

# Understanding speculative investment behavior in the Bitcoin context from a dual-systems perspective

Bitcoin  
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## Abstract

**Purpose** – The purpose of this paper is to examine users' decision-making mechanism of speculative investment behavior and its sequential consequences in the Bitcoin context from a dual-systems perspective.

**Design/methodology/approach** – Original data were collected via a survey of 334 participants with experience in Bitcoin speculative investment. The partial least squares method was used to test the proposed model.

**Findings** – Speculative investment behavior in the Bitcoin context is driven by strong impulse and weak self-control, leading to negative consequences. The extent of the imbalance between the two cognitive systems is greater with the subjective norm than without it, thus facilitating speculative investment behavior. Noteworthy differences in the impulse and self-control effects on Bitcoin speculative investment are found with differences in Bitcoin objective and subjective knowledge.

**Originality/value** – This study is the first attempt to empirically investigate users' decision-making mechanism used when speculating in Bitcoin.

**Keywords** Bitcoin, Speculative investment behaviour, Dual-systems perspective, Subjective norm, Bitcoin knowledge

**Paper type** Research paper

## 1. Introduction

Bitcoin, the most prominent cryptocurrency, has attracted substantial public attention and been prominently addressed by media, venture capitalists and financial and governmental institutions. Proposed by Nakamoto (2008), Bitcoin is a peer-to-peer electronic payment system that can be sent directly from one party to another without central authority or intermediaries. Although Bitcoin was originally defined as an alternative currency, it has also been viewed as a speculative asset because of its considerable user demand. With its price volatility and expected large return, Bitcoin increased in popularity and became known to the public (Blau, 2017).

Orcutt (2015) pointed out that Bitcoin has not seen broad use in retail transactions despite its increasing popularity and public attention. Hur *et al.* (2015) explained Bitcoin's incompetence as an alternative currency against the conventional tools of trade. Previous studies (Baur *et al.*, 2018; Blau, 2017; Cheah and Fry, 2015; Hur *et al.*, 2015) have provided empirical evidence that Bitcoin is mainly used as a speculative asset and not as an alternative currency. That is, customer participation in Bitcoin is indeed speculative, and Bitcoin users perceive Bitcoin only as a speculative investment tool (Baur *et al.*, 2018; Hur *et al.*, 2015). Nevertheless, the use of Bitcoin as an investment vehicle has been overlooked



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because many researchers continue to focus on the value of Bitcoin as an alternative currency and medium of exchange.

In late 2017, many people were tempted to speculate in Bitcoin in ways that challenged their self-control or willpower because of the expected large return derived from Bitcoin price dynamics. With their expectation of a large return, some Bitcoin users lost their self-control and became impulsive, ultimately engaging in speculative investment. At that point, Bitcoin users' speculative investment behavior might not have been intended or planned but rather impulsive. Because the previous IS approaches to examine planned behaviors (e.g. theory of planned behavior (TPB) (Ajzen, 1991) and theory of reasoned action (Ajzen and Fishbein, 1977)) are inadequate to explain speculative investment behavior in the Bitcoin context, a new approach is needed.

In addition, Bitcoin is not regulated for risk mitigation or governance requirements, leading to substantial risks in the market (Bohr and Bashir, 2014; Moore and Christin, 2013). The speculative nature of Bitcoin as an asset results in asset bubbles and price destabilization (Shiller, 1981; Stein, 1987), causing harmful effects on individuals and society. Policy makers and regulators are seriously concerned about the potential risks of Bitcoin and have thus tried to prohibit speculative trading in Bitcoin to block its negative effects on individuals and society. For example, during the Bitcoin peak in 2017, the People's Bank of China ordered its financial institutions to stop providing banking or funding to any activity related to any cryptocurrency (Yu, 2018). Although the prior literature has investigated the technological, economic and regulatory aspects of Bitcoin (Abramova and Böhme, 2016; Böhme *et al.*, 2015; Glaser *et al.*, 2014), only a few studies have examined Bitcoin usage behavior and its sequential consequences from a user perspective.

To bridge that research gap, we have investigated the cognitive processes of Bitcoin users as they made decisions that led to speculative investment behavior, along with the sequential consequences of their choices. We employed a dual-systems perspective to better understand speculative investment behavior in the Bitcoin context. This study investigates three main issues:

- RQ1.* What decision-making mechanism leads Bitcoin users into speculative investment behavior?
- RQ2.* Does the decision-making mechanism of Bitcoin users differ depending on the subjective norm and Bitcoin knowledge?
- RQ3.* Is speculative investment behavior associated with negative consequences in the Bitcoin context?

To answer those research questions, we collected empirical data from 334 Bitcoin users with experience Bitcoin speculation in the year 2017 in South Korea. South Korea was an appropriate place to observe the Bitcoin speculative phenomenon and collect our data because it was third worldwide in terms of Bitcoin trading volume in 2017. The collected data were used to investigate the effects of impulse and self-control on speculative investment behavior in the Bitcoin context from a dual-system perspective. We then determined how impulse and self-control factors differ depending on the subjective norm and Bitcoin knowledge. Finally, the relationship between speculative investment behavior and negative consequences was examined.

## 2. Theoretical background

### 2.1 Bitcoin

Bitcoin has emerged as a fascinating phenomenon in the finance markets. As the first decentralized cryptocurrency, Bitcoin was designed as an electronic peer-to-peer payment system depending neither on central authorities nor on intermediaries to offer diverse

benefits to customers over traditional fiat money (Nakamoto, 2008). With Bitcoin, transaction parties exchange digital money instantly and directly, independent of their geographical location, with low transaction fees and a certain degree of anonymity (Abramova and Böhme, 2016; Böhme *et al.*, 2015; Van Alstyne, 2014). In addition, “mining” of Bitcoin, that is, the creation and transaction of Bitcoins, is entirely dependent on its users (Nakamoto, 2008). However, Bitcoin raises concerns, such as being used by criminals to launder money or trade illicit goods (e.g. illegal drugs) because of its anonymity (Böhme *et al.*, 2015). The innovative features of Bitcoin open new possibilities in the financial and information technology (IT) fields, but it faces shortcomings and potential risks that question its solidity and widespread use. Despite of its popularity and the public attention it has received, the role of Bitcoin as an alternative currency or speculative asset is being still debated (Baur *et al.*, 2018; European Central Bank, 2012; Glaser *et al.*, 2014; Hur *et al.*, 2015; Yermack, 2015). The previous literature has focused on those two conflicting yet coexisting roles of Bitcoin: alternative currency and speculative asset.

The first approach regards Bitcoin as an alternative currency. This approach focuses on Bitcoin as a decentralized peer-to-peer payment system and conceives of it as an alternative to government-backed currencies (Baur *et al.*, 2018; Nakamoto, 2008). Advocates of Bitcoin as an alternative currency were attracted by its global and government-free design, which eliminated chargeback risks, reduced transaction costs and cross-border transactions fees, and increased security, as well as offering full support for mobile devices and the possibility of purchasing special goods (Baur *et al.*, 2015; Baur *et al.*, 2018). Although some researchers have argued that Bitcoin will be an attractive alternative to traditional currencies, their general attitude toward Bitcoin as an alternative currency is not entirely positive. A few researchers (Antonopoulos, 2014; Bohr and Bashir, 2014) limited the potential of Bitcoin as an alternative currency to specific. Grinberg (2012) and Kristoufek (2015) noted that Bitcoin seems to be the new, revolutionary payment method for micropayments because credit card fees are hardly profitable for small transactions. However, Hur *et al.* (2015) reported the incompetence of Bitcoin as an alternative currency because its level of network effects is low. Orcutt (2015) pointed out that Bitcoin has seldom been used in retail transactions. Baur *et al.* (2018) indicated that societies and businesses are still far from adopting and using Bitcoin as an alternative currency in daily transactions. Brezo and Bringas (2012) analyzed the risks of cryptocurrencies, taking Bitcoin as an example. They highlighted that Bitcoin is vulnerable to speculation and misinformation and that no regulatory body oversees the market. Grant and Hogan (2015) explained six risks taken on by companies or individuals who use Bitcoin: price volatility, exchange rate risk, future legislation, theft or loss, third-party reliability and e-commerce vulnerabilities. Bohr and Bashir (2014) claimed that appropriate legal policies and regulations are essential to overcoming the existing risks and threats slowing down the adoption and use of Bitcoin as a medium of exchange.

