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How free and freemium mobile applications create and capture value: A Review of Network Effects, Consumer Behavior, Advertising and Data Monetization

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ABSTRACT

Free and freemium mobile applications have become a key feature of the digital economy, raising the question of how applications that charge users little or nothing at the point of access can generate significant economic value. This paper analyzes nine studies (2016 - 2026) on how mobile apps generate revenue, how freemium apps compete, what motivates consumers to purchase, how user data is monetized, and how developers select a revenue model. This literature review suggests that the absence of a direct price may promote wider use due to decreased uncertainty and increased benefits of the network effect as the number of users increases. Companies can make money with a large user base by using advertisements, premium options, engagement, and monetizing data. However, existing studies do not support the idea that a free application is more profitable than a paid one. Profitability really comes down to how these factors interact: adoption, where you sit in the network, how you make money, how unsure customers are, what features your product has, and how likely they are to pay. The review also identifies significant flaws in the existing evidence, including short observation periods, platform and locational restrictions, differences between mobile and PC applications, reliance on modeling or indirect measures, self-reported survey data, evidence drawn only from mobile games, and an overall focus on app value rather than an individual app value and limited examination of competitive attention dynamics. The review concludes that upcoming research should examine these mechanisms jointly and across contemporary, multi-platform application markets.

KEYWORDS: freemium, free apps, mobile app monetization, network effects, data monetization, attention economy, consumer uncertainty

1. Introduction

Digital applications employ business models that enable access without a considerable payment. In the free or advertising-sponsored scheme, customers receive the product at no purchase cost. Nevertheless, developers can benefit from advertising, data, and sometimes offer a paid version of the application. For instance, Instagram, Snapchat, and TikTok are worth billions of dollars, but at the same time, they are free to use. The paid applications have some additional functions, various modes, or a pro version that is more developed than a free one. Paid apps, by contrast, require a fee to unlock the software or a subscription to access the application. The economic and behavioral challenges posed by such a feature are of great interest to economists.

The differences among revenue, adoption, and profitability are significant. Revenue depends on the application's business model and pricing. Adoption, meanwhile, is explained by the number of users and their growth rate. In addition, the application must be profitable relative to the costs of maintenance, development, promotion, and operation. The reviewed articles use different definitions of profit, including revenue, adoption, purchase intention, value, and business-model fit. Therefore, these terms are not similar or interchangeable.

Several economic mechanisms make free or Freemium models attractive. First, removing upfront costs reduces the risk of buying an inferior product. Second, a larger audience enables network effects. Third, audiences provide an outlet for advertising. Fourth, Freemium applications allow some users to convert into paying customers. Fifth, attention and data can be monetized. Each of the nine papers presented in this work focuses on one aspect of this process but does not fully detail the relationship between any of these mechanisms and profitability, let alone their combination.

The authors also frame the problem differently. Rietveld treats freemium as a revenue-generating model; Appel et al. see the free version as little more than consumer sampling; Boudreau et al. examine network effects and competition; Li et al. suggest that users provide their data and attention in exchange for access to free services; Deng et al. build on the sampling idea by testing it with real data rather than theory; Brynjolfsson et al. examine the attention users give up; and Mikučiūnaitė looks beyond freemium and compares it with seven other ways apps make money.

2. Review Methodology

This paper contains nine articles discussing the economics and psychology of free, freemium,

and paid apps. The inclusion criteria were the relevance to the paper's topic and the quality of arguments presented by the authors. All the articles are about network effects and competition, mobile-app business models and consumer behavior, Freemium research, revenue-model choice, and data value. Below, I will comment on each article, discussing the authors' arguments, results, mechanisms, moderators, and methodology.

This literature review began with an open-ended Google search using the question "why do free apps profit more than apps that charge you" to identify existing research on this topic. From there, I located relevant papers using the search terms social media, data monetization, freemium, strategies companies use to increase economic value, marketing, consumer psychology, and network effects. I chose these terms to focus on business strategies on the company side (how companies design a model) and the data side (how companies collect user data to generate revenue). I selected papers by publication date and limited the review to works published between 2016 and 2026 to keep it relevant to today's app economy. I accessed full texts through open-access hubs such as MDPI, RIETI, open-access conference proceedings, UCL Discovery, and NBER Working Papers. These hubs provided access to papers published in journals like the 'International Journal of Research in Marketing', Strategic Management Journal, Management Science, Information Systems Research, Strategic Entrepreneurship Journal, the RIETI Discussion Paper Series, and the Journal of Theoretical and Applied Electronic Commerce Research. Of the papers reviewed, I selected nine based on their relevance to the research question, prioritizing papers that focus on increasing economic value and how companies collect and use data over papers that just explored 'free versus paid.'

