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ICT product diffusion in US and Korean markets

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Abstract

Purpose – The purpose of this paper is to identify how adoption drivers change before and after key milestones of ICT product adoption (i.e. critical mass point (CMP) (adoption rate 16 percent), market saturation point (MSP) (50 percent) and new generation release point (NGRP)) based on actual subscriber data of the mobile communications industry that represents the ICT market, so that it has implications for the rejuvenation of ICT product adoption that has rarely been addressed in earlier studies.

Design/methodology/approach – This study examined the overall characteristics of ICT product diffusion by tracking the actual patterns of US and Korean mobile market subscribers using the Bass diffusion model.

Findings – This study found that innovation effects gain influences on ICT product diffusion after CMP, MSP and NGRP; imitators are becoming innovators by repeated rejuvenation experiences; and cultural differences have significant influences on imitators' ICT product adoption, but not on innovators.

Originality/value – These findings imply that rejuvenation enabled by technology innovation is a key success strategy to dominate the ICT market where the number of innovators, who have strong desires for new generation products, is constantly growing.

Keywords Bass diffusion model, ICT market, Market saturation, Overshooting, Rejuvenation

Paper type Research paper

1. Introduction

As one of the largest ICT markets, the global mobile communications market grew in penetration rate from 15.5 (2001) to 96.2 percent (2013). The performance is striking comparing to the fixed telecom market penetration rate that has remained around 16 percent since 2001 (ITU, 2013). Many countries have witnessed radical development and saturation of their domestic ICT markets, and market competition is growing intensively (Lee *et al.*, 2010, 2013; Genakos and Valletti, 2011). To win the fierce competition, ICT players have proactively executed marketing campaigns to retain existing customers while attracting competitors' customers, and overshot product features beyond what customers expected (Lee *et al.*, 2014). In general, "overshooting" triggers unnecessary price hikes and poses risks of not serving customer needs (Christensen, 1997; King and Tucci, 2002; Von Hippel, 2009). Despite such potential problems, ICT companies are launching new products before the lifecycle of existing products end to beat their competitors (e.g. iPhone vs Galaxy).

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Many researchers have paid attention to diffusion of ICT products. They focussed on the factors affecting ICT product adoption in order to help ICT companies secure and retain competitive edge of new products released by technology innovation (Teng *et al.*, 2002; Van den Bulte and Stremersch, 2004; Van den Bulte and Joshi, 2007). However, different-generation products are simultaneously consumed in the current ICT market as a result of the cut-throat competition for technology innovation; and cultural differences also affect ICT markets (Kim *et al.*, 2011; Lee *et al.*, 2012). In this market, different product life cycles (PLCs) exist together by rejuvenation, and consumers in different cultures have different perception on rejuvenation. That is, previous studies neglected the fact that unlike in other markets, rejuvenation and cultural differences are prominent in ICT markets, because market saturation has transformed the object of competition from potential adopters to post-adopters, and the importance of new products release is based on ICT technology innovation. Accordingly, the current study seeks to investigate the influence of ICT product diffusion and cultural differences, taking into account the rejuvenation phenomenon and cultural differences caused by the technology innovation competition that is visible in the contemporary ICT market, which has not been addressed in previous studies.

Thus, this study is designed to investigate mixed presence of different-generation ICT products enabled by rejuvenation and overshooting, and the influence of cultural differences on ICT product diffusion on the basis of the actual subscriber data of the US and Korean mobile communications market so that it can set forth effective strategies to encourage ICT product adoption. It aims at identifying how product diffusion drivers change before and after key points of ICT product adoption, i.e. critical mass point (CMP, adoption rate 16 percent), market saturation point (MSP, 50 percent) and new generation release point (NGRP); and suggesting implications for ICT product diffusion by taking rejuvenation into account. It also examines the influence of cultural differences between the US and Korea on ICT product adoption. This study is expected to provide ICT players within saturated markets and/or targeting new markets with useful guidelines to help understand drivers of ICT product adoption and to set up specific market strategies.

2. Literary reviews

2.1 Technology innovation in the mobile communications market

Data transmission speeds defined by the International Telecommunication Union (ITU) determine the generation of mobile communications technology. First generation (1G) is characterized by analogue communications and later generations are defined by data transmission speeds. According to Ministry of Information and Communication, 1G was first adopted by Japan in 1979, 2G adoption was led by Europe in 1993 and 3G by the USA in 2004. Then, 4G, which enables massive data transmission at high speeds has been widely adopted since 2010. Currently, telecommunications players are fiercely competing to first win the future market of 5G, that is under development. The following Table I briefs on

		1G	2G	3G	4G	Source
Year of adoption	USA	1983	1992	2003	2010	Dunnewijk and Hultén (2007),
	Korea	1985	1996	2003	2011	Fuentelsaz *et al.* (2008), KCC (2014),
	Europe	1981	1995	2003	2011	GSA (2014), 4GAmerica (2014)
	Japan	1979	1991	2001	2010	
Transmission speed		–	153.6 Kbps	14.4 Mbps	75 Mbps	Lee *et al.* (2013)

Table I. Adoption of each generation of the mobile communications technology

the history of mobile technology innovation. Early innovation was mostly focussed on usefulness, with iconic examples of MP3 phone (Samsung Electronics, 1999), camera phone (Sharp, 2000) and DMB phone (Samsung Electronics, 2005). Recently, the innovation focus was diversified into software and Apps by the emergence of Smartphone embedded with iOS or Android (Park and Chen, 2007; Tracy, 2012).

