AGGRESSIVE MONETIZATION: WHY THE PAY FOR CURRENCY MODEL IS DOMINATING THE iOS APP STORE TODAY

by

Theodore B. Kitchen

* * * * * * * * *

Submitted in partial fulfillment
of the requirements for
Honors in the Department of Economics

UNION COLLEGE

May, 2014

ABSTRACT

KITCHEN, THEODORE. Aggressive Monetization: Why the Pay for Currency Model is Dominating the iOS App Store Today.
Department of Economics, May 2014.

ADVISOR: Yufei Ren

The Apple iOS App Store has only been around for 5 years, and yet it has completely changed the way that mobile software is distributed. In this brief period, the online marketplace has seen dramatic shifts in the most successful strategies used by iOS software developers and, more specifically, game developers to gain revenue. As of March 14th 2014 fifteen of the twenty top-grossing iOS apps feature some form of in-app currency that users may purchase with real money, eighteen are mobile video games, and all twenty of these apps are free to download. This paper explores a new business strategy, the pay for currency model, which has been highly successful in generating huge profits from App Store software distribution. This paper first builds on existing economic models for network externalities to include non-paying customers and provides an argument for how iOS games with in-app currencies can achieve a form of first-degree price discrimination.

TABLE OF CONTENTS

LIST OF TABLES AND GRAPHS

I. Introduction

1.1 Games in the App Store

According to an Apple press release, as of January 7th, 2013 the App Store has achieved over 40 billion app downloads and app developers have been paid over seven billion dollars for their products and services. These figures are quite large given how recently the App store came into existence.

Since its inception in July 2008, the Apple iOS App Store has revolutionized the way that consumer software has been distributed. In a relatively short time period, the Apple controlled software marketplace has seen dramatic shifts in how software development firms use the iOS operating system platform to distribute successful software products. A highly volatile marketplace, the App Store has seen many shifts in which apps are popular, and how apps make money. One thing that has remained fairly consistent is that most of the top positions on Apple's "highest grossing" apps list; have been held by mobile computer games. This has many implications for how video games are becoming accessible to a more general audience. In the past it was necessary to purchase a gaming console in order to play high quality video games. With the number of high production value games on the App Store, it seems that video games are beginning to be more appealing to anyone with a smartphone, a population which has seen enormous growth in the past several years.

While the App Store's top grossing list is comprised almost entirely by games, the market for iOS games on the App Store is quite distinct from the market for mainstream console video games that run on Sony's PlayStation or Microsoft's Xbox. One important difference is the scale of the gaming software. PlayStation and Xbox games offer better resolution and graphics, more reliable online play and longer and larger games. New games for designed for the home console market can run as high as $65, whereas paid video game programs in the App Store rarely cost more then $5 or $10 and there is a large number of completely free games available as well.

1.2 Distribution Strategies Used in the App Store

There are several different models that firms use to price and distribute their software goods in the App Store. Proprietary software is the most traditional form of software distribution. In the proprietary software distribution model, the software is priced and distributed like a single good. The firm sets a fixed price for the software good, and any user who purchases the good will have unlimited use of the entire product. One example of a popular proprietary title on the App Store is “Minecraft: Pocket Edition” which is sold for $6.99.

One distribution method that has seen widespread use in the App Store is the freemium model. In this model, the user may first download a free version, which has advertising, or some disabled functionality. The distributor then also offers a premium version of the app, which costs a flat fee in exchange for full functionality and/or disabled advertising. The user may play the free version as a trial, and then if the user likes the free version enough, he or she may choose to purchase the full version. In the freemium model, the software company provides two or more products: the trial version which is free to download but has limitations, and then a premium paid version of the App which costs money to download. The firm may also then offer an “elite” version of the app, which has even more functionality and content than the premium version. One example of this type of app is the original "Angry Birds" game, which saw tremendous success in the early days of the App Store.

Recently, there has been some innovation in the way that people pay for iOS apps. Now, software distributors have the ability to allow what is called an "in app purchase". In-app purchases allow users to purchase virtual goods and services automatically with a credit card. For example, within Pandora Radio, a free internet radio app, a user may purchase Pandora One for $3.99 removing advertisements. In-app purchases can also be for some kind of in app currency. For example within the iOS game *Clash of Clans,* the user is able to purchase "gems", which is an in game currency that allows the player to progress faster. In-app purchases have completely turned around the way firms become profitable on the App Store. In-app purchases can range from digital currency, software updates, extra progress in a game, or added functionality.

Games such as Clash of Clans can be said to be following the pay for currency business model. In this model, the full game is free for the player to download but players may purchase some form of in-game currency. This in game currency can serve a variety of functions. In some games, the currency allows users to progress through the game more quickly. The currency may also be used to purchase additional features in the game. For example a user could spend in game currency to purchase better weapons in a fighting game, or new buildings in an empire builder game. It is important to note, that in the context of mobile games, the currency can only be used to purchase virtual goods within the context of the game. That is, the currency cannot be used to buy other goods that are not part of the game. Another feature of these in-game currencies is that they are non-transferrable. A user who purchases in game currency may not give that currency to another user.

In the past 3 years, the iTunes App Store has become a completely different place. Three years ago, the game apps that dominated the App Store's top grossing list mostly followed a freemium business model. Since the inception of the in-app purchase in the App Store however there has been an explosion in the number of games following the pay for currency model. Many firms have been very successful in implementing this new model because most of the top-grossing apps on the App Store have some sort of in game currency.

1.3 Price Discrimination in the App Store

One of the most interesting aspects of the pay for currency model is the way that it allows consumers to spend as much money as they want. In a game such as the original Angry Birds, which did not follow the pay for currency model, a user may play the trial version for free, and then if their reservation price is higher than the price, they may purchase the full game. On the other hand, in a game like Clash of Clans, which follows the pay for currency model, a user may download the full version for free and then purchase currency to advance more quickly through the game. In this model, each user faces the decision of how much money to spend on in-game currency. Users who value progress in the game more highly will spend more than users who do not care about progressing in the game. This paper argues that this is a form of 1^{st} degree price discrimination because each consumer will be charged exactly what he or she is willing to pay. This is especially important because some dedicated consumers might be willing to spend hundreds if not thousands of dollars on the currency.

1.4 Network Externalities for iOS Apps

Part of the reason that the pay for currency model is dominating the freemium business model is that positive network externalities are generally much stronger in pay for currency. In the freemium model, the software company benefits from network externalities by users simply wanting to play the full version because their friends are. This seems to be a simple bandwagon effect, as people want to have the product that everyone else has. Once a user has bought the game however, the network externality does not cause the user to want to spend more money on the game because there is no option to spend more money once the full version is downloaded.

