

모바일 게임 인앱구매에 영향을 주는 요인에 관한 연구

An Empirical Analysis of In-app Purchase Behavior in Mobile Games

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요 약

모바일 게임 산업은 빠르게 성장하는 산업으로 이미 놀라운 크기의 시장 규모를 가지고 있다. 이러한 모바일 게임의 산업적 중요성에 따라 점차 구매의도에 대한 연구와 함께 실제 인앱구매 행동에 관한 연구가 요구되고 있다. 따라서 본 논문은 국내 모바일 게임업체에서 제공한 실제 게임 로그 데이터셋을 분석하여 인앱 구매의 핵심 동인을 연구하였다. 구체적으로, 목표 지향적, 습관적, 그리고 사회적 상호작용적 게임플레이의 인앱구매에 대한 영향을 분석하고, 추가적으로 게임플레이와 구매 행동과의 재귀적 관계도 고려하였다. 음이항 회귀분석 분석 결과, 모든 요인들이 당기의 인앱구매에 긍정적인 영향을 미치는 것으로 나타났다. 또한, 일반화 적률법 분석 결과, 이전의 습관적인 게임플레이는 인앱구매에 긍정적인 영향을 미치지만, 이전의 사회적 상호작용적 게임플레이와 이전의 인앱구매는 현재의 인앱구매에 부정적인 영향을 미치는 것으로 나타났다. 이러한 연구 결과를 토대로 본 연구는 모바일 게임플레이의 다양한 특성들이 인앱구매에 미치는 영향에 대한 이해를 향상시킬 수 있으며, 나아가 연구자와 실무자에게 의미 있는 통찰력을 제공할 수 있을 것으로 기대된다.

키워드 : 인앱구매, 모바일 게임, 음이항 회귀분석, 일반화 적률법 모형, GMM

I. Introduction

Many mobile game companies continue to ride the

growing wave of the free-to-play strategy, and they rely on virtual-item sales as their main source of revenue (Kimppa *et al.*, 2016). Free-to-play strategy is that the game allows users play a game free, and they can use additional functionality by consuming purchased items. Game providers can easily obtain many new players because this strategy offers users free entry into a game. However, the free-to-play model

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for mobile games does not assure to gain a profit because only a few players purchase in-app items. Below 5% of players spend money in the most of mobile casual games (Runge *et al.*, 2014). Since the profit of game companies can be generated by this small portion of players who spend their money in the game, it is important to figure out the factors which drive in-app purchase in mobile casual games.

Although starting to shed light on this salient topic (Animesh *et al.*, 2011; Guo and Barnes, 2011; Koh *et al.*, 2008), but many studies focus psychological motivation to purchase and rely on survey and experiment as a research method (Hamari *et al.*, 2017; Jang *et al.*, 2019). Although those research methods are effective to investigate players' abstract intention to purchase, those cannot analyze the effects of concrete gameplay behavior on purchase behavior in the game. Thus, this study investigates the effects of gameplay behavior on purchase decision by analyzing game-log dataset with gameplay and in-app purchase. In detail, this study suggests the research question as follows.

- What are the key drivers which affect in-app purchasing behaviors in a mobile game?
- How do the drivers differently affect users' in-app purchasing behaviors in a mobile game?

To answer the research questions, we analyze the effects of gameplay in three perspectives: game achievement, usage, and social-interaction as significant motivators of in-app purchase based on previous research. As our empirical models, negative binomial regression is firstly conducted for investigating the effects of suggested factors to in-app purchase due to the characteristic of the dependent variable (i.e., over-dispersed distribution). Furthermore, the relationship between playing behaviors of the previous period and playing behaviors of the current period is also considered using generalized method of moments

(GMM) model because the relationship with in-app purchase and playing behaviors could be recursive. The empirical results present that game achievement, usage, and social-interaction in the current period have a positive effect on in-app purchase in the current period. The effect size of social interaction is the biggest among suggested factors. In addition, game achievement and usage in the previous period have a positive effect on in-app purchase in the subsequence period. However, the effect of social interaction in the previous period is negative on in-app purchase of the subsequent period. These findings provide meaningful insights for researchers and practitioners. In following sections, our hypotheses and the research data are suggested. Then the research model, our results, and conclusion are discussed.