The review is interpretative, not a systematic review or meta-analysis. Therefore, these nine studies do not represent all research on mobile-app monetization, as the paper's research gaps section notes. This limitation is justified, given that several articles on the topic involve different devices, regions, techniques, and outcome variables. Instead, the review highlights the common themes and problems of the analyzed research.

3. Theoretical Background

3.1 Consumer uncertainty and adoption

An upfront price can make adoption difficult, as it requires people to spend money on an unknown digital product. By contrast, a free version of the same service lets users try it before

paying more to upgrade. In that sense, the authors mention the free version as a consumer sampling method. In a way, people can see whether it is worth spending money on an application that solves specific problems, offers value, or serves as a tool for creativity and productivity. Free versions obviously incentivize consumption, but adoption does not equal profitability. The following work by Deng, Lambrecht, and Liu (2023) actually tested the idea and used real-life app store adoption figures.

3.2 Network effects

Network effects offer another reason why free access is so appealing. If the value of the service depends, to some extent, on the degree of user adoption, then increasing the number of users can make the service more attractive to current and potential customers. Boudreau, Jeppesen, and Miric (2022) analyzed competition in digital markets and found that network effects were linked to a firm's position in the competitive landscape and business-model choice. The study revealed that the benefits from network effects were not distributed equally among firms: depending on the competitive position, both the market power and the business model – subscription, free or freemium – affected the degree to which the company was able to benefit from them.

3.3 Advertising, attention and data

Free applications monetize users without charging an access fee by trading attention for advertising opportunities, generating economic value from the abundance of users rather than a single transaction. In addition, Li, Nirei, and Yamana (2019) argue that user data can be an important source of economic value in the digital economy, meaning that the contributions of users' activity, attention, and data rather than money can lead to the value captured by the firm. Brynjolfsson, Kim, and Oh (2024) similarly treat time as the real cost of free apps, offering another angle on how attention may be valued despite the absence of a price.

3.4 Freemium conversion and paid upgrades

Freemium enables dual monetization by driving mass adoption with a core product/service, with additional features available for an extra fee. As Rietveld (2018) found, in terms of games, freemium games attracted larger user bases but generated less revenue per user, while a greater variety of paid items was associated with higher revenue. However, revenue per user is considerably lower unless the game offers substantial paid upgrades. In other words, the freemium games may attract more users than paid games; however, the revenue per user is lower. Thus, it is essential to consider both metrics when evaluating the performance of different pricing

models. According to Mikučiūnaitė (2024), Freemium is one of the monetization strategies along with advertising, subscriptions, in-app purchases, data monetization, affiliate marketing, and selling apps.

4. Review of the Selected Studies

Each study is described by its main argument, mechanism, whether it tests moderators or mediators, method, and limitations.

4.1 Network effects and digital competition

Boudreau et al. (2022) investigated competition in freemium digital markets and used the launch of Apple's Game Center as a natural change in the competitive environment. Their analysis compared results related to the launch and showed that network effects could lead to substantially different benefits in which a product is placed depending on its position in the market and its mode of delivery. One limitation is that the time frame of the observation window was relatively short (about 70 days), thus possibly capturing only short-term reactions to given actions and not long-term trends in customer and network development. Another limitation of the information provided above is its connection to the early App Store at Apple, which is considerably different from the current market trends related to advertising and other ways of monetization. The network effect was not uniformly distributed among “winners” and “also-rans”: it depended critically on whether the app provider occupied the first rank or was in the second position and whether it used a Freemium or a paid-to-download business model. Overall, being a leader and being free created a self-reinforcing system, whereas paid apps saw little network-driven improvement. This leader effect is consistent with Deng et al. (2023), who found that a free version increases discoverability in the app store. The study also measures network effects arising from one specific social feature, so it does not show whether the findings apply to non-social free apps such as a flashlight or calculator app.

