the Telecommunications Act of 1996, Goldfarb and Xiao (2011)

analyze the entry decisions of competitive local exchange carriers and show that as CH model suggests managers are not equally good at conjecturing the competitive behavior. Similarly, Goldfarb and Yang (2009) empirically test and validate CH model by analyzing the decisions of managers at 2,233 Internet Providers to offer their customers access through 56K modems in 1997.

In this paper, we aim to investigate whether it is more advantageous to be a naive or a strategic entrant when a market is at the very immature stage. Since Camerer et al. (2004) show that CH model works well in entry game we adapt CH model to conduct our analysis. In our adaptation, the naive player is zero-step thinker who does not account for the competitors' actions and randomly sets its price. We specifically focus on when a market is at the very early stage of its development because the extant literature suggest that as time passes the markets become more sophisticated and players show more rationality (Goldfarb and Xiao, 2011; Chong et al., 2005; Slonim, 2005; List, 2003; Ostling et al., 2010). In our model, there is a strategic incumbent who currently is the only firm serving in this new market. The future of this new market is unknown to everyone, except the incumbent. The incumbent knows whether the future market size will be high or low (i.e., high state vs. low state) and needs to decide what to announce about the future market size. After the incumbent's announcement an entrant decides whether to enter or not. If the entrant decides to enter and incurs the entry cost then it learns the true value of the future demand and firms simultaneously set their prices. Otherwise, the entrant exists the game. For an entrant it is not profitable to enter the market if the future market size is low. In the following period, the future market size becomes public and another entrant arrives and decides whether to enter or not. Finally, firms set their prices and game ends. Consumers need to buy a single unit in each period. There are two types of consumers: one type of consumers has a high search cost and randomly buys, while the other type buys the lowest priced product in the market.

We show that if the category growth rate and the entry barriers are high it is more profitable to be a naive entrant than a strategic one. When the incumbent faces a strategic entrant, it never truthfully reveals that the future market size is high. Thus, in equilibrium based on its prior the strategic entrant

either never enters and misses the market opportunity or always enters and wastes the entry cost when the future market size realizes low. However, when the incumbent faces a naive entrant, if the category growth rate and the entry barriers are high it reveals that the future market size is high. When the entry barriers are high, the strategic entrant does not find it profitable enter even in the high state if the naive entrant has entered. Thus, by revealing that the future market size is high and hence accommodating the naive entrant the incumbent deters the following strategic entrant. In fact, this incentive of incumbent is so strong that in an extension we show that even if the naive entrant has a significant cost advantage over both the incumbent and the following strategic entrant the incumbent would still prefer to accommodate the naive entrant to deter the strategic one. The incumbent does so because it is more profitable to be in duopoly with a naive entrant than with a strategic one and when the category growth rate is high enough, the gain in future duopoly profits dominates the gain from deterring the naive entrant and be a monopoly for a period. This means that when the category growth rate and the entry barriers are high, the naive entrant has an informational advantage regarding the future prospects of the market, which creates profit advantage for the naive entrant over the strategic one. Furthermore, in the high state the naive entrant's duopoly profits are higher than the strategic entrant. This happens because a naive entrant does not price competitively as a strategic entrant does and as a result, the incumbent's expected duopoly price is higher when it is in a duopoly with a naive entrant than when it is in a duopoly with a strategic entrant. Due to these two effects combined it is more profitable to be an early naive entrant than an early strategic entrant.

We identify that the profit advantage of a naive entrant has a non-monotonic relationship with the category growth rate and with the competitiveness of the market. More specifically, if the entry cost is not very high and the competitiveness of the market is low the naive entrant's profit advantage decreases as the category growth rate increases. However, if the entry cost is very high and/or the competitiveness of the market is high the naive entrant's profit advantage increases with the category growth rate. Similarly, if the entry cost is not very high (very high) the naive entrant's profit advantage increases

(decreases) as the competitiveness of the market increases. Thus, we interestingly show that as the market becomes more competitive it may be even more profitable to be a naive entrant. The existence of non-monotonic relationship between the naive entrant's profit advantage and the market parameters is mainly caused by whether the strategic entrant can enter based on its prior or not and differential impact of these parameters on the naive entrant's and the strategic entrant's profits.

Finally, our paper can also be seen as related to the literature on entry deterrence and preemption. In this literature incumbents can deter entry by using product quality as an instrument (Hung and Schmitt, 1992; Donnenfeld and Weber, 1995; Lutz, 1997), brand proliferation (Schmalansee, 1978; Brander and Eaton, 1984; Bonanno, 1987), investing in excess capacity (Dixit, 1980; Bunch and Smiley, 1992; Maskin, 1999), intensive advertising (Smiley, 1988; Bunch and Smiley, 1992), penetration pricing (Eliashberg and Jeuland, 1986), signaling market profitability (Milgrom and Roberts, 1982; Bagwell and Ramey, 1990; Harrington, 1986) and entering before demand takes off (Shen and Villas-Boas, 2010). There are also papers focus on cases in which incumbent firms issue preannouncements regarding their new product plans to preempt entrants by signaling them that the future competition would be very tough as they enter and try compete with the incumbent's new and better products (Eliashberg and Robertson, 1988; Rabino and Moore, 1989). In relation to the extant literature on entry deterrence, our paper shows that the incumbent would like to accommodate entry of an early naive entrant to deter entry of late strategic entrants by revealing that the future market size would be high. Such truthful communication also provides a profit advantage to the naive entrant over the strategic one.

The rest of the paper is organized as follows. Section 2 lays out the basic model setup. Section 3 solves for the case in which all the entrants are fully strategic. Section 4 solves for the case in which entrants vary in their strategic thinking and investigates whether and when it is more profitable to be a naive entrant. Finally, Section 5 concludes and suggests managerial implications.

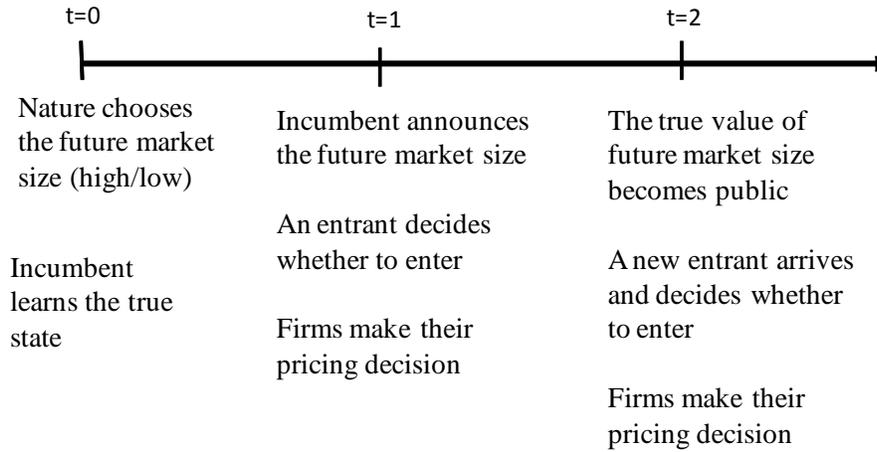
2 Model Set-Up

In the current period (at $t=0$), there is a single firm in the product market and a unit mass of consumers with reservation price of one. The future demand for this product market is uncertain. With probability $\frac{1}{2}$ the future demand would be high ($D = D_H$) and with probability $\frac{1}{2}$ the future demand would be low ($D = D_L$, where $D_H > D_L$). At $t=0$ Nature determines whether the future demand is high or low. The incumbent learns the true value and decides whether to announce that the future demand is high or low. Let a denote the incumbent's announcement, where $a = \{D_H, D_L\}$. We assume no punishment cost for untruthful announcement. Following the incumbent's announcement, at $t=1$ an entrant decides whether to enter or not. The entrant needs to incur a fixed cost (F_E) to enter the market. The entrant does not know the true value of the future market size and enters only if it thinks that the true value of the future market size is high. If the entrant decides to enter then it learns the true value of the future market size and firms simultaneously choose their prices. Otherwise, the entrant exits the game. We simply assume that firms' manufacturing costs are equal to zero. At $t=2$ the true value of the market size becomes public and a new entrant arrives. The product market size at $t=2$ is equal to $D_H R$, where R is the category growth rate and greater than one, in the state of high demand and to $D_L R$ in the state of low demand. After the new entrant makes its entry decision firms simultaneously choose their prices and game ends. Figure 1 depicts the timeline of the game. Consumers need to buy a single unit in each period and there are two types of consumers. α proportion of consumers have high search cost and randomly buy from any firm in the market. However, $(1 - \alpha)$ proportion of consumers do not have a search cost and would buy the lowest priced product.¹ Finally, we would like to note that to make our analysis we assume that when there is no entry at $t=1$, the new entrant enters at $t=2$ if it becomes public that the state is high and does not enter if it becomes public that the state is low.²

¹We could alternatively model the consumers' purchasing behavior such that α proportion of consumer have a high search cost and they would consider buying only from the incumbent. Our results would qualitatively stay the same.

