The Emergence of Free-to-Play: A Theoretical Model of Video Game Pricing under Uncertainty

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1 Introduction

The rapidly expanding video game industry has drawn attention from both the general populous and academics, in introducing a novel model of competition between firms with ”free-to-play” games. According to SuperData (2019), a division of The Neilsen Company the global digital games market has grown significantly over the past year to $109.8 Billion in 2018, exhibiting 11% year-over-year growth. In addition, 80% of this revenue was generated from “free-to-play” games highlighting the significance of this recently adopted strategy. The industry originated with firms traditionally marketing their games as premium games, requiring consumers to purchase the game at a flat amount. New strategies from firms have emerged and been adopted at an unprecedented rate, these are mainly summarized by: ”free-to-play” and ”pay-to-play” (subscription based) games.

In a continuously evolving and highly competitive market, we seek to develop a model to represent the decision making made by firms, in whether to price their games with a premium or engage in a ”free-to-play” strategy, in determining their optimal video game pricing under uncertainty.

2 Related Literature

The concept of a market with asymmetric information between buyers and sellers regarding the quality of a product is brought forth by Akerlof (1970). Consumers purchase cars based on their expectations on the type of car they will receive, and sellers respond to their offers. The market resolves in the degradation of quality of cars being sold in the market, known iconically as lemons. Despite, the valuable contribution from his findings, an assumption is made in that the value of the car is solely determined by the price for the consumer. This model does not account for the fact that individuals may differ in the amount that they value a product (despite being deemed low quality).

Our model seeks to embrace this reality, whereby the objective quality of the game affects the distribution of types of consumers. For simplicity, we will assume there are high type and low type consumers and two types of qualities of games. Higher quality games, will produce a higher proportion of high type consumers relative to low quality games.

Hagiu (2009) contributes to the literature on the direct interactions between consumers and developers of video games via two-sided platforms. Developers sell directly to their consumers mediated by platforms. His work concludes that product variety is the key factor in determining optimal pricing structures for platforms deciding whether to charge consumers or producers. The logic being that the more demand for variety of types of games from the consumer, the less substitutable those games become. This addresses the price elasticity of demand for the type of game faced by producers, and determining market power between producers and consumers. Consequently, the platform extracts higher revenue from either the producers or consumers, contingent on which has market power. Video game console makers make most of their profits on the game developer side (through royalties), whilst software platforms like Windows make most of their profits on the consumer side. This can be understood by noting that consumers demand for product variety is significantly higher for video games than for software applications. Additionally, two-sided platforms face a pricing decision one whether to charge membership fees or usage fees (royalties).

Our focus will be on the direct interaction between game developers and consumers and the pricing decisions faced by the developer. We will focus on the two most commonly used pricing strategies used by developers: charging a premium (denoted as high price in our model) or adopting a "free-to-play" strategy. Additionally, developers will provide downloadable content, which can be purchased additionally to the original game, reflective of what we observe in contemporary markets.

3 The Model

3.1 The Decision Process

The firm (game developer) produces either a high or low quality game based on the exogenous probability $\alpha\ in(0,1)$. The firm extracts revenue from consumers in two ways: through the price for their original game and through the purchasing of additional downloadable content (DLC). They can choose between charging a high price P_H for the game or set the price to $P_L = 0$, in which case the firm gives away the game for free. In either case, consumers become a high type (θ_H) or a low type (θ_L) with a positive probability. Additional revenue, represented by δ, will be generated through streams such as downloadable content or aesthetic improvements which will be purchased exclusively by high types. The quality of the game determines the probability with which a consumer is a high type: q_H represents the probability the consumer is high type given a high quality game and q_L represents the probability the consumer is high type given a low quality game, we assume that $1 > q_H > q_L > 0$. Therefore, the payoffs to a firm given a game of quality i for high and low price respectively are:

$$P_H + q_i \cdot \delta \tag{1}$$

$$q_i \cdot \delta \tag{2}$$

The consumer observing the price, will form a belief about the probability that the game is high quality given by μ_H for a high price and μ_L for a price of zero. The consumer does not know whether the game is high quality or not, but they do know distribution of good quality games and the effect it has on their possible type, given by α, q_L and q_H. Based on these parameters, the prices, the consumers value and the beliefs they observe a high quality game; the consumer will choose to buy the game or not. If they buy the game given price $i \in \{L, H\}$ then the payoff to the consumer is given by:

$$\mu_i \cdot (q_H \cdot (v_H - \delta) + (1 - q_H) \cdot v_L) + (1 - \mu_i) \cdot (q_L \cdot (v_H - \delta) + (1 - q_L) \cdot v_L) - P_i \quad (3)$$