2.2 Rejuvenation

The product lifecycle theory was proposed based on observations of a modified Heckscher-Ohlin model in international trade. The theory proposes the four phases of a product's lifecycle. Product lifecycle is divided into an introduction stage of continued growth in the product's early stage, a growth stage of reimport for common usage, a maturing product stage of expanded external demand, and a saturation stage of decreased demand. In the past, PLC was linked to irreversible biological life cycle. However, growing attention is paid to the concept of rejuvenation recently, renovating a product by new growth strategy (Butler, 1980; Müller *et al.*, 2013). Rejuvenation refers to a continuum of different-generation PLCs by creation of new concept and technology innovation (Ayres and Steger, 1985; Cooper *et al.*, 1992), not the life cycle of a single PLC. Accordingly, many researchers have considered rejuvenation in PLC, with their primary focus on how and when to rejuvenate a product that nears the end of its PLC (Baum, 1998; Hague, 2002). As Table II suggests, many studies have dealt with drivers and strategic utilization of rejuvenation.

2.3 Cultural difference

Culture is defined as shared symbols and norms of social collectivity, such as a nation. One way to clarify the concept of culture is to identify the dimensions of cultural variation. The most popular cultural theory that has been adopted in information systems research is Hofstede's model (Bélanger and Crossler, 2011; Jackson, 2011; Hovav and D'Arcy, 2012). Hofstede (1984) defined culture as "the collective programming of the mind which distinguishes the members of one human group from another." Hofstede (1991) defined five dimensions of culture: Individualism/Collectivism, Power Distance, Uncertainty Avoidance, Masculinity/Femininity and Long-term Orientation. Based on the five dimensions, Griffith *et al.* (2000) identified two culture types: Type 1 culture has "individualistic-small power distance-weak uncertainty avoidance" characteristics (such as the USA and Canada), while Type 2 cultures (Korea, Chile and Mexico) have "collectivistic-large power distance-strong uncertainty avoidance." These concepts

Table II. Studies on rejuvenation

Researcher	Contents
Butler (1980)	If tourists to a certain destination decrease, man-made attractions and untapped natural resources may rejuvenate the area and increase tourists again
Ayres and Steger (1985)	Products at the declining stage of PLC may be reversed by new strategic technology
Cooper *et al.* (1992)	Based on the Butler's (1980) rejuvenation theory, rejuvenating is critical to sustainable growth
Baum (1998)	Based on the tourism area life cycle (TALC), fresh starts of PLC were explained by various components, including transportation and culture
Hague (2002)	PLC is rejuvenated by technology innovation
Whitfield (2009)	The study presents a cyclical model to explain rejuvenation that has not been fully explained by linear models

of cultural types have been examined in many studies (Kim *et al.*, 2011; Lee *et al.*, 2012). The following Figure 1 illustrates how product adoption patterns differed in Types 1 and 2 countries identified by Lee *et al.* (2012).

3. Research model and hypotheses

3.1 Research model

This study is to examine changes in ICT product adoption by rejuvenation that arise at different stages, on the basis of innovation effects and imitation effects suggested by Bass's (1969) diffusion model. To this end, whether a certain pattern exists was investigated by *F*-test (Mahajan *et al.*, 1988) and *J*-test (Derbaix, 1995; Venkatraman *et al.*, 1994); innovation and imitation effects were compared between before and after CMP (16 percent) and MSP (50 percent), which are critical milestones of ICT product diffusion, as well as between before and after NGRP; and the effects of cultural differences on ICT market dynamics was examined on the basis of the earlier comparisons (Figure 2).