²This requires $\frac{D_L R \alpha}{2} < F_E < \frac{D_H R \alpha}{2}$.

Figure 1: The Timeline of The Game



3 All The Entrants Are Strategic

We will start our analysis with the case in which all the entrants are strategic-i.e., they can correctly conjecture the behavior of the incumbent and the potential entrants. This means that the beliefs of all the players regarding what their opponents will do are consistent with each other.

Proposition 1 *In equilibrium the incumbent never reveals the true value of the future market size. The entrant at $t=1$ always enters if the entry cost is not too high and never enters otherwise.*

Recall that the entrant who arrives at $t=1$ does not want to enter if it thinks that the future market size is low and prefers to enter otherwise. For that reason, if the incumbent's equilibrium strategy is truthfully revealing the future market size (i.e., $a = D \forall D$) the incumbent would never truthfully announce when the future market size is high, but always deviate and untruthfully announce that the future market size is low so to deter entry at $t=1$. By doing this the incumbent would be able to receive monopoly profits for a period before the true value of future market size becomes public. Following the same logic, there cannot exist an equilibrium in which $a = D_H$ when $D = D_L$ and $a = D_L$ when $D = D_H$ either.

If the entry cost is not so high in equilibrium the entrant that arrives at $t=1$ enters based on its prior. In that case, the entrant wastes the entry cost if the market size realizes low. However, if the entry cost

is so high in equilibrium the entrant that arrives at $t=1$ does not enter. In that case, the entrant misses the opportunity if the market size realizes high.

4 Entrants Vary in Their Strategic Thinking

So far, we have assumed that all players are fully rational and strategic. However, in real life some firms are less strategic than others. In the following we will investigate the case in which the entrant at $t=1$ is naive. In line with the CH model, we model the naive entrant as zero-step thinker. In CH model zero-step players randomize equally among all available strategies. Thus, in our model the naive entrant does not account for competitors' actions and randomizes its pricing decision uniformly between $\frac{\alpha}{n-(n-1)\alpha}$ and 1, where n is the number of players.³ We would like to note that neglecting competition is not unusual behavior. Simonsohn (2010) provides evidence for neglecting competition from sellers' behavior on ebay and Rabino and Moore (1989), in their experimental work, show that people do not fully consider competitors in games. Since the naive entrant does not account for the incumbent's incentive to lie about the future prospects of the market it believes in its announcement: it prefers to incur F_E and enter if the incumbent announces that the future market size is high and exists the game otherwise.⁴ We will continue to assume the entrant arriving after $t=2$ is strategic.

Proposition 2 *In equilibrium the incumbent reveals the true value of future market size iff the category growth rate and the entry barriers are high (i.e., $R > R^*$ and $F_E > F_E^*$). The naive entrant at $t=1$ enters when the true value of the market size is high iff $R > R^*$ and $F_E > F_E^*$.*

In equilibrium, when the incumbent announces that the future market size is high, the naive entrant who arrives at $t=1$ enters, but not the strategic entrant who arrives at $t=2$ (this happens because $F_E > F_E^*$). If the incumbent deviates and untruthfully announces that the future market size is low

³Note that the entrant knows that $\frac{\alpha}{n}$ proportion of consumers would buy its product at the price of one. This means that the minimum amount of profit that the entrant would receive is $\frac{\alpha}{n}$. Thus, the lowest price the entrant is willing to charge is equal to $\frac{\frac{\alpha}{n}}{\frac{\alpha}{n} + (1-\alpha)}$ (i.e., $\frac{\alpha}{n-(n-1)\alpha}$).

⁴The naive entrant would enter if $F_E < \frac{1}{2-\alpha} \cdot (\frac{2-\alpha}{2})(1+R)D_H$, where $\frac{1}{2-\alpha}$ is the naive entrant's expected price and $\frac{2-\alpha}{2}$ is the total market share it can get (ignoring the competition). Thus, we will conduct the rest of our analysis for $\frac{(1+R)D_L}{2} < F_E < \frac{(1+R)D_H}{2}$.

then the naive entrant does not enter, but the strategic entrant enters at $t=2$ when it becomes public that the future market size is indeed high. Therefore, by revealing that the future market size is high the incumbent accommodates the naive entrant and deters the strategic one. Why does the incumbent want to deter the entry of a strategic entrant by accommodating the naive one? When the incumbent announces that the state is low two things happen. On one hand, since it deters the naive entrant it becomes a monopolist for a period and earns higher profits. This positive outcome naturally encourages the incumbent to be untruthful. However, for the incumbent it is more profitable to be in a duopoly with a naive entrant than with a strategic entrant. As the category growth rate (R) increases the future profit advantage the incumbent derives from being in a duopoly with a naive entrant rather than with a strategic entrant increases. As a result, for high enough R (i.e., $R > R^*$) the negative future prospects of deviation from truthful equilibrium offsets the current gain and hence, the incumbent prefers to be truthful.

Furthermore, the truthful equilibrium (i.e., $a = D \forall D$) is unique for $R > R^*$ and $F_E > F_E^*$. The intuition for this as follows. If the incumbent's equilibrium strategy were $a = D_H$ when $D = D_L$ and $a = D_L$ when $D = D_H$ then the naive entrant would not enter when $D = D_H$, but the strategic entrant would enter at $t=2$. If the incumbent deviates to $a = D_H$ when $D = D_H$ then the naive entrant enters and there will be no entry afterwards for $F_E > F_E^*$. As we know from Proposition 2, if $R > R^*$ for the incumbent with $D = D_H$ it is more profitable to accommodate the entry of the naive entrant so to deter the entry of the following strategic entrants. If the incumbent's equilibrium strategy were announcing that the future market size is high (i.e., $a = D_H \forall D$) regardless of the actual future market size, in equilibrium the naive entrant would always enter at $t=1$ and invest as if the market size is high. If the incumbent with $D = D_H$ deviates to $a = D_L$ then the naive entrant at $t=1$ would not enter and a strategic entrant would enter at $t=2$ (i.e., when it becomes public that $D = D_H$). As we know from Proposition 2, if $R > R^*$ when the incumbent with $D = D_H$ deviates to $a = D_L$ its payoff would be less than its equilibrium payoff. However, if the incumbent with $D = D_L$ deviates to $a = D_L$ then neither

the naive entrant at $t=1$ nor the strategic entrant at $t=2$ would enter (i.e., after the true value of the future market size becomes public). As a result, the incumbent with $D = D_L$ would earn a higher payoff than its equilibrium payoff when it deviates to $a = D_L$. If the incumbent's equilibrium strategy is always announcing that the future market size is low (i.e., $a = D_L \forall D$), at $t=1$ the naive entrant would not enter, but when it becomes public that $D = D_H$, a strategic entrant will enter. If the incumbent deviates to $a = D_H$ the naive entrant would enter at $t=1$ and there will be no entry afterwards if $F_E > F_E^*$. As we know from Proposition 2, if $R > R^*$ for the incumbent with $D = D_H$ it is more profitable to accommodate the entry of the naive entrant so to deter the entry of the following strategic entrants.

Proposition 3 *The incumbent's incentive to reveal the true value of the future market size increases as*

- *the future market size in the high state (D_H) increases*
- *the category growth rate (R) increases*
- *the proportion of consumers with a high search cost (α) decreases (i.e., the competitiveness of the market increases).*

Naturally, as the future market becomes more attractive (i.e., D_H increases) the incumbent's profits increase regardless of whether the incumbent is a monopoly, in a duopoly with a naive entrant, in a duopoly with a strategic entrant. However, the increase in the incumbent's profit when it is in a duopoly with a naive entrant dominates the increase in its profits both when it is in a duopoly with a strategic entrant and when it is a monopoly. As a result, as D_H increases so does the incumbent's incentive to truthfully announce the future market size.

Since it is more profitable to be in a duopoly with a naive entrant than with a strategic entrant as the category growth rate (R) at $t=2$ increases the incumbent becomes more willing to reveal the high future market size so to accommodate the naive entrant and deter the entry of strategic entrant at $t=2$.

