A general theory of crime and computer crime: An empirical test ☆

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ABSTRACT

Computer crime has become a global issue and continues to rapidly grow; however, few studies had examined the applicability of a general theory of crime in explaining computer deviance. Using a panel of 2,751 Korean youths, the current study examined whether low self-control theory can be useful as a theoretical framework for explaining computer crime. The results indicated the applicability of low self-control theory in explaining both illegal download of software and illegal use of others' personal identification online. Consistent with the theory's prediction, opportunity variables, especially hours of computer use, were found to be significant predictors of computer crime. The shortcomings of the current research and the directions for future research were discussed.

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Introduction

Computers and computer related technologies have become essential tools that have significantly affected various aspects of personal and social lives, ranging from education, business, to cultural and leisure activities. With the widespread use of personal computers and high speed internet, various computer-related deviant and criminal behaviors have increased significantly, such as hacking, illegal downloading of music and software programs, and stealing others' passwords (Audal, Lu, & Roman, 2008; Christensen & Eining, 1991; Foster, 2004; Gopal & Sanders, 1998; Higgins, Wolfe, & Ricketts, 2009; Hollinger, 1991; Hollinger & Lanza-Kaduce, 1988; Rahim, Seyal, & Rahman, 1999).

While the accurate extent and overall cost of computer deviance is unknown and the estimated cost of computer deviance actually varies across studies, previous research indicates that computer deviance is a global phenomenon (Federal Bureau of Investigation, 2005; Gottleber, 1988; McEwen, Fester, & Nugent, 1989; Pawar & Goyal, 1994). For example, Pawar and Goyal (1994) identified a high level of software piracy in East Asian countries (i.e., Thailand, China, South Korea, and Japan), ranging from 81 to 98 percent, resulting in multi-billion dollar financial cost to software developers. A recent survey of 2,066 business organizations in the United States by the Federal Bureau of Investigation (2005) revealed that 64 percent of businesses reported financial losses from at least one computer security incident.

Given the importance of the issue, a growing number of studies in recent years have examined computer deviance, focusing on the etiology of computer deviance and whether traditional criminology theories (i.e., low self-control theory, social learning theory, rational choice theory) can be utilized to explain computer deviance (Foster, 2004; Higgins, 2005, 2007; Higgins, Fell, & Wilson, 2006; Higgins & Makin, 2004a, 2004b; Higgins, Wilson, & Fell, 2005; Higgins et al., 2009; Hinduja, 2004, 2006; Skinner & Fream, 1997; Willison, 2006; Yar, 2005). Overall, empirical findings provided supportive evidence of traditional criminology theories' ability in explaining various types of computer-related deviance. Though these empirical studies had improved the understanding of the etiology of computer deviance, there were several limitations. First, a limited number of empirical studies had examined the generalizability of a general theory of crime to explaining computer deviance, despite the theory's claim that low self-control is the primary cause of *all criminal behaviors*, including violent and white-collar crime. Second, prior studies typically employed convenience samples of college students; consequently, results were difficult to generalize to a general population of youth.

The current research attempted to address these limitations by examining the applicability of a general theory of crime in explaining computer crime through analysis of longitudinal data collected on a panel of 2,751 Korean adolescents. This study was important from at least three perspectives. First, an advanced, comprehensive exploration of the etiology of computer deviance is critical as a highly networked modern society becomes more vulnerable to computer deviance and requires prevention and cyber security (McQuade, 2006). Second, the study represented the first attempt to examine the etiology of computer deviance using a nationally representative sample of adolescents. As mentioned above, a majority of prior studies on computer deviance used a convenience sample of college students, based on the justification that this particular group is more likely to use computers, possess knowledge of computer-related technology, and consequently commit more computer deviance. Contrary to this assertion, however, several studies (Aisbett, 2001; Becker, 2000;

Lenhart, 2005) indicated that more than 85 percent of adolescents in both Australia and the United States used a computer with Internet access for various purposes ranging from e-mail, chatting, to entertainment. Moreover, the National Internet Development Agency of Korea (2008) found nearly 100 percent of Korean adolescents reported the use of a computer and the internet at least once a month. As a younger generation is more likely to be proficient with technology and become capable of committing various types of computer deviance, it was necessary to examine this new phenomenon with a national sample of adolescents. Third, the study was also important for exploring the generalizability of a general theory of crime outside of the context of the United States, as computer deviance is a global phenomenon and an international issue.