In the pay for currency model of iOS games, users are encouraged to compete with one another (in the sense of making a bigger village, getting a higher score, etc.). What this does is it makes players want to spend more money in order to achieve a higher rank in the game faster. This allows firms to take profits from users' competitive behavior. It is players' desire to compete with each other that allows firms to charge players to quickly advance. Many players are more willing to discreetly pay money to advance and keep up with their friends than to spend hours playing the game to advance more slowly.

At first glance, one might assume that both pay for currency applications and freemium applications are primarily benefiting from the bandwagon effect. This is a good observation for freemium apps. Because the way that these apps make profit is through purchases of the premium app, each additional purchase of the app due to the bandwagon effect makes a profit for the firm.

In the pay for currency model however, this does not work as well. Yes, the bandwagon effect doubtless causes higher downloads of the app, but downloads alone do not generate the firm's revenue. Instead, players are competing with each other to have the highest score. Users who spend money can advance faster, and so there is an incentive to purchase currency in order to be more competitive against other users. At the highest levels of the game, this can be quite serious and users often spend quite a lot of money in order to remain the highest ranked.

1.5 Other Economic Advantages of the Pay for Currency Model

One trend that many markets have seen in recent years has been a shift from consumers purchasing goods and services with a one-time payment, to a subscription model in which the customer periodically makes payments to use the product or service. In many ways the pay for currency model more closely resembles a subscription rather than a goods business model. While the pay for currency model is not a true subscription business model, it is far similar to a subscription model than it is to the one time payment model.

In the freemium business model, a user has two transactions possible to them. The first is to download the free game. This benefits the distributor in several ways even though it does not provide direct profit. Every download of an app, even a free app is a benefit to the distributor. A higher download count means higher advertising revenues, greater network externalities, a more significant presence in the App Store, and also makes the company more likely to attract investors. It is important to note that all of these benefits are also achieved by download count in the pay for currency model.

The second transaction available to the user after downloading the free trial version is to upgrade to the premium version. This generates one-time revenue for the distribution company. Once a user has downloaded the premium version, the distribution company can no longer generate any revenue from that consumer.

On the other hand in the pay for currency model, the first transaction available to consumers is still the free download of the app. This again comes with the same benefits to producers as it does in the free premium model, except with stronger network externalities as described above. In the freemium model, the user may only make one more transaction: buying the premium app. In the pay for currency model, the user is able, and likely to make numerous additional purchases over time. The company gains a cash flow over time, similar to that in the subscription business model described above. This allows the firm to be sustained through periods of lower downloads of the app. The pay for currency model is also parallel to the subscription model in the fact that its costs will be much higher. In freemium, only a small amount of maintenance is required of the firm once the App is released. In the pay for currency model however, the firm must maintain expensive servers that handle the multiplayer aspects of the game.

Another reason that this business model is so effective is that the initial free download allows users to have a dynamic reservation price. Perhaps one month, a user does not use the app very much, and they are able to pay a smaller “subscription” price than they normally would. On the other hand, in a different month, a user could use the app a lot, and be willing to spend quite a lot of money on in app purchases effectively increasing their subscription reservation price. The user is neither restricted by a set monthly fee, or by a single payment, but each month may pay as much as they are possibly willing to.

1.6 The Contribution and Organization of this Paper

This paper seeks to investigate the economics behind what makes the pay for currency model so successful in the iOS App Store marketplace. This thesis is organized into four sections in addition to this introduction. The second section is a literature review, which looks into related economic topics such as price discrimination, network externalities, and software as a service. The third section constructs an economic model for network externalities that allows for non-paying users. The fourth section compares price discrimination in the pay for currency model and the freemium model and argues that the pay for currency model achieves a form of first-degree price discrimination. The final section will be a conclusion that will discuss the economic implications of the increasingly powerful distribution tools available to software distributors.

II. Literature Review

The economics of mobile and more specifically iOS app distribution is a relatively new field and, as a result, there is not much existing economic literature on the topic. Firstly this paper seeks to review literature about the underlying economic ideas that are helpful in explaining the pay for currency model's success in the App Store. Secondly this paper seeks to review literature about the economics of software distribution in general.

2.1 Review of Price Discrimination

Because it is such an important aspect of the pay for currency model, several papers in this literature review focus on price discrimination. Kou Ahn and Aydin (2011) study price discrimination in a retail market. The examples of this paper help us understand in chapter four how the freemium model is a form of third-degree price discrimination. The retail goods market has many differences from the online marketplace of the App Store but it is important to look at other forms of price discrimination in different types of marketplaces.

Silve and Bernhardt (1998) explain how some firms allow their software to be pirated as a form of price discrimination. In this paper they explore how firms may have incentives to allow limited piracy or illegal downloading of their software. In this way the firm gets more people using their software and more familiar with it, making their product more well known and widely used. This idea has many parallels to the pay for currency model. Firstly, in both cases firms are benefiting from more people using their software even if they are not paying customers through network externalities. Secondly, in both cases firms are reaching consumers with extremely low reservation prices. While not specifically about mobile software, this paper is especially useful because it gives insight into how price discrimination is applied in the software industry in general. Another important point of this paper is how software firms may benefit from network externalities that result from more people using their product and being familiar with it even if the consumer is not a paying customer.

Before we explore exactly why freemium firms are third-degree price discriminators in chapter 4, we must justify the existence of a free version of the game. In freemium games, a free version is sold at a price of zero and at least one pay version is sold at prices set by the firm. A question arising from this then, is what does the firm gain by selling the free version at a price of zero? Silve and Bernhardt (1998) provide an answer to this question. From this 1998 paper we learned that software companies can benefit by allowing limited piracy of their software, in the presence of network externalities.

Firms that follow the freemium model use the same technique. They allow less serious customers to download a portion of the game for free, because network externalities allow them to gain revenue by adding non-paying users. In both of these cases the firms allow an inferior version to be given away for free. The free versions of the iOS games do not have all the features that the full version does. Similarly the free pirated software comes with a risk of being caught and penalized for software piracy.

Pindyck and Rubinfeld (2005) lay out the basics of price discrimination. The authors define first-degree price discrimination as selling goods or services to each consumer at his or her reservation price. The pay for currency business model also achieves a form of first-degree price discrimination because each user may spend their reservation price on buying advancements in the game. A key idea here is how first-degree price discrimination is able to convert virtually all consumer surplus into producer surplus. Other important information in this chapter includes information on other types of price discrimination. This is important in analyzing how other business models such as freemium use price discrimination.

Varian(2010) provides another perspective on price discrimination. This provides us with several examples of different types of price discrimination. This chapter is extremely important to the argument that the pay for currency model achieves first-degree price discrimination and that the freemium model is a form of third-degree price discrimination.