The second approach considers Bitcoin as a speculative asset. Given the low adoption and use of Bitcoin as a payment system, this approach asserts that Bitcoin is less of a currency and more of a speculative investment. In particular, the unusual rise and fall in the price of Bitcoin leads to price volatility, which raises the question of whether Bitcoin functions as an alternative currency at all. These researchers argue that Bitcoin has lost its function as a currency against conventional payment tools and is only understood as a speculative asset in the Bitcoin market. Surowiecki (2011) and Spenkelink (2014) claimed that Bitcoin is hoarded by speculators rather than used as medium of exchange. Hur *et al.* (2015) discovered the degree to which the participation of Bitcoin users depends on speculative opportunities in the Bitcoin market. Baur *et al.* (2018) found that users only receive Bitcoin and never send it on to others. Those studies thus reveal that Bitcoin is primarily used as a speculative investment vehicle, due to its high volatility and

large returns. However, Ron and Shamir (2013), Blau (2017) and Gandal *et al.* (2018) found that Bitcoin price dynamics result from price manipulation not speculation. Gandal *et al.* (2018) found suspicious manipulations in a Bitcoin trade in late 2013 that exerted important real effects on the price leap. Hur *et al.* (2015) claimed that the nature of Bitcoin is speculative, but they went on to suggest that its speculative nature might not dominate user behaviors entirely. Urquhart (2016) asserted that Bitcoin is a relatively new investment asset, making it similar to a new alternative investment in an emerging market. He concluded that strong inefficiency is expected during the infancy of Bitcoin but predicted that it will become efficient over time. Blau (2017) did not find any direct association between Bitcoin and speculation and found no evidence that speculative trading contributed to the unprecedented rise and subsequent crash in Bitcoin's value. The relationship between speculative investment behavior and price volatility in the Bitcoin context is still debated in the literature.

### *2.2 Dual-systems perspective on impulse and self-control*

Dual-systems theory has been applied in numerous contexts, including consumer behavior research, such as the service evaluation of healthcare users (Rolland *et al.*, 2013), risk attitudes of private investors (Fehr and Hari, 2014), excessive mobile phone use (Soror *et al.*, 2015) or social media use (Turel and Qahri-Saremi, 2016) and employee acceptance of IS (Bhattacharjee and Sanford, 2006). Watts (2015) suggested dual-systems theory as a promising approach for studying IS use phenomena.

Dual-systems theory posits that a human's thought process is guided by two structurally different systems: reflexive and reflective (Lieberman, 2007; Soror *et al.*, 2015; Strack and Deutsch, 2004; Turel and Qahri-Saremi, 2016). The reflexive system processes information using cognitive and affective associations that trigger a rapid behavioral response. By contrast, the reflective system processes information based on rules that exert control over actions (Soror *et al.*, 2015). The reflexive system is characterized as fast, impulsive, automatic and non-conscious, whereas the reflective system is slow, controlled, conscious and analytical.

The dual-systems perspective is particularly concerned with how the two systems compete to determine behavior (Strack and Deutsch, 2004), suggesting that decisions can be made reflexively through spontaneous and effortless processing (reflexive system) or reflectively through intentional and systematic processing (reflective system). The two systems do not occur in isolation but interact in decision making. Most of the time, the two systems work in harmony. However, when the two systems come into conflict, a tug-of-war between them influences behavior (Hofmann *et al.*, 2009; Soror *et al.*, 2015). That is, while the reflexive system generates an impulse to engage in (or avoid) a behavior, the reflective system reflects on that impulse and behavior to determine whether they are aligned with a person's long-term goals and decide whether the behavior should be enacted or inhibited (Strack and Deutsch, 2004).

Examples of the two systems in the literature are automatic affective reactions vs self-control (Friese and Hofmann, 2009; Hofmann *et al.*, 2009; Turel and Qahri-Saremi, 2016), habit vs self-regulation (Soror *et al.*, 2015), heuristic processing vs systematic processing (Chaiken, 1980; Zhang *et al.*, 2014) and automatic stereotyping vs suppression (Devine, 1989). To investigate the decision-making process pertaining to speculative investment behavior in the Bitcoin context, we use impulse to represent the reflexive system and self-control to represent the reflective system.

### *2.3 Speculative investment behavior in the Bitcoin context*

Bitcoin prices experienced a dramatic increase, from \$5.28 at the beginning to its peak price of \$18,900 in December 2017, and then fell to below \$6,500 in February 2018. Despite the

potential risks and widespread misinformation about Bitcoin, many people were obsessed with Bitcoin investment. People thought that buying Bitcoin to sell it later is actually worth more than they think and thus they spent a substantial amount of money and time with the expectation of great profits. Bitcoin users searched for speculative opportunities in the Bitcoin market. The prior literature pointed out that speculators distort market prices through their activities, thereby harming people who depend on the commodities being traded (Angel and McCabe, 2009). Speculators do not produce anything useful and are parasites upon society. Thus, speculative behavior results in negative consequences for both individuals and society. Therefore, we define speculative investment behavior in the Bitcoin context as a behavior of buying or selling Bitcoin by spending time and money in the expectation of profiting from market fluctuations.

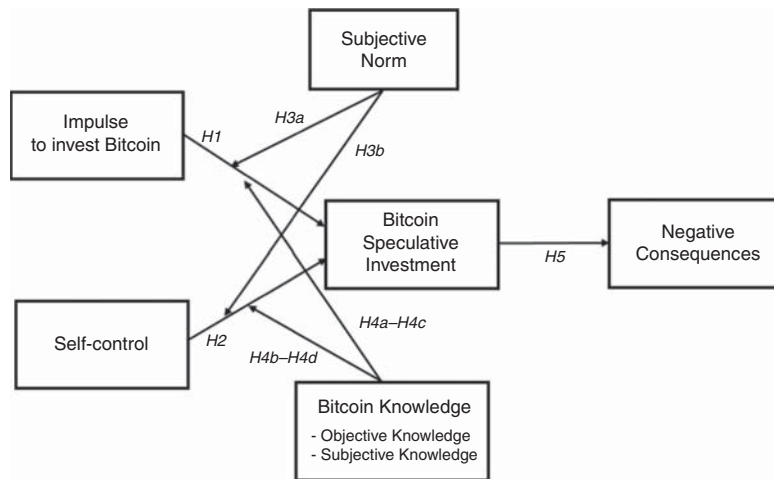
Dual-systems theory has been particularly useful in explaining the etiology of unplanned or problematic consumer behaviors. Prior researchers (Soror *et al.*, 2015; Spada, 2014; Turel *et al.*, 2014; Turel and Qahri-Saremi, 2016; Turel and Serenko, 2010) have investigated unplanned user behavior and problematic IT use behavior, such as internet overuse, mobile e-mail and Facebook addiction, and problematic mobile phone and SNS use. The dual-systems perspective indicates that an imbalance between the reflexive and reflective systems can result in a strong impulse to engage in unplanned behavior with ineffective self-control. Speculative investment behavior in the Bitcoin context occurred when users were exposed to an external cue (e.g. high volatility and large return) that generated a strong urge to impulsively invest in Bitcoin, which weakened self-control. Strong impulses reinforce people's drive to engage in speculative investment behavior, making it difficult to resist temptation and ultimately leading to speculative investment behavior (Turel and Qahri-Saremi, 2016). Therefore, speculative investment behavior in the Bitcoin context can be explained as an unplanned behavior of Bitcoin usage driven by an imbalance between the reflexive and reflective systems.

Although many researchers and regulators have expressed concern about Bitcoin speculation, the sequential consequences of speculative investment behavior in the Bitcoin context remain underexplored. The nature of speculation might lead Bitcoin investors to experience distraction and interference in their work and social activities, negative emotions and financial ruin. Speculative investors are also exposed to significant potential risks through Bitcoin's technical design, such as threats from malicious software and criminal usage, hacking or loss through its anonymity and legal and regulatory risk (Abramova and Böhme, 2016; Cheah and Fry, 2015; Grant and Hogan, 2015). Hence, Bitcoin as a speculative asset motivates this research to enrich the existing literature on unplanned behavior with Bitcoin, namely, Bitcoin speculation.

### 3. Research model and hypotheses

Based on dual-systems theory, this study regards Bitcoin speculative investment behavior influenced by the outcome of the tug-of-war between the two systems. In this study, the reflexive system is represented as an impulse, and the reflective system is represented as self-control. The impulse can be either good or bad depending on the situation (Soror *et al.*, 2015; Turel and Serenko, 2010), but when the impulse conflicts with already established goals, self-control needs to be engaged (Hofmann *et al.*, 2009). Therefore, this study proposes a research model in which Bitcoin speculative investment behavior is influenced by the impulse and self-control simultaneously, which leads to negative consequences. The research model then hypothesizes that the effects of impulse and self-control differ depending on the subjective norm and Bitcoin knowledge (i.e. objective and subjective knowledge (SK)). Figure 1 shows the proposed model.