Below, the definition and extent of computer crime is examined along with computer deviance in the context of South Korea. Key propositions and concepts from a general theory of crime are discussed and empirically tested to assess the overall fit of low self-control theory to the phenomenon of computer crime.

Definition and extent of computer crime

There is no consensus on the definition of computer crime, mainly because it is a contemporary, innovative criminal/deviant phenomenon that involves diverse and perpetually advancing computer-related harmful activities (Foster, 2004; McQuade, 2006; Wall, 2001). Various terms have been used interchangeably to describe criminal behaviors involving computers and advanced information technology devices, including computer-related crime, cybercrime, technological crime, computer-assisted crime, digital crime, electronic crime, and Internet crime (McQuade, 2006). A common theme among definitions of computer crime is the illegal use of a computer or computer-related devices by individuals, groups, or organizations with special knowledge of computers.

A significant number of studies (Foster, 2004; Gopal, Sanders, Bhattacharjee, Agrawal & Wagner, 2004; Higgins, 2007; Higgins et al., 2009; Hinduja, 2003, 2004, 2006; Hollinger, 1988, 1992; Husted, 2000; Koen & Im, 1997; Mann & Sutton, 1998; Skinner & Fream, 1997; Taylor, 1999; Wall, 2005; Wilson, Patterson, Powell, & Hembury, 2006) have focused on the extent of various types of computer crime, including illegal copying and trading of commercial computer software, illegal access to another's computer system, and the creation/dissemination of a computer virus program; most using nonrandom samples of university students. For example, Hollinger (1992) conducted the first empirical research on computer deviance perpetrators' social and demographic characteristics using a sample of 1,766 university students. The study found that 10 percent of university students in the sample reported illegal use, download, or copying of commercial computer software and about 3 percent indicated involvement in illegal intrusion into another's computer system during a previous semester. A study by Skinner and Fream (1997) found that 34 percent of college students in their sample reported pirating commercial software in the past year, while less than 2 percent of respondents were involved in the development and/or dissemination of virus programs. With a sample of 2,032 university students, Hinduja (2004) examined computer deviance focusing on music piracy and found that 62 percent of respondents downloaded at least one MP3 file in the previous week, while 88 percent engaged in music piracy over the course of their lifetime. A recent study by Wilson et al. (2006), using the 2003/2004 British Crime Survey, indicated that approximately one-fourth of youths (10 to 25 years old) with access to the internet reported involvement in illegal downloading of movies, music, and software in the previous year. The findings also showed that one percent of youths reported involvement in illegal spreading of a computer virus. Overall, previous studies indicated that youths and college students are frequently involved in the use, download, and/or trade of pirated software and are less

involved in the development and/or dissemination of virus programs, online purchase with false identity, and illegal access to another's computer system.

Internet use and computer crime in the context of South Korea

During the last several decades, South Korea achieved unprecedented economic success, resulting in rapid industrialization and urbanization of Korean society (Rhee & Kim, 2004). Moreover, the country has become one of the leading nations in the information, communication, and technology sector, enjoying a very high rate of Internet usage (Kushida & Oh, 2006; Rhee & Kim, 2004). Consequently, Internet and telecommunication-related electronic devices have become an essential part of Korean life; their usage ranging from information searches, recreational activities, internet shopping, cyber club/community activity, communication through email/chatting, and trading stocks (National Internet Development Agency, 2008). A recent study by the National Internet Development Agency of Korea (2008) on a nationally representative sample of 25,128 citizens in 10,000 households found that approximately 80 percent of households indicated ownership of a personal computer at home along with Internet access, mostly through high speed Internet access. Regarding the use of the Internet, 76 percent of respondents age six and older used the Internet at least once during the month prior to the survey. Interestingly, nearly 100 percent (99.8 percent) of youths between the ages of ten and nineteen and young adults in their twenties reported spending an average fourteen hours a week using the Internet.