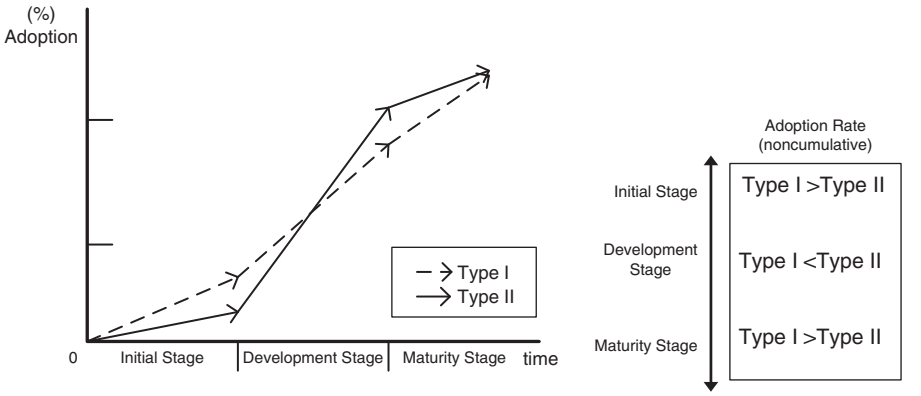
3.2 Research hypotheses

3.2.1 Diffusion effect at the CMP of ICT market. According to the innovation diffusion theory, innovativeness that encourages early adoption of new products was divided into five groups (e.g. innovators, early adopters, early majority, late majority and laggards) by the time-lag to new product adoption. The most critical point, CMP (16 percent), is the point when the first two groups finish product adoption and the third group begins adoption. The CMP is a point when social normative beliefs formed by innovative groups are about to take off as a common norms (Baraldi, 2012; Lee *et al.*, 2013). Widespread innovativeness may increase innovators and decrease imitators. Thus, innovative social normative beliefs take root before the CMP, this may lead to a clear difference in ICT product diffusion patterns. Based on this assumption, it is expected that increasing innovators will reinforce innovation effects after the CMP while imitation effects shrinking. Thus, this study sets forth the following hypotheses to verify the changes in ICT product adoption before and after the CMP:

H1. The CMP of the ICT market has an impact on diffusion of ICT products.

H1a. The CMP of the ICT market has a positive (+) impact on innovation effects.

H1b. The CMP of the ICT market has a negative (−) impact on imitation effects.



Source: Lee *et al.* (2012)

Figure 1.
Difference in adoption pattern

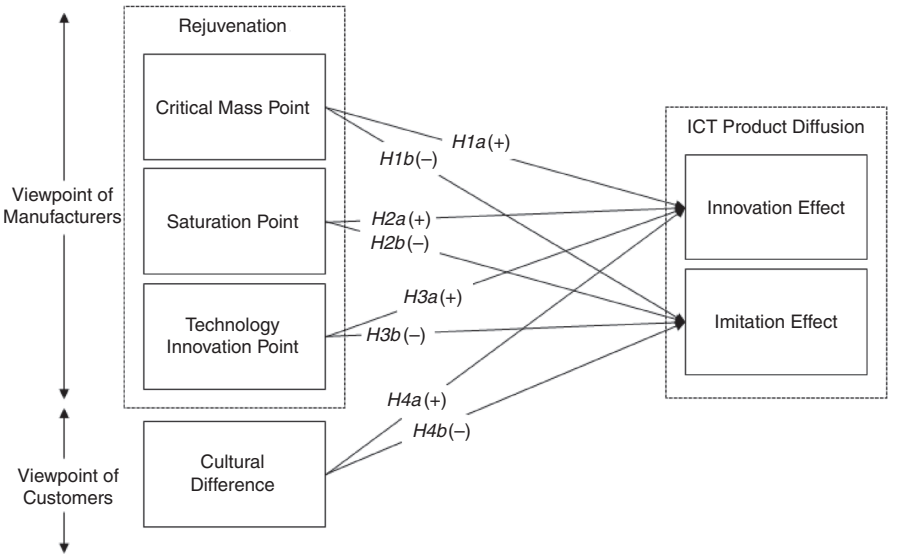


Figure 2.
Research model

3.2.2 Diffusion effects in a saturated ICT market. Another critical point of innovation diffusion theory is when the early majority group finishes product adoption and the adoption speed begins to decline. Under the theory, the adoption rate is on a constant rise to 50 percent, then turns to go down because of market saturation. Then, the market is going through a big change as the competition intensified and new generation products launched (Low and Johnston, 2006; Forman *et al.*, 2010). Overshooting, in particular, appears after market saturation. Despite unnecessary price increases by overshooting, ICT players compete for technology innovation targeting those who already adopted technology(Christensen, 1997; Danneels, 2004). This may represent that unlike in other markets, overshooting has a positive impact on product diffusion in the ICT market. Based on this assumption, it is expected that a saturated ICT market may encourage market players to devote more efforts to technology innovation, which in turn reinforces innovation effects. It may also facilitate churning of post adopters, which may lead to weaker imitation effects. Thus, this study sets forth the following hypotheses to verify the influence of ICT market saturation:

H2. Saturation of ICT market has an impact on diffusion of ICT products.

H2a. Saturation of ICT market has a positive (+) impact on innovation effects.

H2b. Saturation of ICT market has a negative (–) impact on imitation effects.

3.2.3 Diffusion effect in an ICT market with technology innovation. ICT products of a certain category have advanced into next generations (Eisenhardt, 1989; Eisenhardt and Tabrizi, 1995). Such an evolution creates new potential markets, and new products in the new markets have new PLCs. As a result of repeated technology innovation, ICT products have become easier to use and more useful for more purposes (Mahajan *et al.*, 2000; Bayraktar *et al.*, 2012; Lee *et al.*, 2013). Along with the evolution, adopters become more assured of ease-of-use and usefulness of new-generation product than before (Tseng and Lo, 2011). Accumulated experiences during the evolution help adopters

understand technology innovation and new technology, and the evolution affects their adoption behavior. That is, innovative ICT products may fuel expectations of post adopters, and the expectations may, in turn, influence ICT product diffusion. Based on the assumption, it is expected that technology innovation raises expectations of post adaptors and reinforces innovation effects, while imitation effects shrink as post-adopters churn from the previous-generation products. Thus, this study sets forth the following hypotheses to verify the influence of technology innovation in the ICT market:

H3. Technology innovation of the ICT market has an impact on diffusion of ICT products.

