Perceived Benefit and Risk as Multidimensional Determinants of Bitcoin Use: A Quantitative Exploratory Study

Completed Research Paper

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Abstract

Over recent years, the innovative decentralized payment system Bitcoin has received much attention in practice and academia. Despite a growth of transaction volume and an increasing attention in the area of e-commerce, there is little academic research examining the factors influencing adoption. To fill this research gap, this paper documents an exploratory study of the key determinants and inhibitors of Bitcoin use. Drawing upon the Technology Acceptance Model and a literature review, we integrate various benefits and risks of Bitcoin use to form the multidimensional constructs Perceived Benefit and Perceived Risk. We propose and empirically test a theoretical model that explains the use of Bitcoin as an online payment system for legitimate purchases and money transfers. Furthermore, we recognize several conceptual and methodological development potentialities for technology acceptance theories in the context of decentralized and sharing economy systems.

Keywords: Bitcoin, blockchain, decentralization, information technology adoption, perceived benefit, perceived risk, payment system, electronic commerce

Introduction

Technological advances and growing consumer demand for convenient, flexible, cost- and time-efficient transactions continue to drive the evolution of payment systems (Ali et al. 2014). The recent and potentially disruptive digital innovation in the money transmission landscape is the emergence of decentralized currencies and online payment protocols grounded on peer-to-peer networks and public key cryptography. The most prominent example is Bitcoin, which is worth the equivalent of $9 billion at current market prices and exhibits a steady growth of the daily transaction volume (Blockchain.info 2016). The number of Bitcoin-accepting merchants shows an upward trend too, and is expected to surpass 150,000 retailers worldwide by the end of 2016 (Coindesk.com 2016).

Bitcoin is a decentralized system, the security and reliability of which are ensured by collective efforts of a peer-to-peer-network and a probabilistic consensus protocol (Nakamoto 2008). It offers diverse benefits over traditional fiat money, which, combined, arguably substantiate its potential for being the next financial revolution (Gao et al. 2015; Kelly 2014). In contrast to conventional payment schemes, whose operations are centrally controlled by financial institutions, Bitcoin depends neither on authorities nor on intermediaries. With decentralized currencies, transaction parties exchange digital money in an instant and direct manner, independent of their geographical location, with low fees and a certain degree of anonymity. In spite of that, Bitcoin faces shortcomings and risks that question its solidity and widespread use. Since no physical commodity or sovereign obligation backs Bitcoin, its market value is defined by expectations of others' willingness to use it in the future (Zohar 2015). This explains fluctuating exchange rates between Bitcoin and fiat currencies. Also, there are concerns of Bitcoin being used by criminals for money laundering or trade of illicit goods (Böhme et al. 2015).

The phenomenon of decentralized currencies has already engendered fruitful academic research on Bitcoin's technical capabilities and limitations (Andrychowicz et al. 2015; Decker and Wattenhofer 2013; Eyal and Sirer 2014; Sompolinsky and Zohar 2014; Vasek et al. 2014), modifications and extensions (Ali et al. 2015; Barber et al. 2012; Ben Sasson et al. 2014; Saxena et al. 2014), the economic analysis (Becker et al. 2013; Hileman 2015; Mai et al. 2015; Möser and Böhme 2015), the regulatory status and measures (Brito et al. 2015; Christopher 2014; Rückert 2016; Stokes 2012; Tu and Meredith 2015). Work on social aspects, system adoption, user attitudes and behavior is emerging, however still scarce (Bohr and Bashir 2014; Brenig et al. 2015; Connolly and Kick 2015; Gao et al. 2015; Glaser et al. 2014; Krombholz et al. 2016; Kumpajaya and Dhewanto 2015). We see a need to better understand why individuals are willing or hesitating to use Bitcoin; which factors, and to what degree, facilitate or impede its acceptance. Ascertaining heterogeneous beliefs and views of users will enable us to clarify the perceived strengths and weaknesses of Bitcoin and, on a broader scale, to determine influential factors to create value for users as well as for innovative businesses adopting the sharing economy model and blockchain technologies. In the presence of network externalities typical for payment systems (Rochet and Tirole 2003; Rysman 2009), our study may also shed light on the perceived individual and social benefits of decentralized systems.

For that, we refer to the well-established theories in information systems (IS) research on technology adoption (Davis 1989, 1993; Venkatesh and Davis 1996; Venkatesh et al. 2003) and devise a model to explore drivers and barriers of Bitcoin usage. We integrate multiple aspects into the concepts of *Perceived Benefit*, *Perceived Ease of Use* and *Perceived Risk*, which jointly influence the technology use process (Featherman and Pavlou 2003; Wu and Du 2012). The following research question motivated this study:

Which positive and negative factors do influence individuals who use Bitcoin for legitimate payments transactions?

By presenting our theoretical model of Bitcoin usage and the empirical results, we seek to lay down a foundation and foster further research in this direction. Specifically, this study opens up several research avenues towards conceptual and methodological enhacements of technology acceptance theories in the field of decentralized systems.

The remainder of this paper is structured as follows. We begin with a summary of the related work on IS adoption and the literature review of benefits and risks of Bitcoin. In the third section, we introduce our research model and corresponding hypotheses. The methodological approach and empirical results are presented in the next section, followed by a discussion of the theoretical and practical implications. The last section concludes with a summary of limitations and an outlook on future research.

Theoretical Background

Technology Acceptance of Online Payment Systems

The most prominent model applied in IS research to interpret user adoption of a wide range of new technologies is the Technology Acceptance Model (TAM), first introduced in (Davis 1989) and later extended in (Featherman and Pavlou 2003; Venkatesh and Davis 2000; Venkatesh et al. 2003). It theorizes that an individual's behavioral intention (BI) towards the actual system use is largely driven by two antecedent constructs: *perceived usefulness* (PU) and *perceived ease of use* (PEU). PU measures "the individual's subjective assessment of the utility offered by the new IT in a specific task-related context" (Gefen et al. 2011). PEU indicates the degree to which a consumer believes that interacting with a new technology would be free of mental efforts (Featherman et al. 2010). Numerous empirical studies demonstrated the practical application of the TAM in different IS domains and confirmed its capability of explaining a substantial proportion of the variance in behavioral intention and system usage (Venkatesh and Davis 2000).

The user-facing functions of decentralized payment protocols resemble those of long-established electronic payment systems. In order to get a theoretical basis, we review existing work on modelling consumer acceptance of online transaction processing systems. This stream of research deals with the adoption of e-commerce systems for online shopping (Featherman et al. 2010; Gefen et al. 2011; Pavlou

2003), online banking systems (Lee 2009; Martins et al. 2014; Montazemi and Saremi 2013; Pikkarainen et al. 2004; Wang et al. 2003) and mobile payment services (Liu et al. 2012; Mallat 2007; Schierz et al. 2010). Most reviewed studies adhere to the same design principle: the "core" TAM model is taken as a starting point and tailored to each specific domain by adding relevant or omitting insignificant variables. The belief variables PU and PEU typically form a cornerstone of most models, as empirical results show that both have a strong positive effect on user adoption of online transaction processing systems.