Note that as the proportion of consumers with a high search cost (α) decreases the market becomes more competitive. However, counterintuitively, Proposition 3 reveals that as the market becomes more

competitive the incumbent's incentive to reveal that the future market size is high increases. How can this happen? First of all note that as α increases the difference between the incumbent's monopoly profits and its duopoly profits at $t=1$ decreases. This outcome obviously decreases the incumbent's incentive to deviate from the truthful equilibrium. Furthermore, as α increases so do the incumbent's duopoly profits at $t=2$. But, the increase in the incumbent's duopoly profits is higher when it is in duopoly with a strategic entrant than when it is a duopoly with a naive entrant. Naturally, this outcome increases the incumbent's incentive to deviate from the truthful equilibrium. This negative force dominates the formerly mentioned positive force and as a result, as α increases so does the incumbent's incentive to deviate from the truthful equilibrium.

Corollary 1 *For $F_E > F_E^*$ and $R > R^*$ the incumbent has more incentive to invest in increasing the category growth rate when it faces a naive entrant than a strategic one at $t=1$.*

According to Corollary 1, a product category may grow faster if the early entrants to the product category are naive rather than strategic. This happens because as we explained in Proposition 2 if $F_E > F_E^*$ and $R > R^*$ in equilibrium the incumbent prefers to accommodate the naive entrant to deter the following strategic entrant. Since the incumbent earns higher profits when it is in a duopoly with a naive entrant than with a strategic one the incumbent would be more willing to invest to increase the category growth when the early entrant to the new product market is naive.

4.1 Is It Better To Be A Naive Entrant?

So far we have discovered that facing a strategic or a naive entrant can significantly alter the incumbent's announcement strategy and outcome of the game. In the following we will investigate whether it can ever be more profitable to be a naive entrant than a strategic one at $t=1$ and if so why.

Proposition 4 *For $R > R^*$ and $F_E > F_E^*$ it is more profitable to be a naive entrant than a strategic one at $t=1$.*

There are two sources of the naive entrant's profit advantage. First, as we know from Proposition 2, for $R > R^*$ and $F_E > F_E^*$ the incumbent truthfully reveals whether the future market size is high or low if the entrant at $t=1$ is naive. However, as we know from Proposition 1 that if the entrant at $t=1$ is strategic the incumbent would never truthfully reveal the future market size. Hence, if the entry cost is very high such that at $t=1$ the strategic entrant cannot enter based on prior then in equilibrium the strategic entrant that arrives at $t=1$ would lose the opportunity when the true value of the future market size is high. On the other hand, if the entry cost is not so high that at $t=1$ the strategic entrant prefers to enter based on its prior then in equilibrium the strategic entrant that arrives at $t=1$ will waste the entry cost when the true value of the future market size is low. Thus, the naive entrant has an information advantage over the strategic entrant. Second, in the high state per period duopoly profit of a naive entrant is higher than one of a strategic entrant. This happens because a naive entrant does not price competitively as a strategic entrant does and as a result, the incumbent's expected duopoly price is higher when it is in a duopoly with a naive entrant (equal to $\frac{1}{2-\alpha}$) than when it is in a duopoly with a strategic entrant (equal to $\frac{\alpha}{2(1-\alpha)} \ln(\frac{2-\alpha}{\alpha})$).⁵ Unless $R > R^*$ and $F_E > F_E^*$ the incumbent would never reveal that the market size is high even when it faces a naive entrant. As a result, the naive entrant that arrives at $t=1$ would not make any profits and have profit advantage over the strategic entrant.

In the following we investigate how (D_H, R, α) parameters affect the expected profit advantage of a naive entrant over a strategic one when $R > R^*$ and $F_E > F_E^*$ (i.e., when the truthful equilibrium is unique).

Proposition 5 *The naive entrant's expected profit advantage*

- *increases as the future market size in the high state (D_H) increases*
- *decreases as the category growth rate (R) increases if the entry cost is not very high and the proportion of high search cost consumers is big and increases otherwise.*

⁵(Ashiya, 2000) shows that the incumbent firm may want to accommodate the entry of a weak entrant with a high manufacturing cost to deter the entry of a strong entrant with a low manufacturing cost who contemplates to enter after the weak entrant. However, unlike in our model, the payoff of the strong entrant is higher than the payoff of the weak entrant.

- *increases as the proportion of consumers with a high search cost (α) decreases (i.e., the competitiveness of the market increases) if the entry cost is not very high and increases otherwise.*

We know from Proposition 4 that the naive entrant's profit advantage comes from two sources: 1. it receives perfect information about the true value of the future market size and hence neither misses the opportunity when the future market size is high nor wastes money by entering when the future market size is low, and 2. its per period duopoly profits are higher than the strategic entrant's. Since per period duopoly profits are multiplied with D_H when the state is high the naive entrant's profit advantage increases as future market size in the high state increases.

We know that in equilibrium at $t=1$ the only information a strategic entrant has is its prior and it would enter based on its prior if the entry cost is not very high. When the entry cost is not very high, the strategic entrant would be at the market at $t=1$ regardless of the state is high or low. However, the naive entrant will enter at $t=1$ only when the state is high. Therefore, at $t=2$ the increase in the category growth rate (R) makes the strategic entrant's profits to increase both in the high state and in low state, while it makes the naive entrant's profits to increase only in the high state. If the proportion of consumers with high search cost is high the total impact of R on the strategic entrant's profits is higher than its impact on the naive entrant's and hence, the naive entrant's expected profit advantage decreases as R increases if the entry cost is not very high. On the other hand, if the entry cost is very high so that in equilibrium the strategic entrant cannot enter at $t=1$ based on its prior then R does not play any role on the strategic entrant's profits and thus, the naive entrant's expected profit advantage increases as R increases.

Naturally, both entrants' per period duopoly profits increase as the competitiveness of the product market decreases (i.e., α increases). However, since a strategic entrant competitively prices as α increases the increase in its per period duopoly profits is higher than the increase in a naive entrant's per period duopoly profits. We know that in equilibrium at $t=1$ the only information a strategic entrant has is its prior and it would enter based on its prior if the entry cost is not very high. When the entry cost is

not very high, since the strategic entrant would be at the market at $t=1$ as the naive entrant and α has a bigger impact on the its duopoly profits than on the naive entrant's surprisingly as α increases (i.e., the competitiveness of the market decreases) the naive entrant's profit advantage decreases. This means that as the market becomes more competitive it becomes even more profitable to be a naive entrant. On the other hand, when the entry cost is very high, since the strategic entrant would never enter at $t=1$ based on its prior as α increases so does the naive entrant's profit advantage.

4.2 What If The Later Entrants Are Not Fully Strategic?

In our basic model, we have assumed that there is a naive entrant only at $t=1$. In a way we have assumed that the entrants become smarter as time passes. Then, naturally one may wonder whether the incumbent would ever truthfully reveal the future market size and hence, it would still be profitable to be a naive entrant at $t=1$ when the entrants arriving after $t=1$ are not fully strategic. In the following we will investigate this issue.

Corollary 2 *The incumbent would not reveal that future market size is high unless the future entrant (i.e., the one arrives at $t=2$) is expected to be smarter than the one that arrives at $t=1$.*

This happens because if the entrant that arrives at $t=2$ is as naive as the previous one then the incumbent does not lose anything by deterring the entry at $t=1$, on the contrary would be able to collect the monopoly profits for a period.⁶ Obviously, in this case at $t=1$ it would be more profitable to be a strategic entrant than a naive one. Following this, to investigate whether the truthful equilibrium can uniquely exist if the entrants become strategic gradually after $t=1$ we modified our model such that an entrant that arrives at $t=2$ is strategic with probability y and naive with probability $(1 - y)$.

Proposition 6 *In equilibrium the incumbent reveals the true value of future market size iff $y > y^*$, $R > \hat{R}^*$ ($\hat{R}^* > R^*$), and $F_E > F_E^*$.*

⁶We simply assume that the entrant that arrives at $t=2$ does not hear the incumbent's announcement at $t=1$, but just relies on the public information about the future market size.

Proposition 6 validates that if the entrant arrives at $t=2$ is expected to be smarter than the one that arrives at $t=1$ the incumbent would prefer to truthfully reveal the future market size. Therefore, as in Proposition 4, the category growth rate and the entry barriers to the market are high it is more profitable to be a naive entrant. This interestingly means that the possibility of a late strategic entrant makes an early naive entrant to earn more than an early strategic entrant.