A limited number of studies (Chang, 2004; Lee & Ha, 2004; S. Lee, 2000) have examined the etiology of computer crime among Korean adolescents. The results indicate that negative relationships with parents, association with delinquent peers, and low self-control were positively related to computer deviance and cyber sexual abuse. Using a sample of 1,113 Korean youths, S. Lee (2005) examined the effects of individual, school, and family factors on computer deviance such as hacking, virus spreading, spam mail distribution, and illegal distribution of another's personal information in cyberspace. The results indicated that the perceived importance of cyberspace (i.e., cyberspace is important to me, cyberspace itself is my life), attitude toward computer deviance, and self-control were significantly related to computer deviance. Youths who reported a high level of attachment to cyberspace, positive attitudes toward computer deviance, or low levels of self-control were more likely to engage in various types of computer deviance. Interestingly, the study found that younger adolescents, females, and those from higher social classes were more likely to commit computer deviance.

Low self-control theory and computer crime

Gottfredson and Hirschi (1990, pp. 89-90) have argued that low self-control and opportunity are key predictors of criminal behavior. According to the theory, individuals with low self-control tend to seek immediate gratification, are insensitive to others, possess limited cognitive and academic skills, and are physically active. Consequently, those with low self-control are more likely to engage in delinquent and/or criminal behaviors which provide immediate gratification with little effort or skill. Furthermore, the theory asserts that self-control predicts not only delinquent/criminal behaviors, but also explains analogous behaviors such as drinking, smoking, gambling, drug use and white collar crime; since all of these behaviors share common characteristics of criminal behavior such as provision of immediate gratification, minimal efforts and planning, and lack of consideration of future consequences. Gottfredson and Hirschi (1990) also suggest the pivotal role of opportunity on the relationship between low self-control and criminal behaviors. According to the theory, individuals

with low self-control are more likely to engage in deviant behaviors when presented with opportunity.

Numerous studies empirically tested core propositions of the theory, mainly focusing on the relationship between low self-control and deviant behaviors (see Baron, 2003; Grasmick, Tittle, Bursik, & Arneklev, 1993; Hay, 2001; Pratt & Cullen, 2000). Overall, findings support the theory's primary argument that individuals with low self-control are more likely to engage in deviant and criminal behaviors. Several studies (see Arneklev, Grasmick, Tittle, & Bursik, 1993; Burton, Evans, Cullen, Olivares, & Dunaway, 1999) examined the applicability of low self-control to explain imprudent behaviors such as drinking, smoking, gambling, and risky sexual behavior. The results indicated that those with low self-control are more likely to engage in various types of imprudent and risky behaviors, consistent with the prediction of the theory.

Several studies (Foster, 2004; Higgins, 2005, 2006, 2007; Higgins et al., 2009; Hinduja, 2004) had tested the applicability of a general theory of crime to explaining computer crime. Foster (2004) examined the effects of low self-control, opportunity, and their interaction on computer deviance and found that both low self-control and opportunity (i.e., access to a computer and Internet use) had significant positive effects on computer deviance. Those low in self-control and/or greater opportunities tended to engage in various types of computer deviance. Using a sample of university students, Hinduja (2004) examined whether three dominant criminology theories (general strain theory, general theory of crime, and social learning theory) can explain computer related deviant behaviors. The study found that both attitudinal and behavioral measurements of low self-control are significantly related to music piracy. Higgins (2005) studied a sample of 316 college students and found a significant positive relationship between low self- control and software piracy, even after controlling for other theoretically important factors such as association with software pirating peers. In a recent study, Higgins et al. (2009) used a sample of 353 undergraduate students to examine the explicability of social learning and low self-control theories on intentions and actions of digital piracy among three different groups (low, medium, and high digital piracy group). The findings show that low self-control is not a significant predictor in distinguishing three groups of actual digital piracy; however, it distinguishes two of the three groups in the measurement of the scenario-based intentions to commit digital piracy.