Another dominant trend in the academic literature is the consideration of *perceived risk* (PR) as an inhibitor to conducting money transactions on the web. In general, perceived risk can be thought of as "uncertainty regarding possible negative consequences of using a product or service" (Featherman and Pavlou 2003). The Internet age has brought with it uncertainty in system acceptance due to the distant and impersonal nature of the online environment and made risk an inevitable element of online commerce (Pavlou 2003). However, the consideration of perceived risk as a generic construct seems to be a significant limitation, as it is by its nature a multidimensional concept and usually comprised of several varieties of risk (Pavlou 2001; Wang et al. 2003). Instead of theorizing it at an abstract level, Pavlou (2003) puts forward the idea of modelling risk as a higher-order construct, which is formed by multiple lower-order determinants.

In line with this proposal, a number of later studies address the multidimensionality and measurement problem of perceived risk by applying the risk-component approach. Various risk dimensions (e.g., financial risk, performance risk, privacy risk, social risk and time-loss risk) have been proposed to measure the overall perceived risk in the context of the adoption and use of Internet-based payment systems (Featherman et al. 2010; Ho and Ng 1994; Lee 2009). Alternatively, some authors confine this concept exclusively to security and privacy risks arguing that those tend to be of a particularly critical concern among users of online and mobile banking systems (Featherman et al. 2010; Pikkarainen et al. 2004; Schierz et al. 2010; Wang et al. 2003).

Benefits and Risks of Bitcoin

Bitcoin is a relatively nascent and controversial technology. Therefore, we can reasonably assume that individuals are heterogeneous in their beliefs and perceptions of the benefits and risks of Bitcoin. In this study, we follow the proposed recommendation of treating these concepts as second-order constructs, composed of distinctive and semantically related first-order variables (Featherman and Pavlou 2003; Lee 2009; Pavlou 2003). To define the underlying first-order constructs and questionnaire items, we reviewed extant literature on cryptographic currencies with the key purpose of identifying and summarizing the benefits, utilities, and potential risks of Bitcoin.

Research on Bitcoin is still in its emerging stage and characterized by multidisciplinary publications, which are disseminated across many peer-reviewed academic journals, conference and workshop proceedings, working papers and technical reports. It is also common in this research domain that many high-quality fundamental works are not available in recognized research databases. These facts called for *a targeted search* of relevant articles instead of the conventional way of querying prominent IS journals and databases. The literature review was initialized with the construction of a list of reputable scholarly venues with a track dedicated to decentralized currencies or the blockchain technology. We also queried Google Scholar, as this platform enables to search for published works across many disciplines and sources. The search strings used to scan a title as well as the full body were "Bitcoin", "blockchain", "cryptographic currency", "virtual currency", "decentralized currency", and close variations of these. To a smaller extent, we employed the backward search strategy in order to replenish our selection with other potentially relevant papers.

Benefits of Bitcoin

Positioned at the intersection of technology, economics and policy, Bitcoin calls for an interdisciplinary approach to studying its usefulness, risks and usage (Hileman 2015). Table 1 summarizes the results of our literature review and structures Bitcoin benefits along these three dimensions. From a technological perspective, the core protocol's feature is decentralization, which contributes to the public endorsement of Bitcoin as a payment method. In a distributed consensus network, the need for a central authority to control the system's operation becomes obsolete. Thereby, Bitcoin follows the „user-first“ rule, bypassing the role of traditional financial intermediaries (Gao et al. 2015; Yee 2014). As online payments can be made directly between users, Bitcoin offers faster transaction speeds than other payment alternatives. Another relevant aspect is the mining process, which accounts for the overall stability, security and reliance of the decentralized payment system (Nakamoto 2008). Being incentivized by financial remuneration in the form of newly generated bitcoins[1] and transaction fees, special network participants, called miners, contribute computational resources to verify transactions among parties and to maintain a consistent state of a public ledger. This ledger records the complete payment history in ordered blocks of transactions and is commonly referred to as a blockchain.

Perspective	Benefit	References
Technology	Decentralization	(Ali et al. 2014), (Barber et al. 2012), (Böhme et al. 2015), (Krombholz et al. 2016), (Nakamoto 2008), (Zohar 2015)
	Faster transaction speeds	(Gao et al. 2015), (Zohar 2015)
	Security and control of money	(Gao et al. 2015), (Van Alstyne 2014)
Economics	Lower transaction fees	(Ali et al. 2014), (Barber et al. 2012), (Beer and Weber 2014), (Böhme et al. 2015), (Gao et al. 2015), (Van Alstyne 2014), (Zohar 2015)
	Speculating opportunities	(Ali et al. 2014), (Böhme et al. 2015), (Gao et al. 2015), (Glaser et al. 2014), (Hur et al. 2015)
	Mining rewards	(Barber et al. 2012)
Policy	Transaction irreversibility	(Barber et al. 2012), (Beer and Weber 2014), (Zohar 2015)

Table 1. Benefits of Bitcoin

An economic cost-benefit analysis points out presumably low transaction fees, speculation opportunities and mining rewards as potential reasons of interest in Bitcoin. In theory, fees are optional and paid out to whatever miner successfully verifies a block with that transaction in it. In practice, most transactions in the blockchain include a fee, which can be explained, for example, by a default value configured in the standard client software (Möser and Böhme 2015). Compared to traditional payment options, Bitcoin fees are typically lower than charges individuals bear when making international payments and transfers, whereas cost savings in case of local retail purchases are not always apparent (Böhme et al. 2015; Van Alstyne 2014).

Fluctuating exchange rates between Bitcoin and fiat currencies open up an opportunity for trading and speculating on exchange markets. Seeking to take advantage of the high price volatility, many users appear to be acquiring bitcoins not to use them to pay for goods or services, but rather to hold until exchange rates appreciate (Böhme et al. 2015). This fact raises the ongoing debate in academia and practice about the right interpretation of Bitcoin as a digital currency or a mere investment tool (Glaser et al. 2014; Hur et al. 2015). Although investment opportunities influence individuals' decision to use Bitcoin, the recent study of Hur et al. (2015) reports that the speculative nature of Bitcoin is not an exclusive reason of Bitcoin adoption.

Bitcoin transactions are irreversible in that transferred money can be returned back to the sender only upon the consent of the recipient. Irreversibility is a natural design choice, which is justified by the absence of a central arbiter to verify and reverse unwanted or accidental transactions (Zohar 2015). Whether it is a positive or a negative feature of Bitcoin is debatable. The inability to reverse confirmed payments protects merchants against chargebacks fraud. On the other hand, users have little chances of getting money back in cases of fraud or accidental mistakes in transaction details.

[1] We adhere to the common convention of using capital-B Bitcoin to refer to the payment system, and lower-b bitcoin to refer to the unit of account.

Risks of Bitcoin

Like any other payment system, Bitcoin exposes its holders to certain types of risk. A comprehensive overview of the protocol's risks can be found in (Böhme et al. 2015). The authors distinguish between market risk, counterparty risk, transaction risk, operational risk, privacy risk as well as legal and regulatory risk. We have adopted this classification as a framework for our literature review. The results are summarized in Table 2. Since some risks are explanatory from the already discussed aspects and principles of Bitcoin, we limit our discussion here to less obvious ones.