An impulse arises when a latent motivation meets an activating stimulus that is suitable for satisfying this (Frieze and Hofmann, 2009). Impulses occur automatically and without



**Figure 1.**  
Research model

effort from an individual. Loewenstein (1996) indicated that an impulse typically possesses a strong incentive value consisting of a primitive hedonic reaction to a tempting stimulus. Hofmann *et al.* (2009) referred to an impulse as people's tendency to perform an unplanned behavior, often an urge to approach or act on a temptation at hand. An unconstrained impulse makes people do something unconsciously until it has naturally come to a bad end (e.g. reaching the bottom of a potato-chip bag while dieting) (Hofmann *et al.*, 2009). Most unconstrained impulsive behaviors interfere with long-term goals or generate interpersonal conflict at a certain point (Bogg and Roberts, 2004; Tangney *et al.*, 2004). According to Harden and Tucker-Drob (2011), impulse refers to the reflexive system's output, defined in the present study as people's tendency to act on behavioral impulses without planning or considering potential consequences.

Self-control describes an individual's ability to control or regulate their emotions and behaviors (Hofmann *et al.*, 2009). An individual's self-control reflects on the consequences of a behavioral choice and attempts to prevent it if those consequences are deemed damaging or socially unacceptable (Hofmann *et al.*, 2009). Self-control is particularly manifested in people's restraint standards, that is, long-term standards about how behavior should be regulated in a given domain of life (Hofmann *et al.*, 2009). Self-controlled individuals are more adept than their impulsive counterparts at regulating their behavioral, emotional and attentional impulses to achieve long-term goals. In this study, self-control, which is from the reflective system, is defined as people's tendency to override or inhibit undesired behavioral tendencies (such as impulses) and refrain from acting on them, based on Tangney *et al.* (2004).

Social cognitive theory (Bandura, 1997) suggests that a person's self-regulatory mechanism influences their level of self-control and a lack of self-control leads to various types of problematic behaviors and social maladaptation. Collins and Lapp (1992) pointed out that individuals who possess the ability to resist a temptation develop strong self-control, which mitigates unplanned behavior. People with high self-control are good at controlling and overriding their impulses, leading to a low level of unplanned behaviors, whereas those with low self-control more often act on their impulses, leading to a high level of unplanned behavior (Friese and Hofmann, 2009). Therefore, impulse makes it more likely that investors will engage in Bitcoin speculative investment behavior. Simultaneously, self-control makes investors consciously aware of their behavior,

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preventing or inhibiting Bitcoin speculative investment behavior. Consequently, the following hypotheses are developed:

*H1.* Impulse is positively associated with Bitcoin speculative investment behavior.

*H2.* Self-control is negatively associated with Bitcoin speculative investment behavior.

When people adopt or use technological innovations, the social context of the decision makers should not be ignored. If the social context is in favor of adopting and using a technology, then it plays an important role in the decision process (Webster and Trevino, 1995). Bass (1969) emphasized that innovation adoption and use are significantly influenced by the pressures of the social system. The importance of the subjective norm as an attitude toward technology use has previously been established in the IS context. TPB (Ajzen, 1991) suggests that the subjective norm is a significant determinant influencing planned behaviors such as technology adoption and usage. In TPB, the subjective norm refers to beliefs about the expectations of important referent others and users' motivations in complying with those expectations (Chiou, 1998). Based on Fishbein and Ajzen (1975), we account for the social context by including the subjective norm, defined as user perceptions about whether most people who are important to them think that they should invest in Bitcoin.

Users exposed to greater social pressure will more impulsively invest in Bitcoin as a speculative asset because they want to belong among their referent people and promote others' goals. Baur *et al.* (2015) found that some people unfamiliar with the Bitcoin process attempted to use or invest in Bitcoin merely because of a friend's recommendation. Glaser *et al.* (2014) also found that Bitcoin users' participation in speculation was positively influenced by positive news but not influenced at all by serious negative news, such as thefts and hacking. Liu and Tsyvinski (2018) argued that consumer activities on search forums, such as Google and social medial sites (e.g. Twitter), are related to the price of Bitcoin. They reported that an increase in keyword searches for Bitcoin led to an increase in the Bitcoin price. Based on those prior studies, the subjective norm might be associated with speculative investment behavior in the Bitcoin context.

However, given that such speculative investment is regarded as an unplanned behavior, a new role for the subjective norm is required to explain our proposed model. Rook and Fisher (1995) found that the social norms related to products or services moderated the effects of consumers' impulsive tendencies. They indicated that consumers can experience social encouragement or discouragement when the urge to engage in a behavior arises. Moreover, Sawang *et al.* (2014) pointed out that the effect of perceived behavioral control on intention to use technology differs depending on the subjective norm. The subjective norm motivates users to find a way to fit in with relevant others by changing their self-control (Markus and Kitayama, 1991). Therefore, we propose that the subjective norm promotes an impulse and simultaneously mitigates self-control to allow individuals to comply with others' Bitcoin speculative investment behavior. The strengthened impulse and weakened self-control of Bitcoin investors trigger them to actively engage in highly Bitcoin speculative investment behavior. As such, we propose the following hypotheses:

*H3a.* The subjective norm strengthens the effect of impulse on Bitcoin speculative investment behavior.

*H3b.* The subjective norm weakens the effect of self-control on Bitcoin speculative investment behavior.

The level of consumers' product knowledge influences their decision-making behavior (Brucks, 1985; Park *et al.*, 1994). Consumers' product knowledge is divided into objective knowledge (OK) and SK. OK refers to accurate, product-related information stored in

memory, whereas SK refers to people's perceptions of what or how much they know about a product. Although SK is strongly related to OK, the two do not always coincide (Brucks, 1985; Park *et al.*, 1994). OK is usually measured via testing procedures under the supervision of an impartial third party, whereas SK can be measured using self-assessments. In other words, OK describes what an individual actually knows, whereas SK reflects an individual's degree of confidence in their knowledge (Brucks, 1985; Chiou, 1998).

The importance of OK in wise financial decision making is unquestionable (Hadar *et al.*, 2013). Financial education programs typically focus on increasing consumers' OK. In the Bitcoin context, Henry *et al.* (2018) highlighted that many people had heard of Bitcoin, but only a few people had adopted and used it because of a lack of Bitcoin knowledge. Hadar *et al.* (2013) found that consumers with a high level of OK about financial instruments can deter their willingness to pursue a risky investment. OK about financial decisions usually diminishes the urge to engage in speculation even when user confidence and willingness to take risks are considered. That is, OK restricts impulse and facilitates self-control, leading people to manage their risky investments. Therefore, we hypothesize that:

*H4a.* The effect of impulse on Bitcoin speculative investment behavior is weaker in the high OK group than in the low OK group.

*H4b.* The effect of self-control on Bitcoin speculative investment behavior is stronger in the high OK group than in the low OK group.

People's behaviors are strongly influenced by their confidence in their ability to perform them (Chiou, 1998). In uncertain and complex choice settings, SK has been shown to be a stronger motivation of behavior than OK (Hadar *et al.*, 2013; Mishra and Kumar, 2011). Hadar *et al.* (2013) pointed out that willingness to pursue a risky investment increases when SK is high. Bitcoin users with a high level of SK are more likely to use stereotypical information or heuristics that provide simplistic cues in complex decision-making settings (Lee and Lee, 2009). This attitude toward Bitcoin investment can promote the effect of impulse and overshadow the effect of self-control, leading to Bitcoin speculation. Thus, the effect of impulse on Bitcoin speculative investment behavior will be stronger, and the effect of self-control will be weaker when Bitcoin users have high SK. Thus, we hypothesize the following:

*H4c.* The effect of impulse on Bitcoin speculative investment behavior is stronger in the high SK group than in the low SK group.

*H4d.* The effect of self-control on Bitcoin speculative investment behavior is weaker in the low SK group than in the high SK group.

Prior studies have shown that impulse triggers strong urges to engage in a behavior that will be problematic if performed (Hofmann *et al.*, 2009; Strack and Deutsch, 2004). In this study, Bitcoin speculative investment behavior is regarded as the unplanned behavior of Bitcoin use driven by an imbalance between the reflexive and reflective systems. Considering the nature of speculation and the potential risks of Bitcoin, Bitcoin speculative investment behavior could lead to negative outcomes such as financial loss, distraction and interference in work and social activities, negative emotions, and low work performance (Fox and Moreland, 2015; Moqbel and Kock, 2018). Policy makers and regulators are concerned about the individual negative outcomes that derive from a high level of Bitcoin speculative investment and deem them socially unacceptable. Thus, several countries, such as China and Korea, established strict regulations to hinder that behavior. However, only a few studies have clearly investigated whether Bitcoin speculative investment behavior actually leads to negative consequences for individual users.