H3a. Technology innovation of the ICT market has a positive (+) impact on innovation effects.

H3b. Technology innovation of the ICT market has a negative (−) impact on imitation effects.

3.2.4 Diffusion effect in culturally different ICT markets. Two culture types and their distinctive characters were identified in previous studies (Hofstede, 1991; Campbell and Kwak, 2010; Bertot *et al.*, 2010). Type 1 is individualistic and not very uncertainty-avoiding whereas Type 2 is collectivistic and strongly uncertainty-avoiding. Thus, it may be assumed that cultural differences lead to different levels of understanding on new-generation products and adoption of technology innovation. It needs to be confirmed how cultural differences of ICT markets affect ICT product adoption, and this should be considered when establishing market dominance strategies for each Type. Thus, this study sets forth the following hypotheses to verify the influence of cultural differences on ICT product diffusion:

H4. Cultural differences of ICT markets have an impact on diffusion of ICT products.

H4a. Innovation effects are stronger in Type 1 countries than in Type 2 countries.

H4b. Imitation effects are stronger in Type 2 countries than in Type 1 countries.

4. Empirical analysis

4.1 Data collection

This study used the total population and mobile communications subscriber data of the USA and Korea to verify that backed by rejuvenation, several generations of a certain-category product simultaneously exist in the ICT market, which affects the process of ICT product diffusion; and how cultural differences affect adoption of ICT product rejuvenation in each market. Type 1 is represented by the USA, home to global ICT giants, including Apple, Google and Microsoft (OECD, 2013). Its mobile penetration rate reached 95 percent in 2011, but actually exceeded 100 percent in 2008 when its under-15 population taken into account. The country has been the leader of technology innovation and adoption in the global ICT market (ITU, 2013; OECD, 2013). Meanwhile, Type 2 is represented by Korea where technology innovation was much left behind in early stages (1G introduced in 1984 an 2G in 1996), but both mobile technology and market were explosively developed after then and the market was already saturated. With constant technology innovation and adoption, the country was ranked 1st in the ICT Development Index 2011. To ensure reliability of this analysis, data was collected from accredited organizations: ITU (www.itu.int) and KCC (http://eng.kcc.go.kr).

4.2 Analysis method

The diffusion model suggested by Bass (1969) was used to study the influence of market saturation and technology innovation. This model has since been used to study the diffusion factor of products because it can be used to calculate coefficients for innovation effects and imitation effects, find various individual factors, and predict forms of future diffusion.

The Bass diffusion model can be seen as taking into account both internal and external influences in order to provide S-curves. That is, this model is based on the concept that diffusion is influenced by both internal and external factors. Bass (1969) divided these internal and external factors into innovation effects and imitation effects and expressed them using a linear function:

$$\frac{dN(t)}{dt} = p[m-N(t)]+\frac{q}{m}N(t)[m-N(t)], \quad n(0) = pm \tag{1}$$

In the above Equation (1), $p[m-N(t)]$ represents those innovators who are not influenced by the number of adopters of a product at the time of adoption, while $(q/m)N(t)[m-N(t)]$ represents imitators who are influenced by the number of people who have previously adopted the product. The present research found innovation effects (p) and imitation effects (q) using the nonlinear least square method suggested by Srinivasan and Mason (1986).

4.3 Analysis result

4.3.1 H1. To test the influence of CMP on ICT product adoption, innovation effects (p) and imitation effects (q) before and after CMP (16 percent) were compared and the result is presented by Table III. This analysis found that innovation effects surged after CMP in both countries (USA: 0.00752→0.0549, KR: 0.000233→0.0.0221), while imitation effects decreased (USA: 0.3839→0.2011, KR: 0.6391→0.3576). This result demonstrates that imitators in the ICT market are turning to innovators after CMP by the social normative beliefs formed by early innovators. That is, innovators who adopted ICT products quickly have great influences, and imitators influenced by innovators choose to adopt ICT products, not following innovators. Also, innovation effects begin to surge

	USA (10,000)		Korea (10,000)	
Rapid adoption	Before (1985~1997)	After (1998~2012)	Before (1984~1998)	After (1999~2012)
Bass diffusion model				
m	5,331.2	25,468.8	1,398	3,964.1
p (innovation effect)	0.00752	0.0549	0.000233	0.0221
q (imitation effect)	0.3839	0.2011	0.6391	0.3576
F-value	11.75***	76.84***	4.96**	8.19***
R^2	0.9867	0.4615	0.9937	0.0688
White-noise test				
Null value	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$
Test statistics	3.93***	2.33**	1.97*	0.52 (0.6158)

Notes: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Table III.
Comparison between before and after CMP

after the CMP despite many potential adopters before then, implying that if an ICT product secures a certain scale of market in the early stage, the market is likely to radically take off.