We require that the payoff for a high type be strictly greater than the payoff for a low type, that is:

$$v_H - \delta > v_L > 0$$

We also require the following two assumptions which state, given a low quality game and a high price the expected payoff for the consumer is negative, and given a high quality the expected payoff is positive. Such that:

$$q_L \cdot (v_H - \delta) + (1 - q_L) \cdot v_L - P_H < 0$$
$$q_H \cdot (v_H - \delta) + (1 - q_H) \cdot v_L - P_H > 0$$

4 Equilibrium

An equilibrium can be defined in the following way:

$$(\sigma_F^H, \sigma_F^L, \sigma_C^H, \sigma_C^L, \mu, \beta)$$

Where σ_F^i is the probability the firm prices high given they observe a game of quality $i \in \{H, L\}$, σ_C^i is the probability the consumer buys the game given they observe price $i \in \{H, L\}$.

Given the way the model has been defined, the expected payoff of a low price game for a consumer will always be positive. Therefore the consumer observing a low price will always choose to buy the game implying $\sigma_C^H = 1$, also making the parameter μ_L irrelevant in the definition of the Nash Equilibrium. Therefore for simplicity we can define the Nash Equilibrium as:

$$(\sigma_F^H, \sigma_F^L, \sigma_C^H, \mu_H)$$

4.1 The Consumer Decision

What makes the model interesting is the consumers actions given they observe a high price. This decision is what drives firms to adopt different pricing strategies. To see this, one can solve for the condition under which a consumer is going to buy the game or not buy the game. In the previous section the expected payoff for a consumer that observes a high price is given. Setting that expression equal to 0 and solving for μ_H gives the conditions under which a consumer is indifferent between buying and not buying. Solving this we get:

$$\mu_H = \frac{P_H - q_L \cdot (v_H - \delta) - (1 - q_L) \cdot v_L}{(q_H - q_L) \cdot (v_H - \delta - v_L)} \tag{4}$$

Equation (4) provides some intuition into how the consumer makes the decision to buy the game. Initially, notice that the the expression on the left hand side is increasing with P_H. If the price is higher, then the consumer must have a higher belief that the game is high quality in order to choose to buy the game. Intuitively, if the consumer observes an extremely high price they must strongly believe they are going to like the game in order to buy it.

Additionally, the expression on the right is decreasing in both the expected value of a low quality game and the expected value of a high quality game, which means if the expected value of any type of game is higher the consumer is more willing to buy games and does not need a strong belief that it is a high quality game. An increase in expected value could occur through an increase in q_H, q_L, v_H, v_L or a decrease in δ.

With this definition of the consumer decision, we define Nash Equilibria corresponding to 3 different cases.

4.2 Case 1: The Consumer Always Buys

The first case corresponds to left hand side of equation (4) from the previous section being strictly greater than the right, where the consumers belief that they observe a high quality game is sufficiently large so that they always buy the game. In practice, this would represent a well established game franchise, where firms would know consumers are extremely likely to buy it (such as EA sports games or the Final Fantasy franchise etc.). Since we know the consumer always buys the game, the firm will always price high irrespective of the quality of the game. Shown by:

$$\begin{aligned} &P_H + q_i \cdot \delta > q_i \cdot \delta \\ &P_H > 0 \end{aligned}$$

The last statement is true by assumption. Then by belief consistency we have that:

$$\mu_H = \frac{\alpha \cdot 1}{(1-\alpha) \cdot 1 + \alpha \cdot 1} = \alpha$$

So the Nash Equilibrium is given by:

$$(\sigma_F^H, \sigma_F^L, \sigma_G^H, \mu) = (1, 1, 1, \alpha)$$

From this Nash Equilibrium we can see that if the ex-ante probability that the game is high quality is sufficiently large, then the consumer will always buy the game. The exact value that probability needs to be is dependent on the high price and the expected value given high or low quality games, seen previous section.