In this study, we define negative consequences as the extent to which an individual experiences personal, social and professional problems as a result of Bitcoin speculative



investment behavior (Haagsma *et al.*, 2013; Soror *et al.*, 2015). A high level of speculative investment behavior is expected to correlate positively with inappropriate investing and thus with an increase in negative consequences such as financial loss, negative emotions, distraction from one's work, and trouble in social activities and relationships. As a result, the following hypothesis is developed:

- H5. Bitcoin speculative investment behavior is positively associated with negative consequences.

## 4. Research methodology

### 4.1 Measurement

To achieve content validity, we developed our measurement items based on an intensive literature review. Based on the extant innovation and IS literature, we developed comprehensive multiple-item measures of impulse, self-control, subjective norm, SK, Bitcoin speculative investment behavior and negative consequences. To test users' OK about Bitcoin, 14 questions with three multiple-choice answers (True/False/Don't know) were developed. Measures of Bitcoin speculative investment behavior were also developed to assess the potential for Bitcoin speculation; it contains four general questions about overspending of time and money. Negative outcome (Caplan, 2010; Haagsma *et al.*, 2013) was assessed by four questions about financial loss, psychological trouble, trouble in work and social activities and degree of difficulty in managing life overall. Because respondents often underreport negative behaviors and consequences and over-report positive behaviors, we statistically controlled for the presence of social desirability bias by using the short form of the Marlowe–Crowne social desirability scale (Reynolds, 1982). Age, gender, education and annual income, which have all been found to potentially influence Bitcoin speculative investment behaviors, were used as control variables in this study.

Before conducting the main survey, a pre-test was performed to examine the reliability and validity of the instruments. The pre-test involved 30 respondents with experience investing in Bitcoin in 2017. The pre-test results led to a significant refinement and restructuring of the questionnaire. The initial face and internal validity of the measures were also established. The measures were evaluated using a seven-point Likert-type scale, ranging from “extremely low” (1) to “extremely high” (7). The structure of the measurements used, and the relevant studies are shown in Table AI (Appendix).

### 4.2 Sample and data collection

In this study, we targeted Bitcoin users with experience in Bitcoin speculation in the year 2017 in South Korea because from 2017 to early 2018 is the heaviest period of Bitcoin speculation in which the Bitcoin price rose sharply from \$894 to \$18,900 and then promptly fell below \$6,500 and Bitcoin trading volume in the year 2017 in South Korea was active enough to rank third worldwide. Survey questionnaires were distributed and collected for three weeks in April 2018, when the price of Bitcoin had just fallen after its peak in 2017.

E-mail invitations were first sent to the targeted participants. We continued sending invitations until 1,000 respondents accepted the offer to participate. Respondents, who all had Bitcoin investment experience over the previous three months, were asked to respond to the entire questionnaire. To ensure that the respondents fully understood the survey context, an initial screening question was asked to determine whether they had experience using and investing in Bitcoin. After the main survey, a total of 359 responses were received, of which 25 were classified as outliers and eliminated. Thus, 334 responses were used in our analysis, indicating a usable response rate of 33.4 percent. In our sample, most respondents (95.2 percent) had Bitcoin investment experience during 2017 and early 2018, the heaviest period of Bitcoin speculation in the cryptocurrency trading market, as shown in Table I.

IMDS 119,7	Division			Division		
	Freq.			Percent (%)		
1440	<i>Gender</i>			<i>Annual income</i>		
	Men			Below \$20		
	Women			\$20–39.9		
	Total			\$40–59.9		
	<i>User characteristics</i>			\$60–79.9		
	Early adopters			\$80–100		
	Late adopters			Above \$100		
	Total			Total		
	<i>Age</i>			<i>Period of investment</i>		
	20–29			From 2018		
	30–39			From 4/4 in 2017		
	40–49			From 3/4 in 2017		
	50–59			From 2/4 in 2017		
	60+			From 1/4 in 2017		
	Total			From 2016		
				From 2015 or before		
				Total		
	<i>Education</i>			<i>Frequency of investment</i>		
	Under high school			Daily		
	High school			Weekly		
	College/associate			Monthly		
	Bachelor			Every 3 mon.		
	Master			Every 6 mon.		
	PhD			Once a year		
	Total			Almost not use		
				Total		
	<i>Bitcoin use for other purpose</i>					
	As a means of payment for goods services					
	As a means of cross-border money transfers					
	As a store of value					
	As a means of earning mining revenue					
	Do not use					
	Total					

**Table I.**  
Sample characteristics

Therefore, our sample was adequate for investigating speculative investment behavior among Bitcoin users.

Table I summarizes the characteristics of the respondents. Our sample predominantly consisted of men (56.3 percent) age 30–39 (27.5 percent) who regarded themselves as early adopters and had bachelor’s degrees (65.0 percent) and \$20,000–\$39,900 in annual income. In terms of frequency, respondents invested in Bitcoin weekly (43.1 percent), monthly (26.0 percent), or daily (16.8 percent). In terms of Bitcoin use for other purpose than speculative means, of the respondents, 31 percent used Bitcoin as a store of value, followed by those who did not use Bitcoin for other purposes (26 percent) and those who used it as a means of payment for goods or services (22.7 percent), as a means of earning mining revenue (16.0 percent), and as a means of cross-border money transfer (3.8 percent).

### 5. Analysis and results

The partial least squares (PLS) method was adopted to examine the proposed model and its hypotheses. The PLS is recommended for predictive research models with an emphasis on theory development (Fornell and Bookstein, 1982). Given that the current study is an initial

attempt to advance a theoretical model that investigates the cognitive decision-making process involved in Bitcoin speculative investment behavior, we chose PLS because of its appropriateness for exploratory science (Chin, 1998). Smart PLS version 3.00 was used to analyze the measurement and structural models.

### 5.1 Measurement model

To validate our measurement model, we began by assessing the content, convergent and discriminant validity of the constructs (Hair *et al.*, 1998). First, to test content validity, we examined the process by which scale items were generated (Straub, 1989). That process confirmed the content validity of our scales. Second, we evaluated convergent validity examining the Cronbach's  $\alpha$ , composite reliability (CR) and average variance extracted (AVE) for each construct (Barclay *et al.*, 1995).

As shown in the Panel A of Table II, the Cronbach's  $\alpha$  and CR values were higher than the recommended level (0.7) (Chin *et al.*, 2003). The AVE values of our measures were higher than 0.5 (Fornell and Larcker, 1981), thereby supporting convergent validity. In addition, the discriminant validity of our instrument was assessed using the square root of the AVE (Fornell and Larcker, 1981). As shown in the Panel A of Table II, the square root of the AVE of every construct in the measurement model exceeds all off-diagonal correlations between the focal constructs and all other constructs in the model. Moreover, each of the measurement items loaded higher than 0.70 (Hair *et al.*, 1998). Overall, the measurement model was strongly supported by the gathered data and was suitable for further analysis.

The multicollinearity of all variables was assessed using variance inflation factors (VIFs). The VIF values for the variables were acceptable, ranging from 1.033 to 1.361. Those results and the correlation indicated that multicollinearity was not a serious issue with this research model (Neter *et al.*, 1996). Finally, we checked for possible common method variance (CMV) using Harman's single-factor test (Podsakoff *et al.*, 2003). The results validated that the seven factors were extracted with an eigenvalue that was greater than one and that no general factor was apparent in the unrotated factor structure, indicating no excessive CMV.

### 5.2 Structural model

**5.2.1 Hypothesis tests.** Based on an adequate measurement model and a suitably low level of multicollinearity, all proposed hypotheses were tested using PLS. The path coefficients,  $t$ -values, and  $R^2$  were used to test the structural model (Figure 2). As illustrated in Figure 2, all paths within the research model were supported at the 0.01 level. The proposed model accounted for 50.0 percent of the variance in Bitcoin speculative investment behavior and 54.8 percent of the variance in negative consequences.