4.3.2 H2. To examine the influence of market saturation on ICT product diffusion, innovation effects (p) and imitation effects (q) before and after MSP (50 percent) were compared and the result is presented by Table IV. This analysis found that innovation effects soared after market saturation (USA: 0.00247→0.1445, KR: 0.0033→0.0625) while imitation effects decreased (USA: 0.3368→0.1265, KR: 0.3391→0.2324) in both countries. This demonstrates that ICT players are making various attempts to win the neck-and-neck competition when the ICT market is saturated. They even opt for overshooting to attract post adopters who have higher expectations and demands for product quality than those in other markets. Meanwhile, dwindling imitation effects may imply post adopters churn to new generations after market saturation. Such a picture shows that many innovators are creating demands for new ICT products by constantly moving up to new generation technology, and the market becomes more polarized as innovators have greater expectations for technology innovation while imitators have little or no such interest.

4.3.3 H3. To identify the influence of technology innovation on ICT product diffusion, innovation effects (p) and imitation effects (q) of each technology generation were examined and the result is presented in Table V. This analysis found that technology innovation boosted innovation effects (USA: 0.0187→0.0236→0.1518, KR: 0.000002141→0.0347→0.0814) and decreased imitation effects (USA: 0.7535→0.4582→0.2494, KR: 1.4586→0.9994→0.4237) in both countries. This implies that the ICT market is changed by technology innovation, and ICT product diffusion is driven by innovation effects. In addition, ICT product adoption time becomes earlier with gradually increasing innovation effects, meaning that the cycle of technology innovation gets shortened because technology innovation has less impact on ICT product adoption. It should also be noted that ICT product adopters are becoming more embracive about new technology. This implies that post adopters have stronger desires on new technology while fully utilizing available technology after adopting an ICT product. Their attitude may lead the changes in the ICT product diffusion drivers.

	USA (10,000)		Korea (10,000)	
Market saturation	Before (adoption rate 50%)	After (adoption rate 50%)	Before (adoption rate 50%)	After (adoption rate 50%)
Bass diffusion model				
m	16,063.7	14,936.3	2,681.4	2,680.8
p (innovation effect)	0.00247	0.1445	0.00333	0.0625
q (imitation effect)	0.3368	0.1265	0.3391	0.2324
F-test (F-value)	47.38***	39.76***	4.26**	18.56***
R^2	0.9204	0.5992	0.7043	0.2726
White-noise test				
Null value	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$
J-test (test statistics)	3.60***	1.68 (0.1547)	2.34**	0.71 (0.4957)

Notes: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Table IV.
Comparison between before and after MSP

Technology innovation	USA (10,000) 1G	2G	3G	Korea (10,000) 1G	2G	3G
Bass diffusion model						
m	755.7	14,163.4	14,331.8	–	–	–
p (innovation effect)	0.0187	0.0236	0.1518	0.000002141	0.0347	0.0814
q (imitation effect)	0.7535	0.4582	0.2494	1.4586	0.9994	0.4237
F-value	10.24**	4.70**	57.66***	58.00***	12.37***	8.36**
R^2	0.9782	0.3205	0.8083	0.9945	0.7512	0.3386
White-noise test						
Null value	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$	$\alpha = 0$
Test statistics	1.92 (0.1502)	1.78 (0.1180)	3.79**	2.56	1.09*	3.06**

Notes: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Table V.
Analysis by technology generation

4.3.4 H4. To verify the influence of cultural differences on ICT product diffusion, innovation effects (p) and imitation effects (q) were t-tested and the result is presented in Table VI. The test did not find any significant difference in innovation effects (p), but did find a meaningful difference in imitation effects with Korea's average (0.6300) being higher than USA's (0.3418). This implies ICT product diffusion patterns are different in Types 1 and 2 countries. In addition, innovators of both countries have similar tendency but imitators are different. That is, innovators who are enthusiastically adopting new technology innovation are not differed by culture, while imitators show different adoption behaviors by culture. In both countries, innovators are individualistic and aggressively embracing uncertainties of innovative technology. On the other hand, imitators were different by culture in that Korean imitators were more collective and affected by word of mouth than their American counterparts.

Table VII summarizes the results of hypothesis verification. In sum, innovation effects (p) go up while imitation effects (q) go down after CMP, MSP and NGRP. Also, cultural differences have significant influences on imitators, but not on innovators (Figure 3).

5. Conclusion

ICT markets have already saturated in many countries, but technology innovation in the industry never stopped. Within the markets, red ocean strategy and technology innovation may shape the dynamics of ICT product diffusion. Previous studies on ICT product diffusion mostly failed to consider mixed presence of different generation products as a result of market saturation and product rejuvenation, and accompanying changes in post adopters' product adoption behavior. Thus, this study attempts to examine the rejuvenation in the ICT market by identifying adoption drivers of different

Valuable	Group	n	Mean	Std.	t-value	df	p
p	USA	8	0.0509	0.0623	1.027	14	0.322
	Korea	8	0.0255	0.0316			
q	USA	8	0.3418	0.1948	−1.792	14	0.095*
	Korea	8	0.6300	0.4118			