Risk	Risk determinant	References
Market risk	Price volatility and exchange rate risk	(Bohr and Bashir 2014), (Brezo and Bringas 2012), (Gao et al. 2015), (Glaser et al. 2014), (Grant and Hogan 2015), (Van Alstyne 2014)
Counterparty risk	Security breaches or malfunction of exchanges / wallet providers	(Bohr and Bashir 2014), (Grant and Hogan 2015), (Meiklejohn et al. 2013), (Moore and Christin 2013), (Van Alstyne 2014)
Transaction risk	Irreversibility of transactions	(Beer and Weber 2014), (Meiklejohn et al. 2013)
	Possible cancelation of a confirmed transaction	(Eyal and Sirer 2014), (Karame et al. 2012), (Sapirshtein et al. 2016)
	Potential blacklisting of bitcoins of dubious origin	(Möser et al. 2013), (Möser et al. 2014)
Operational risk	Security flaws or incidents (e.g., forgotten or stolen passwords)	(Brezo and Bringas 2012), (Gao et al. 2015), (Grant and Hogan 2015), (Vasek et al. 2016)
	Potential vulnerabilities in the protocol design	(Eyal and Sirer 2014), (Karame et al. 2012)
Privacy risk	Linking Bitcoin addresses to real identifiers	(Androulaki et al. 2013), (Brezo and Bringas 2012), (Meiklejohn et al. 2013), (Reid and Harrigan 2013), (Ron and Shamir 2013)
Legal and regulatory risk	Uncertain legal and regulatory status of Bitcoin	(Bohr and Bashir 2014), (Grant and Hogan 2015), (Grinberg 2011), (Reid and Harrigan 2013)

Table 2. Risks of Bitcoin

There are a variety of third-party financial intermediaries in the Bitcoin ecosystem, e.g., currency exchanges, remote wallets, or transaction anonymizers (Moore and Christin 2013). Möser et al. (2014) emphasize "some intermediaries are necessary to make Bitcoin usable as a global Internet currency". Without exchanges bringing together buyers and sellers, it is hardly possible for interested individuals to acquire initial bitcoins. But, intermediaries inevitably expose their clients to counterparty risk due to potential security vulnerabilities of systems. For example, the high-volume exchange Mt. Gox ceased its operation in 2014, reporting the loss of 754,000 of its customers' bitcoins (equivalent to approximately $450 million at the time of closure) (Böhme et al. 2015). Moreover, bitcoins might be lost due to users' own inadvertence, such as typos in the transaction, forgotten passwords or security flaws of devices used.

It is possible, although unlikely, that an already confirmed transaction turns to be invalid due to the existence of another longer blockchain. This can happen due to a fork in the blockchain, when two or more miners concurrently publish blocks of transactions with the same preceding block. The rule for resolving this issue dictates miners to adopt and mine on the longest chain. Eventually, a majority of miners will convert to the same longest chain, cancelling any transactions recorded in other alternative chains. Another determinant of transaction risk, potential blacklisting of bitcoins of dubious origin, is brought up by discussions and concerns about the potential use of Bitcoin for illegal activities. Although not widely implemented today, blacklisting imposes a threat due to a period of uncertainty between the execution of a transaction and its blacklisting (Möser et al. 2014). Therefore, users might face a risk of accepting allegedly legal bitcoins, which could be later blacklisted by law enforcement authorities and consequently lose their value.

Research Model: Constructs and Hypothesis Development

Before presenting the research model of Bitcoin use, the choice of the TAM as a theoretical framework for this study is justified. As the TAM is developed specifically to explain technology acceptance with strong background from prior theories (Davis 1989), it has dominated this stream of IS research since its introduction. Its parsimony, explanatory power and the ease of its application in different contexts largely explain the common choice of the TAM as a theoretical framework for much of IS research on user adoption of new systems (Venkatesh and Davis 2000; Venkatesh et al. 2003). Compared to other similar models, the main advantages of the TAM for this study are its simplicity, solid theoretical basis, ample empirical support in the IS literature, and a well-established measurement inventory (Wang et al. 2003). Given the lack of academic work on user adoption behavior toward innovative blockchain-based payment systems, the TAM is a suitable candidate for the theoretical foundation of the first study of this kind, as it keeps the model parsimonious and supports designing consistent measurements for a newly established research domain.

The TAM is grounded on the theory of reasoned action, which asserts that the best predictor of a behavior is an individual's intention to perform the behavior (Fishbein and Ajzen 1975). Thus, many studies on IS adoption and user behavior have examined behavioral intention rather than system usage as a dependent variable in the theoretical framework (Wu and Du 2012). This is also due to the lack of consensus in IS research on how to conceptualize and properly measure the system usage construct (Burton-Jones and Straub 2006). For example, system usage can be measured as actual usage (e.g., log records), reported usage (e.g., users' estimates of spent hours) or assessed usage (e.g., frequency on an ordinal scale) (Wu and Du 2012). To shed light on the role of BI and system usage in explaining user behavior, Wu and Du (2012) examined these two variables and concluded that a research model predicting BI may not necessarily predict the actual system usage. Therefore, the authors urge scholars to include the system usage construct as an ultimate dependent variable and, if possible, measure both actual and assessed usage in empirical studies. Following this recommendation, we incorporate the theoretical constructs *Perceived Benefit* (PB), *Perceived Ease of Use* (PEU), *Perceived Risk* (PR) into the model to explain the endogenous construct *Usage Behavior* (UB). We prefer to use the construct *Perceived Benefit* as it is more general than *Perceived Usefulness* and a better match to *Perceived Risk*. Figure 1 illustrates our research model.

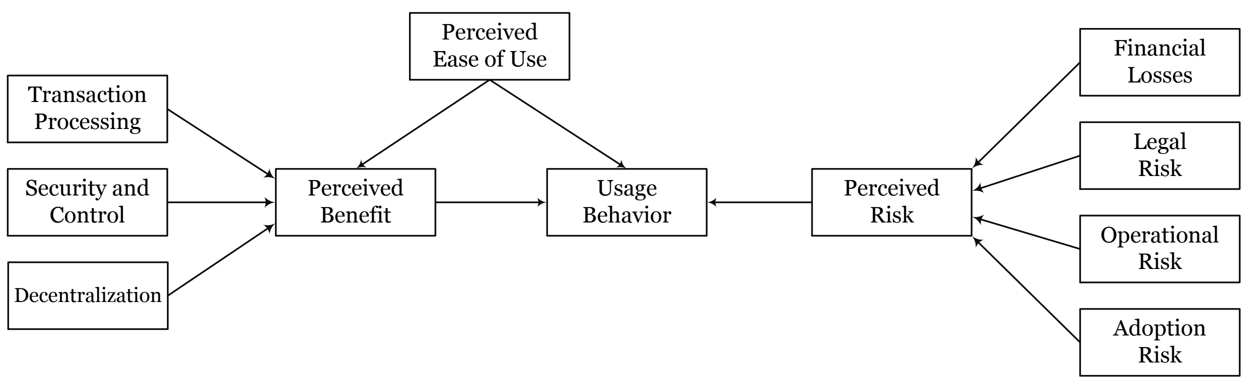

Figure 1. Research Model

There are different conceptions and measurements of Bitcoin adoption. For instance, one may measure it in terms of the number of computer nodes running the Bitcoin client (Böhme 2013) or by the amount of bitcoins owned or exchanged by users. We believe that Bitcoin use should be foremost considered from the perspective of its primary goal, which is to be the alternative payment system for purchases and money transfers. Our sample has demonstrated that decentralized payments with Bitcoin is the second most common use case after keeping bitcoins as a store of value: almost 71% hold some or all bitcoins in hope of their appreciation in value over time, and 67.4% use their holdings as a means of payments for goods or services (see Appendix A). In light of the fact that decentralized payment systems are subject to positive network externalities, holding bitcoins as a store value diminishes the future potential of Bitcoin and is therefore of no particular interest in the study of Bitcoin use. With respect to speculation, every second respondent reports to use Bitcoin for trading. Among them, there is a subgroup of respondents