Figure 2 demonstrates that the impulse to invest in Bitcoin exerted a significant positive effect on speculative investment behavior ( $\beta = 0.307$ ,  $p < 0.01$ ). Thus,  $H1$  was supported. Self-control was negatively related to speculative investment behavior ( $\beta = -0.230$ ,  $p < 0.01$ ), providing support for  $H2$ . The results also reveal that the effect of impulse was greater than that of self-control, indicating that Bitcoin investors had impulsively engaged in speculative investment behavior. The results show that the moderating effect between impulse and the subjective norm on Bitcoin speculative investment behavior ( $\beta = 0.199$ ,  $p < 0.01$ ) was smaller than the single effect of impulse ( $\beta = 0.307$ ,  $p < 0.01$ ). The subjective norm did not strengthen but rather weakened the effect of impulse on speculative investment, not supporting  $H3a$ . Moreover, the subjective norm positively influenced self-control regarding Bitcoin speculative investment behavior ( $\beta = 0.174$ ,  $p < 0.01$ ), whereas self-control alone exerted a negative influence ( $\beta = -0.230$ ,  $p < 0.01$ ). The moderating effect between the subjective norm and self-control was

Table II.  
Results of the  
measurement model  
analysis

(a) Assessment of reliability and validity

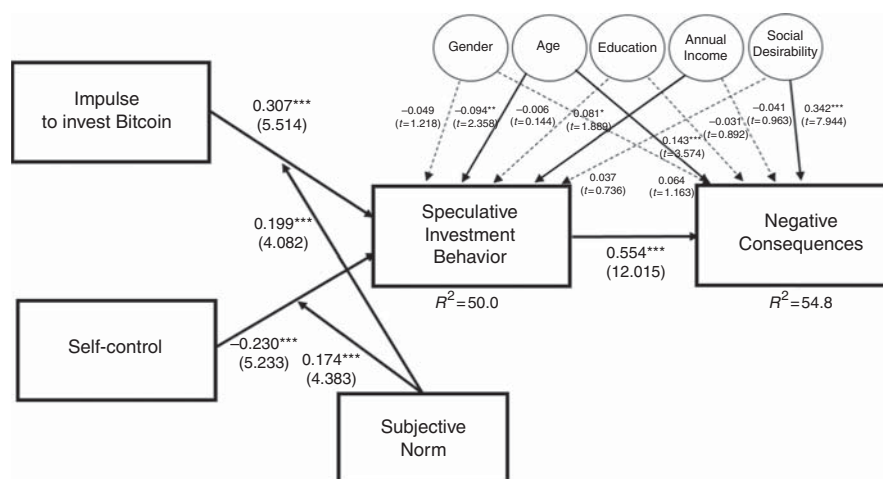
Construct	Item	Cronbach's $\alpha$	CR	AVE	SAVE	Loading	t-Statistic
Impulse	IP1	0.921	0.944	0.808	0.899	0.905**	67.395
	IP2					0.903**	66.190
	IP3					0.871**	48.688
	IP4					0.915**	80.005
Self-control	SC1	0.785	0.875	0.700	0.837	0.828**	23.783
	SC2					0.885**	54.190
	SC3					0.794**	20.786
	SN1					0.864**	40.784
Subjective norm	SN2	0.896	0.927	0.762	0.873	0.884**	51.387
	SN3					0.864**	42.061
	SN4					0.880**	55.313
	SI1					0.797**	33.324
Speculative investment behavior	SI2	0.866	0.909	0.713	0.845	0.861**	54.566
	SI3					0.847**	46.909
	SI4					0.872**	59.685
	NC1					0.901**	67.094
Negative consequence	NC2	0.957	0.967	0.853	0.924	0.907**	76.713
	NC3					0.934**	122.534
	NC4					0.935**	119.297
	NC5					0.940**	119.191

(b) Correlations of variables

Construct	Means (SD)	1	2	3	4	5	6	7	8	9	10	11
1. Gender	1.437 (0.497)											
2. Age	2.805 (1.316)	0.039										
3. Education	3.757 (0.919)	-0.109*	-0.066									
4. Income	2.686 (1.235)	-0.191**	0.177*	0.184**								
5. Social desirability	4.167 (0.592)	-0.030	-0.081	0.050	0.140*							
6. Impulse	3.574 (1.319)	0.087	0.038	-0.051	0.085	0.272**						
7. Self-control	5.036 (1.020)	0.091	0.081	0.051	-0.103	0.135*	-0.259**					
8. Subjective norm	3.812 (1.248)	0.123*	0.075	-0.031	0.120*	0.310**	0.400**	-0.046				
9. Objective knowledge	0.396 (0.236)	-0.309**	-0.176**	0.258**	0.075	-0.092	-0.268**	0.035	-0.336**			
10. Subjective knowledge	4.516 (1.020)	-0.218**	-0.167**	0.129*	273**	0.203**	0.056	0.001	0.266**	0.400**		
11. Speculative investment	3.650 (1.335)	-0.036	-0.069	-0.001	0.214**	0.246**	0.537**	-0.352**	0.455**	-0.094	0.296**	
12. Negative consequence	2.881 (1.501)	0.096	0.076	-0.069	0.121*	0.344**	0.541**	-0.263**	0.407**	-0.341**	0.021	0.644**

Notes: CR: composite reliability; AVE: average variance extracted; SAVE: square root of AVE. \* $p < 0.05$ ; \*\* $p < 0.01$

Notes: CR: composite reliability; AVE: average variance extracted; SAVE: square root of AVE. \* $p < 0.05$ , \*\* $p < 0.01$



Notes: \* $p < 0.10$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$

**Figure 2.**  
Results of  
hypothesis tests for  
the total group

significant, but the subjective norm weakened the effect of self-control on speculative investment behavior, thus supporting *H3b*. Finally, we tested the relationship between Bitcoin speculative investment behavior and negative consequences. We found that Bitcoin speculative investment behavior had a significant positive effect on negative consequences ( $\beta = 0.554$ ,  $p < 0.01$ ). Therefore, *H5* was supported.

Among the five control variables, education was related to neither speculative investment behavior nor negative consequences (Figure 2). However, annual income had a positive and significant effect on Bitcoin speculative investment behavior ( $\beta = 0.081$ ,  $p < 0.10$ ), and social desirability was positively related to negative consequences ( $\beta = 0.336$ ,  $p < 0.01$ ). Age had a significant negative effect on speculative investment behavior ( $\beta = -0.094$ ,  $p < 0.05$ ) and a significant positive effect on negative consequences ( $\beta = 0.143$ ,  $p < 0.01$ ). These results showed that young investors with a high annual income engaged the most in Bitcoin speculative investment behavior, and old investors with high social desirability experienced the highest level of negative consequences, within the total group.

**5.2.2 Moderation test of Bitcoin knowledge.** Based on the previous literature (Brucks, 1985; Chiou, 1998; Hadar *et al.*, 2013; Park *et al.*, 1994), Bitcoin knowledge was divided into OK and SK. To test the hypothesized moderation effects of Bitcoin knowledge, we used a median-split method to divide subjects into high- and low-knowledge groups (OK: Median = 7.0, SD = 3.3; SK: Median = 4.1, SD = 1.0). As shown in Table III, our user classification produced four groups: the high OK group ( $n = 113$ ), the low OK group ( $n = 221$ ), the high SK group ( $n = 207$ ) and the low SK group ( $n = 127$ ).

		Objective knowledge		Total
		Low (0)	High (1)	
Subjective knowledge	Low (0)	93	34	127
	High (1)	128	79	207
Total		221	113	334

Note:  $n = 334$

**Table III.**  
User classification by  
Bitcoin subjective and  
objective knowledge

As indicated in Table IV, the effects of impulse and self-control on Bitcoin speculation varied depending on the two types of Bitcoin knowledge. Specifically, the high OK group presented a weaker coefficient path for impulse ( $\beta = 0.189, p < 0.05$ ) than the low OK group ( $\beta = 0.385, p < 0.01$ ), providing support for *H4a*. The effect of self-control on the speculative investment behavior in the high OK group ( $\beta = -0.253, p < 0.05$ ) was greater than that in the low OK group ( $\beta = -0.194, p < 0.01$ ). Thus, *H4b* was supported. In other words, the high OK group had higher self-control than the low OK group. Within the high OK group, the subjective norm strengthened the effect of impulse ( $\beta = 0.223, p < 0.05$ ) and weakened the effect of self-control ( $\beta = 0.209, p < 0.10$ ) on Bitcoin speculative investment behavior. In the low OK group, the moderating effect of the subjective norm on impulse was not significant on speculative investment behavior, whereas that on self-control was positively significant ( $\beta = 0.203, p < 0.01$ ). Bitcoin speculative investment behavior had a significant positive effect on negative consequences in both the high and low OK groups ( $\beta = 0.566, p < 0.01$ ;  $\beta = 0.609, p < 0.01$ , respectively), but the low OK group experienced greater negative consequences than the high OK group.

The impulse to invest in Bitcoin was stronger in the high SK group ( $\beta = 0.328, p < 0.01$ ) than in the low SK group ( $\beta = 0.215, p < 0.05$ ), which supports *H4c*. Moreover, the high SK group had weaker self-control ( $\beta = -0.252, p < 0.01$ ) than the low SK group ( $\beta = -0.294, p < 0.01$ ). Therefore, *H4d* was supported. In the high SK group, the effects of the subjective norm on both impulse and self-control were positive and significant on speculative investment behavior ( $\beta = 0.190, p < 0.05$ ;  $\beta = 0.177, p < 0.01$ , respectively). In the low SK group, the subjective norm did not strengthen the effect of impulse, but it did weaken the effect of self-control on speculative investment behavior ( $\beta = 0.182, p < 0.10$ ). The negative consequences from speculative investment were greater in the high SK group ( $\beta = 0.543, p < 0.01$ ) than in the low SK group ( $\beta = 0.529, p < 0.01$ ).