II. Hypothesis Development

Game is well-designed systems to offer enjoyment and characterized by explicit rule in the system towards discrete goal or results (Deterding *et al.*, 2011). Game players enjoy games with rule-bounded, goal-oriented play (i.e., ludus) or exploratory free-form play (i.e., paidia) (Caillois, 2001). According to goal-setting theory, people be inclined to be motivated by elaborated goals which are specific, difficult, but achievable (Khansa *et al.*, 2015). In the game context, players try to achieve explicit and attractive goals such as going to higher stages, obtaining more score or getting new items (Choi and Kim, 2004). Game developers construct multi-tiered goal structures and provide various types of virtual items to attract players to keep completing their goals by effectively lessening their boredom (Fields and Cotton, 2011). Game developers are trying to fit the suitable difficulty level at each goal because players easily get bored with the game when the game is too easy for players, or players

feel frustrated when the game demand higher ability than players' (Zarnekow, 2015). Since it is not easy to set suitable difficulty level for all players, game developers set additional ways to enjoy when players encounter the difficult task to proceed the game. One effective way for players to progress higher goals or overcome tasks is employing purchased items in mobile games (Vorderer *et al.*, 2003). For example, in-app items relieve time restriction or reduce difficulty of tasks in the game by providing hints. Even though players need to pay extra money for in-app items, players who are eager to progress to the higher stage are likely not to care additional money to pay. Furthermore, compared to novice players, skillful players know better which items are the most suitable to overcome their tasks in their situation. Therefore, they are more likely to purchase in-app items than novice players who do not understand which items are suitable (Kim *et al.*, 2013). The higher stages indicate the higher level of proficiency about the game (Park *et al.*, 2018). Therefore, the game achievement or the skillfulness of players can be measured by the stage number which players completed in the game, so the first hypothesis is defined as follows.

H1: Game achievement is positively related to in-app purchases in mobile games.

In addition to game achievement, game usage is also useful to predict in-app purchase. Venkatesh and Agarwal (2006) present that the effect of use behavior is positively related to purchase behavior in e-commerce sites. This can be also applied to mobile game context. The players, who frequently login the game or often play the game, have a higher probability of buying virtual items because they are exposed more often to item lists. Play frequency can be measured by how often the players play the mobile game (Huizenga

et al., 2009). Play frequency is the good measurement of game usage particularly in the mobile casual game because it requires less time commitment to overcome each task compared to other game genre. Furthermore, game usage has also been found to be an indicator of addiction and habitual gameplay which are positively associated with in-app purchase (Yee, 2006). Moreover, the frequency of past behavior is strongly related to habit and is used as a proxy when measuring the strength of habits (Neal *et al.*, 2006). Thus, this study investigates the relationship between gameplay frequency and in-app purchase. So, the second hypothesis is postulated as follows.

H2: Game usage is positively related to in-app purchases in mobile games.

Moreover, social-interaction activity is one of essential conditions for game enjoyment and have positive impact on in-app purchase (Wohn, 2014). Players with more friends have more possibility to play the game longer and buy in-app contents than players with less friends in games. Moreover, social interaction activity using in-app contents has functional and aesthetic effects on other players depending on the characteristics of in-app contents. Players can learn the use of functional items when they observe other players use the items for achieve their goals (Park *et al.*, 2018). Similarly, based on observing the use of aesthetic items by other players, players can learn the value of aesthetic items such as costumes, avatar and pet. Players express their identity through aesthetic items such as costumes, avatar and pet (Kim *et al.*, 2011). Thus, many game developers are trying to encourage interaction with other players by setting in-app contents (Chang, 2013). Therefore, the relationship between social interaction and in-app purchase is investigated and the third hypothesis is presented as follows.

H3: Social interaction is positively related to in-app purchases in mobile games.

III. Research Dataset

The dataset used for the empirical analysis is player-level gameplay logs collected from one of the famous mobile puzzle games in Korea. The mobile puzzle game is a typical type of mobile casual games. The basic mechanism of mobile puzzle games is almost similar. The representative game is Candy Crush (Macworld, 2018). Players can go to the next stage after finding all card pairs with the same patterns in a limited time. (e.g., 30 seconds or one minute). Unless a player matches all card pairs in the limited time, he/she cannot proceed to the next stage. As same as other mobile puzzle games, in this game, players can exchange money with virtual hard currency (e.g., *Crystal* in the research dataset) at and then exchange the hard currency with virtual soft currency (e.g., *Coin* in the research dataset) or items (e.g., *Pet*, *Costume*, *Heart*, etc. in the research dataset) inside the game

world. Among these several situations about item transaction cases, this study defines in-app purchase is the frequency of purchasing virtual hard currency. About nine weeks is determined as our research time window based on the opinions of field experts. The detailed game playing information for 3,820 individual players were recorded for 66 days from April 9 to June 13 in 2016, and the total number of observations is 136,903. The mechanism of mobile puzzle games is almost similar and simple. In addition, this mobile game still available in the same format, so it is still meaningful to analyze this dataset. Specifically, the data contains the gameplays (*i.e.*, game play frequency) and IAP consumption (*i.e.*, purchase frequency) of each player. Positioning player identifier variable as the panel variable, the dataset is reformulated into a daily panel dataset. For hypothesis tests, the effects of game achievement, usage and social interaction on players' in-app purchase are estimated.