4.2 Monetization of mobile applications

Appel et al. (2020) analyzed properties of mobile-app monetization with the help of analytical and machine learning models to differentiate between revenues from advertising and paid versions. The paper emphasizes the role of uncertainty in the process and the possibility that free versions serve as a sampling method. However, the analysis treats applications relatively

independently and therefore pays limited attention to competition for users' finite attention. The assumption that paid-app prices remain constant also limits how well the findings capture dynamic pricing and changing business strategies. The paper identifies two factors: how annoyed users become by advertisements and how uncertain they are about whether they will like the app. The free version serves as a sample through which users decide whether they like the app, which eventually pushes some to pay. However, since the study in question is a mathematical model and, therefore, not an empirical experiment, the justification of the sampling process is not based on observations but rather predictions. A later study (Deng, Lambrecht, & Liu, 2023) tested the claim in practice on the data of a major application store.

4.3 Consumer purchase behavior

Al-Adwan and Sammour conducted a study in 2021 that focused on factors affecting the purchase decision of mobile apps by consumers in Jordan. This research contributes to the topic by exploring the consumer's buying behavior instead of basing the information on the buyer or market level. The research has the main limitation of focusing only on the population of Jordan. Consumer attitudes toward mobile-app purchases in Jordan cannot automatically be generalized to other countries or cultural settings. The study is also the only one reviewed that directly asks people, through surveys, why they buy an app. However, self-reported surveys may not match what people actually do, which is a gap between stated preference and revealed preference. The study focuses on the factors that drive purchases and does not test moderators or mediators, so it does not explain how relationships change under different conditions.

4.4 Freemium business models

Rietveld (2018) researched the concept of value creation and capture in the game industry, focusing on freemium video games on the Steam platform. The article showed that such a game could attract many more users and, at the same time, bring less revenue per user than a paid game. The research results determined the factors that influence the value capture ability of a freemium game. It found out that the presence and diversity of paid upgrades in games directly affect their ability to obtain value from the increased user base. However, the article is mainly based on the data obtained from PC gaming. Therefore, it is difficult to say how the results can be applied to mobile applications. The variety of paid add-ons moderated the effect: more variety increased revenue, since different players are willing to pay for different things. The study also assumes that people find it hard to evaluate a product before use, which may not hold for easily accessible

goods or for apps where brand reputation or reviews signal quality. In addition, Steam users are a very specific, gaming-literate group and are therefore a weak stand-in for an average free-app user, such as someone using a weather or banking app.

4.5 Revenue-model selection

Tidhar and Eisenhardt (2020) analyzed the fit of revenue models and firm and product characteristics by applying machine learning and multiple case studies. Instead of providing a traditional moderation or mediation model, the authors classified firms based on certain characteristics, such as their product complexity and resource availability. Therefore, its main value lies in the fact that it provides a classification of firms based on certain revenue model features, showing that their selection process might be conditional on their characteristics, not a superior option for all cases.

4.6 The value of user data

Li et al. (2019) attempted to quantify the economic value of data by contrasting companies' balance-sheet values and their market values. They argued that the discrepancy could be explained by intangible assets, notably users' relationships with the firms. This is one way to interpret how value is extracted from users without any monetary compensation. Nevertheless, data value is difficult to measure directly, and the analysis relies partly on estimated rather than directly observed internal company data. Large companies do not publicly release much data about their internal numbers, so much of it must be approximated rather than directly measured, which limits the method to smaller case studies rather than large datasets. The method also assumes that data and user relationships explain the gap between book and market value. In contrast, the gap could also reflect brand strength or growth expectations, which the paper does not isolate. The study did not include moderators or mediators.

4.7 Free versions and spillover effects on paid apps

Deng, Lambrecht, and Liu (2023) conducted a study with the free version of the mobile game and its influence on the rankings in the application store of the paid version, basing their research on real statistics provided by Apple's website instead of using estimations. The result of the study revealed that introducing a free option increased daily ratings of a game by 8.9%. The study uses daily ratings as a metric for supply-demand. The authors compared these apps with matched control apps, suggesting the increase was not coincidental. The results appear driven by consumers sampling the free version and by improved app discovery. This evidence therefore

presents empirical support for the sampling mechanism proposed by Appel et al. (2020), which had been demonstrated only via mathematical modeling. A limitation is that the study examined only mobile games, whereas some of the largest applications, such as Instagram and Snapchat, do not have a paid version. It therefore remains unclear whether demand would increase comparably for non-game applications.