To further validate the proposed model and hypotheses, we conducted an *ad hoc* test by Bitcoin user types because user levels of both OK and SK varied. As shown in Table V,

	Objective knowledge		Subjective knowledge	
	High ( <i>n</i> = 113)	Low ( <i>n</i> = 221)	High ( <i>n</i> = 207)	Low ( <i>n</i> = 127)
IP → SI	0.189** (2.014)	0.385*** (5.963)	0.328*** (5.000)	0.215** (2.068)
SC → SI	-0.253** (2.464)	-0.194*** (3.920)	-0.252*** (5.110)	-0.294*** (2.743)
IP × SN → SI	0.223** (1.966)	0.075 (1.082)	0.190** (2.480)	0.217 (1.225)
SC × SN → SI	0.209* (1.884)	0.203*** (3.701)	0.177*** (3.854)	0.182* (1.647)
SI → NC	0.566*** (6.234)	0.609*** (10.754)	0.543*** (10.452)	0.529*** (6.734)
Gender → SI	-0.114 (1.168)	-0.001 (0.016)	-0.051 (1.116)	0.024 (0.299)
Age → SI	-0.142 (0.623)	-0.048 (1.068)	-0.085 (1.478)	-0.041 (0.585)
Education → SI	-0.055 (0.700)	0.018 (0.494)	-0.009 (0.190)	-0.009 (0.127)
Annual income → SI	0.112 (1.126)	0.025 (0.497)	0.030 (0.487)	0.140 (1.853)
Social desirability → SI	0.010 (0.043)	0.102* (1.716)	0.048 (0.799)	-0.111 (0.556)
Gender → NC	0.042 (0.545)	-0.007 (0.154)	0.089 (1.957)	0.026 (0.585)
Age → NC	0.176** (2.269)	0.088* (1.824)	0.077 (1.575)	0.207*** (3.004)
Education → NC	-0.152* (1.816)	0.032 (0.879)	-0.073 (1.591)	0.020 (0.296)
Annual income → NC	0.011 (0.130)	-0.058 (1.080)	0.025 (0.437)	-0.102 (1.250)
Social desirability → NC	0.340* (1.709)	0.284 (5.064)	0.374*** (7.051)	-0.200 (0.826)
<i>R</i> <sup>2</sup>				
SI	0.338	0.626	0.559	0.378
NC	0.473	0.580	0.612	0.395

**Table IV.**  
PLS analysis results  
of moderation tests for  
Bitcoin knowledge

**Notes:** IP: impulse; SC: self-control; SN: subjective norm; SI: speculative investment behavior; NC: negative consequence. \* $p < 0.10$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$

	Expertise ( <i>n</i> = 79)	Well-Informed ( <i>n</i> = 34)	Self-confident ( <i>n</i> = 128)	Stranger ( <i>n</i> = 93)
	High in OK/ High in SK	High in OK/ Low in SK	Low in OK/ High in SK	Low in OK/ Low in SK
IP → SI	0.166 (1.357)	0.042 (0.366)	0.483*** (5.450)	0.224** (2.059)
SC → SI	−0.332*** (3.056)	−0.101 (0.712)	−0.168** (2.311)	−0.343*** (3.282)
IP × SN → SI	0.296* (1.787)	−0.340 (1.044)	−0.026 (0.211)	0.179 (0.833)
SC × SN → SI	0.215* (1.859)	0.243* (1.657)	0.226*** (2.963)	0.075 (0.483)
SI → NC	0.581*** (5.257)	0.479*** (4.041)	0.591*** (7.883)	0.588*** (6.734)
Gender → SI	−0.117 (1.325)	−0.070 (0.611)	−0.019 (0.331)	0.081 (1.054)
Age → SI	−0.058 (0.504)	−0.224** (2.562)	−0.080 (1.171)	0.068 (0.981)
Education → SI	−0.051 (0.545)	−0.254** (2.423)	0.022 (0.460)	−0.020 (0.308)
Annual income → SI	0.005 (0.042)	0.385*** (3.160)	−0.017 (0.115)	0.077 (0.874)
Social desirability → SI	−0.049 (0.209)	−0.342 (1.082)	0.101 (1.245)	−0.159 (0.749)
Gender → NC	−0.068 (0.846)	0.400*** (4.629)	0.075 (1.315)	−0.162 (2.260)
Age → NC	0.263*** (3.031)	0.017 (0.228)	−0.007 (0.111)	0.167** (2.022)
Education → NC	−0.181* (1.874)	−0.059 (0.528)	−0.017 (0.307)	0.073 (1.178)
Annual income → NC	−0.020 (0.191)	0.158 (1.593)	0.045 (0.623)	−0.140* (1.757)
Social desirability → NC	0.390 (1.532)	−0.059 (0.317)	0.310*** (4.157)	−0.260 (0.797)
<i>R</i> <sup>2</sup>				
SI	0.476	0.681	0.654	0.554
NC	0.526	0.441	0.638	0.479

**Table V.**  
PLS analysis results  
of *ad hoc* tests  
among four types  
of Bitcoin users

**Notes:** IP: impulse; SC: self-control; SN: subjective norm; SI: speculative investment behavior; NC, negative consequence. \**p* < 0.10; \*\**p* < 0.5; \*\*\**p* < 0.01

simultaneously considering Bitcoin OK and SK produced four distinctive user groups: the *expertise* (high OK and high SK) group (*n* = 79), the *well-informed* (high OK and low SK) group (*n* = 34), 3) the *self-confident* (low OK and high SK) group (*n* = 128) and the *stranger* (low OK and low SK) group (*n* = 93). We conducted four separate PLS analyses to test each group individually (Table V).

The results showed that the effect of impulse on Bitcoin speculative investment in the self-confident group was the highest ( $\beta = 0.483$ ,  $p < 0.01$ ). The effect of self-control was the greatest on Bitcoin speculation in the stranger user group ( $\beta = -0.343$ ,  $p < 0.01$ ) and then the expertise group ( $\beta = -0.332$ ,  $p < 0.01$ ), with that in the well-informed group being none. The self-confident group showed the highest negative consequences from Bitcoin speculative investment ( $\beta = 0.591$ ,  $p < 0.01$ ) among the four user groups, followed by the stranger group ( $\beta = 0.588$ ,  $p < 0.01$ ). The subjective norm had a significant effect on impulse in Bitcoin speculation only in the expertise group ( $\beta = 0.296$ ,  $p < 0.10$ ), and the well-informed user group had the weakest effect on self-control with the subjective norm ( $\beta = 0.243$ ,  $p < 0.10$ ).

The self-confident group engaged in the most risky and dangerous Bitcoin investments, showing a combination of high impulse, low self-control and high negative consequence. The expertise group was the safest with high self-control and no impulse, making it the most controlled and reasonable group. However, with the subjective norm, the impulse strengthened ( $\beta = 0.296$ ,  $p < 0.10$ ) and weakened self-control ( $\beta = 0.215$ ,  $p < 0.10$ ), leading to Bitcoin speculation in this group. The stranger group had high impulse but the strongest self-control, giving it a balanced tendency. The subjective norm had no moderating effect on impulse or self-control in the stranger group. Furthermore, the results showed that young users with a high annual income tended to speculate on Bitcoin and that men in the well-informed group generally experienced negative consequences from their

speculative investments. In both the expertise and stranger groups, old users tended to experience negative consequences from their speculations. The self-confident group seemed to cut down its negative consequences, and its real losses could be big.

## 6. Discussions and implications

### 6.1 *Discussions of findings*

Despite the high expectation of potential in Bitcoin, many researchers have questioned its viability. In practice, Bitcoin is mainly used as a speculative asset, not an alternative currency. Nakamoto (2008), who first proposed Bitcoin to the world, did not predict this situation, which led us to ask: what is the cognitive process people use when they treat Bitcoin as a speculative asset which was not its original purpose? Does Bitcoin speculative investment behavior truly result in negative consequences? This study attempts to answer those research questions here by investigating the decision-making mechanism of people who engaged in Bitcoin speculation.

First, the results of this study showed that Bitcoin speculative investment behavior is largely unplanned. The price volatility and temptation of a large return caused Bitcoin users or investors to lose their self-control and be easily swayed by impulse, leading them to engage in unplanned behavior, Bitcoin speculation. To explain Bitcoin speculative investment behavior, we adopted the dual-systems perspective, which posits that two different systems (i.e. reflexive and reflective) compete to determine people's behavior. The results of this study empirically reveal that an imbalance between the two cognitive systems leads to speculative investment behavior.