The key variables are described in <Table 1>. To verify the factors affecting in-app purchase, the dependent variable is IAP_{it} which can be measured by

<Table 1> Description of Variables

Variables		Definition
Dependent Variable	IAP_{it}	Player i 's frequency of in-app purchase at t
Explanatory Variables	$Achieve_{it}$	Player i 's latest stage at t
	$Usage_{it}$	Player i 's play frequency at t
	$Social_{it}$	The number of game invitations by Player i at t
Controls	$Days_{it}$	The number of days since Player i signed up at t

<Table 2> Descriptive Statistics and Pearson Correlations

Variable	Mean	SD	1	2	3	4	5
1 IAP_{it}	0.009	0.148	1.000				
2 $Days_{it}$	239.17	119.56	-0.015	1.0000			
3 $Usage_{it}$	14.306	11.804	0.095	-0.100	1.0000		
4 $Achieve_{it}$	322.28	175.56	0.004	0.440	0.053	1.0000	
5 $Social_{it}$	0.534	0.860	0.049	-0.006	0.184	0.216	1.0000

the frequency of in-app purchase of player i at a certain date t . Regarding game achievement, $Achieve_{it}$ is measured by player i 's the latest stage at a certain date t . In terms of game usage, $Usage_{it}$ is player i 's gameplay frequency at a certain date t . In addition, social interaction $Social_{it}$ is measured as the number of invitations by Player i at a certain date t . $Days$ variable is added as a control variable and defined as the number of days since Player i signed up at time t since it may influence in-app purchase. <Table 2> describes descriptive statistics and Pearson correlations.

IV. Research Model

For testing our hypotheses, the techniques of multiple panel data analysis are conducted including the ordinary least square (OLS) model, the fixed effect model and the random effect model. We firstly conduct robustness checks for selecting the proper model fitted to the dataset. To test for random effects, Breusch-Pagan Lagrange multiplier (LM) test is employed which helps select between a simple OLS model and a random effect model. The result of LM test demonstrates that the random effect model is more appropriate for our dataset. Next, the Hausman test is conducted to check whether the random effect model or the fixed effect model is proper for the dataset. The result reveals that the regressors are not related to error terms in our dataset. Therefore, the estimation incorporates fixed effects for players to consider unobserved characteristics of individual players. Thus, the econometric model is described as follows.

$$IAP_{i,t} = \beta_1 Achieve_{i,t} + \beta_2 Usage_{i,t} + \beta_3 Social_{i,t} + \beta_4 Days_{i,t} + \mu_i + \epsilon_{i,t} \quad (1)$$

In this equation, players are indexed by i , and time

is indexed by t . β_i is coefficients' estimates for the frequency of in-app purchase at the time of day t . μ_i accounts for the individual cross-sectional effect which is player characteristics. The error term $\epsilon_{i,t}$ control for the idiosyncratic effects. Since the dependent variable utilized in this study is over-dispersed count variable, negative binomial regression is carried out to confirm the validity of the analysis.

Additionally, we also analyze the recursive relationship with playing behaviors and purchasing behaviors because players may play more after purchasing items and vice versa. Thus, the relationship with playing behaviors and in-app purchase within different time windows is considered. Our second econometric model with the recursive relationship is described as follows:

$$IAP_{i,t} = \delta_1 Achieve_{i,t-1} + \delta_2 Usage_{i,t-1} + \delta_3 Social_{i,t-1} + \delta_4 Days_{i,t} + \delta_5 IAP_{i,t-1} + \phi_i + \omega_{i,t} \quad (2)$$

Since the lagged dependent variable in dynamic models is associated with the player-specific effect, estimating dynamic models is more challenging than estimating static models. To overcome this challenge, Arellano and Bond (1991) suggest using the generalized method of moments (GMM) model in first differences because the cross-sectional effects are removed by first-order differencing. To test the consistency of the GMM estimators, Arellano and Bond's serial autocorrelation test and Sargan test are employed. The result of Arellano and Bond's serial autocorrelation test verifies the errors in the first-difference regression do not present the serial correlation. The result of Sargan test also reveals the validity of the GMM estimators. Therefore, GMM analysis is conducted to see the recursive relationship with gameplay and in-app purchase in our second model.