2.2 Review of Network Externalities

Another chapter in the textbook by Pindyck and Rubinfeld (2005) provides the general idea of how network externalities work. This section of the Microeconomics textbook includes information about how network externalities work. Specifically "The Bandwagon Effect" has a lot of implications for this thesis. The authors explain that the bandwagon effect happens when the more consumers already have a product or service, the more other consumers will want it, hopping on the metaphorical "bandwagon". This explains the idea that a product or service can be more attractive the more people are using it. This is applicable to the pay for currency model, in which consumers are more likely to play a game that many of their friends play because of many of the interactive features. It is important to note however that the bandwagon effect does not fully explain the effect of the pay for currency model's network externalities. The bandwagon effect only refers to wanting to have the same products as peers. While this is certainly also true of pay for currency games, these games have another aspect which is player competition. Not only do consumers want to have the product because those around them have it, but they are motivated to purchase currency in order to better compete with friends who also use the software.

Varian(2010) lays down the foundation of the economic model that chapter three of this thesis builds on. Varian takes the approach of representing network externalities with a quadratic demand curve. This idea proves to be very useful for interpreting how pay for currency apps make money. This work provides a concrete model for network externalities that allows us to build on the general ideas that we got from Pindyck and Rubinfeld(2005).

One of the first economists to look into how network externalities affect the computer industry in general was Chow (1967). This paper, although old for a paper about the economics of the computer industry, perfectly highlights how positive network externalities have a huge effect on the demand for computers. This translates directly into the demand for software, and in the case of this thesis, mobile software. The more people using a computer product, the more useful the product will be, and more people will want it and gain utility from it. This idea is even more powerful in recent years with the advent of the Internet. Not only are people using the same products, but are actually interacting with each other in the products over the Internet. This has significant implications about how powerful network externalities can be for computer products.

2.3 Other Sources of Interest

Suarez, Cusumano and Kahl (2013) give insight into the model of software as a service. This paper is about how software firms rely on service revenues when product sales decline. The most important point that the authors make is that when a software firm supplying software goods (standalone pieces of software that users only buy once) begins to supply services, their best decision is to remain in the services market. This relevant because one of the advantages of a pay for currency app is that it is able to support itself on service revenues (in app currency purchases) to sustain itself even when download count might be in decline. In many ways it makes more sense to think of an iOS App using the pay for currency model as a service rather than a product. This is because unlike a product, which a consumer buys only once, pay for currency App users have a certain amount of money that they are willing to spend *over a certain period of time.* The result of this is that each month, each consumer is paying however much his or her monthly reservation price is for the service of using the App.

The ideas presented in these papers come together to make the basis of this thesis. The most important ideas are those of first and third-degree price discrimination, and network externalities. It is these ideas that allow us to explain why the pay for currency model is such an effective strategy.

III. The role of network externalities

3.1 A Model for Network Externalities With Non-Paying customers

When considering the microeconomics of iOS app distribution, as well as software distribution in general, it is important to assess the importance of network externalities. As we learned from Chow(1967), the computer software industry is especially likely to experience these externalities.

If we look at iOS games that follow the pay for currency model we can see even stronger reasons to believe in the presence of network externalities. One reason is that most of these games have some sort of server that allows users to interact and compete with each other. Economic intuition tells us that users can gain additional utility for the interactive element of the games, which allows them to compete with their friends and other players. We assume that players get more satisfaction by being part of a network in which there are more people to compete with. According to Varian(2010), this results in the players having a higher willingness to pay if they can get higher utility from the product.

One significant economic question is why games that follow the pay for currency model always allow free riders to use up bandwidth and server time on the network. Certainly having higher server traffic means higher costs for these firms, so why do they allow for users to join without spending any money? A possible answer to this question lies in benefits from network externalities. Perhaps having a larger network allows for these firms to generate more revenue, or makes it easier for them to enter a market. To explore this, we start with the model for network externalities presented in Varian(2010).

In this model we will start by constructing a model for demand without network externalities. We will then add to the model to include network externalities. Let N_m denote the maximum number of people willing to purchase a software good, that is, the number of people who will purchase the good at a price of zero. Assuming a linear demand curve, let those people be indexed in increasing order of willingness to pay by:

$$v = 1, 2, 3 \ldots N_m$$

and assume for now that the value of the good to person v is also v.

Let the price of this good be denoted by p. Then the number of people who buy the good will be N_m-p. This model will change however when we introduce network externalities.

Now, assume that this market exhibits network externalities this will mean that each person's willingness to pay for a good will depend on the number of people using this good. We suppose that person v places a value of vn on the good where n is the size of the network. We will also assume that $n \leq N_m$ because the number of people actually buying the good can never be greater than the number of people willing to buy the good at a price of zero. Let c denote the marginal cost of production of the good. In this model we will assume that firms will set price equal to marginal cost. That is, we are assuming that $c = p$. For simplicity we will also assume that the firm is facing constant marginal costs, meaning a flat supply curve.

For any given price, one of the people in the market will be just indifferent to purchasing the good. Let $\widehat{v}$ denote the index of this person. This person's willingness to pay will equal the price giving:

$$p = \widehat{v}n$$

from this we get that the number of people willing to pay for the good is

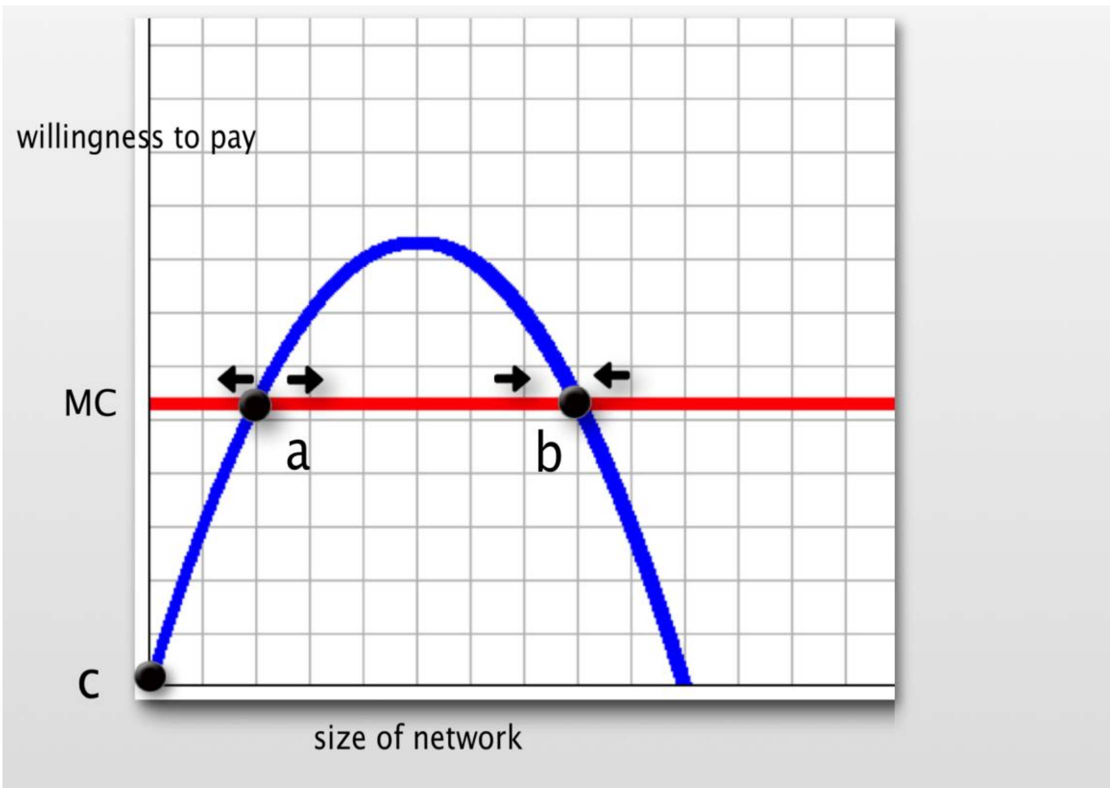
$n = N_m - \widehat{v}$

solving for $\widehat{v}$ and substituting, equilibrium will be at

$$p = n(N_m - n) \tag{3.1}$$

We plot the equation on graph 3.1.

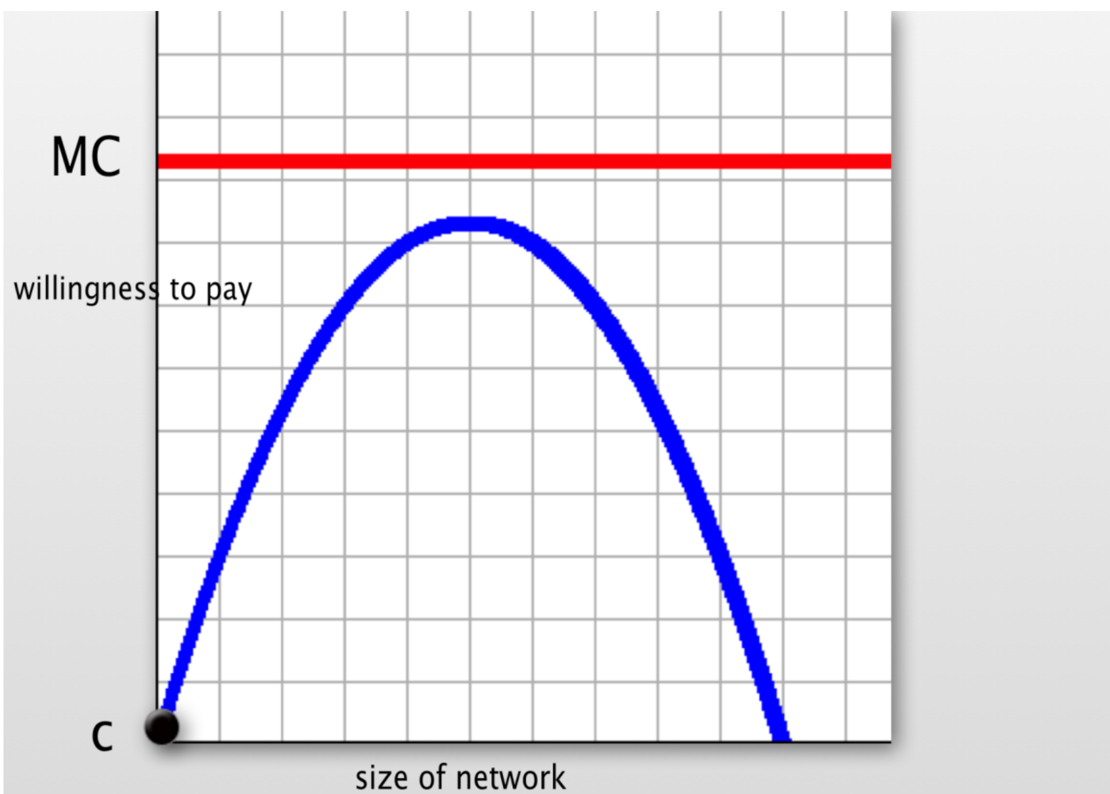
GRAPH 3.1 Demand Curve for Firms with Network Externalities



From the graph we can see that there are three potential equilibriums. The first is at point c. In this case no one is in the network, and no one is willing to join because an empty network is useless. The second equilibrium occurs at point a. This represents the critical mass of the network. If a firm doesn't reach this critical size of the network, the demand slips backward towards zero because willingness to pay is too low. When the network surpasses its critical mass, it continues to get larger until it falls back to equilibrium at point b. Any firm attempting to enter a market that involves significant network externalities, must attempt to reach the network critical mass as quickly as possible, because failing to do so will result in a return to equilibrium with no consumers in the network. Point b represents the only stable equilibrium. Surpassing the critical mass will push the firm towards the equilibrium at point b.

There is case however, in which a firm is completely unable to be profitable in this market. Suppose that firm is facing costs that are higher than anyone's willingness to pay. This scenario is depicted in graph 3.2.

Graph 3.2 A Firm Facing too High a Marginal Cost



In this case, the firm is unable to make the price low enough for people to join and the only equilibrium will be at point c with a quantity of zero. This firm will only be able to enter this market if demand is somehow shifting up. Thinking back on the lessons from Varian(2010) about network externalities and the formation of this demand curve, we know people's willingness to pay for the good depends on the size of the network.

In our current model, we assume that consumers have only two choices: purchase the good with the network externality, or don't purchase the good. This makes sense for goods that cost money to buy, but products that follow the pay for currency model present the user with the option to be a free rider. A user can download the app, and use just as much of the network's bandwidth and computing resources as a paying customer at no cost to themselves. For purposes of analyzing the pay for currency model we assume that consumers have three options. The first is to not download the app and not make any purchases. The second choice is to be a free rider by downloading the app and not spending any money on it. The third choice is to join the network and spend money on the product.