Second, this study found that speculative investment behavior in the Bitcoin context is driven by the combination of a strong impulse and weak self-control. Consistent with previous studies, we found that Bitcoin speculative investment behavior was strongly associated with an imbalance between impulse and self-control. For example, Bitcoin investors with low impulse and high self-control controlled and mitigated their speculative investment behavior, leading to a low level of negative consequences. By contrast, investors with strong impulse and low self-control reacted on impulse, strengthening their speculative investment behavior and leading to a high level of negative consequences. To prevent Bitcoin speculative investment behavior and its negative consequences, the function of self-control is essential. If self-control is weak, it cannot regulate behavioral and emotional impulses, resulting in Bitcoin speculation.

Third, Bitcoin speculation investment behavior usually has negative consequences, but the extent of those negative consequences was not as great as expected. It should be noted that speculation is not an investment. Speculation (spending much time and money in the expectation of profits) is typically deemed risky and dangerous for investors and can lead to negative consequences. The strong temptation of a large return overshadows the high risks of speculation and drives people to engage in Bitcoin speculative investment behavior with low self-control, which can result in negative outcomes. However, we found that the extent of actual negative consequences from Bitcoin speculation was not great because the mean for this construct was low (Panel B of Table II). Although Bitcoin speculation was significantly related to negative consequences, the findings showed that those negative consequences might be less serious than anticipated.

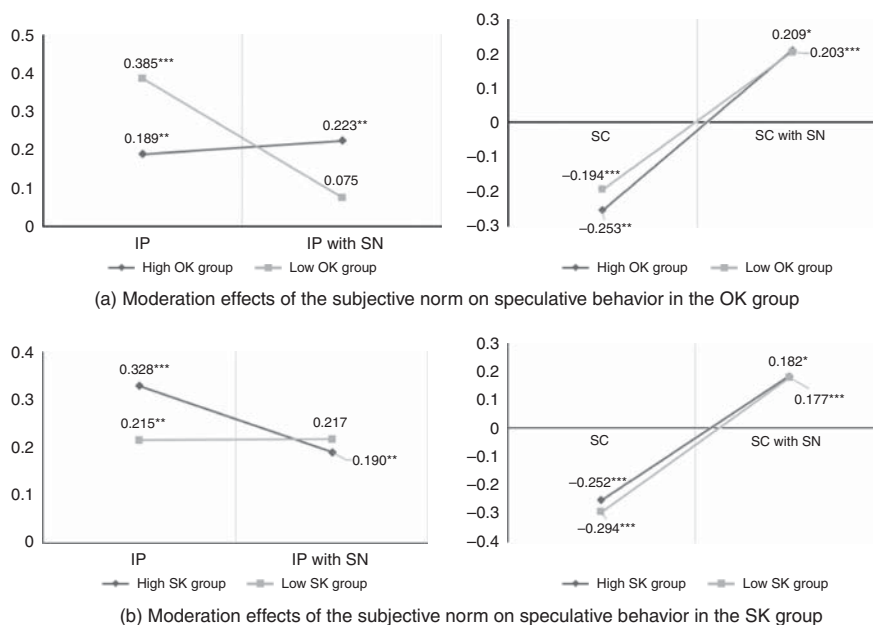
In this study, we discovered an interesting notion about the role of the subjective norm as a moderator between the reflexive and reflective systems. The subjective norm weakened self-control, thereby promoting Bitcoin speculation; however, a subjective norm favorable toward Bitcoin did not strengthen impulse but rather weakened it. One possible explanation is that Bitcoin investment directly involves money, unlike technology adoption, so the subjective norm cannot drive investors to immediately comply with their referents. For example, when friends and referents recommend Bitcoin investment, investors might think about their budget or the possibility of financial loss, which would slightly weaken impulse.



However, positive news stories or a further recommendation could drive people to weak self-control, leading to engage in Bitcoin speculative investment behavior. With the subjective norm, the extent of imbalance between the two systems was greater than without the subjective norm, which increased Bitcoin speculative investment behavior.

Noteworthy differences in the impulse and self-control effects were found depending on the two types of Bitcoin knowledge (i.e. OK and SK). As shown in Figure 3, the high OK group and the low SK group resisted speculating in Bitcoin, whereas the low OK group and the high SK group were strongly obsessed with Bitcoin speculation. The high OK group and the low SK group present strong self-control with weak impulse. Our results indicate that people in the high OK group managed to prevent damage from Bitcoin speculation and tried to maintain their standard of investment while investing in Bitcoin. The users with low SK showed the highest self-control against Bitcoin speculation because they are the most conservative and unconfident given the high level of uncertainty associated with Bitcoin investment outcomes. The subjective norm had more influence on the high OK group than the low SK group. Although the high OK group was more controlled and conscious than the other three groups, with the addition of the subjective norm, this group became more impulsive and non-conscious than the other three groups, leading to engage in Bitcoin speculation.

A possible explanation for this intriguing result is that the subjective norm stimulates the leading characteristics of the high OK group and thus triggers them to hurry to be ahead of technical trends and be opinion leaders. Bitcoin speculative investment behavior in the high SK group and low OK group was driven from a strong impulse with little self-control. Specifically, the low OK group had the highest impulse and weakest self-control to invest in Bitcoin, resulting in widespread participation in Bitcoin speculation and the most negative consequences of any group. Those results were consistent with a prior study (Glaser *et al.*, 2014) reporting that new users with little or no actual Bitcoin knowledge tended to want to



**Figure 3.**  
Moderation effects of  
the subjective norm  
depending on Bitcoin  
knowledge

**Notes:** IP: impulse; SC: self-control; SN: subjective norm; OK: objective knowledge; SK: subjective knowledge. \* $p < 0.10$ , \*\* $p < 0.5$ , \*\*\* $p < 0.01$

participate in speculative investment. The high SK group, which was willing to pursue a risky investment, easily engaged in Bitcoin speculation, with predictable negative consequences. Therefore, Bitcoin speculative investment behavior in the low OK group and high SK group should be carefully supervised and managed by regulators.

### *6.2 Theoretical and practical implications*

The results of this study carry several theoretical implications for researchers. First, to our best knowledge, this study is the first attempt to empirically examine the decision-making mechanism in Bitcoin speculation from the user perspective. In this study, we proposed the two different cognitive systems, impulse and self-control, based on the dual-systems perspective to investigate investors' decision-making mechanisms for Bitcoin speculation. The theoretical and empirical validation of the effect of impulse and self-control on Bitcoin speculative investment behavior is a significant research contribution of this study. A detailed understanding of the decision-making mechanism behind Bitcoin speculative investment behavior would allow significant progress in the IS field.

Second, this study expands the current research on Bitcoin speculative investment behavior, which received significant public attention but has been mostly overlooked by academic researchers. We found that Bitcoin speculative investment behavior is an unplanned behavior driven by an imbalanced interaction between high impulse and low self-control. Our findings show that the decision-making process involved in Bitcoin speculation is similar to that of other unplanned or problematic behaviors in IT use (e.g. internet overuse, mobile e-mail and Facebook addiction, and problematic SNS use and mobile phone use). This study thus facilitates a balanced view and encourages the use of the dual-systems perspective in IS research.

Third, this study highlights the role of the subjective norm in the cognitive process behind Bitcoin speculative investment behavior. Although the subjective norm was originally proposed as a determinant of planned behavior (Ajzen, 1991), the effect of the subjective norm on unplanned behavior had not previously been investigated in the IS literature. This study empirically validated how Bitcoin investment decisions reacted with the subjective norm. Interestingly, the subjective norm strongly weakens self-control but is almost ineffective on impulse because impulse represents a preoccupation with persistent thoughts about a behavior. This study provides a detailed understanding of the effect of the subjective norm on Bitcoin speculative investment behavior.

Fourth, this study reveals that the effects of impulse and self-control on Bitcoin speculation differ depending on two types of user knowledge about Bitcoin. We focused on the different influences of impulse and self-control in high- and low- Bitcoin knowledge groups. The high OK group and the low SK group were reserved in Bitcoin speculation, whereas the low OK group and the high SK group were willing to speculate in Bitcoin. This study thus sheds light on how Bitcoin investors differ in their decision-making process concerning speculative investment behavior depending on their Bitcoin knowledge.