Overall, these limited empirical findings indicated the generality of low self-control theory in predicting computer crime. Although these empirical studies were informative and suggested the possibility of utilizing the general theory to explain computer crime, previous studies suffered from several limitations, including non-random sampling of college students and the use of cross-sectional data. The current study addressed shortcomings of earlier research and assessed the generalizability of a general theory of crime across a representative sample of adolescents with adequate measures of theoretically relevant variables over time. Two key concepts of a general theory of crime - self-control and opportunity (i.e., typically using computer at home, membership in a cyber club, and hours of computer use) were measured to clarify the theory's application to computer crime.

Method

Data

For the current research, the first and second waves of the Korea Youth Survey, collected in 2003 and 2004, were used. The Korea Youth Policy Institute (government agency) had implemented a longitudinal project sampling a nationally representative sample of Korean adolescents and their parents to understand various issues Korean youths experience such as academic achievement, secondary work experience, deviant behaviors, cyber crime, fear of crime, and stressful life events. Research participants and their parents were contacted yearly between 2003 and 2008, yielding six years of data. Waves I and II were available for analysis in the current research project.

In order to create a nationally representative sample of eighth grade Korean youth starting in 2003 (typically 14 years old), a stratified multi-stage cluster sampling method was employed. First, South Korea was stratified into twelve regional districts (provinces and metropolitan cities) and middle schools in each region were randomly selected according to the size of the middle school population. For example, 20 middle schools were selected in Seoul where 120,826 middle school students attended, while only three middle schools were chosen in Ulsan where 16,479 middle school students attended. After selecting a sample of middle schools throughout the country, researchers randomly chose one class per school (approximately 25 to 30 students) and asked students and their parents to voluntarily participate in the longitudinal study. In the first wave, researchers visited the schools and asked students to voluntarily fill out the questionnaire in a designated classroom. In the second wave, researchers and each of the students who agreed to continue to participate in the research met at a designated place outside of school, with the approval of students' parents. Students were asked to respond to the questionnaires and a nominal gift was given to each participant in order to encourage continued participation in each wave. In order to collect information such as parental education level, family income, parent's career, and family structure, a telephone survey was conducted with respondents' parents during both Wave I and II.

Overall, 3,449 middle school students (1,725 males and 1,724 females) from 104 middle schools voluntarily participated in the first wave of the longitudinal project. In the second wave (collected in 2004), 3,188 students of the original study continued to participate and the attrition rate of participants from the first wave to the second wave of data collection was eight percent, which is relatively low. Of the students retained in the study, 2,751 (80%) respondents had valid data for inclusion in the current analysis.

Dependent measures

Two different types of computer crime from the second wave of the longitudinal data were used as dependent variables. At Wave II, respondents were asked how often they were involved in illegal downloading of software and illegal use of another's registration number or identification number (equivalent to social security number in the United States) online during the last year. Both dependent variables were continuous variables. The findings (see Table 1) indicated that 17 percent of the respondents reported that they illegally downloaded software online at least one time during the previous 12 months. Twelve percent of respondents in the sample also indicated their involvement of illegal use of another's identification number at least one time during the last year.

Independent Measures

The independent measures discussed below were all recorded from the first wave of the survey. This ensures proper temporal ordering of the independent measures' impact on the various dependent measures of deviance.

Low self-control

According to a general theory of crime (Gottfredson and Hirschi, 1990, pp. 89-90), low self-control consists of six dimensions, including impulsive, insensitive, physical, risk taking, short-sighted, and nonverbal. While the 24-item scale developed by Grasmick et al. (1993) has been widely used in prior empirical studies as an attitudinal measure of low self-control, data used in the current study