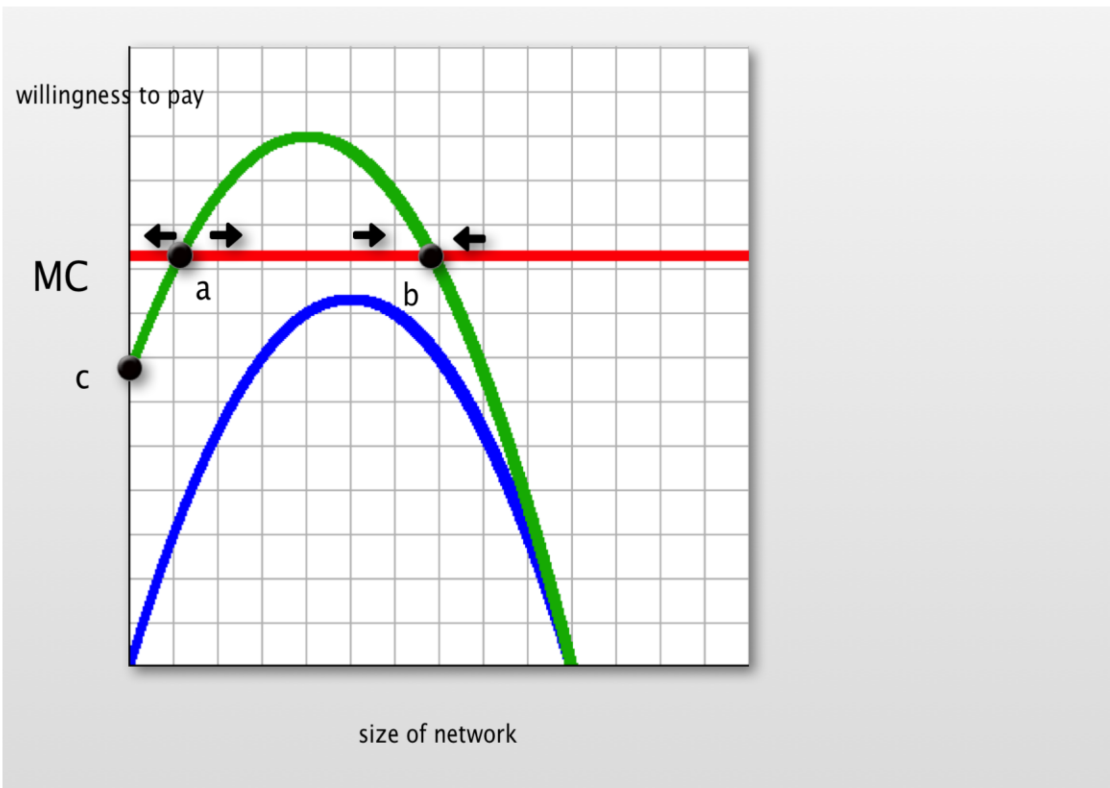
Turning back to the economic intuition surrounding network externalities, we know that the more people using a network, the more people will be willing to pay. In this case allowing free riders to a network can have an effect on paying customers' willingness to pay. Let n_f denote the effect of network free riders on consumer's willingness to pay and let n still denote the number of paying customers on the network. Also assume that any increase or decrease in the number of free riders will increase or decrease n_f respectively. In this case revenue for the firm is still equal to $n*p$. The free riders do not directly contribute to the firm's revenues but still help to strengthen the network externalities.

The new demand curve is defined by

$$p = (n + n_f)(N_m - n) \tag{3.2}$$

The number of free riders will not directly increase revenues but will make paying users willing to pay more, shifting the demand curve up and bringing the flat supply curve under the top of the demand curve. Graph 3.3 shows how the demand curve will shift if a constant number of free riders are added to the network.

Graph 3.3 The Effects of Adding Free riders



A firm can shift its demand curve up by allowing a number of free riders in to the network. This allows the firm to enter markets that would otherwise be prohibitively expensive. In this graph, point a once again represents the firm's critical mass, and point b represents the stable equilibrium for the firm. Point c however is less straightforward. We must first remember that in this graph, we are assuming a constant level of n_f. With this in mind, we know that this firm already has network externality effects of n_f even if there are no paying customers in the network. Point c represents the maximum marginal cost a firm could face and still have a critical mass of zero. This means that if a firm can start out by getting enough free riders in the network, they will be able to reach their critical mass before any paying customers join.

Before in app purchases existed, it was more difficult for firms to allow free riders onto the same server as paying customers. Users could not download apps for free and then later decide to spend money on it and so firms were unable to get large user bases of free riders to help boost willingness to pay. This is the case that we can see in graph 2. Because willingness to pay is so far under the cost of production, firms are not able to enter the market. With the advent of the in-app purchase, software companies have been able to lure a large enough base of free riders that the network externality effects cause market demand to surpasses the cost of providing the service.

3.2 Comparative Statics

Firms that utilize the pay for currency model may benefit from these free riders in three ways. We make propositions about these three advantages and use comparative statics to prove them. The first proposition is that allowing free riders on a network can increase the maximum marginal cost for which a firm can be profitable. Secondly, adding free riders will allow firms to gain higher revenues. The final proposition is that adding free riders allows a firm to reduce the required critical mass of the network, allowing for easier market entry.

Proposition 1: A firm can enter a market with a higher marginal cost by allowing free riders to join.

We prove this proposition in two ways. Firstly we show that the maximum marginal cost is always higher for firms with free rider network externality effects. Secondly, we show that the derivative of c_{max} with respect to n_f is always positive given our assumptions.

Looking our original model without free riders, we know that there is a maximum level of marginal cost for a firm to be successful in the market. From equation 3.1 and the fact that p = c at equilibrium, we have:

$$c = n(N_m - n) \tag{3.3}$$

simplifying equation 3.3 we get

$$c = N_m n - n^2 \tag{3.4}$$

to find the highest marginal cost that the firm can face, we take the derivative with respect to n from equation 3.4 and set it equal to zero.

$$\frac{\delta c}{\delta n} = N_m - 2n$$

$$0 = N_m - 2n$$

$$2n = N_m$$

$$n = \frac{N_m}{2} \tag{3.5}$$

Plugging 3.5 into equation 3.3 we get

$$c_{max1} = \frac{N_m}{2}(N_m - \frac{N_m}{2})$$

$$c_{max1} = \frac{N_m^2}{2} - \frac{N_m^2}{4}$$

and finally

$$c_{max1} = \frac{N_m^2}{4} \tag{3.6}$$

So we know that a firm that does not allow free riders is only be able to get to a stable equilibrium if the marginal cost is less than c_{max1}. Now let us consider a firm that allows a number of free riders to join. These free riders generate network externality effects of n_f. We solve for the highest possible marginal cost in which the firm may still have a stable equilibrium. We start with our demand curve for network externalities with free riders given by equation 3.2.

$$c = (n + n_f)(N_m - n) \tag{3.7}$$

$$c = N_m n - n^2 + N_m n_f - n_f n \tag{3.8}$$

Taking the derivative we get

$$\frac{\delta c}{\delta n} = N_m - 2n - n_f$$

$$0 = N_m - 2n - n_f$$

$$2n = N_m - n_f$$

$$n = \frac{N_m - n_f}{2} \tag{3.9}$$

substituting equation 3.9 back into the equation 3.8 we get

$$c_{max} = N_m(\frac{N_m - n_f}{2}) - (\frac{N_m - n_f}{2})^2 + N_m n_f - n_f(\frac{N_m - n_f}{2}).$$

This equation can be simplified to into

$$c_{max} = \frac{N_m^2}{4} + \frac{n_f^2}{4} + \frac{N_m n_f}{2}. \tag{3.10}$$

The firm that allows free riders and has a free rider effect of n_f is able to reach a higher value of c_{max} than a firm with no free riders is able to reach of c_{max1}. The firm allowing free riders can produce at a higher marginal cost than the firm that does not allow free riders. What this means is that firms that allow free riders are able to support bigger networks that have higher marginal costs than firms that do not allow free riders.