4.3 Case 2: The Consumer never Buys

The case where the consumer never buys the game corresponds to the condition where the left side of equation (4) is less than or equal to the right side. To see this, consider the case where the firm will never price high given a high quality game:

$$\sigma_C^H \cdot (P_H + q_H\delta) < q_H\delta$$
$$\sigma_C^H < \frac{q_H\delta}{P_H + q_H\delta}$$

Then by belief consistency $\mu_H = 0$ since the consumer will never observe a high price for a high quality game. Therefore consumers will never buy a high price game, as the expected payoff of a low quality game at a high price is negative (by assumption). The implied Nash Equilibrium can be defined by:

$$(\sigma_F^H, \sigma_F^L, \sigma_C^H, \mu_H) = (0, 0, 0, 0)$$

In practice, we would observe this outcome if firms with a high quality game know that a low percentage of people will buy their game, however will attract some consumers if their game is free. By attracting these consumers, they will achieve a positive payoff through the high types purchasing additional content. It may be the case that observing a low quality game, they will want to price high. However, consumers knowing high quality games are free, will never buy at a high price because the game is revealed to be low quality, yielding a negative expected payoff. Thus, we will only observe firms using "free-to-play" pricing strategy.

4.4 Case 3: Consumer Mixed Strategy

The outcome that is most likely to occur in practice is consumers mix between buying and not buying games when they observe the high price. These are the games in which there is uncertainty about how consumers react to prices. Depending on exactly how the consumer mixes, different equilibria can arise. We saw in case 2, that if:

$$\sigma_C^H < \frac{q_H \delta}{P_H + q_H \delta}$$

All firms have an incentive to price low. Therefore there are two mixing strategies of interest. The first will correspond to $\sigma_F^H = 1$, in order for this to occur we require:

$$\sigma_C^H \cdot (P_H + q_H \delta) > q_H \delta \tag{5}$$

$$\sigma_C^H > \frac{q_H \delta}{P_H + q_H \delta} > \frac{q_L \delta}{P_H + q_L \delta} \tag{6}$$

Where the last inequality holds since $q_H > q_L$. This Nash Equilibrium is essentially the same as the consumer always buying equilibrium from case 1, however here $\sigma_C^H \in \left(\frac{q_H \delta}{P_H + q_H \delta}, 1 \right)$. It can be thought of as a more realistic generalization of the first case where consumers do not always buy but do so with extremely high probability and the implications are the same. The second case we are interested in, is where:

$$\sigma_C^H = \frac{q_H \delta}{P_H + q_H \delta} > \frac{q_L \delta}{P_H + q_L \delta}$$

As can be seen in this equation the firm is indifferent between pricing high and pricing low if they have a high quality game, but will always price high if they have a low quality game.

Then by belief consistency:

$$\mu_H = \frac{P_H - q_L \cdot (v_H - \delta) - (1 - q_L) \cdot v_L}{(q_H - q_L) \cdot (v_H - \delta - v_L)} = \frac{\alpha \sigma_F^H}{(1-\alpha) + \alpha \sigma_F^H}$$
$$\sigma_F^H = \frac{P_H - q_L \cdot (v_H - \delta) - (1 - q_L) \cdot v_L}{q_H \cdot (v_H - \delta) + (1 - q_H) \cdot v_L - P_H} \cdot \frac{1-\alpha}{\alpha}$$

Therefore the Nash Equilibrium can be defined as:

$$\sigma_C^H = \frac{q_H \cdot \delta}{P_H + q_H \cdot \delta}$$
$$\sigma_F^L = 1$$
$$\sigma_F^H = \frac{P_H - q_L \cdot (v_H - \delta) - (1 - q_L) \cdot v_L}{q_H \cdot (v_H - \delta) + (1 - q_H) \cdot v_L - P_H} \cdot \frac{1-\alpha}{\alpha}$$
$$\mu_H = \frac{P_H - q_L \cdot (v_H - \delta) - (1 - q_L) \cdot v_L}{(q_H - q_L) \cdot (v_H - \delta - v_L)}$$

Intuitively, this is what we expect to see. Free high quality games generate equivalent revenue to high priced high quality games. Consequently, low quality games will do strictly better in pricing high relative to making their game free, as a result of the difference in expected payoffs from the lower proportion of high types.