Note: *$p < 0.1$

Table VI.
Cultural difference analysis between USA and Korea

Hypotheses	Result
H1: the CMP of the ICT market has an impact on diffusion of ICT products	Accept
H1a: the CMP of the ICT market has a positive (+) impact on innovation effects	Accept
H1b: the CMP of the ICT market has a negative (–) impact on imitation effects	Accept
H2: saturation of ICT market has an impact on diffusion of ICT products	Accept
H2a: saturation of ICT market has a positive (+) impact on innovation effects	Accept
H2b: saturation of ICT market has a negative (–) impact on imitation effects	Accept
H3: technology innovation of the ICT market has an impact on diffusion of ICT products	Accept
H3a: technology innovation of the ICT market has a positive (+) impact on innovation effects	Accept
H3b: technology innovation of the ICT market has a negative (–) impact on imitation effects	Accept
H4: cultural differences of ICT markets have an impact on diffusion of ICT products	Partially Accept
H4a: innovation effects are stronger in Type 1 countries than in Type 2 countries	Reject
H4b: imitation effects are stronger in Type 2 countries than in Type 1 countries	Accept

Table VII. Hypothesis verification results

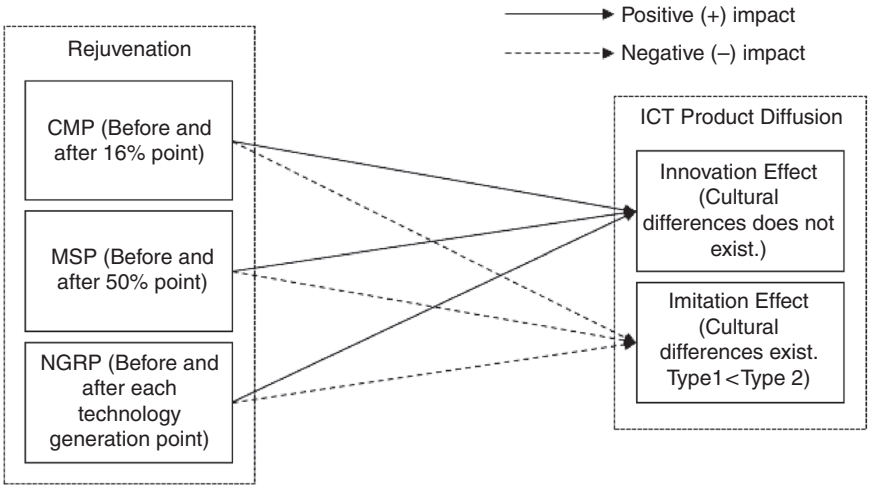


Figure 3. Research result

stages (CMP, MSP and NGRP). Many of the existing studies on product diffusion have dealt with the survey. But, they have a limitation that they failed to consider the actual situation of the ICT market. That is to say, they could not represent all adopter groups or include numerous factors in their analysis. This study overcame the limitation of previous research by engaging in research analysis that can reflect the current situation of the ICT market through considering the impact of market saturation and technology innovation on ICT product diffusion and through using actual subscriber data.

This study confirmed the influence of rejuvenation on ICT product diffusion. First, innovation effects (p) on ICT product diffusion surge after CMP, MSP and NGRP. This means that innovators are aggressively embracing innovative technology, even including overshooting features as a result of cut-throat competition between ICT

players. Thus, overshooting strategy by ICT companies' technology innovation is an important strategy for ICT product diffusion. Second, backed by repeated rejuvenation experiences, imitators have better understanding on ICT technology and are turning to innovators who can objectively choose new and innovative products. That is, whereas imitators in the past blindly followed innovators, today's imitators accept technology based on their confident judgment on ease-of-use and usefulness of the products. Therefore, technology innovation is the most important strategy for imitators as well as innovators. Its importance has been increasing following market saturation. As a result, although launching a new generation ICT product through technology innovation may be overshooting, it will still have a significant impact on imitators and can lead them to adopt the innovation. Third, cultural differences were hardly found between innovators, but did have significant influences on ICT product diffusion. Innovators are more aggressively embracing new technologies that are being developed at a higher-than-before pace, while product adoption patterns by imitators are different by culture. For example, Korean mobile market subscribers decreased dramatically due to the government's subsidy policy change since October 2014, which means that imitators are not renewing their mobile phone when its switching cost is higher. On the other hand, innovators showed higher interest in the recently released iPhone6. Lastly, the status of market saturation needs to be re-defined. As innovation effects increase and imitation effects decrease after CMP and MSP, ICT companies need to begin rejuvenation efforts after early innovators finish product adoption.

This study has the following implications for ICT product diffusion. First, a product diffusion strategy backed on aggressive overshooting is necessary to drive innovators' ICT product adoption. This study confirmed that innovators are willing to assume high costs to adopt innovative technology. In addition, ICT companies' rejuvenation efforts should focus on them because market saturation begins when innovators finish adoption. Second, it is necessary to develop a new definition of and product diffusion strategies on imitators. They have long been exposed to ICT and becoming innovators who understand and objectively choose new technology. As ICT is on a continuum of previous technologies, imitators are no longer blindly chasing innovators. Thus, ICT players need to develop rejuvenation strategies that can be readily accepted by imitators or that can turn them into innovators. Lastly, although cultural differences between innovators no longer exist in the highly globalized ICT market, ICT product adoption by the majority imitators is still greatly affected by cultural differences. Accordingly, technology innovation strategies are needed to assure imitators of Type 1 countries of ease-of-use and usefulness of ICT products, while diversified marketing strategies based on the local culture are needed to persuade imitators of Type 2 countries.