4.8 The value of free goods and attention

Brynjolfsson, Kim, and Oh (2024) addressed how to place a monetary value on services with no price. Because free services such as Google or Wikipedia have no price, the authors constructed a model that treats users' time as the real cost of a free application. They find that the value extracted from these free apps amounts to billions of dollars a year to users who don't actually pay anything. The authors do not test moderators and mediators. The study's main value lies in measuring time spent, which serves as a proxy for value. It complements Li et al. (2019): whereas Li et al. estimate the value of data from the firm's perspective, Brynjolfsson et al. examine the user's side by asking how much people's attention is worth. A limitation is that they measure value at an aggregate level rather than for individual applications. The study therefore cannot indicate how much value comes from Instagram, free weather applications, or free news sites.

4.9 Comparing monetization methods

Mikučiūnaitė (2024) compared seven other app monetization methods, including advertising, subscription, in-app purchase, Freemium, data monetization, affiliate marketing, and direct app sales. Rather than assessing one specific way of monetizing mobile applications, this paper compares several methods. Unlike other works, this research considers multiple app monetization methods, not just one.

The author concluded that there is no best practice for app monetization and that everything depends on an application's purpose. Thus, this paper provides a more comprehensive understanding of ways to increase revenue from mobile applications by showing that neither subscription nor freemium is the only way to profit from apps. Moreover, the authors mentioned that it is essential to analyze the pros and cons of each method and choose the most appropriate one for a specific app. However, the authors did not collect and analyze data; instead, they reviewed existing information.

5. Cross-Study Synthesis

Taken together, the nine studies offer evidence that the attractiveness of free and, in particular, freemium products cannot be due to a single mechanism. Several of these mechanisms can coexist and reinforce one another. First, free access lowers adoption barriers. If the product's use involves network effects, wider adoption creates a more attractive environment for every user. Then, higher engagement can facilitate monetization through alternative means such as advertising or data sales. In the case of a freemium design, some users can be upgraded to the paid version of the product.

One critical synthesis is the difference between scale and value capture. In general, the free app can maximize the number of users without maximizing revenue per user. Rietveld's results clearly explain this synthesis. At the same time, Appel et al. highlight the importance of sampling and uncertainty. Boudreau et al. offer insight into a network benefit that requires a particular market position to maximize value. Moreover, Li et al. extended the synthesis to cover some different data value beyond ordinary transactions.

While the literature simultaneously suggests that the mechanisms are contingent, and that product characteristics, competitive position, the number and variety of paid upgrades, consumer uncertainty, and geographical context, among other things, could moderate outcomes, these reviewed studies, therefore, offer more support to the proposition that free access could facilitate a certain pathway to value creation, rather than the broader proposition that the free applications would be inherently more profitable than the paid ones.

Deng et al. (2023) confirm the practical case for Appel et al. (2020)'s proposition regarding an application's sampling method. In addition, they explain why the said app would gain greater discoverability in the app store due to being free. On the other hand, Brynjolfsson et al. (2024) discuss the value to the consumer of having the choice of using the service without paying, thus building upon the article by Li et al. (2019), which analyzes the worth of the data from the provider's perspective. Lastly, Mikučiūnaitė (2024) describes how universal applying of monetization methods does not always work, citing other profit opportunities, such as the Freemium example.

The studies also differ in whether they identify moderating or mediating factors. Boudreau et al. found that the benefit of network effects depended on whether an app ranked first or second and whether it was freemium or paid upfront. Appel et al. pointed to advertising annoyance and consumer uncertainty, Rietveld to the variety of paid add-ons as a moderator, and Deng et al. to

sampling and discoverability. Al-Adwan and Sammour, Brynjolfsson et al., and Li et al. did not examine either.

Across the studies, network effects and data collection appear to most consistently favor free apps. Free apps keep gathering data with every scroll and click, which may add value over time.