(31.4% of the total sample) who trade on exchange markets more than 25% of their total bitcoins on a monthly basis (see Appendix A). We can speculate that these "active traders" may have other motives of using Bitcoin, which should be examined in a separate study with a larger sample. Thus, we exclude speculation, mining, gambling, or illegal payments out of the research scope and restrict our focus here on the use of Bitcoin for typical legitimate payments. Due to the very nature of Bitcoin and the pseudonymity it promotes, it is however hardly possible to longitudinally measure the actual use of the system on the individual level. Therefore, we propose transaction activity measured on an ordinal frequency scale as a viable indicator of the active Bitcoin use.

The presented model was derived as follows. First, we referred to the results of our literate review and constructed a list of questions structured into three topical sections: 1) benefits, 2) risks and 3) use cases. Besides questions about use cases of interest (for this study), this list included statements about trading and speculation on exchange markets, mining, gambling, or illegitimate purchases. We also asked respondents to evaluate their attitude to all risk types presented in Table 2. With empirical data at hand, we performed a separate exploratory factor analysis (with Varimax rotation) of the survey items within each section. The factor analysis of the benefit-related questions yielded that potential trading revenues and the absence of chargebacks load only on the fourth and fifth factors. Similarly, the factor analysis of the use cases showed that trading and mining do not sufficiently load on any of the first five factors. Even though the factor analyses were more exploratory than confirmatory, with no attempts to validate constructs, they support our proposition to separately analyze the use of Bitcoin for payments and for speculation or mining purposes. Drawing upon the outcomes of the factor analyses, we reduced the list to the questionnaire items with a high loading and deduced the first-order constructs of PB and PR from the most significant factors. The questionnaire items used in the final evaluation of the model are listed in Appendix B.

Perceived Benefit reflects an individual's perceptual belief that the use of Bitcoin will result in both direct and indirect positive outcomes. It is measured by manifest variables clustered in accordance to the factor analysis into the three first-order constructs: 1) *Transaction Processing (TP)* comprises transaction-related benefits of using Bitcoin for payments; 2) *Security and Control (SC)* refers to perceptions about the overall security of the Bitcoin system; 3) *Decentralization (DE)* conceptualizes beneficial implications of the Bitcoin's core design principle. *Perceived Risk* refers to user's perception of the uncertainty and negative consequences associated with the use of Bitcoin for online payments and money transfers. It is formed by the four first-order constructs, which are also derived from the factor analysis: 1) *Financial Losses (FL)* are related to potential money losses; 2) *Legal Risk (LR)* captures an unclear legal status and a lack of universal regulation of Bitcoin; 3) *Operational Risk (OR)* refers to system's potential vulnerabilities and the irreversibility of Bitcoin transactions; 4) *Adoption Risk (AR)* reflects the uncertainty of Bitcoin regarding its future acceptance by merchants. The ultimate dependent construct *Usage Behavior (UB)* reflects self-reported user's engagement in legitimate transaction activities. We employ a reflective-formative type model (Becker et al. 2012) for the constructs PB and PR, since the first-order constructs are not interchangeable and each of them captures a specific aspect of perceived benefit or perceived risk of Bitcoin use (Hair et al. 2013).

Prior research on the adoption of online payment systems provides evidence that individuals tend to use online and mobile banking due to benefits and performance improvements (Liu et al. 2012). Lee (2009) empirically demonstrated a strong positive effect of perceived benefit of using online banking on behavioral intention. Our literature review shows that Bitcoin offers similar monetary and non-monetary benefits (e.g., low transaction fees for international remittances, 24/7 accessibility etc.). Furthermore, it has additional features such as decentralization, which in turn leads to the independence from authorities and different security trade-offs. In support of that, the descriptive empirical study by Krombholz et al. (2016) reports that most of their interviewed Bitcoin users mentioned the decentralized protocol as one of the main reasons to start using Bitcoin. Therefore, we hypothesize the following:

H1: Perceived benefit influences users' engagement in Bitcoin transactions positively.

Analogously to the domain of Internet banking (Featherman et al. 2010; Lee 2009), perceived risk is more likely to negatively influence users' readiness to transact with Bitcoin. The rationale for this is that individuals commonly fear potential losses due to the impersonal and distant nature of online payment systems (Pavlou 2003). As Bitcoin is an unprecedented technology, users are exposed to other far-reaching risks, e.g., monetary losses caused by volatile exchange rates, the lack of a legal regulation, or the inability to reverse transactions. Consequently, individuals are likely to show reluctance in the active use of Bitcoin primarily for their subjective concerns. Thus, we can assume the following:

H2: Perceived risk influences users' engagement in Bitcoin transactions negatively.

We adhere to the general premise in the IS adoption literature that perceived ease of use either directly or indirectly (through PB) influences the acceptance of Internet technology (Pavlou 2003). Individuals are more inclined to adopt and use a new technology, if it is both easy to learn and easy to use (Wang et al. 2003). Bitcoin, as an unprecedented technology, should also adhere to this common TAM prediction, as individuals need first to learn basic concepts and principles of the technology and operation of Bitcoin. These arguments lead us to the following propositions:

H3: Perceived ease of use influences users' engagement in Bitcoin transactions positively.

H4: Perceived ease of use influences perceived benefit of Bitcoin positively.

Research Methods and Results

Instrument Design and Data Collection

In general, truly representative sampling is difficult to achieve in practice (Groves 1989). This is even more challenging in case of sampling users of global systems like Bitcoin, that are by design decentralized, pseudonymous and voluntary to use. Established conventions of recruiting respondents (e.g., in colleges, universities, through subscription mails or by means of the Amazon Mechanical Turk service), which are consensually accepted among social scientists as a source of (not necessarily representative) empirical data, are not effective or applicable to decentralized systems. Of equal importance are potential coverage and measurement errors due to the non-response and disclosure behavior of Bitcoin users involved in illegal activities. Even under the guarantee of anonymity and confidentiality of respondents' inputs, criminals may not readily share their usage experience with third parties. Acknowledging these issues and their impact on representativeness, in the absence of a better alternative, we decided to advertise our survey questionnaire on online forums, blogs and social networking sites popular in the Bitcoin community. This way, we obtained a convenience sample of 86 respondents after filtering out incomplete responses in the questionnaire items.