5 Conclusion

The decision making by game developers in setting the price of their game is subject to the consumers expectations on the quality of their game. A "free-to-play" game will attract more consumers to acquire the game, but be dependent in revenue solely on the high types in the market purchasing additional downloadable content. On the other hand, pricing high will attract less consumers, but revenue will be extracted from all consumers and from additional downloadable content being purchased. The optimality of pricing under the addressed uncertainty is dependent on the key parameters addressed in this paper on consumer expectations of the quality of their game and beliefs that they will extract a net positive payoff from purchasing the game.

We have shown in this model that firms which face consumers that have a high belief that a game is of high quality, or have extremely high payoffs from playing the game, should price games high in order to extract the maximum amount of revenue possible. However, if firms face a market where their game is unlikely to sell at a high price, they should release their game for free and maximize the probability of people playing the game in order to extract revenue through additional content.

6 Extensions

Possible extensions to the model to be explored would consist of representing the dynamic interactions between game developers and consumers over numerous periods of time. In reality game developers gain a reputation in producing series of games, which alters the expectations of consumers for the level of quality of games that they produce in the future. Conversely, franchises that charge a high price and produce a bad game can have detrimental effects on future sales and expectations of their future games. Additionally, we observe advertisement for games put forth by developers, which could be modelled by an additional move for developers in deciding whether or not to advertise, the costs in level of advertising and the effect on expectations of consumers on the quality of game being sold. The number of players deciding to play a game could also have a major impact on the level of quality of the game, people often play video games in a social setting and the player base can have significant effects on quality. Pricing and quality can also be made continuous in exploring trade-offs firms face in varying their prices and the expected payoffs arising therefrom. The emergence of pre-ordering by consumers for games, could also be explored in a signalling model adaptation for the type of consumers game developers are faced with (varying the types of consumers, i.e. critical versus complacent consumers). Finally, incorporating varying levels of competition between firms could add merit in better representing what we observe in reality. The varying level of competition could be expressed in the context of Hagiu (2009), whereby the degree of demand for variety from consumers resolves in substitutable, and thus less competed games.

References

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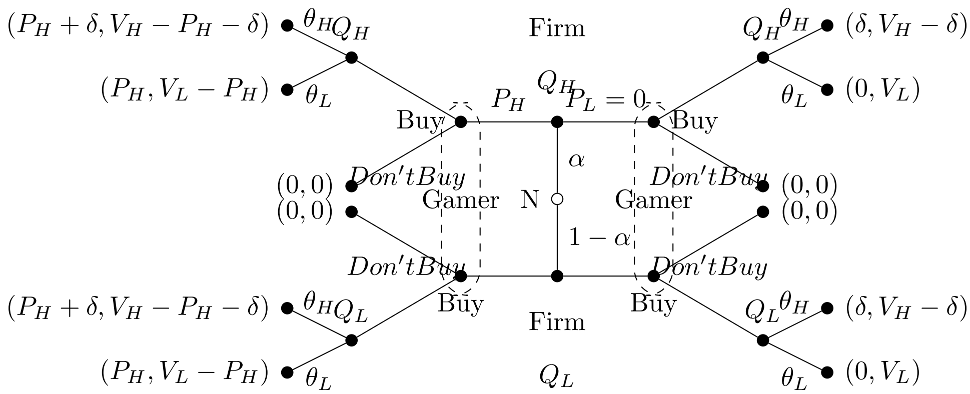
Appendix

Game Tree



<u>Variable Description:</u>

- P_H - High price
- P_L - Low price equal to 0, "Free-to-Play"
- δ - Price for additional downloadable content (DLC)
- V_H - Value of game for high type (with DLC)
- V_L - Value of game for low type
- θ_H - Probability of being high type
- θ_L - Probability of being low type
- Q_H - High quality game
- Q_H - Low quality game
- α - Probability of being a high quality game (distributed by nature)