Table 1
Descriptive statistics of independent and dependent variables

	Min	Max	Mean	S.D.
Dependent measures				
Illegal download of software online at Wave II	0	100	1.78	9.55
Illegal use of other's ID online at Wave II	0	100	0.57	4.25
Independent measures				
Low self-control	7	35	19.37	4.48
Hours of daily computer use	0	12	2.42	1.63
Using computer usually at home	0	1	0.88	0.32
A member of cyber club	0	1	0.23	0.42
Control variables				
Illegal download of software online at Wave I	0	100	3.24	12.11
Illegal use of other's ID online at Wave I	0	100	1.08	5.61
Respondent gender (male = 1)	0	1	0.50	0.50
Parental income	5	3500	290.00	210.00
Academic rank	1	45	16.29	10.25
Parental attachment	5	25	16.78	3.84

N = 2,751.

contained only seven items. For example, respondents were asked to indicate agreement with the following items: I would rather finish an interesting activity than study for an examination tomorrow; I tend to give up when something gets hard and complicated; when I am angry I cannot control myself; I tend to not finish homework on time; I tend to enjoy risky behavior; I enjoy teasing and harassing others; I can hit others if I am really upset. Though the seven items do not measure all six dimensions of low self-control delineated by the theory, these items gauge key characteristics of low-self control such as impulsivity, preference for simple tasks, risking taking, and temper. A low self-control index was created by combining these seven items and it was coded so that higher scores indicate low levels of self-control. The response options for each item ranged from 1 (strongly disagree) to 5 (strongly agree). The low self-control scale (Cronbach's α = .68) had a range of 7 to 35 and a mean level of 22.4.

Opportunity measures

In addition to self-control, Gottfredson and Hirschi (1990) also note that opportunity to engage in deviance is a necessary pre-condition to delinquent behaviors. Computer deviance, in particular, requires knowledge and specific opportunity structures that may not be equally available to all youths, despite the ubiquity of the internet and internet access in Korea. More specifically, computer deviance is reliant on access to a computer. Therefore, three factors relevant to opportunity structure for computer deviance were used. The first measured a typical location of youth's computer usage, the second captured the number of hours that youth reported spending on the computer, and the third indicated cyber club participation at Wave I. A typical location of youth's computer use was a dichotomous measure (1 = typically using computer at home, 0 = typically using computer outside home) and 88 percent of youths report typically using computer at home during the last 12 months. Daily computer time was measured as a count of the hours that youths reported using a computer on a daily basis, which ranges from 0 to 12 hours and has a mean of 2.4 hours. Cyber club was a binary variable that measured membership in online organizations (1 = club member, 0 = no) during prior 12 months and the descriptive statistics indicated that 23 percent of youths report belonging to one or more cyber clubs.

Control Variables

Five factors which are found to have significant effects on traditional deviant behaviors were included as control variables from Wave I data, including: gender, parental income, class academic rank, parental

attachment, and prior computer crimes. Respondent gender was captured using a dichotomous measure (1 = male, 0 = female). Parental income was measured by an item asking respondents' parents their monthly income based on Korean currency (won). It was coded so that higher scores indicated higher income. Academic rank was measured with a continuous variable, with higher scores indicating respondents' lower rank by academic achievement. In South Korea, a student's academic performance ranking in his/her class is notified to both a student and his/her parents in each semester. South Korea has adopted a national curriculum structure and schools are tightly supervised by the central government; therefore, there are no discernible differences among schools in terms of number of students in each class and academic curriculum. For 130 cases, class rank at Wave I was missing and therefore class rank from Wave II was substituted for the missing Wave I data. This treatment of missing data for this control variable is reasonable, given the stability of class rank between Waves I and II (Pearson correlation = .87). Parental attachment (Alpha = .84) was measured by summing five items and some of these items are: My parents try to spend time with me as often as possible, my parents show love and caring toward me, and my parents and I often have conversations. It was coded so that a higher score indicated a higher level of parental attachment. Prior illegal downloading of software and illegal use of another's identification number at Wave 1, lagged dependent measures, were also measured and used as control variables in the corresponding analyses.

Results

A series of negative binominal regression models were estimated to separately examine predictors of illegal download of software and illegal use of other's personal identification number online and the findings are presented in Tables 2 and 3. In each table, the first model tested the unique effect of low-self control on computer crime and the second model included both low self-control and opportunity factors. At every step, five control variables were included in the model.