The sample demographics are summarized in Table 3. To get a general picture of how well our sample reflects a representative population, we compared it with representative data for the adult population of Internet users, which we collected independently in the six European countries[2] as part of another research initiative. This large-scale survey interviewed 6395 respondents and included a question on how informed respondents consider themselves to be about Bitcoin (see the summarized results in Table 4). The field time of both studies was in summer 2015. Similar to other empirical studies on Bitcoin (Bohr and Bashir 2014; Krombholz et al. 2016), our sample consists of predominantly male users in the age range of 25 to 34 years. The representative survey has revealed that among those who have heard about Bitcoin and know what it is, there are twice as many males as females. So, the fraction of female participants is clearly underrepresented in our sample. In terms of the age distribution, the sample has a significantly larger (lower) proportion of users in the age range of 25 to 34 years (15 to 24 and 55 to 64 years). The respondents in our convenience sample self-reported a high level of knowledge about Bitcoin: half of the sample are advanced users and experts of Bitcoin, who first adopted Bitcoin 2-4 years ago.

Measure	Items		
Gender	Male (n=81; 94.2%)	Female (n=2; 2.3%)	Not specified(n=3; 3.5%)
Age	15-24 (n=8; 9.3%) 25-34 (n=34; 39.5%) 35-44 (n=21; 24.4%)	45-54 (n=13; 15.1%) 55-64 (n=3; 3.5%) >65 (n=3; 3.5%)	Not specified (n=4; 4.7%)

[2] Estonia, Germany, Italy, the Netherlands, Poland and the United Kingdom.

Education	Elementary school (n=11; 12.8%) College/associate (n=7; 8.1%) High school (n=13; 15.1%)	Bachelor (n=20; 23.2%) Master (n=26; 30.2%) PhD (n=3; 3.5%)	Not specified (n=6; 7.0%)
Knowledge about Bitcoin[3]	Medium (n=43; 50%)	Advanced (n=38; 44.2%)	Expert (n=5; 5.8%)

Table 3. Sample Demographics

Measure	Category	I have heard about it and know what it is.		I have heard about it but I don't know what it is.		I have never heard about it.		Refusal	
Gender	Male	1538	66.7%	480	50.5%	1180	37.7%	3	50%
	Female	767	33.3%	470	49.5%	1954	62.3%	3	50%
	Total	**2305**	**100%**	**950**	**100%**	**3134**	**100%**	**6**	**100%**
Age	15-24	378	16.4%	147	15.5%	446	14.2%	0	0%
	25-34	548	23.8%	187	19.7%	588	18.8%	1	16.7%
	35-44	452	19.6%	168	17.7%	614	19.6%	1	16.7%
	45-54	453	19.7%	203	21.4%	671	21.4%	1	16.7%
	55-64	279	12.1%	128	13.5%	472	15.1%	2	33.3%
	>65	162	7.0%	111	11.7%	313	10.0%	1	16.7%
	Refusal	33	1.4%	6	0.6%	30	1.0%	0	0%
	Total	**2305**	**100%**	**950**	**100%**	**3134**	**100%**	**6**	**100%**

Table 4. Reported Awareness of Bitcoin (Representative Survey; n = 6395)

The questionnaire items needed to measure *Perceived Benefit* were reported on an ordinal scale from "strongly disagree" to "strongly agree", which we interpret as an interval scale (coded from 1 to 5) in the statistical analysis. The list of statements about various benefits of Bitcoins was displayed to respondents in a random order to avoid response order effects. To evaluate respondents' attitudes to different risk types, participants were asked to rate their level of concern on a continuous scale of 1 to 5, with 1 and 5 reflecting the lowest and the highest level of concern, respectively. The questionnaire items related to the UB construct (i.e., self-reported engagement in legitimate transactions with Bitcoin) were reported on an ordinal seven-point frequency scale (1 = never, 2 = once a year or less, 3 = every 6 months, 4 = every 3 months, 5 = monthly, 6 = weekly, 7 = daily).

To test our hypotheses, we used Partial Least Squares (PLS) and the R-software package plsm for a number of reasons. Since the theory on Bitcoin use is not developed yet, our study can be characterized as exploratory. In such situation, where prediction and explanation of target constructs are of main concern, Hair et al. (2013) recommend to choose PLS over the covariance-based structural equation modeling. Secondly, PLS is preferred for its lower requirements on a sample size, measurement scales, and residual distributions (Chin 1998). Thirdly, it enables both reflective and formative constructs to be simultaneously incorporated within the model (Hair et al. 2013).

[3] The anchor points were defined as follows: Medium = "I am familiar with Bitcoin's basic principles and common terms." Advanced = "I fully understand Bitcoin's technical aspects.", Expert = "I am able to reflect upon new ideas for Bitcoin improvements and implement them."

Measurement Model

Following the guidelines in Becker et al. (2012) for estimating hierarchical latent variables, we apply the repeated indicator approach to measure the second-order constructs. Thus, PB was evaluated by the observable variables of TP, SC and DE, while PR was measured by the variables of FL, LR, OR, and AR. To assess the reflective measurement model, we examined construct reliability, convergent and discriminate validity based on the evaluation criteria suggested in (Fornell and Larcker 1981). Internal consistency and reliability were evaluated using a composite reliability (CR) indicator, the acceptable value of which for exploratory research is 0.6 or higher (Hair et al. 2013). High composite reliability scores in Table 5 show that each construct has strong internal reliability and thus, is measured by uniform indicator variables.

Convergent validity is usually confirmed through the examination of indicator loadings and the average variance extracted (AVE) (Fornell and Larcker 1981; Hair et al. 2013; Lee 2009). While Hair et al. (2013) recommend that indicator factor loadings should be 0.7 or higher, Lee (2009) specify the minimal threshold value at 0.5. Table 6 demonstrates that all items have a loading on the respective construct higher than 0.6. We find these results acceptable considering a varying semantic content of the items per construct. The second indicator AVE, which represents a percentage of the variance of indicators explained by a construct, should exceed the value of 0.5 (Lee 2009). Table 5 shows that all constructs except for TP satisfy this requirement. The AVE value of *Transaction Processing* is 0.49, which we consider close enough to 0.5 to be acceptable.

Construct	Items	CR	Mean	AVE	Construct	Items	CR	Mean	AVE
TP	4	0.80	4.53	0.49	**LR**	2	0.89	2.67	0.79
SC	2	0.84	4.32	0.73	**OR**	2	0.83	2.29	0.71
DE	3	0.78	4.27	0.54	**AR**	2	0.87	1.97	0.77
PEU	3	0.79	3.38	0.55	**UB**	4	0.85	2.28	0.53
FL	4	0.85	2.60	0.59					