This study also provides several practical implications for practitioners and policy makers. First, it provides policy makers and regulators with valuable insights to develop effective and practical policies for supervising and preventing Bitcoin speculation. The results of this study show that Bitcoin speculative investment behavior is driven by an imbalance between strong impulse and weak self-control, which can be corrected by strengthening self-control or weakening impulse. A strict governmental approach forbidding impulsive Bitcoin investment could effectively restrain Bitcoin speculation. However, such a strict governmental approach could stimulate users' desire for profit, accelerating illegal Bitcoin speculation, or it could depress all Bitcoin transactions and the overall market. Therefore, policy makers and regulators should carefully consider how they help investors balance their two cognitive systems.

Second, the subjective norm plays an important role in promoting or preventing cryptocurrency speculation. Our findings show that the extent of the imbalance between the two cognitive systems is greater with the subjective norm than without it. Thus, the subjective norm increases Bitcoin speculative investment behavior. Especially, preventing self-control from weakening by social pressure is more important than restraining impulse. Our results suggest that adequate information or OK about the actual benefits and risks of Bitcoin could prevent social influence and allow investors to make rational decisions about their speculative investments. Regulating misinformation about Bitcoin investment is also necessary to prevent speculative investment.

Third, this study offers policy makers and regulators a deep understanding of Bitcoin knowledge. In the Bitcoin context, the high OK group and the low SK group show reserve when given the chance to speculate in Bitcoin, whereas the low OK group and the high SK group seek financial gains through Bitcoin speculation. In particular, the low OK group tends to be the most exposed to danger through Bitcoin speculation. That understanding of Bitcoin users' characteristics can enable effective regulations, thereby preventing speculation and simultaneously facilitating healthy investment in Bitcoin. Building a risk-free transaction environment in the Bitcoin context is important and could inspire higher levels of confidence about Bitcoin transactions in potential users. Moreover, providing OK about Bitcoin could inhibit the effect of the impulse and improve self-control. These findings thus provide valuable information for policy makers and regulators who seek practical guidance in establishing Bitcoin regulations and setting the direction of governance requirements.

### *6.3 Limitations and future research directions*

Despite its contributions, this study has several limitations. First, this study relied on respondent self-reported data. Because respondents might have inflated their positive behavior responses (i.e. self-control) and downplayed their negative behavior responses (i.e. speculative investment behavior and negative consequences), the actual levels of our constructs might be overestimated or underestimated. We thus employed social desirability as a control variable to prevent this research bias, but the possibility of bias still exists. Future studies should objectively assess these constructs to reduce that gap and provide stronger results. Second, out of the many possible manifestations of the reflexive and reflective systems, this study measured one general impulse and self-control. Considering that impulse and self-control are multifaceted, multi-dimensional constructs, their conceptualization and measurement might have captured only a subset of the processes underlying impulse and self-control. Therefore, their effects might be biased, so future studies should extend impulse and self-control into multi-dimensional constructs to capture a whole set of processes.

Third, because Bitcoin research is still in its early stage, the measures of Bitcoin speculative investment behavior were not tested comprehensively. Although they were drawn from the theoretical literature and validated by the procedure proposed by Moore and Benbasat (1991), further studies are necessary to ensure their validity and develop more valid measurements. Fourth, the research scope of this study was limited to Bitcoin, which is the first decentralized and most popular cryptocurrency. Therefore, our findings might not be applicable to other cryptocurrencies (e.g. Ethereum, Ripple, Bitcoin cash, Dash, Eos and Light coin). Future research needs to extend the research scope from Bitcoin to other cryptocurrencies to provide comprehensive implications. Finally, our findings might not be completely generalized because most of our sample was restricted to a specific time period and nation, from 2017 to early 2018 in South Korea. Therefore, the results of this study must be interpreted cautiously. Considering the importance of time and national characteristics in Bitcoin, future studies need to apply a specific method, such as longitudinal analysis, and collect more data to closely observe and investigate worldwide Bitcoin speculation phenomenon across different time periods and nations.

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Appendix

Constructs	Questionnaire	References
Impulse (IP)	IP1. I often invest in Bitcoin on impulse IP2. I often invest in Bitcoin on the spur of the moment IP3. I often invest in Bitcoin without any deliberation IP4. I generally invest in Bitcoin without thinking many times	Eysenck and Eysenck (1978) and Harden and Tucker-Drob (2011)
Self-control (SC)	SC1. I exert effort to maintain my investment budget when I invest in Bitcoin SC2. I exert effort not to over-budget when I invest in Bitcoin SC3. I exert effort not to spend considerable time and money when I invest in Bitcoin	Eysenck and Eysenck (1978) and Tangney <i>et al.</i> (2004)
Subjective norm (SN)	SN1. My friends or my co-workers think that I should invest in Bitcoin SN2. My friends or my co-workers think that investing in Bitcoin is a general trend SN3. People who are important to me invest in Bitcoin SN4. Many people around me invest in Bitcoin	Taylor and Todd (1995)
Subjective knowledge (SK)	Compared to average people SK1. What is my knowledge level about cryptocurrency? SK2. What is my knowledge level about Bitcoin? SK3. What is my knowledge level about other cryptocurrencies (i.e. Ethereum, Bitcoin Cash, LiteCoin, EOS, Ripple, Dash and so on)? SK4. What is my knowledge level about the cryptocurrency market and its outlook?	Brucks (1985) and Park <i>et al.</i> (1994)
Objective knowledge (OK)	Please answer the following questions. If the statement is true, please choose "True." If the statement is wrong, please choose "False." If you don't know, please choose "Don't know" OK1. Proofs of statement or PoS, introduced as part of Bitcoin, mean that Bitcoin uses a hash algorithm to generate new blocks OK2. Bitcoins are sent and received through software and websites called wallets OK3. Blockchain is an open, distributed ledger that can efficiently record transactions between two parties, leading to safekeeping of ledgers OK4. Bitcoins are offered as an incentive to people who perform the computation work required to generate blocks, and no more than 31 million Bitcoins will ever exist OK5. The Bitcoin blockchain can create financial transactions as well as generate financial applications directly related to contracts OK6. A private blockchain refers to a blockchain platform for a special purpose operated by special people, of which Bitcoin and Ethereum are good examples OK7. Ethereum is the first of public blockchain 2.0 OK8. A hard fork refers to a rule change such that the new rules consider the blocks produced by old software to be invalid OK9. Satoshi Nakamoto proposed a peer-to-peer network system to prevent the double-spending problem without requiring third parties because double-spending is a potential flaw in a digital cash scheme allowing a single digital token to be spent more than once	Brucks (1985), Park <i>et al.</i> (1994) and Chiou (1998)

Table AI.  
Structure of the  
survey instrument

(continued)



Constructs	Questionnaire	References
	OK10. ICO (Initial Coin Offering) is the launch of a new coin and its sale to the public, which has become a popular method of crowdfunding	
	OK11. The Korean government (i.e. the Financial Service Commission) permits ICOs in Korea	
	OK12. Electronic money, cyber money, and cryptocurrency are legal and protected by the Korean government	
	OK13. Segregated Witness or SegWit refers to a Bitcoin Improvement Proposal to overcome two shortcomings of Bitcoin, scalability and malleability, and was thus employed by Bitcoin to improve the current Bitcoin blockchain design	
	OK14. The Cryptocurrency Exchange deals with trades in which actual cryptocurrencies are sent and received	
Speculative investment behavior (SI)	SI1. I often invest in Bitcoin during my work time SI2. I invest in Bitcoin using more money than my income SI3. I invest in Bitcoin using more money than my original budget SI4. Overall, I invest in Bitcoin by spending considerable time and money	Billieux <i>et al.</i> (2008) and Venkatesh <i>et al.</i> (2008)
Negative consequence (NC)	NC1. I have received a financial loss from investing in Bitcoin NC2. I am in psychological trouble from investing in Bitcoin NC3. I am in trouble at work because of investing in Bitcoin NC4. I am in trouble with social engagements or activities because of investing in Bitcoin NC5. Overall, investing in Bitcoin has made it difficult for me to manage my life	Caplan (2010), Soror <i>et al.</i> (2015) and Haagsma <i>et al.</i> (2013)
Social desirability (SD)	SD1. It is sometimes hard for me to go on with my work if I am not encouraged SD2. I am always willing to admit when I make a mistake SD3. On a few occasions, I have given up doing something because I thought too little of my ability SD4. There have been times when I felt like rebelling against people in authority even though I knew they were right SD5. I sometimes feel resentful when I do not get my way SD6. There have been occasions when I took advantage of someone SD7. No matter who I am talking to, I am always a good listener SD8. I sometimes try to get even rather than forgiving and forgetting SD9. I have never resented being asked to return a favor SD10. There have been times when I was quite jealous of the good fortune of others SD11. I am sometimes irritated by people who ask favors of me SD12. I am always courteous, even to people who are disagreeable SD13. I have never deliberately said something that hurt someone's feelings	Reynolds (1982)

Table AI.

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