V. Results

The result of our first model is demonstrated in Column (1) of <Table 3>. The result shows that the game achievement is positively related to in-app purchases (H1 is supported). The game usage is positively related to in-app purchases (H2 is supported). The social interaction is also positively related to in-app purchases (H3 is supported). The effect of social interaction is the biggest among the effects of the suggested variables.

The results of the second model are demonstrated in Column (2) of <Table 3>. The results present that the game achievement in the previous period is not related to in-app purchases in the current period. The game usage in the previous period is positively related to in-app purchases in the current period. The social interaction in the previous period is negatively related to in-app purchase in the current period. The in-app purchase in the previous period is negatively related to in-app purchase in the current period.

The effect sizes of all suggested variables in the previous period are smaller than those in the current period. This implies that the effect duration is quite

short, so the game developers need to consider the effect duration of suggested factors and encourage game achievement, usage and social interaction in suitable time depending on the players' situation. This is also described by the unique characteristics of mobile casual games. The retention rate of mobile casual games is quite low because many mobile casual games are released with similar functionality and design (Runge *et al.*, 2014). Therefore, the game developers try to entice players into spending money during the players' short playing duration.

In addition, the noticeable point is that social interaction has a positive effect and the biggest among suggested factors in the current period, but its effect becomes negative in the subsequence period. This presents that the active social interaction is positive on in-app purchase at the moment but does not have the continuous effect. Thus, for encouraging in-app purchase, game developers need to focus on the present social interaction, not previous or subsequent one. Furthermore, regarding the effect of in-app purchase in the previous period on in-app purchase in the current period, players might spend in-app contents during more than one day, so the previous purchased

<Table 3> Results from Negative Binomial Regression and GMM

Dep. variable	$IAP_{i,t}$	(1)	(2)
Independent variables	$Achieve_{i,t}$	0.0013 ^{***} (0.0001)	
	$Usage_{i,t}$	0.0231 ^{***} (0.0003)	
	$Social_{i,t}$	0.2507 ^{***} (0.0083)	
	$Days_{i,t}$	0.0019 ^{***} (0.0619)	
	$Achieve_{i,t-1}$		0.0000(0.0000)
	$Usage_{i,t-1}$		0.0002 ^{***} (0.0000)
	$Social_{i,t-1}$		-0.0014 ^{***} (0.0000)
	$Days_{i,t-1}$		-0.0000(0.0000)
	$IAP_{i,t-1}$		-0.0166 ^{***} (0.0037)
Observation		136,903	
Number of Players		3,820	

Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

items cannibalizes the current ones. Game developers could overcome this situation by making various types of in-app contents or generating various functions to promoting the consumption of players' purchased items.

VI. Discussion

This study empirically investigates the factors on in-app purchase in a mobile casual game. It especially focuses on game achievement, usage and social interaction. All suggested variables in the current period have a positive effect on the frequency of in-app purchases. In addition, we also look at the recursive relationship with gameplay and in-app purchase. The game usage in the previous period has a positive effect on in-app purchase in the current period, but the social interaction and in-app purchase in previous period are negative on in-app purchase in the current period. This study provides one of the first empirical evidence that examines the factors on in-app purchase in the mobile casual game using large-scale player log data from a mobile game company. It is also expected that this study can offer significant implications to game developers who use free-to-play strategy as their monetization strategy. For example, players with high game achievement, usage and social interaction might be important to sell in-app contents, and it needs to focus on players with high social interaction in the current period, not the previous or subsequent ones. However, this study is not without limitations. The demographic information of players is not used for analysis such as age, gender and nationality due to data limitations. In addition, the analyzed dataset is from the mobile casual game only, so the effect differences of suggested factors among other games cannot be figured out although the effect can be various depending on game genre. If further analysis could be conducted including demographic information and the characteristics of

game genre, the results will be more luxuriant and strengthen the current results.

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Abstract

The mobile game industry has become the one of the fastest growing industries with its astonishing market size. Despite its industrial importance, a few studies empirically considered actual purchasing behavior in mobile games rather than the intention to purchase. Therefore, this paper investigates the key drivers of in-app purchase by analyzing the game-log dataset provided from a mobile game company in Korea. Specifically, the effects of goal-directed, habitual and social-interacted playing behavior are analyzed on in-app purchase. Furthermore, the recursive relationship with playing and purchasing behaviors is also considered. The result shows that all suggested factors have positive impacts on in-app purchase in the current period. In addition, the effect of previous habitual playing has a positive impact, but the effect of social-interacted playing and in-app purchase in the previous period have negative impacts on in-app purchase of the current period. These findings can improve our understanding of the impact of game playing on in-app purchase in mobile games, and provide meaningful insights for researchers and practitioners.

Keywords: In-App Purchase, Mobile Game, Negative Binomial Regression, Generalized Method of Moments Model

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