Table 5. Reliability Measures of the First-Order Latent Variables

	TP	SC	DE	PEU	FL	LR	OR	AR	UB
TP1	**0.70**	0.29	0.09	0.26	-0.08	-0.08	0.06	-0.13	0.25
TP2	**0.77**	0.51	0.16	0.11	-0.15	-0.05	0.06	-0.16	0.19
TP3	**0.65**	0.34	0.11	0.33	-0.33	-0.15	0.00	-0.11	0.32
TP4	**0.68**	0.38	0.34	0.39	-0.21	-0.16	0.11	-0.11	0.14
SC1	0.44	**0.86**	0.35	0.21	-0.35	-0.21	0.04	-0.18	0.33
SC2	0.50	**0.85**	0.29	0.18	-0.42	-0.20	-0.02	-0.31	0.23
DE1	0.18	0.26	**0.77**	0.07	-0.13	-0.13	-0.04	-0.04	0.08
DE2	0.24	0.30	**0.78**	0.07	-0.10	-0.02	-0.07	-0.09	0.13
DE3	0.12	0.26	**0.63**	-0.08	-0.19	-0.14	-0.29	-0.09	0.13
PEU1	0.37	0.21	-0.02	**0.87**	-0.13	-0.04	0.10	-0.23	0.34
PEU2	0.27	0.11	-0.12	**0.67**	-0.14	0.01	0.03	-0.14	0.05
PEU3	0.21	0.17	0.18	**0.67**	-0.29	-0.12	-0.12	-0.05	0.22
FL1	-0.15	-0.22	-0.05	-0.10	**0.79**	0.45	0.29	0.33	-0.40
FL2	-0.22	-0.50	-0.16	-0.22	**0.80**	0.34	0.17	0.42	-0.42
FL3	-0.13	-0.25	-0.23	-0.05	**0.76**	0.29	0.35	0.43	-0.27
FL4	-0.34	-0.40	-0.13	-0.38	**0.71**	0.38	0.23	0.44	-0.47
LR1	-0.19	-0.24	-0.03	-0.08	0.41	**0.87**	0.13	0.27	-0.26

	TP	SC	DE	PEU	FL	LR	OR	AR	UB
LR2	-0.10	-0.19	-0.17	-0.06	0.44	**0.91**	0.30	0.28	-0.41
OR1	0.10	-0.04	-0.20	0.02	0.23	0.28	**0.85**	0.08	-0.23
OR2	0.04	0.06	-0.07	0.01	0.33	0.14	**0.83**	0.14	-0.13
AR1	-0.20	-0.32	-0.05	-0.19	0.51	0.27	0.08	**0.88**	-0.26
AR2	-0.11	-0.18	-0.12	-0.15	0.40	0.27	0.15	**0.87**	-0.27
UB1	0.30	0.37	0.14	0.35	-0.47	-0.39	-0.17	-0.23	**0.86**
UB2	0.14	0.22	0.20	0.18	-0.32	-0.22	-0.17	-0.20	**0.74**
UB3	0.21	0.16	0.05	0.21	-0.33	-0.27	-0.08	-0.24	**0.66**
UB4	0.26	0.17	0.06	0.18	-0.36	-0.21	-0.22	-0.22	**0.66**

Table 6. PLS Cross-Loadings

Cross loadings and the Fornell–Larcker criterion are usually used to establish discriminant validity of the model (Fornell and Larcker 1981; Hair et al. 2013). As evident in Table 6, a loading of each item on its associated construct is in absolute terms greater than all of its loadings on the other constructs in the model. The more conservative Fornell–Larcker criterion requires the square root of AVE of each construct to be greater than its highest correlation with any other construct (Hair et al. 2013). Table 7 shows that this requirement is satisfied too. Thus, all common evaluation criteria have been met, providing confidence in the overall reliability of the measurement model.

	TP	SC	DE	PEU	FL	LR	OR	AR	UB
TP	**0.70**								
SC	0.55	**0.85**							
DE	0.25	0.37	**0.73**						
PEU	0.39	0.23	0.04	**0.74**					
FL	-0.27	-0.45	-0.19	-0.25	**0.77**				
LR	-0.16	-0.24	-0.12	-0.08	0.48	**0.89**			
OR	0.08	0.01	-0.16	0.01	0.34	0.25	**0.84**		
AR	-0.18	-0.29	-0.10	-0.19	0.53	0.31	0.13	**0.88**	
UB	0.34	0.36	0.14	0.35	-0.52	-0.40	-0.21	-0.28	**0.73**

Table 7. Fornell–Larcker Criterion Analysis

Structural Model

With respect to the structural model, the explanatory power is typically evaluated on the basis of the significance of the path coefficients and the coefficient of determination, commonly known as R^2 value. The results of the PLS analysis with 500 bootstrap runs are presented in Figure 2. Altogether, our model explains 40% of the variance in *Usage Behavior*. In light of the exploratory nature of our study, this result can be deemed as acceptable. In addition, the Stone–Geisser's Q^2 value (Geisser 1975; Stone 1974) for the endogenous reflective construct *UB* is measured by using blindfolding procedures and omitting every fifth data point in the construct's indicators. As the cross-validated redundancy Q^2 is 0.16 and larger than zero (Hair et al. 2013; Sarstedt et al. 2014), the path model exhibits predictive relevance for *Usage Behavior*. However, the structural model cannot be characterized as highly predictive, as the Q^2 value does not exceed the threshold of 0.5 (Chin 2010).

Although at the different levels of significance, PLS estimates of the path coefficients provide support for all of the proposed hypotheses. *Perceived Benefit* (β = 0.21, $p < 0.05$) and *Perceived Ease of Use* (β = 0.17, $p < 0.05$) have a significant positive effect on *Usage Behavior*, whereas *Perceived Risk* (β = -0.44, $p < 0.001$) influences respondents' willingness to use Bitcoin negatively and strongly significantly. *Perceived*

Ease of Use is found to have a weak, however significant positive effect (β = 0.03, p < 0.05) on *Perceived Benefit*. Somewhat unexpectedly, the path coefficient between *Decentralization* and *Perceived Benefit* is less than for the causal relationships between *Transaction Processing* / *Security and Control* and *Perceived Benefit*. The opposite could be expected because the wording of two of the three questionnaire items used to measure *Decentralization* (see Appendix B) implies a relationship between the construct and system use and therefore might over-state the true effect. To control for this, we have performed two additional analyses by fitting the initial model 1) with *Decentralization* measured by the remaining item and 2) without the construct of *Decentralization*. In both cases, the path coefficients between *Transaction Processing* / *Security and Control* and *Perceived Benefit* declined by no more than 0.2. All significance levels remained the same and R^2 statistics expectedly went down marginally to 37.7%. The path coefficient between *Decentralization* and *Perceived Benefit* in the first scenario was 0.18. Thus, the comparatively low loading of *Decentralization* cannot easily be attributed to a measurement artifact. The empirical analysis also shows that *Financial Losses*, *Legal Risk* and *Adoption Risk* tend to substantially influence *Perceived Risk*, while *Operational Risk* has a lower impact.