The intuition behind Proposition 6 is as follows. The incumbent is aware of that the entrant at $t=1$ is naive, but the entrant arriving at $t=2$ can be strategic with probability y . Obviously, if the probability of the entrant at $t=2$ being strategic is high enough (i.e., $y > y^*$) following the same logic in Proposition 2 the incumbent wants to reveal the high future market size to accommodate the naive entrant at $t=1$ so to deter the possible strategic entrant coming later. The main difference between Proposition 2 and Proposition 6 is that when the incumbent is not for sure that the entrant arriving at $t=2$ is strategic, it is willing to reveal the high future market size only if the category growth rate is very high (i.e., $R > \hat{R}^*$). This happens because with probability $(1 - y)$ the later entrant is also naive and hence, by revealing the high future market size so early the incumbent is missing the opportunity of earning monopoly profits for nothing. However, this loss would be compensated if the category growth rate is very high and hence, the incumbent's expected future gain in duopoly profits by being in a duopoly with a naive entrant rather than with a strategic entrant is very high. Note that the truthful equilibrium (i.e., $a = D \forall D$) is unique for $y > y^*$, $R > \hat{R}^*$ ($\hat{R}^* > R^*$), and $F_E > F_E^*$.

Finally, we would like to note that, based on their empirical results, (Goldfarb and Xiao, 2011) suggest that allowing for heterogenous strategic ability is important in the early times of an industry. Similarly, laboratory and field work (Goldfarb and Xiao, 2011; Chong et al., 2005; Slonim, 2005; List, 2003; Ostling et al., 2010) shows that repeated play leads to higher rationality. Thus, in our model as time passess it is natural to expect the potential entrants become more sophisticated by learning from the accumulated experience of the players in the market.

4.3 Incumbent Accommodates a Naive Entrant With a Cost Advantage

So far to simplify our analysis we have assumed that the manufacturing cost is zero for all the firms. However, especially in emerging markets one would expect local naive entrants to be able to produce and sell at a lower cost than big international strategic entrants. Thus, one may wonder what happens if in an emerging market a strategic incumbent faces a naive entrant with a cost advantage. More specifically, would the incumbent still want to accommodate a naive entrant with a cost advantage to deter entry of a strategic entrant without such advantage? To explore this issue we modify our basic model such that both the incumbent's and the strategic entrants' manufacturing cost is equal to c (where $c < 1$) while the naive entrant's manufacturing cost is zero.

Proposition 7 *In equilibrium the incumbent reveals the true value of the future market size iff $c < c^*$, $R > \tilde{R}^*$ and $F_E > \tilde{F}_E^*$. The naive entrant at $t=1$ enters when the true value of the market size is high iff $c < c^*$, $R > \tilde{R}^*$ and $F_E > \tilde{F}_E^*$.*

Therefore, even if the early naive entrant has a cost advantage as long as the cost advantage is not very high the incumbent prefers to accommodate the naive entrant by revealing that the future market size is high. Since $F_E > \tilde{F}_E^*$ the entry of the naive entrant at $t=1$ deters the entry of a strategic entrant at $t=2$. This means that incumbent prefers to accommodate a naive entrant with a cost advantage so to deter the entry of a strategic entrant. As long as the incumbent's competitive disadvantage relative to the naive entrant is not too high (i.e., $c < c^*$) for the incumbent it is more profitable to be in a duopoly with a naive entrant than with a strategic one. Thus, when the category growth rate is high enough (i.e., $R > \tilde{R}^*$) the gain in duopoly profits at $t=2$ offsets the profit gain due to being a monopoly at $t=1$ in case the incumbent deters the entry of a naive entrant.

One may think that for the incumbent to want to accommodate a naive entrant with a cost advantage rather than a strategic entrant without such advantage the incumbent's manufacturing cost must be very small. However, one can show that even for $c = \frac{3}{4}$ and $\alpha = 0.3$ the incumbent would want to reveal the true value of of the future market size. Thus, the incumbent may want to accommodate a naive entrant

with a cost advantage even when the naive entrant's cost advantage is substantial and the product market is quite competitive.

5 Conclusion

In this paper we embraced an empirically proven fact that not all managers are equal in strategic thinking and investigated whether it is more advantageous to be a naive or a strategic entrant when a market is at the immature stage and the potential entrants are not fully informed about the future of the market. To do so we adopted CH model, which allows the heterogeneity among the players' accurately conjecture competitors' behavior, and showed that it is profitable to a naive entrant who ignores the competition and randomizes its acts than a fully strategic one if the market growth rate and entry cost to the market are high. When facing a naive entrant, the incumbent prefers to truthfully reveal the future prospects of the market and accommodate the entry. The incumbent does so to deter the late strategic entrant because it is more profitable to be in a duopoly with a naive entrant than with a strategic one. Since the incumbent never prefers to truthfully reveal the future prospects of the market when it faces a strategic entrant the naive entrant has an information advantage over the strategic one. Furthermore, the naive entrant does not price competitively as the strategic entrant and hence the incumbent's expected duopoly price is higher when it is in a duopoly with a naive entrant. These two effects combined make it more profitable to be a naive entrant. We also showed that the naive entrant's profit advantage has a non-monotonic relationship with the category growth rate and the competitiveness of the market due to the differential impact of these market parameters on the naive entrant's and strategic entrant's profits.

We believe that our results have several important managerial implications for incumbent firms. First, it makes a significant difference in an incumbent firm's decision to deter entry and to invest in developing the product category whether it faces a naive entrant or a strategic entrant. Our results show that unlike when the early entrant is strategic, when the early entrant is naive it may be more profitable to accommodate the entry, even if the potential entrant has a cost advantage. The incumbent

would benefit more from accommodating the naive entrant as future prospects and the competitiveness of the market increase. Second, if the incumbent has a chance to invest in developing the category it would benefit more from it when the early entrant is naive.

We also believe that our paper adds to the growing marketing literature that adopts the behavioral economic paradigm to provide insights on marketing phenomena and firms' strategies (Amaldoss and Jain (2005b); Amaldoss and Jain (2005a); Amaldoss and Jain (2008b); Amaldoss and Jain (2008a); Chen et al. (2010); Chen and Cui (2012); Cui et al. (2007); Feinberg et al. (2002); Hardie et al. (1993); Ho and Zhang (2008); Jain (2009); Lim and Ho (2007); Orhun (2009); Syam et al. (2008); Rooderberk et al. (2011); Grubb (2009); Greenleaf (1995); Kopalle et al. (1996); Heidhues and Koszegi (2008)). There are several extensions to our analysis one can embark on. For example, one can investigate how and when an early naive entrant learns and becomes fully strategic after entry and how such a process would change the results derived in this paper. One can also look into what would happen if the incumbent is not fully strategic or there are multiple naive entrants with different level of strategic thinking.

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Appendix

The entry of strategic entrant at t=2: Case of no entry at t=1 and the future market size is high

Recall that $\alpha/2$ proportion of consumers would only buy from the incumbent and $\alpha/2$ proportion of consumers would only buy from the entrant. The rest (i.e., $(1 - \alpha)$ proportion of consumers) would buy the lowest price product. Therefore, firms' pricing will be a mixed strategy such that each firm will maximize $\pi_i = DR[\alpha/2 + (1 - \alpha)(1 - F(p_i))]p_i$, where $i = (\text{incumbent}, \text{entrant})$. This case is the same as that studied in Varian (1980) and Narasimhan (1988). Since neither firm would charge a price which makes them earn less than $\frac{DR\alpha}{2}$ in order to capture $\frac{2-\alpha}{2}$ proportion of the market the equilibrium price support is $(\underline{p}, 1)$, where $\underline{p} = \frac{\alpha}{2-\alpha}$. The expected profits of firms would be $\pi_i^* = \frac{DR\alpha}{2}$ and the cdf of the equilibrium price would be $F^*(p_i) = 1 - \frac{\alpha}{2\beta} \frac{1-p_i}{p_i}$. Therefore, if $F_E < \frac{DR\alpha}{2}$ the strategic entrant which arrives at t=2 would enter when there is only the incumbent in the market and the state is high. If at t=1 the strategic entrant thinks that the state is low the maximum profit it can receive is equal to $\frac{D_L(1+R)\alpha}{2}$ (this happens if no other entrant enters at t=2). Hence, if $F_E > \frac{D_L(1+R)\alpha}{2}$ the strategic entrant would not enter at t=1 when it thinks that the state is low. Note that if $F_E > \frac{D_L(1+R)\alpha}{2}$, where $\frac{D_L(1+R)\alpha}{2} > \frac{D_LR\alpha}{2}$, the strategic entrant who arrives at t=2 would not enter when the state is low.