Now that we have equation 3.10 for the maximum marginal cost for a firm with n_f free rider effects, we can take the derivative with respect to n_f to see how these effects change c_{max}.

$$\frac{\delta c_{max}}{\delta n_f} = \frac{n_f}{8} + \frac{N_m}{2} \tag{3.11}$$

since both n_f and N_m are positive by assumption, equation 3.11 shows us that the derivative of c_{max} with respect to n_f is always positive. In other words, a firm can be profitable in markets that would otherwise be too costly by adding free riders to the network.

Proposition 2: Adding free riders to a network has a positive effect on overall revenue for a firm.

The first assumption that must be made here is that the firm is facing a marginal cost of less than c_{max} because otherwise a firm is not able to be profitable in this market. We show that adding free riders boosts revenue by proving that

$$\frac{\delta R}{\delta n_f} > 0$$

Showing this tells us that in an increase in the number of free riders results in an increase in total revenue where R is revenue generated by the firm. To begin, we have the revenue equation.

$$R = cn \tag{3.12}$$

Substituting equation 3.7 into equation 3.12 gives

$$R = n(n + n_f)(N_m - n)$$

$$R = N_m n - n^3 + n_m n_f n - n_f n^2$$

we then take the derivative with respect to n_f

$$\frac{\delta R}{\delta n_f} = N_m n - n^2 \tag{3.13}$$

We know that this is always positive because n is always smaller than N_m and both are positive by assumption. By our assumption that an increase in the number of free riders results in an increase in n_f, we have that adding more free riders to a network results in higher revenues. Economically speaking, this means that firms who allow free riders face consumers who have a higher willingness to pay for their product. The firm is generating more revenue at this level with free riders than if they do not have free riders. More free rider effects means a higher value of R or more revenue for the firm.

Proposition 3: Allowing free riders into a network allows firms to have lower critical masses.

This means that it will take fewer paying customers to reach the critical mass. Let the critical mass of the network be denoted n_{crit}. Assume that c_{max1} exists and that the firm is able to enter the market and be profitable. In order to show this, we must prove that

$$\frac{\delta n_{crit}}{\delta n_f} < 0$$
.

In our model for network externalities with free riders, from equation 3.7 we know that the critical mass is at

$$c = (n + n_f)(N_m - n) \tag{3.14}$$

Solving equation 3.14 however gives two different values of n. One of these values is the equilibrium condition, and the other will be the critical mass. In order to solve for critical mass we use the quadratic formula. The quadratic formula gives two values when solved. The larger of this value is the point of equilibrium where the firm is producing. The smaller value is the critical mass of the network. Simplifying equation 3.14 gives

$$c = -n^2 + N_m n + N_m n_f - n_f n \tag{3.15}$$

setting equation 3.15 equal to zero

$$0 = -n^2 + N_m n + N_m n_f - n_f n - c \tag{3.16}$$

Using the correct version of the quadratic formula on equation 3.16 gives us an equation for n_{crit}. The correct version is the one where the terms are added, because this results in the smaller value that represents the network's critical mass.

$$n_{crit} = \frac{(n_f - N_m) + \sqrt{(N_m - n_f)^2 + 4(N_m n_f - c)}}{-2} \tag{3.17}$$

taking the derivative with respect to n_f in eqation 3.17 gives us

$$\frac{\delta n_{crit}}{\delta n_f} = -\frac{1}{2} - \frac{n_f + N_m}{2\sqrt{n_f^2 + 2N_m n_f + N_m^2 - 4c}} \tag{3.18}$$

Since n_f and N_m are both positive by assumption, we can conclude from equation 3.18 that

$$\frac{\delta n_{crit}}{\delta n_f} < 0$$
.

In this way we have proven that an increase in n_f results in a decrease in the critical mass of the network. This is a very important phenomenon in markets such as the iOS App Store. We know from Varian(2010) that firms in markets with network externalities are not able to be profitable at any point below the firms' critical mass. Firms who are trying to enter a market, must make it very attractive to join the network, which requires users to already be on the network. We have learned from proposition 3 that it is possible for a firm to reduce the required number of paying customers at the critical mass by adding free riders to the network. This makes it easier for a firm to enter the market. In this way firms are incentivized to get as many free riders as possible until the critical mass is reached.

3.3 Numerical Examples

The table below shows this model's predictions for several variables first for a firm that experiences network externalities, and then for a firm that also experiences network externalities, but also allows for free riders to join the network. In this example firm 1 is the firm that does not allow for free riders and firm 2 does allow for free riders. In this case, we are assuming that N_m is equal to 100 for both firms, that n_f is equal to zero for firm 1, and that n_f is equal to 20 for firm 2. We explore how these firms marginal cost and critical mass differ for different levels of marginal cost.

Table 3.1 Numerical Example

Firm	Firm 1	Firm 1	Firm 2	Firm 2
Marginal Cost	2,000	3,000	2,000	3,000
Revenue	144,722	0	160,000	193,485
Critical Mass	27.639	N/A	0	15.505
Max Cost	2500	2500	3600	3600

As we can see from table 3.1, the firm that allows free riders gains several advantages over the firm that does not. First of all in the case that marginal cost is equal to 2000, both firms are able to enter the market because 2000 is under both firm's maximum value for p. We do see however that firm 2 is able to generate more revenue than firm 1 based on this model.

Using economic intuition, we can say that that the free rider effects boost everyone else's willingness to pay. This means that some people who previously were not purchasing the good now are willing to pay for the good so n or the number of people buying increases.

Another important observation here lies in the interpretation of critical mass. The critical mass is the unstable equilibrium that the firm must surpass in terms of number of paying customers in the network in order to be successful in the market. With a marginal cost of 2000, firm 1 needs to get n to be greater than 27.639 in order to enter the market. Firm 2 however seems to have a critical mass of zero. This is because firm 2 has enough free riders to get their critical mass down to zero, so they do not need any paying customers to get up to that point. The firm will then be able to attract paying customers who have increased willingness to pay until equilibrium is reached.