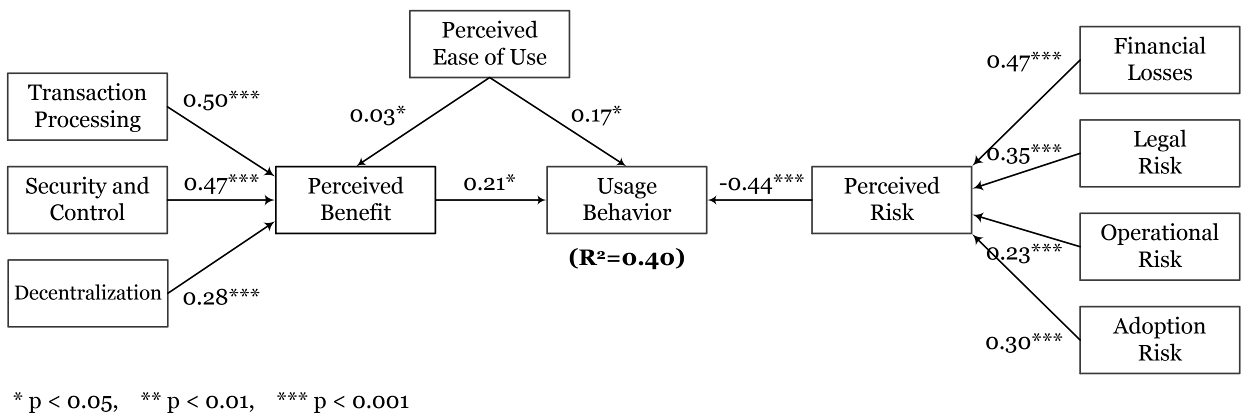

Figure 2. PLS Estimates

We conduct a multi-group analysis to test for moderation effects of the level of knowledge about Bitcoin. We split the sample into two equally large groups: users with medium knowledge (n=43) and advanced users and experts (n=43). The parametric approach (Hair et al. 2014) to test whether there is a significant difference between the path coefficients reveals a (weakly significant) distinction in the effect of *Perceived Risk* on *Usage Behavior* (β_1 = - 0.22, β_2 = - 0.59, p < 0.1). This result suggests that users with advanced and expert knowledge about Bitcoin and seem to be more concerned about the risks of using the innovative decentralized system. In addition, we check the moderation effects of the age by splitting the sample into the groups of younger (< 35 years, n=42) and older (≥ 35 years, n=40) users[4]. This analysis however does not reveal any significant differences in the path coefficients.

Contributions and Implications

Up to date, there is a limited number of published empirical studies on perceptions of Bitcoin users. Most of them are of exploratory nature and provide solely aggregated descriptive data, for example, about the Bitcoin community (Bohr and Bashir 2014), country-specific consumer adoption and use of Bitcoin (Kumpajaya and Dhewanto 2015), or about user experiences with Bitcoin security and privacy (Krombholz et al. 2016). From the perspective of theory building, this study represents a first attempt to apply a variant of the TAM model to a novel domain and contribute to the emerging IS literature on decentralized currencies. Built on the literature review, the presented theoretical model of Bitcoin use embodies a range of the positive and negative aspects of Bitcoin and conceptualizes the multidimensional constructs of Perceived Benefit and Perceived Risk. It can be treated as a reference in further examinations of the influencing factors of Bitcoin adoption.

[4] We ignore data points with a not specified age (n=4).

The empirical analysis has confirmed the soundness of the developed model and showed the varying effects of perceived benefit, perceived ease of use and perceived risk on Bitcoin use. Modeling PB and PR as multidimensional concepts proved to be an effective approach to explaining the use of Bitcoin, as we were able not only to assess their overall impact on Bitcoin use, but also to observe individual effects of the underlying determinants. Our results support the common view that individuals have substantial concerns with regard to cryptographic currencies. Bitcoin is unable to attract a wider audience of users due to its fluctuating value, the risk of financial losses in case of malfunction or security breaches of service providers' systems or users' own devices, and the lack of consumer protection. This, in turn, has several important implications for practice. First, the fear of financial losses due to counterparty risk or security incidents calls for well-thought risk management approaches and insurance protection of consumers. Some wallet providers (e.g., BitGO, Coinbase) already cooperate with insurance companies and offer their users insurance policies against certain types of security threats. However, there is no market for the insurance and protection of individual holders of Bitcoin, chiefly because the way Bitcoin functions makes it challenging for insurers to verify claims of theft. Secondly, the interest of Bitcoin users in being legally protected highlights a need for a transparent strategy towards regulating decentralized currencies in order to ensure both consumer protection and the compliance of Bitcoin stakeholders with the law. Furthermore, the analysis has shown that Bitcoin users are also concerned about possible regulatory restrictions towards the use of Bitcoin.

Perceived ease of use has been found to have the weakest effect on system use. The descriptive statistics in Appendix B shows that the mean values and standard deviations of the questionnaire items used to measure this construct are slightly greater than 3 (the neutral score on the 5-point rating scale) and 1, respectively. We therefore conjecture that users consider Bitcoin as a complicated and not very intuitive system, requiring a lot of learning effort, in particular, at the initial stage of adoption. Indeed, individuals who would like to start using Bitcoin first need to educate themselves and learn the common terminology and basic operational principles, which are not straightforward to less tech-savvy individuals. Also, the lack of *Perceived Ease of Use* may be explained by an excessive burden of secure key storage put on the user. A majority of our respondents reported that they became more security-aware due to the interaction with Bitcoin, and undertook additional measures to protect their computer and mobile devices.

Somewhat surprisingly, the empirical data has revealed that the core design principle, decentralization, has the weakest effect among other determinants of perceived benefit of Bitcoin. This contradicts the common claim of users that the blockchain technology and decentralization are the primary reasons for the adoption of Bitcoin (Krombholz et al. 2016). Such inconsistency might be partly due to the lack of understanding of the intricate notion of decentralization among less tech-savvy Bitcoin users. While some may perceive decentralization as the absence of a single central entity with global knowledge of the system state, others may interpret it as the independence from financial institutions and authorities. In line with this conjecture, our preliminary multi-group analysis showed that users who use Bitcoin to pay for goods or services restricted in the jurisdiction (n=13) value decentralization twice as much as the others ($\beta_1 = 0.5$, $\beta_2 = 0.25$, $p < 0.1$). Secondly, decentralization causes substantial storage and computational costs due to the high among of redundancy, as witnesses in Bitcoin by the enormous size of the blockchain, which is replicated on all nodes. With the increasing number of users and transactions, network externalities lead, on the one hand, to the greater value of the Bitcoin network and, on the other hand, to higher costs. This trade-off calls for future investigations of how perceived network externalities impact the use of decentralized systems. Thirdly, the true level of decentralization in practical systems falls often far behind of what is theoretically possible. In the case of the Bitcoin ecosystem, strong concentration tendencies are observable, which thwart the idea of realizing a fully decentralized system (Böhme et al. 2015).

In addition, individuals may be guided by their beliefs about social rather than individual benefits of the blockchain technology when making the initial decision of whether to use or not to use Bitcoin. The blockchain has properties of a public good (Möser and Böhme 2015), which raises questions about its provision by volunteers (Hirshleifer 1983). Individuals endorse the innovative idea of the blockchain technology and associate it with the public value generated to society at large. Moreover, the on-going discussions on the potential application of the blockchain technology beyond the financial sector leads to a greater recognition of its social benefits. However, the TAM theory in its current state does not envisage a construct which would reflect the link between social benefits and the adoption of a technology. The TAM is a model of an individual technology use. As it predates the emergence of decentralized systems by decades, it posits perceived usefulness of IS systems exclusively from the perspective of individual benefits. In later studies, technology acceptance models were extended with social factors such as social value or subjective norms (Davis et al. 1989; Mathieson 1991). Closer inspection, however, reveals that they are different from the notion of perceived benefits of decentralization discussed here. As "the sharing aspect of peer-to-peer makes these technologies fundamentally social in nature" (Song and Walden 2007), social benefits should be considered as an additional antecedent of the adoption of decentralized systems. This calls for an extension of the common definition of social benefits beyond altruistic enjoyment and pleasure of helping others (Hawlitschek et al. 2016; Song and Walden 2007).