The entry of strategic entrant at t=1 when it thinks that the future market size is high:

If at t=2 there are three strategic players (i.e., an entry happened at each period) then $\alpha/3$ proportion of consumers would only buy from one of three firms. Therefore, firms' pricing will be a mixed strategy such that each firm will maximize $\pi_i = DR[\alpha/3 + (1 - \alpha)(1 - F(p_i))^2]p_i$. Since neither firm would charge a price which makes them earn less than $\frac{DR\alpha}{3}$ in order to capture $\frac{3-2\alpha}{3}$ proportion of the market the price support is $(\underline{p}, 1)$, where $\underline{p} = \frac{\alpha}{3-2\alpha}$. The expected profits of firms would be $\pi_i^* = \frac{DR\alpha}{3}$ and the cdf of the equilibrium price would be $F^*(p_i) = 1 - \sqrt{\frac{\alpha}{3\beta} \frac{1-p_i}{p_i}}$. This means that when the state is high and there are two incumbents in the market, the entrant which arrives at t=2 would always enter if $F_E < \frac{D_H R\alpha}{3}$ and would not enter otherwise. Thus, when the entrant which arrives at t=1 learns from the incumbent's announcement that the state is high it would enter if $F_E < \frac{(R+1)D_H\alpha}{2}$. Obviously,

$F_E < \frac{D_H R \alpha}{2}$ is sufficient for $F_E < \frac{(R+1)D_H \alpha}{2}$. Thus, we will only consider $\frac{D_L(1+R)\alpha}{2} < F_E < \frac{D_H R \alpha}{2}$.

Proof of Proposition 1:

We will show that a separating equilibrium (i.e., an equilibrium in which the incumbent reveals the true value of the future market size cannot exist).

In a separating equilibrium (i.e., either $a = D \forall D$ or $a = D_L$ when $D = D_H$ and $a = D_H$ when $D = D_L$) the entrant would enter at $t=1$ when it learns that the future market size is high. When the state is high and strategic entrant enters, the incumbent's profits would be equal to $\frac{(R+1)D_H \alpha}{2}$ if $F_E > \frac{D_H R \alpha}{3}$ and would be equal to $\frac{(2R+3)D_H \alpha}{6}$ otherwise. However, when the true state is high, if the incumbent deviates from its equilibrium action the entrant would think that the state is low and would not enter. In this case, the incumbent's expected profits would be equal to $\frac{(R\alpha+2)D_H}{2}$. Since $\frac{(R\alpha+2)D_H}{2} > \frac{(R+1)D_H \alpha}{2}$ and $\frac{(R\alpha+2)D_H}{2} > \frac{(2R+3)D_H \alpha}{6}$ the incumbent would always deviate when the future market size is high and hence separating type of equilibrium cannot exist.

Therefore, the possible remaining equilibria are pooling type pure strategy equilibria (i.e., $a = D_H \forall D$ or $a = D_L \forall D$) and mixed strategy equilibria.

In a pooling type of equilibrium, the entrant would make its entry decision based on its prior. Hence, the entrant's expected profits would be equal to $\frac{(D_H+D_L)(R+1)\alpha}{4}$ if $F_E > \frac{D_H R \alpha}{3}$ and would be equal to $\frac{(D_H+D_L)(2R+3)\alpha}{12}$ otherwise. This means that in a pooling type of equilibrium the entrant would enter if $\frac{D_H R \alpha}{3} < F_E < \frac{(D_H+D_L)(R+1)\alpha}{4}$ or if $F_E < \min \left\{ \frac{(D_H+D_L)(2R+3)\alpha}{12}, \frac{D_H R \alpha}{3} \right\}$ and the entrant would not enter if $\max \left\{ \frac{D_H R \alpha}{3}, \frac{(D_H+D_L)(R+1)\alpha}{4} \right\} < F_E$ or if $\frac{(D_H+D_L)(2R+3)\alpha}{12} < F_E < \frac{D_H R \alpha}{3}$.

In a mixed strategy equilibrium, regardless of whether $D = D_H$ and $D = D_L$ the incumbent is indifferent between $a = D_H$ and $a = D_L$. Thus, regardless of the incumbent's announcement the entrant either always enters or never enters. Let $\mu_E^H = \text{prob}(D = D_H \mid a = D_H)$ and $\mu_E^L = \text{prob}(D = D_H \mid a = D_L)$. Thus, in equilibrium when $a = D_H$, the entrant's expected profits would be equal to $\frac{(\mu_E^H D_H + (1-\mu_E^H)D_L)(R+1)\alpha}{2}$ if $F_E > \frac{D_H R \alpha}{3}$ and would be equal to $\frac{(\mu_E^H D_H + (1-\mu_E^H)D_L)(2R+3)\alpha}{6}$ otherwise. Similarly, when $a = D_L$, the entrant's expected profits would be equal to $\frac{(\mu_E^L D_H + (1-\mu_E^L)D_L)(R+1)\alpha}{2}$

if $F_E > \frac{D_H R \alpha}{3}$ and would be equal to $\frac{(\mu_E^L D_H + (1 - \mu_E^L) D_L)(2R + 3)\alpha}{6}$ otherwise. In equilibrium the entrant would enter if $\frac{D_H R \alpha}{3} < F_E < \min \left\{ \frac{(\mu_E^H D_H + (1 - \mu_E^H) D_L)(1 + R)\alpha}{2}, \frac{(\mu_E^L D_H + (1 - \mu_E^L) D_L)(R + 1)\alpha}{2} \right\}$ or if $F_E < \min \left\{ \frac{(\mu_E^H D_H + (1 - \mu_E^H) D_L)(2R + 3)\alpha}{6}, \frac{(\mu_E^L D_H + (1 - \mu_E^L) D_L)(2R + 3)\alpha}{6}, \frac{D_H R \alpha}{3} \right\}$ and the entrant would not enter if $\max \left\{ \frac{D_H R \alpha}{3}, \frac{(\mu_E^H D_H + (1 - \mu_E^H) D_L)(1 + R)\alpha}{2}, \frac{(\mu_E^L D_H + (1 - \mu_E^L) D_L)(1 + R)\alpha}{2} \right\} < F_E$ or if $\max \left\{ \frac{(\mu_E^H D_H + (1 - \mu_E^H) D_L)(2R + 3)\alpha}{6}, \frac{(\mu_E^L D_H + (1 - \mu_E^L) D_L)(2R + 3)\alpha}{6} \right\} < F_E < \frac{D_H R \alpha}{3}$. \square

Entry Decision of Naive Entrant at t=1:

Since at t=1 $\frac{\alpha}{2}$ proportion of consumers would only buy from the naive entrant the naive entrant would not charge a price which makes it earn less than $\alpha/2$ in order to capture $\frac{2-\alpha}{2}$ proportion of the market. The naive entrant's price is uniformly distributed between $\frac{\alpha}{2-\alpha}$ and 1. Thus, at t=1 the expected price of the naive entrant is $\frac{1}{2-\alpha}$. Since the naive entrant ignores the competition its expected profits would be equal to $\frac{1}{2-\alpha}(\frac{\alpha}{2} + 1 - \alpha)(1 + R)D_H$. Thus, for the naive entrant to enter when it thinks that the state is high we need $F_E < \frac{(1+R)D_H}{2}$. Obviously, the naive entrant would not enter when it thinks that the state is low if $F_E > \frac{(1+R)D_L}{2}$.

Therefore, we will conduct the rest of our analysis for $\min \left\{ \frac{RD_H \alpha}{2}, \frac{(1+R)D_H}{2} \right\} > F_E > \max \left\{ \frac{(1+R)D_L}{2}, \frac{(1+R)D_L \alpha}{2} \right\}$.

This is equivalent to $\frac{RD_H \alpha}{2} > F_E > \frac{(1+R)D_L}{2}$.

Proof of Proposition 2:

In the following we will characterize the conditions under which the truthful equilibrium (i.e., $a = D \forall D$) can exist.

In truthful equilibrium at t=1: the naive entrant enters and randomly sets a price as a draw from $U(\frac{\alpha}{2-\alpha}, 1)$ when $a = D_H$ and does not enter when $a = D_L$. When $D = D_H$, if the incumbent charges price p_i its expected profits would be $\pi_{incumbent} = D_H [\alpha/2 + (1 - \alpha) \frac{(1-p_i)}{1-\frac{\alpha}{2-\alpha}}] p_i$. Therefore, the incumbent's equilibrium price would be $p_i^* = \frac{1}{2-\alpha}$, where $\frac{\alpha}{2-\alpha} < \frac{1}{2-\alpha} < 1$, and its expected profits would be $\pi_{incumbent}^* = \frac{D_H}{2(2-\alpha)}$, where $\frac{1}{2(2-\alpha)} > \alpha/2$.