Consistent with previous research findings, the results of model 1 indicated that self-control was a significant predictor of illegal downloading of software (see Table 2). Youths with low self-control were more likely to engage in the illegal download of software. Three opportunity factors were added to the baseline model and the findings

Table 2
Negative Binomial Regression Models of Illegal Downloading Online

	Model 1	Model 2
Constant	-0.11	-0.62
	(0.56)	(0.61)
Illegal download of software online at Wave I	0.07**	0.06**
	(0.01)	(0.01)
Respondent gender (male = 1)	0.87**	0.77**
	(0.16)	(0.16)
Parental income	-1.11*	-1.19*
	(0.48)	(0.48)
Academic rank	-0.04**	-0.04**
	(0.01)	(0.01)
Parental attachment	-0.02	-0.01
	(0.02)	(0.02)
Low self-control	0.04*	0.02
	(0.02)	(0.02)
Hours of daily computer use		0.20**
		(0.05)
Using computer usually at home		0.34
		(0.24)
A member of cyber club		0.57**
		(0.19)
Model X^2	137.40**	162.70**
Nagelkerke R^2	0.06	0.07

Note 1: Robust standard errors in parentheses.
Note 2: * p<.05; ** p<.01; *** p<.001.

Table 3
Negative Binomial Regression Models of Illegal Use of Another's Identity Online

	Model 1	Model 2
Constant	-1.53*	-1.73**
	(0.61)	(0.66)
Illegal use of another's identification at Wave I	0.24**	0.24**
	(0.05)	(0.05)
Respondent gender (male = 1)	0.57**	0.66**
	(0.17)	(0.17)
Parental income	-0.17	-0.14
	(0.43)	(0.44)
Academic rank	-0.02**	-0.03**
	(0.01)	(0.01)
Parental attachment	-0.03	-0.03
	(0.02)	(0.02)
Low self-control	0.05**	0.04*
	(0.02)	(0.02)
Hours of daily computer use		0.14*
		(0.06)
Using computer usually at home		0.02
		(0.27)
A member of cyber club		0.24
		(0.20)
Model X^2	117.50**	125.50**
Nagelkerke R^2	0.06	0.06

Note 1: Robust standard errors in parentheses.
Note 2: * $p<.05$; ** $p<.01$; *** $p<.001$.

in the model 2 show that two opportunity factors (hours of computer use and a member of cyber club) were significantly related to illegal download of software in the expected direction. Youths that spend more time using computers and/or joined a cyber club were more likely to engage in illegal downloading of software online. Interestingly, the significance of low self-control on this type of computer crime disappears after the inclusion of various computer related crime opportunity factors to the baseline model.

As expected, gender had a significant and positive effect on the illegal download of software in that males were more likely to commit computer deviant behaviors. Interestingly, academic rank had a significant negative effect on illegal download of software, where academically competent youths were more likely to engage in illegal download of software. The findings also indicated that youths who engaged in illegal down of software at Wave 1 were more likely to engage in the illegal behavior at Wave II.

Table 3 presents parallel results for illegal use of other's personal identification number online (equivalent to social security number). Consistent with the findings in Table 2, the results indicated that low-self control was a significant predictor of illegal use of another's personal identification number online in the model 1. Youth with low self-control were more likely to engage in illegal use of another's personal identification number online. One opportunity factor (hours of computer usage) also played a significant role on the illegal use of other's personal identification number online. The findings also showed that low self-control continued to have a significant effect on illegal download, even after the inclusion of opportunity factors to the baseline model.

Consistent with the findings in Table 2, the results indicated that gender, academic performance, and prior computer crime were all significantly related to the illegal use of another's personal identification number online.