In the case that marginal cost is equal to 3000, we can see a different story here. Firm 1 in this case has really no way of entering the market. Their potential consumers are simply not willing to pay enough for them to cover cost. Without free riders to boost other consumer's willingness to pay, firm 1 cannot enter the market without huge losses. Firm 2 on the other hand can enter the market. This firm will enjoy revenues of 193,485 and a critical mass of 15.505.

IV Price Discrimination

So far we have discovered that network externalities allow for firms to enter markets that would otherwise be prohibitively costly by allowing free riders to increase the network effects on willingness to pay. Allowing these free riders also allows the firms to generate more revenue. This helps us understand how the large server based games that use the pay for currency model are able to enter the market in the App Store. One question that remains however, is what about the pay for currency model allows for greater generation of profits than other business models? One possible answer to this question lies in price discrimination. This chapter argues that apps that follow the "freemium" model make use of 3rd degree price discrimination, while the pay for currency model achieves a form of first-degree price discrimination

4.1 Defining Price Discrimination

The two types of price discrimination here are be first-degree price discrimination and third-degree price discrimination. According to Varian(2010) "First-degree price discrimination means that the monopolist sells different units of output for different prices and these prices may differ from person to person"(Varian 2010, 462) This means that in order to be perfect price discrimination, every unit of output is sold for as much as anyone is willing to spend on it. In this scenario, everyone who buys the good does so at their own reservation price. Most economics textbooks agree that there are few if any real life examples of perfect price discrimination at work. Varian(2010) uses the example of a website that offers deals on airfare. This achieves a form of price discrimination, but the airline does not capture consumer surplus from those consumers that have a reservation price above the retail value of the ticket. The airline that uses this practice does not achieve perfect price discrimination in the way that the pay for currency model does. The rise of the in-app purchase, and subsequently the pay for currency model, actually seems to come much closer to perfect price discrimination than any previous existing market.

Third-degree price discrimination usually occurs when a firm charges different prices for a good to different groups of people. In third-degree price discrimination often what happens is that a firm will set different prices in different markets for a good. This allows the firm to charge higher prices in the market that has a higher willingness to pay for the good. The application of third-degree price discrimination in the App Store mostly takes the form of the "freemium" games that we mentioned earlier. We explore exactly how this concept of third-degree price discrimination applies to the "freemium" model later in this chapter.

4.2 Freemium Model as Third Degree Price-Discrimination

Recall that in the freemium model, several versions of the game are distributed. Often, one of these versions is free, although this does not matter for purposes of third-degree price discrimination. The firm distributes different versions of the game software at different prices. This could mean that the free or lower priced versions contain advertisements, it could mean that only some of the content of the game is available for these cheaper versions, or that progress can only be made up to a certain point in the game unless the premium version is purchased. The highest priced version distributed is the full game, with no advertisements or restrictions.

When we think back on what it means to be third-degree price discrimination it is not immediately obvious how this applies to the freemium model. Third-degree price discrimination involves selling units of output at different prices to different groups, but who are the different groups in this case? In the freemium model, we can consider at least two distinct groups of gamers. One group is the core gamers. These are people who enjoy playing this video game enough to spend money on it. The premium version of the game software is targeted at this group of people. The other group of people targeted is the casual gamers who do not enjoy playing video games as much.

A similar example of this kind of third-degree price discrimination is the sale of airline tickets. In this case airline firms offer two (or more) options to consumers. The first option to consumers is to buy a coach ticket. The second option is to buy a first-class ticket. In this way the airline charges different prices to different groups who have different willingness to pay for airline tickets. In the same way, freemium games offer a free or less expensive version that resembles a coach ticket, and then also a premium version which is the "first-class" version of the game.

There are several assumptions of third degree price discrimination that we must examine before we accept the claim that freemium firms are third-degree price discriminators. The first assumption is that the firm can identify at least two distinct groups of people and can sell the software to each group at different prices. The second is that the goods are non-transferable, so that people in the higher paying group cannot simply buy the good from those in the lower paying group. The third assumption is that the same good is produced for both groups of consumers.

Looking at the first assumption, we must ask how freemium app distribution firms identify distinct groups of consumers. In this case, the groups of consumers are split up into groups by their reservation price. Someone who values the game more is generally willing to pay more for the game to buy the premium version. This allows this consumer to get more use out of the game. Similarly, someone who does not value the game very highly is more likely to be content with the limited version of the game. This person does not spend the extra money on the premium version and is content to use the free or less expensive version. Returning back to our question of how firms identify these groups of consumers, we can see that it is the consumers who identify themselves. Consumers who place a high enough value on the game buy the full version, while others may only download the less expensive version.

Our second assumption of third-degree price discrimination is that the goods are non-transferable. There are several barriers in place that prevent these goods from being transferable. The key idea here is that in order to purchase these products, a consumer must use an Apple ID, which is unique to them. This means that a game can only be downloaded to devices, which share an Apple ID. Apple places restrictions on the number of devices that can use the same Apple ID. Technically a user could share a game that they bought with one or two other people, but this would mean that both users devices are linked to the same Apple ID. This is quite inconvenient for the consumer because then they cannot make their own App Store purchases.

Another question about goods being non-transferable lies in the concept of software piracy. After all many types of software goods are redistributed online for free illegally over peer-to-peer file sharing networks. Does this mean then that someone can download the full version of a freemium game and then redistribute it for free? It turns out that Apple again solves this problem by closely controlling what software can be run on their devices. On the Android platform, the largest competitor to Apples iOS operating system, users can download software anywhere written by anyone and run it on their device. Apple devices are different however. Apple devices can generally only run software downloaded from the App Store. This means that Apple has direct control over all software that is runnable on their devices. Even if the source code for an app became readily available, people would still not be able to transfer the product to each other. This is because in order to run source code on an Apple Device, a user needs to purchase an Apple developer license. This license costs $100 per year, far more than almost every game in the app store. A person is better off simply buying the game rather than trying to pirate by purchasing a developer license. In this way Apple prevents piracy of App Store software and ensures that all software goods for iOS devices are non transferable.

The third assumption is the most difficult to justify for the freemium model. We claim that it is the same good that is being sold to all groups of consumers, but at first it seems that the people paying for the premium version are actually buying a different good. After all when a consumer buys the more expensive version, they are buying more levels, features, or playing time. It is true, that from a consumer's perspective, it seems as though the premium version is a better good that is a different unit of output.

Looking from the firm's perspective however, we can see a different story. To the firm, there is no distinction between producing each version of the game. It costs just as much for the firm to distribute a free version of the app as it does to distribute the premium version. The vast majority of the production process for these games is independent of the different versions of the game. The firm spends lots of money designing and implementing things like the graphics, game engine, and user interface, but then it is extremely easy for the firm to release different versions with or without certain features or levels at different prices. In a sense, consumers are paying different amounts for the firm's efforts to create the game framework, because it is released in different versions.