In truthful equilibrium at t=2: when $D = D_H$, if the strategic entrant enters then the naive entrant randomly set a price as a draw from $U(\frac{\alpha}{3-2\alpha}, 1)$. If a strategic player i , where $i = \{incumbent, entrant\}$,

charges price p_i the expected payoff of the strategic player would be $\pi_i = D_H R [\alpha/3 + (1 - \alpha) \frac{(1-p_i)}{1-\frac{\alpha}{3-2\alpha}} (1 - F(p_i))] p_i$. We can show that the price support is $(\underline{p}, \tilde{p}] \cup \{1\}$. $\tilde{p} = \operatorname{argmax} [\alpha/3 + (1 - \alpha) \frac{(1-p_i)}{1-\frac{\alpha}{3-2\alpha}}] p_i$ so that $\tilde{p} = \frac{3-\alpha}{2(3-2\alpha)}$. The expected profits of the incumbent and the strategic entrant is $\pi_i = \frac{D_H R \alpha}{3}$. From $D_H R [\alpha/3 + 1 - \alpha] \frac{(1-p_i)}{1-\frac{\alpha}{3-2\alpha}} (1 - F(p_i)) p_i = D_H R \alpha/3$, we get $F(p_i) = 1 - \frac{\alpha}{3-2\alpha} \frac{1}{p_i}$. Because $F(1) = 1 - \frac{\alpha}{3-2\alpha}$. There is a probability mass $q_1 = 1 - F(1) = \frac{\alpha}{3-2\alpha}$ at 1. From $F(\underline{p}) = 0$, we get $\underline{p} = \frac{\alpha}{3-2\alpha}$. Because $F(\tilde{p}) = \frac{3(1-\alpha)}{3-\alpha}$, there is a probability mass $q_2 = F(1) - F(\tilde{p}) = \frac{3(1-\alpha)\alpha}{(3-2\alpha)(3-\alpha)}$ at \tilde{p} . From $1 > \tilde{p} > \underline{p}$, we have $3 - 2\alpha > \alpha$ which always holds.

Proof for price support being $(\underline{p}, \tilde{p}] \cup \{1\}$: Consider the two strategic firms, i and j . For any given p_i , if $p_j \geq p_i$, the optimal p_j is obviously $\hat{p}_j = 1$. If $p_j < p_i$, then $\pi_j = [\alpha/3 + (1 - \alpha) \frac{(1-p_i)}{1-\frac{\alpha}{3-2\alpha}}] p_j$. Therefore, the optimal p_j if $p_j < p_i$ is $\hat{p}_j = \min(p_i - \varepsilon, \tilde{p})$, where $\tilde{p} = \frac{3-\alpha}{2(3-2\alpha)}$. Therefore, given the price distribution of p_i , the price distribution of p_j must be that a p_j with non-zero density is equal to $\min(p_i - \varepsilon, \tilde{p})$ or 1 for some p_i ; and visa versa. Therefore, the price support is $(\underline{p}, \tilde{p}] \cup \{1\}$. A price $\tilde{p} < p < 1$ is dominated by either \tilde{p} or 1. 1 is the best response for \underline{p} from the other firm, \tilde{p} is the best response for 1 from the other firm, a price p in $(\underline{p}, \tilde{p}]$ is the best response for $p + \varepsilon$ from the other firm.

As a result, if $F_E > \frac{\alpha R D_H}{3}$ then in equilibrium the strategic entrant would not enter and the incumbent's expected profits would be equal to $\frac{R D_H}{2(2-\alpha)}$.

Therefore, if $F_E > F_E^* = \max \left\{ \frac{\alpha R D_H}{3}, \frac{(1+R) D_L}{2} \right\}$ in truthful equilibrium when $D = D_H$, the incumbent's total expected profits are equal to $\frac{(1+R) D_H}{2(2-\alpha)}$. If the incumbent deviates and announces $a = D_L$ at $t=1$ the naive entrant does not enter and the incumbent receives monopoly profits of D_H . In this case, at $t=2$ the strategic entrant enters and, as we derived before, the incumbent's expected profits would be equal to $\frac{D_H R \alpha}{2}$.

This means that when $D = D_H$, the incumbent would not deviate from the truthful equilibrium if $\frac{(1+R) D_H}{2(2-\alpha)} > D_H + \frac{D_H R \alpha}{2}$. This inequality holds if $R > R^* = \frac{3-2\alpha}{(1-\alpha)^2}$.

Finally, it is obvious that since in equilibrium no entrant enters when $a = D_L$ the incumbent with $D = D_L$ does not have any incentive to deviate from the truthful equilibrium. \square

Proof of Proposition 3:

When $D = D_H$, the difference between the incumbent's expected equilibrium profit and the expected profit it can receive if it deviates is $\Delta = D_H(\frac{(1+R)}{2(2-\alpha)} - 1 - \frac{R\alpha}{2})$. In the following we will prove that for $R > R^*$ and $F_E > F_E^*$, $\frac{\partial \Delta}{\partial D_H} > 0$, $\frac{\partial \Delta}{\partial R} > 0$, and $\frac{\partial \Delta}{\partial \alpha} < 0$.

It is obvious that since $\frac{(1+R)}{2(2-\alpha)} - 1 - \frac{R\alpha}{2} > 0$, $\frac{\partial \Delta}{\partial D_H} > 0$. $\frac{\partial \Delta}{\partial R} = \frac{1-\alpha(2-\alpha)}{2(2-\alpha)} > 0$. $\frac{\partial \Delta}{\partial \alpha} = \frac{1-R(3-4\alpha+\alpha^2)}{2(2-\alpha)^2}$. Since $R > \frac{3-2\alpha}{(1-\alpha)^2}$ and $\frac{1}{3-4\alpha+\alpha^2} < \frac{3-2\alpha}{(1-\alpha)^2}$, $\frac{\partial \Delta}{\partial \alpha} < 0$. \square

Proof of Corollary 1:

Case of naive entrant: Recall that if $R > R^*$ and $F_E > F_E^*$ and the incumbent faces a naive entrant at $t=1$ the unique equilibrium is that the incumbent truthfully announces the true value of the future market size. The incumbent's expected equilibrium payoffs are equal to $\frac{(1+R)D_H}{2(2-\alpha)}$ when $D = D_H$ and to $(1+R)D_L$ when $D = D_L$. Note that $\frac{\partial(\frac{(1+R)D_H}{2(2-\alpha)})}{\partial R} = \frac{D_H}{2(2-\alpha)}$ and $\frac{\partial((1+R)D_L)}{\partial R} = D_L$.

Case of strategic entrant: We know from the proof of Proposition 1 that in equilibrium when the entry cost is high the strategic entrant who arrives at $t=1$ would not enter based on its prior. In this case, the incumbent's expected equilibrium payoffs are equal to $D_H + \frac{D_H R \alpha}{2}$ when $D = D_H$ and to $(1+R)D_L$ when $D = D_L$. However, if the entry cost is not too high the strategic entrant would enter at $t=1$ based on its prior. In this case, the incumbent's expected equilibrium payoffs are equal to $(1+R)\frac{D_H \alpha}{2}$ if $F_E > \frac{D_H R \alpha}{3}$ and $(\frac{1}{2} + \frac{R}{3})D_H \alpha$ otherwise when $D = D_H$ and to $(1+R)\frac{D_L \alpha}{2}$ when $D = D_L$. Note that $\frac{\partial((1+R)\frac{D_H \alpha}{2})}{\partial R} = \frac{D_H \alpha}{2}$ and $\frac{\partial((\frac{1}{2} + \frac{R}{3})D_H \alpha)}{\partial R} = \frac{D_H \alpha}{3}$.