This study confirms the impact of market saturation and technology innovation, but other factors, such as the socio-cultural environment, can also impact the diffusion of ICT products. Therefore, this study has the following limitations. First, the subscriber data in this study only reflected the USA and Korean ICT market, so the result are hard to be generalized; moreover, the influence of intangible factors was omitted from analysis. Second, because this study specifically defined the points of market saturation and technology innovation, the impact from the process of market saturation or the progress of technology innovation progression has been omitted. Therefore, future studies may address the above limitations and research the omitted impact factors, then the diffusion factors of the ICT market could be understood in more detail.

References

4GAmerica (2014), "4G America home page", available at: www.4gamericas.org (accessed March 2014).

Ayres, R.U. and Steger, W.A. (1985), "Rejuvenating the life cycle concept", *Journal of Business Strategy*, Vol. 6 No. 1, pp. 66-76.

Baraldi, A.L. (2012), "The size of the critical mass as a function of the strength of network externalities: a mobile telephone estimation", *Economics of Innovation and New Technology*, Vol. 21 No. 4, pp. 373-396.

Bass, F.M. (1969), "A new product growth model for consumer durables", *Management Science*, Vol. 15 No. 5, pp. 215-227.

Baum, T. (1998), "Taking the exit route: extending the tourism area life cycle model", *Current Issues in Tourism*, Vol. 1 No. 2, pp. 167-175.

Bayraktar, E., Tatoglu, E., Turkyilmaz, A., Delen, D. and Zaim, S. (2012), "Measuring the efficiency of customer satisfaction and loyalty for mobile phone brands with DEA", *Expert Systems with Applications*, Vol. 39 No. 1, pp. 99-106.

Bélanger, F. and Crossler, R.E. (2011), "Privacy in the digital age: a review of information privacy research in information systems", *MIS Quarterly*, Vol. 35 No. 4, pp. 1017-1042.

Bertot, J.C., Jaeger, P.T. and Grimes, J.M. (2010), "Using ICTs to create a culture of transparency: e-government and social media as openness and anti-corruption tools for societies", *Government Information Quarterly*, Vol. 27 No. 3, pp. 264-271.

Butler, R.W. (1980), "The concept of a tourist area cycle of evolution: implications for management of resources", *The Canadian Geographer/Le Géographe Canadien*, Vol. 24 No. 1, pp. 5-12.

Campbell, S.W. and Kwak, N. (2010), "Mobile communication and social capital: an analysis of geographically differentiated usage patterns", *New Media & Society*, Vol. 12 No. 3, pp. 435-451.

Christensen, C.M. (1997), *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business Press, Boston, MA.

Cooper, C., Johnson, P. and Thomas, B. (1992), *The Life Cycle Concept and Tourism*, Mansell Publishing, London.

Danneels, E. (2004), "Disruptive technology reconsidered: a critique and research agenda", *Journal of Product Innovation Management*, Vol. 21 No. 4, pp. 246-258.

Derbaix, C.M. (1995), "The impact of affective reactions on attitudes toward the advertisement and the brand: a step toward ecological validity", *Journal of Marketing Research*, Vol. 32 No. 4, pp. 470-479.

Dunnewijk, T. and Hultén, S. (2007), "A brief history of mobile communication in Europe", *Telematics and Informatics*, Vol. 24 No. 3, pp. 164-179.

Eisenhardt, K.M. (1989), "Making fast strategic decisions in high-velocity environments", *Academy of Management Journal*, Vol. 32 No. 3, pp. 543-576.

Eisenhardt, K.M. and Tabrizi, B.N. (1995), "Accelerating adaptive processes: product innovation in the global computer industry", *Administrative Science Quarterly*, Vol. 40 No. 1, pp. 84-110.

Forman, C., Ghose, A. and Wiesenfeld, B. (2010), "Examining the relationship between reviews and sales: the role of reviewer identity disclosure in electronic markets", *Information Systems Research*, Vol. 19 No. 3, pp. 291-313.

Fuentelsaz, L., Maícas, J.P. and Polo, Y. (2008), "The evolution of mobile communications in Europe: the transition from the second to the third generation", *Telecommunications Policy*, Vol. 32 No. 6, pp. 436-449.

Genakos, C. and Valletti, T. (2011), "Testing the 'waterbed' effect in mobile telephony", *Journal of the European Economic Association*, Vol. 9 No. 9, pp. 1114-1142.

Griffith, D.A., Hu, M.Y. and Ryans, J.K. Jr (2000), "Process standardization across intra-and inter-cultural relationships", *Journal of International Business Studies*, Vol. 31 No. 2, pp. 303-324.

GSA (2014), "Global mobile suppliers association home page", available at: www.gsacom.com/ (accessed March 2014).