Conclusion

The modern networked society is highly vulnerable to computer-related deviance and criminal behaviors. Although computer crime has become a global issue and continues to grow rapidly, limited studies have examined the generality of low self-control theory in explaining computer deviance. Research to date on the causes of

computer deviance typically utilized cross-sectional data collected from convenience samples of college students, and tended to include limited theoretical measures. The current study utilized longitudinal data on a panel of 2751 Korean youths to address limitations of existing research and assess whether a general theory of crime can be useful as a theoretical framework for explaining computer deviance. Below a summary of findings was presented on the applicability of the general theory as it explains computer-related crime.

Regarding the applicability of a general theory of crime to computer crime, the results indicate a significant positive relationship between low self-control and computer crime. Consistent with previous findings (Higgins, 2005; Hinduja, 2004), youths with low self-control were more likely to engage in illegal software downloads and illegal use of other's identification number online. As suggested by Gottfredson and Hirschi (1990), opportunity also played a pivotal role in explaining computer crime. These findings were especially important in that a majority of previous research only focused on the predictability of low self-control on traditional deviant behaviors, failing to include the measurement of criminal opportunity. In the context of computer crime, it can be argued that measurement of criminal opportunity is critical, because computer deviance (especially serious computer crime) depends on the access to a computer and computer knowledge and skills. The findings showed that hours of computer usage and membership in cyber clubs promoted computer crime. It may be possible that youths using a computer longer and/or joining a cyber club are more likely to possess computer-related knowledge and use chat rooms, discussion forums, and/or message boards, which might provide opportunity to learn how to illegally download software and illegally access and acquire other's personal identification online. More research is necessary to better understanding the unique effects of opportunity factors on various types of computer crime. Overall, these findings provided support for the generality of low self-control theory in explaining computer crime, even outside of the U.S. context.

Although gender and class rank were used as control variables and were not the focus of the current research, it is important to discuss their effects on computer crime. First, the current findings consistently indicated that males were more likely than female adolescents to engage in both the illegal download of software and illegal use of another's personal identification number online. This finding was interesting, since one might expect fewer barriers (i.e., anonymity and absence of physical confrontation in cyberspace) to female involvement in deviance in cyberspace, particularly since computer access is nearly universal for Korean adolescents. Future research should explore the gender difference in computer deviance. Interestingly, the results showed that academic rank had a significant negative effect on illegal download of software in that academically competent youths were more likely to engage in this type of computer crime. This finding may suggest that engaging in illegal download of software requires computer knowledge and skills, and academically competent youths are more likely than their academically incompetent counterparts to possess such knowledge.

Although this study had improved upon previous research through the utilization of longitudinal data, limitations of the current research may have also impacted findings. First, limited types of computer crime were used to examine the applicability of a general theory of crime in explaining computer crime. Additional types of computer crime should be included in future studies of computer-related crime. Second, the current study used an attitudinal measurement of self-control which has been commonly utilized in previous research (see Grasmick et al., 1993; Pratt & Cullen, 2000; Tittle, Ward, & Grasmick, 2003). Criminologists have debated whether attitudinal or behavioral measures of self-control or an alternative scale can adequately measure self-control (see Hirschi, 2004; Piquero & Bouffard, 2007 for the debate over the measurements of self-control and alternative measurement of self-control). Future studies need to employ various

measures of self-control to better understand the applicability of a general theory of crime in explaining computer deviance.

Overall, the current study advanced the empirical development and applicability of low self-control in explaining computer crime by using a longitudinal sample of Korean youths. The findings showed that low self-control theory can be applicably in explaining this emerging form of computer related criminal behaviors and opportunity factors also play a pivotal role in explaining the etiology of computer crime. More research with diverse samples and research methodologies is necessary to examine the generality of a general theory of crime in explaining computer crime and deviance. Moreover, applying traditional theories to deviant behavior within the context of cyberspace and emergent technologies certainly warrants further investigation. For example, empirical findings (Higgins, 2006; Higgins & Makin, 2004a; Higgins et al., 2006; Hinduja, 2004; Skinner & Fream, 1997) demonstrate the applicability of social learning theory in explaining the etiology of computer crime. Future studies should continue to explore the causes of computer deviance using longitudinal data and assess the fit of other criminological theories to this realm of behavior.

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