6. Research Gaps

Several gaps are apparent in the review. Firstly, while many works focus on individual mechanisms, studies that consider the adoption-life cycle model, network effects, engagement, and monetization in tandem are needed. Secondly, some research uses a short observation window and therefore cannot say much about the long-term viability and sustainability of the business model. Third, the literature is limited to specific geographical areas and platforms: findings related to Jordan's early economy, Steam, or the Apple App Store in its infancy may not translate to modern app stores. Fourthly, several works use indirect measures or mathematical modeling rather than measure relevant variables directly.

Fifth, the competition for attention is understudied: Users' limited time and attention may be divided and competed for between apps, and a free app with a large installed user base creates value while simultaneously competing with other apps and services. Sixth, in the selected readings, the moderating and mediating roles of key variables were rarely formally tested. In future research, it may be valuable to try and formally test whether network position, product category, perceived uncertainty, engagement levels, and the availability of paid upgrades moderate or mediate the association between free access and economic performance.

Seventh, the evidence was concentrated in particular categories of apps. Boudreau et al. studied one particular social functionality, and it is unclear to what extent their findings generalize to the entire category of social apps or to apps unrelated to social media, such as a flashlight or a calculator. Deng et al. (2023) only studied mobile games; it is unclear whether an 8.9% increase in demand would be observed in other categories of apps, such as Instagram or Snapchat, which do not have a paid version. Similarly, Rietveld's sample only includes Steam users, who are likely more invested in games than the average free-app user in the weather or banking category.

Eighth, in several articles, the researchers used self-reported, estimated, or aggregated measures. For instance, Al-Adwan and Sammour's use of surveys implies that what respondents said

motivated them to purchase was not what actually motivated them (a distinction between stated and revealed preferences). Li et al. can only estimate internal company metrics, and the researchers could not rule out that brand value or brand growth expectations drove the phenomenon rather than the measured drivers. Finally, Brynjolfsson et al. (2024) rely on aggregated value scores, so they cannot identify each application's contribution to overall value.

Ninth, some conclusions remain untested. Mikučiūnaitė's (2024) paper is a literature review and doesn't collect new data or run experiments, so the paper's comparison of seven monetization methods remains untested in practice. Future research could test if the best monetization method depends on what an app is used for.

7. Discussion

The main point of the argument should be qualified: offering something for free does not necessarily mean that it is impossible to profit from a smaller number of paying customers. Although the paid version of the application tends to make money from a small group of users, the free version allows you to capture value from a larger audience through scale. Additional users attract advertising, network effects, data, engagement, and opportunities to sell other products or services. By emphasizing this idea, the provided articles offer a more comprehensive perspective on how such a strategy affects the sustainability of the business, rather than just comparing how profitable these options are.

Moreover, the profitability of such a business model can hardly be evaluated by the number of downloads or users. For example, an app may have millions of users, but generate very little revenue per user. Therefore, when calculating an app's economic performance, consider factors like revenue, revenue per user, user engagement, and operating costs. In other words, profitability not only depends on the number of users but also on how effectively the application converts its user base into revenue.

Finally, the consumer gains significant value in terms of choice and power. The option to choose between a paid and a free version decreases the risks of a dissatisfying purchase. Moreover, if the product provides network effects, its virality can increase because users are willing to invite their friends. As a result, network effects, advertising revenues, and data utilization become valuable opportunities to convert the experience into profitability.

8. Conclusion

The nine studies found indicate that the economics of free and freemium applications should be considered from the perspective of demand acquisition, network effects, consumer uncertainty, advertising, engagement, paid upgrades, and data-related value. Free access to the product decreases the barriers to its trial and increases the rate at which it can be adopted. Freemium applications with network effects can benefit from the growth in the user base, as users are critical assets, and ad revenue, data, and premium options can capitalize on this growth. At the same time, removing price as a factor in acquisition reduces uncertainty about what one buys, resulting in higher demand and, subsequently, an even greater number of users and data, which can be monetized. However, the studies do not support the claim that free apps are universally more profitable than paid ones. The dynamics depend on the platform, product, market position, consumer trends, and how the company capitalizes on the demand. The subsequent research should be done not on the individual mechanisms but on the system as a whole, and over a long period, to assess the tendencies relevant to modern markets and apps.

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