4.3 Pay for Currency Model as First-Degree Discrimination

Extremely few examples of first-degree price discrimination exist in the real world. This is because there is generally no practical way to actually find out what people's reservation price is for a good. Here, we argue that games that follow the pay for currency model achieve a practical, true form of first-degree discrimination.

Before we can make assumptions about price discrimination we need to clear up exactly *why* the pay for currency model is first-degree discrimination. The most important question about price discrimination here is what the good that people are purchasing is. Most simple economic models assume that consumers are deciding between purchasing a good or not to purchasing a good. In the pay for currency model however, there is no concrete good that costs a specific amount to produce and a specific amount to buy. Users of pay for currency games are free to download and use the game without paying anything. Conversely, a user may also download the game, and spend hundreds or even thousands of dollars on the in-app currency to advance more quickly.

As we discussed earlier, consumers have a certain reservation price for a good, which represents their willingness to spend a given amount of money on that good. If the consumer is willing to spend more on the good than the good's price, then the consumer purchases the good. If not, then the consumer does not purchase the good and the firm does not receive any revenues from that would be customer.

For purposes of this example, we assume that a consumer faces two options. The first choice is to simply refrain from downloading the app at all. The second choice is to download the app and purchase an amount of in-app currency equal to the consumer's willingness to pay. Now at first glance, this should raise some economic suspicion.

It seems here however that the prices do not differ from person to person. Each user gets exactly what he or she pays for in currency. People who spend more are actually buying more output than people who spend less because they get more in-game currency. When we look at the supply side however we can see a different story. To the producer, selling 50 units of currency is no different than selling 50,000 units of currency. In both of these cases, the firm is not actually producing anything; it is simply changing numbers in a computer. For the firm, the marginal cost of producing currency is zero. For this reason, it makes more sense to think of the producer as simply producing the game itself, and each consumer as spending his or her entire willingness to spend on in game currency.

Here it is helpful to look back on the argument for our third assumption of third-degree price discrimination because the argument is very similar. The goods that the consumer is directly purchasing are not the same as the units of output for the firm. This is quite an odd concept, and one that only makes sense in this sort of software market. Like in the freemium model, the good that the firm is producing is the game. In the freemium model, the producer creates a game framework that is then easy to release in differently priced versions. In the pay for currency model, the producer creates the game, and allows different users to spend however much they desire on in-app purchases.

It is important to remember here that we are focusing on the supply side of this market. From the consumer's view, more spending can result in higher utility. From the firm's point of view however the only thing being produced is the game itself. From each consumer who downloads the game, the firm receives the consumer's entire willingness to pay, at no additional cost other than maintaining the server. It is important to note all members of the firm's network cost the same to the firm. It costs nothing for the firm to produce currency, because it is simply part of the game. In other words, the firm faces the same costs for all users, but is able to charge each user their maximum willingness to pay. In this way, the pay for currency model in the App Store has been able to achieve a form of price discrimination that is closer to first-degree than any other business strategies.

V Conclusion

5.1 Summary of the Findings

Looking at the pay for currency model, it is difficult to relate the current models of cost and production functions to this type of market for several reasons. The first reason is a question of how to define output. For most goods, the number of the good that the firm produces is a clear measure of production. Looking at a pay for currency model app however we can see that this gets more complicated. Is production based on how many people download the app? Or is it based on the number of in app purchases? Essentially what models like pay for currency and freemium do is separate the good being supplied from the good being demanded and paid for. This allows the firms to change the unit that the consumer is buying and price discriminate.

Using theoretical methods, we have developed a model for network externalities that allows for non-paying customers. This applies very well to the pay for currency model because this model supports free riders. One of the drawbacks of this model is that it assumes that the good is being distributed at a set price. In chapter four however, we learned that this is not the case in the pay for currency model, which achieves first-degree price discrimination. When we think of network externalities in terms of first-degree price discrimination, it becomes even more powerful.

5.2 Business Implications

In our current model with free riders, each consumer is limited to paying only the price of the good. It does not matter that some consumers are willing to pay exorbitant amounts of money for the good, because they only have to spend the price. In the future, this model could be made more powerful if it could take into account the first-degree price discrimination, and make predictions about consumer and producer surplus.

Because of the presence of network externalities, each person's willingness to pay is dependent on the number of people in the network. In a normal goods market with network externalities, the firm is only able to collect the price of the good from each person that decides to consume.

As mobile device and computer technology become more powerful, software development firms are getting more advanced tools to create pricing and distribution schemes. In-app purchases are a good example of this phenomenon. New computer technology has allowed firms more direct control over each individual user's experience, which in turn allows them to price more effectively. In-app purchases for iPhone games are just the beginning however. The future might bring us new virtual worlds that allow people to interact in business and social settings as well as in gaming settings. The rules and pricing of these types of environments have yet to be determined, but the pay for currency model certainly seems like the beginning. The firms that can make use of these tools, and come up with dynamic and effective business strategies will be the ones to succeed in as these markets become larger and more competitive.

Bibliography

Chow, Gregory C. 1967. "Technological Change and the Demand for Computers." *The American Economic Review* 57.5 pp. 1117-130.

Kou, Chia-Wei, Hyun-Soo Ahn, and Goker Aydin. 2011. "Dynamic Pricing of Limited Inventories When Customers Negotiate." *Operations Research* 59.4 pp. 882-97.

Pindyck, Robert S., and Daniel L. Rubinfeld. 2005. "Price Discrimination." *Microeconomics*. Upper Saddle River, NJ: Pearson Prentice Hall, pp. 393-403.

Pindyck, Robert S., and Daniel L. Rubinfeld. 2005. "Network Externalities." *Microeconomics*. Upper Saddle River, NJ: Pearson Prentice Hall, pp. 136-40.

Suarez, Fernando F., Micheal A. Cusumano, and Steven J. Kahl. 2013."Services and the Business Models of Product Firms: An Empirical Analysis of the Software Industry." *Management Science* 59.2 pp.420-35

Suarez, Fernando F., Micheal A. Cusumano, and Steven J. Kahl. 2013. "Services and the Business Models of Product Firms: An Empirical Analysis of the Software Industry." *Management Science* 59.2 pp.420-35.

Varian, Hal R. 2010. "Network Externalities." *Intermediate Microeconomics A Modern Approach*. New Delhi: East-West, pp.678-86.

Varian, Hal R. 2010. "Monopoly Behavior." *Intermediate Microeconomics A Modern Approach*. New Delhi: East-West, pp. 461-73. Print.