When one compares two cases, it is obvious that $\frac{1}{2(2-\alpha)} > \frac{\alpha}{2}$. Thus, if $R > R^*$ and $F_E > F_E^*$, the incumbent has more incentive to invest in R when it faces a naive entrant than when it faces a strategic entrant. \square

Proof of Proposition 4:

For $R > R^*$ and $F_E > F_E^*$, the naive entrant's total expected equilibrium payoff is equal to $\frac{1}{2} \left(D_H(1+R)\frac{1+2\alpha-\alpha^2}{4(2-\alpha)} - F_E \right)$. On the other hand, the expected equilibrium payoff of a strategic entrant who arrives at $t=1$ is equal to $(1+R)\frac{\alpha(D_H+D_L)}{4} - F_E$ if $\min \left\{ \frac{RD_H \alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4} \right\} > F_E > F_E^*$

(i.e., if the strategic entrant can enter at $t=1$ based on its prior) and to zero if $\frac{RD_H\alpha}{2} > F_E > \max\left\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\}$. Since $\frac{1+2\alpha-\alpha^2}{4(2-\alpha)} > \alpha$ and $F_E > \frac{D_L(1+R)}{2}$, for $R > R^*$ and $F_E > F_E^*$ it is more profitable to be a naive entrant than a strategic one at $t=1$. \square

Proof of Proposition 5:

The naive entrant's profit advantage is equal to $\Delta = \frac{(1+R)}{4}(D_H\frac{(1-\alpha)^2}{2(2-\alpha)} - \alpha D_L) + \frac{F_E}{2}$ if $\min\{\frac{RD_H\alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4}\} > F_E > F_E^*$ and to $\Delta = \frac{1}{2}\left(D_H(1+R)\frac{1+2\alpha-\alpha^2}{4(2-\alpha)} - F_E\right)$ if $\frac{RD_H\alpha}{2} > F_E > \max\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\}$.

$$\frac{\partial\Delta}{\partial D_H} = \frac{(1+R)(1-\alpha)^2}{8(2-\alpha)} > 0.$$

$\frac{\partial\Delta}{\partial R} = \frac{1}{4}(D_H\frac{(1-\alpha)^2}{2(2-\alpha)} - \alpha D_L)$ if $\min\left\{\frac{RD_H\alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\} > F_E > F_E^*$. Note that for $\min\{\frac{RD_H\alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4}\} > F_E > F_E^*$ we need $\frac{R-3}{3(1+R)}D_H < D_L < D_H \min\left\{\frac{\alpha}{2-\alpha}, \frac{R\alpha}{1+R}\right\}$. Such D_L can exist for every $R > R^*$ if $\alpha \geq 0.5$ and for $\frac{3}{1-2\alpha} > R > R^*$ if $\alpha < 0.5$. Therefore, $\frac{\partial\Delta}{\partial R} > 0$ if $D_H > D_L\frac{2\alpha(2-\alpha)}{(1-\alpha)^2}$. Given that $D_H < D_L\frac{3(1+R)}{R-3}$, this can happen only if $3(1+2\alpha-\alpha^2) > R(-3+10\alpha-5\alpha^2)$. Note that $-3+10\alpha-5\alpha^2 < 0 \forall \alpha < 0.368$. Furthermore, $R^* \geq 8$ for $\alpha \geq 0.5$ and $3(1+2\alpha-\alpha^2) < R(-3+10\alpha-5\alpha^2)$ for $\alpha \geq 0.5$. Thus, there exists a α^* ($0.368 < \alpha^* < 0.5$) such that $(3(1+2\alpha-\alpha^2) \leq R(-3+10\alpha-5\alpha^2))_{R=R^*}$ for $\alpha \geq \alpha^*$. This means that $3(1+2\alpha-\alpha^2) > R(-3+10\alpha-5\alpha^2)$ for small enough α values.

$\frac{\partial\Delta}{\partial R} = D_H\frac{1+2\alpha-\alpha^2}{8(2-\alpha)}$ if $\frac{RD_H\alpha}{2} > F_E > \max\left\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\}$. Note that for $\frac{RD_H\alpha}{2} > F_E > \max\left\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\}$ we need $D_L < D_H\frac{R-1}{1+R}$. Obviously, $\frac{\partial\Delta}{\partial R} > 0$ if $\frac{RD_H\alpha}{2} > F_E > \max\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\}$. As a result, $\frac{\partial\Delta}{\partial R} > 0$ if $\frac{RD_H\alpha}{2} > F_E > \max\left\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\}$ or if $\min\{\frac{RD_H\alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4}\} > F_E > F_E^*$ and α is low enough. $\frac{\partial\Delta}{\partial R} < 0$ if $\min\left\{\frac{RD_H\alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\} > F_E > F_E^*$ and α is not too low.

$\frac{\partial\Delta}{\partial\alpha} = \frac{(1+R)}{4}(-D_H\frac{(1-\alpha)(3-\alpha)}{2(2-\alpha)^2} - D_L) < 0$ if $\min\left\{\frac{RD_H\alpha}{2}, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\} > F_E > F_E^*$ and $\frac{\partial\Delta}{\partial\alpha} = D_H(1+R)\frac{5-4\alpha+\alpha^2}{8(2-\alpha)^2} > 0$ if $\frac{RD_H\alpha}{2} > F_E > \max\left\{F_E^*, (1+R)\frac{\alpha(D_H+D_L)}{4}\right\}$. \square

Proof of Corollary 2:

Lets assume that the entrant which arrives at $t=2$ is also naive. In this case, when $D = D_H$, if the incumbent deviates from the truthful equilibrium its expected payoff would be equal to $D_H(1 + \frac{R}{2(2-\alpha)})$.

This happens because by deviating to $a = D_L$ the incumbent deters the naive entrant at $t=1$ and only the naive entrant at $t=2$ enters. However, in equilibrium the incumbent's expected payoff is less than and equal to $\frac{(1+R)D_H}{2(2-\alpha)}$. Since $D_H(1 + \frac{R}{2(2-\alpha)}) > \frac{(1+R)D_H}{2(2-\alpha)}$ the incumbent never truthfully reveals that the future size of the market is high. \square

Proof of Proposition 6:

For $F_E > F_E^*$, In truthful equilibrium when $D = D_H$, the incumbent's expected payoff is equal to $D_H \left(\frac{1}{2(2-\alpha)} + y \frac{R}{2(2-\alpha)} + (1-y)R\Sigma \right)$, where Σ is the incumbent's expected payoff when the entrant that arrive at $t=2$ is naive. Obviously, $\Sigma \leq \frac{1}{2(2-\alpha)}$. If the incumbent deviates then its expected payoff is equal to $D_H \left(1 + y \frac{R\alpha}{2} + (1-y) \frac{R}{2(2-\alpha)} \right) \cdot \frac{1}{2(2-\alpha)} + y \frac{R}{2(2-\alpha)} + (1-y)R\Sigma > 1 + y \frac{R\alpha}{2} + (1-y) \frac{R}{2(2-\alpha)}$ if $y > y^* = \frac{4-2\alpha-\Sigma}{(1-\alpha)^2+4-2\alpha-\Sigma}$ and $R > \hat{R}^* = \frac{3-2\alpha}{y((1-\alpha)^2+4-2\alpha-\Sigma)-(4-2\alpha-\Sigma)}$. Note that $\hat{R}^* > R^* = \frac{3-2\alpha}{(1-\alpha)^2}$. \square

Proof of Proposition 7:

When there is no entry at $t=1$ and the state is high, if the strategic entrant which arrives at $t=2$ enters then firms' pricing will be a mixed strategy such that each firm will maximize $\pi_i = DR [\alpha/2 + \beta(1 - F(p_i))](p_i - c)$, where $i = (incumbent, entrant)$. Since neither firm would charge a price which makes them earn less than $\frac{DR(1-c)\alpha}{2}$ in order to capture $\frac{2-\alpha}{2}$ proportion of the market the equilibrium price support is $(\underline{p}, 1)$, where $\underline{p} = \frac{\alpha+2c(1-\alpha)}{2-\alpha}$. The expected profits of firms would be $\pi_i = \frac{DR\alpha(1-c)}{2}$. Therefore, if $F_E < \frac{D_H R \alpha (1-c)}{2}$ the strategic entrant which arrives at $t=2$ would enter when there is only the incumbent in the market and the state is high.

If at $t=1$ the strategic entrant thinks that the state is low the maximum profit it can receive is equal to $\frac{D_L(1+R)\alpha(1-c)}{2}$ (this happens if no other entrant enters at $t=2$). Hence, if $F_E > \frac{D_L(1+R)\alpha(1-c)}{2}$ the strategic entrant would not enter at $t=1$ when it thinks that the state is low. Note that if $F_E > \frac{D_L(1+R)\alpha(1-c)}{2}$, where $\frac{D_L(1+R)\alpha(1-c)}{2} > \frac{D_L R \alpha (1-c)}{2}$, the strategic entrant who arrives at $t=2$ would not enter when the state is low.