Hague, P.N. (2002), *Market Research: A Guide to Planning, Methodology & Evaluation*, Kogan Page Ltd, London.

Hofstede, G. (1984), *Culture's Consequences: International Differences in Work-Related Values*, McGraw-Hill, New York, NY.

Hofstede, G. (1991), *Cultures and Organizations: Software of the Mind*, McGraw-Hill, New York, NY.

Hovav, A. and D'Arcy, J. (2012), "Applying an extended model of deterrence across cultures: an investigation of information systems misuse in the US and South Korea", *Information & Management*, Vol. 49 No. 2, pp. 99-110.

ITU (2013), "Global ICT development 2001-2013", available at: www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx (accessed March 2014).

Jackson, S. (2011), "Organizational culture and information systems adoption: a three-perspective approach", *Information and Organization*, Vol. 21 No. 2, pp. 57-83.

KCC (2014), "Korea communications commission", available at: http://eng.kcc.go.kr (accessed March 2014).

Kim, Y., Sohn, D. and Choi, S.M. (2011), "Cultural difference in motivations for using social network sites: a comparative study of American and Korean college students", *Computers in Human Behavior*, Vol. 27 No. 1, pp. 365-372.

King, A.A. and Tucci, C.L. (2002), "Incumbent entry into new market niches: the role of experience and managerial choice in the creation of dynamic capabilities", *Management Science*, Vol. 48 No. 2, pp. 171-186.

Lee, S.-G., Lee, E.-b. and Yang, C.-G. (2014), "Strategies for ICT product diffusion: the case of the Korean mobile communications market", *Service Business*, Vol. 8 No. 1, pp. 65-81.

Lee, S.G., Trimi, S. and Kim, C. (2012), "The impact of cultural differences on technology adoption", *Journal of World Business*, Vol. 48 No. 1, pp. 20-29.

Lee, S.-G., Trimi, S. and Kim, C. (2013), "Innovation and imitation effects' dynamics in technology adoption", *Industrial Management & Data Systems*, Vol. 113 No. 6, pp. 772-799.

Lee, S.M., Kim, T., Noh, Y. and Lee, B. (2010), "Success factors of platform leadership in web 2.0 service business", *Service Business*, Vol. 4 No. 2, pp. 89-103.

Low, B. and Johnston, W. (2006), "Relationship equity and switching behavior in the adoption of new telecommunication services", *Industrial Marketing Management*, Vol. 35 No. 6, pp. 676-689.

Mahajan, V., Sharma, S. and Bettis, R. (1988), "The adoption of the M-form organizational structure: a test of imitation hypothesis", *Management Science*, Vol. 34 No. 10, pp. 1188-1201.

Mahajan, V., Muller, E. and Wind, Y. (2000), *New-Product Diffusion Models*, Springer, Berlin.

Müller, B., Kocher, B. and Crettaz, A. (2013), "The effects of visual rejuvenation through brand logos", *Journal of Business Research*, Vol. 66 No. 1, pp. 82-88.

OECD (2013), "Country statistical profiles", available at: http://stats.oecd.org/Index.aspx?DataSetCode = GROWTH (accessed March 2014).

Park, Y. and Chen, J.V. (2007), "Acceptance and adoption of the innovative use of smartphone", *Industrial Management & Data Systems*, Vol. 107 No. 9, pp. 1349-1365.

Srinivasan, V. and Mason, C.H. (1986), "Technical note-nonlinear least squares estimation of new product diffusion models", *Marketing Science*, Vol. 5 No. 2, pp. 169-178.

Teng, J.T.C., Grover, V. and Guttler, W. (2002), "Information technology innovations: general diffusion patterns and its relationships to innovation characteristics", *Engineering Management, IEEE Transactions on*, Vol. 49 No. 1, pp. 13-27.

Tracy, K.W. (2012), "Mobile application development experiences on apple's iOS and android OS", *Potentials, IEEE*, Vol. 31 No. 4, pp. 30-34.

Tseng, F.-M. and Lo, H.-Y. (2011), "Antecedents of consumers' intentions to upgrade their mobile phones", *Telecommunications Policy*, Vol. 35 No. 1, pp. 74-86.

Van den Bulte, C. and Joshi, Y.V. (2007), "New product diffusion with influentials and imitators", *Marketing Science*, Vol. 26 No. 3, pp. 400-421.

Van den Bulte, C. and Stremersch, S. (2004), "Social contagion and income heterogeneity in new product diffusion: a meta-analytic test", *Marketing Science*, Vol. 23 No. 4, pp. 530-544.

Venkatraman, N., Loh, L. and Koh, J. (1994), "The adoption of corporate governance mechanisms: a test of competing diffusion models", *Management Science*, Vol. 40 No. 4, pp. 496-507.

Von Hippel, E. (2009), "Democratizing innovation: the evolving phenomenon of user innovation", *International Journal of Innovation Science*, Vol. 1 No. 1, pp. 29-40.

Whitfield, J. (2009), "The cyclical representation of the UK conference sector's life cycle: the use of refurbishments as rejuvenation triggers", *Tourism Analysis*, Vol. 14 No. 5, pp. 559-572.

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