Conclusion

This exploratory study investigates the use of Bitcoin as an alternative payment system for legitimate purchases and money transfers and explains the main factors influencing it. Drawing upon the results of the literature review, we explore the multidimensional nature of perceived benefit and perceived risk of Bitcoin and evaluate their relative effects on users' engagement in Bitcoin transactions. This approach has shown to be effective in explaining the key determinants and barriers of Bitcoin use. However, our work has a number of limitations that should be addressed in future research. First, the small convenience sample restricts the robustness and generalization of our findings among Bitcoin users and the larger population of non-users. Secondly, our pioneering model ignores other important factors such as hedonic benefits, social factors, facilitating conditions, or trust, which may have substantial impact on individuals' decisions to adopt Bitcoin. In general, all decentralized currencies face the problem of network effects in their adoption, as their benefits and value are positively correlated with the number of users. Therefore, it is needed to analyze what role subjective norms (e.g., recommendations, media coverage etc.) play in the adoption and use of Bitcoin. In contrast to conventional payment systems, users may also have difficulties distinguishing between the perceived benefits and risks of the Bitcoin core system and of third-party service providers whom they actually perceive as the "face" of Bitcoin. Therefore, we encourage in future studies to refine the construct determinants and develop questionnaire items in a way that would clearly designate this distinction.

Acknowledgements

The authors thank all respondents for their participation in the survey as well as Christoph Bergmann and online forum moderators for distributing the link to the questionnaire. We are equally grateful to the anonymous reviewers for their constructive feedback on earlier versions of this paper. Markus Riek has provided valuable support during the data analysis. This work was funded by the German Bundesministerium für Bildung und Forschung (BMBF) under grant agreement No. 13N13505. The representative data presented in Table 4 were collected as part of the E-CRIME project funded by the European Union's 7th Framework Programme under grant agreement No. 607775.

Appendix A – Descriptive Statistics on Bitcoin User Behavior

Table 8 shows how Bitcoin users in our sample distribute, on average, their total holdings of coins among different use cases. The corresponding question was formulated as follows:

On average, how much in percent of your total bitcoins do (did) you use for the following purposes?

For simplicity and better representation, the responses to the minor use cases are not reported in Table 8: 27.9% (24 respondents) and 12.85% (11 respondents) use less than 25% of their bitcoin holdings for transaction fees and for other purposes, respectively.

	as a means of payment for goods and services		as a means of cross-border money transfers		for donations or gifts		as a short-term speculative device		as a store of value	
Do not use	28	32.6%	64	74.4%	46	53.5%	41	47.7%	25	29.1%
Less than 25%	43	50.0%	17	19.8%	33	38.4%	18	20.9%	9	10.5%
25 – 50%	7	8.1%	3	3.5%	5	5.8%	8	9.3%	8	9.3%

50 – 75%	3	3.5%	2	2.3%	1	1.2%	14	16.3%	21	24.4%
75% and more	5	5.8%	0	0.0%	1	1.2%	5	5.8%	23	26.7%
Total	**86**	**100%**	**86**	**100%**	**86**	**100%**	**86**	**100%**	**86**	**100%**

Table 8. Distribution of Respondents' Coins Among Use Cases

Table 9 shows descriptive statistics for the use of Bitcoin for purposes other than legitimate payments and money transfers (that are left out of the scope of the research model). Responses were reported on a seven-point frequency scale. The double asterisks refer to the subsample of users ("active traders") who use more than 25% of their total holdings of bitcoins for trading on speculative markets (see Table 8). The Mann–Whitney test shows a significant difference (W=513, p < 0.001) in trading frequency between the group of "active traders" and the group of respondents who trade less than 25% of their total bitcoins or do not trade at all.

Questionnaire Item	1 = never	2 = once a year or less	3 = every 6 months	4 = every 3 months	5 = monthly	6 = weekly	7 = daily
I use Bitcoin to ...							
trade on exchange markets.	17.4%	11.6%	15.1%	**10.5%***	23.3%**	10.5%	11.6%
earn mining revenues.	**62.8%**	8.1%	8.1%	3.5%	4.7%	3.5%	9.3%
gamble online.	**69.8%**	23.2%	3.5%	2.3%	0.0%	0.0%	1.2%
buy goods or pay for services restricted in my jurisdiction.	**84.9%**	7.0%	4.7%	1.2%	2.3%	0.0%	0.0%

* Percentages in the median category are typeset in boldface. ** Median category of the subsample of "active traders".

Table 9. Frequency of Bitcoin Use for Other Purposes

Appendix B – Questionnaire Items Used in the PLS Model

Questionnaire Item		Mean value	Std. dev.
Transaction Processing (TP)			
TP1	Bitcoin enables to transfer money instantly.	4.52	0.68
TP2	Bitcoin enables to transfer money worldwide.	4.74	0.54
TP3	Bitcoin enables to transfer money with low or no transaction fees.	4.42	0.77
TP4	Bitcoin enables to easily transact money.	4.44	0.75
Security and Control (SC)			
SC1	Bitcoin enables to transfer money securely.	4.13	0.79
SC2	Bitcoin empowers me with the control of my money.	4.50	0.73
Decentralization (DE)			
DE1	I use Bitcoin because it is decentralized.	4.63	0.63
DE2	With Bitcoin I do not have to trust an authority.	4.58	0.66
DE3	I use Bitcoin because I disapprove the conventional financial system.	3.59	1.19
Perceived Ease of Use (PEU)			
PEU1	Bitcoin is intuitive and easy to use.	3.38	1.09
PEU2	Using Bitcoin does not require a lot of mental or learning effort.	3.22	1.07

PEU3	It is easy to convert conventional money into bitcoins and vice versa.	3.54	1.05
Financial Losses (FL)			
FL1	Security vulnerabilities or malfunction of exchanges or wallet providers	2.97	1.19
FL2	Inability to convert bitcoins to conventional currencies, or not at a reasonable price	2.27	1.15
FL3	Losses due to counterparties failing to meet contractual payments or settlement obligations	2.05	1.10
FL4	Losses due to security incidents (e.g., lost passwords, malware)	3.13	1.21
Legal Risk (LR)			
LR1	Legal uncertainty for holders of Bitcoin	2.47	1.36
LR2	Possible government intervention restricting the use of Bitcoin	2.89	1.42
Operational Risk (OR)			
OR1	Losses due to modifications to or vulnerabilities in the Bitcoin protocol	2.15	1.19
OR2	Lack of built-in mechanisms to reverse confirmed transactions	1.91	1.30
Adoption Risk (AR)			
AR1	Lack of adoption in commerce in the long term	2.58	1.09
AR2	Lack of interoperability with other services	2.00	0.97
Usage Behavior (UB)			
UB1	I use Bitcoin to buy physical goods (e.g., electronics, household appliances, clothes).	2.30	1.46
UB2	I use Bitcoin to buy computer software, other digital goods or pay for hosting or cloud computing services.	2.47	1.48
UB3	I use Bitcoin to make cross-border money transfers.	1.95	1.55
UB4	I use Bitcoin to make donations, buy gift cards or give away as presents.	2.40	1.55

Table 10. Questionnaire Items and Corresponding Constructs

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