If at $t=2$ there are three strategic players: firms' pricing will be a mixed strategy such that each firm will maximize $\pi_i = DR[\alpha/3 + \beta(1 - F(p_i))^2](p_i - c)$. Since neither firm would charge a price which

makes them earn less than $\frac{DR\alpha(1-c)}{3}$ in order to capture $\frac{3-2\alpha}{3}$ proportion of the market the price support is $(\underline{p}, 1)$, where $\underline{p} = \frac{\alpha+3c(1-\alpha)}{3-2\alpha}$. The expected profits of firms would be $\pi_i = \frac{DR\alpha(1-c)}{3}$. Thus, when the entrant which arrives at $t=1$ learns from the incumbent's announcement that the state is high it would enter if $F_E < \frac{(R+1)D_H\alpha(1-c)}{2}$. Obviously, $F_E < \frac{D_H R\alpha(1-c)}{2}$ is sufficient for $F_E < \frac{(R+1)D_H\alpha(1-c)}{2}$. For our analysis we will only consider $\frac{D_L(1+R)\alpha(1-c)}{2} < F_E < \frac{D_H R\alpha(1-c)}{2}$.

Case of Naive entrant:

In truthful equilibrium: when $a = D_H$ and the naive entrant enters at $t=1$, since $\frac{\alpha}{2}$ proportion of consumers would only buy from the naive entrant the naive entrant would not charge a price which makes it earn less than $\alpha/2$ in order to capture $\frac{2-\alpha}{2}$ proportion of the market. Thus, it randomly sets a price as a draw from $U(\frac{\alpha}{2-\alpha}, 1)$. Then at $t=1$ the incumbent's expected profits are $\pi_{incumbent} = D_H [\alpha/2 + \frac{2-\alpha}{2}(1-p_i)](p_i - c)$. Therefore, $p_{incumbent}^* = \frac{1}{2-\alpha} + \frac{c}{2}$. Thus, if $p_{incumbent}^* < 1$ (i.e. $\frac{1}{2-\alpha} + \frac{c}{2} < 1$), then $\pi_{incumbent}^* = \frac{D_H(2-(2-\alpha)c)^2}{8(2-\alpha)}$. Otherwise, $p_{incumbent}^* = 1$ and $\pi_{incumbent}^* = \frac{D_H\alpha(1-c)}{2}$.

At $t=1$ the expected price of the naive entrant is $\frac{1}{2-\alpha}$. Since the naive entrant ignores the competition its expected profits would be equal to $\frac{1}{2-\alpha}(\frac{\alpha}{2} + 1 - \alpha)(1+R)D_H$. Thus, for the naive entrant to enter when it thinks that the state is high we need $F_E < \frac{(1+R)D_H}{2}$. Obviously, the naive entrant would not enter when it thinks that the state is low if $F_E > \frac{(1+R)D_L}{2}$.

Therefore, we will conduct the rest of our analysis for $\min\left\{\frac{D_H R\alpha(1-c)}{2}, \frac{(1+R)D_H}{2}\right\} > F_E > \max\left\{\frac{(1+R)D_L}{2}, \frac{D_L(1+R)\alpha(1-c)}{2}\right\}$ -i.e., $\frac{D_H R\alpha(1-c)}{2} > F_E > \frac{(1+R)D_L}{2}$.

If at $t=2$ there are incumbent, the naive entrant, and the strategic entrant the naive entrant randomly sets a price as a draw from $U(\frac{\alpha}{3-2\alpha}, 1)$. If a strategic player i , where $i = \{incumbent, entrant\}$, charges price p_i its expected profit would be $\pi_i = DR[\alpha/3 + \frac{3-2\alpha}{3}(1-p_i)(1-F(p_i))](p_i - c)$. We can show that the price support for the incumbent and the strategic entrant is $(\underline{p}, \tilde{p}] \cup \{1\}$. $\tilde{p} = \operatorname{argmax} [\alpha/3 + \frac{3-2\alpha}{3}(1-p_i)](p_i - c)$ so that $\tilde{p} = \frac{\alpha+(3-2\alpha)(1+c)}{2(3-2\alpha)}$. The incumbent's and the strategic entrant's profit when the state is high is $\pi_i = \frac{D_H R\alpha(1-c)}{3}$. From $DR[\alpha/3 + \frac{3-2\alpha}{3}(1-p_i)(1-F(p_i))](p_i - c) = \frac{DR\alpha}{3}(1-c)$, we get $F(p_i) = 1 - \frac{\alpha}{3-2\alpha} \frac{1}{p_i - c}$. Because $F(1) = 1 - \frac{\alpha}{3-2\alpha} \frac{1}{1-c}$. There is a probability mass $q_1 = 1 - F(1) = \frac{\alpha}{3-2\alpha} \frac{1}{1-c}$

at 1. From $F(\underline{p}) = 0$, we get $\underline{p} = \frac{\alpha}{3-2\alpha} + c$. Because $F(\tilde{p}) = \frac{(3-2\alpha)(1-c)-\alpha}{(3-2\alpha)(1-c)+\alpha}$, there is a probability mass $q_2 = F(1) - F(\tilde{p})$ at \tilde{p} . From $1 > \tilde{p} > \underline{p}$, we get $(3 - 2\alpha)(1 - c) > \alpha$ -i.e., $c < \frac{3(1-\alpha)}{3-2\alpha}$.

Proof for price support being $(\underline{p}, \tilde{p}] \cup \{1\}$: Consider the two strategic firms, i and j . For any given p_i , if $p_j \geq p_i$, the optimal p_j is obviously $\hat{p}_j = 1$. If $p_j < p_i$, then $\pi_j = [\alpha/3 + \frac{3-2\alpha}{3}(1 - p_j)](p_j - c)$. Therefore, the optimal p_j if $p_j < p_i$ is $\hat{p}_j = \min(p_i - \varepsilon, \tilde{p})$, where $\tilde{p} = \frac{3-\alpha+c(3-2\alpha)}{2(3-2\alpha)}$. Therefore, given the equilibrium price distribution of p_i , the price distribution of p_j must be that a p_j with non-zero density is equal to $\min(p_i - \varepsilon, \tilde{p})$ or 1 for some p_i ; and visa versa. Therefore, the price support is $(\underline{p}, \tilde{p}] \cup \{1\}$. A price $\tilde{p} < p < 1$ cannot exist because it is dominated by either \tilde{p} or 1. 1 is the best response for \underline{p} from the other firm, \tilde{p} is the best response for 1 from the other firm, a price p in $(\underline{p}, \tilde{p}]$ is the best response for $p + \varepsilon$ from the other firm.

Thus, if $\frac{D_H R \alpha (1-c)}{2} > F_E > \tilde{F}_E^* = \max \left\{ \frac{(1+R)D_L}{2}, \frac{D_H R \alpha (1-c)}{3} \right\}$ and the naive entrant enters at $t=1$ the strategic entrant that arrives at $t=2$ would not enter. In this case, when $D = D_H$, the incumbent's expected equilibrium payoff is equal to $\frac{2-(2-\alpha)c}{8(2-\alpha)}(1+R)D_H$ if $c < \frac{2(1-\alpha)}{2-\alpha}$ and to $\frac{\alpha(1-c)}{2}(1+R)D_H$ otherwise.

If the incumbent deviates the naive entrant thinks that the state is low and would not enter. In this case, the incumbent's expected payoff is equal to $D_H(1-c + \frac{R\alpha(1-c)}{2})$. Obviously, since $(1-c + \frac{R\alpha(1-c)}{2}) > \frac{\alpha(1-c)}{2}(1+R)$ the incumbent always deviate if $c > \frac{2(1-\alpha)}{2-\alpha}$. For $c < c^* = \frac{2(1-\alpha)}{2-\alpha}$ the incumbent would not deviate if $R > \tilde{R}^* = \frac{8(1-c)(2-\alpha)-(2-(2-\alpha)c)^2}{((2-\alpha)(1-c)-\alpha)^2}$. Note that $c^* < \frac{3(1-\alpha)}{3-2\alpha}$. \square

Numerical Example: let $\alpha = 0.3$ and $c = \frac{3}{4}$. $c^* = \frac{7}{8}$, $\tilde{R}^* = 184$, and $0.0375D_H R > F_E > \tilde{F}_E^* = \max \{0.5(1+R)D_L, 0.025D_H R\}$. For small enough D_L values there can exist F_E such that $0.0375D_H R > F_E > 0.5(1+R)D_L$. \square