U.S. Consumers' Adoption and Use of Bitcoin and other Virtual Currencies *

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Abstract

Bitcoin has gained notoriety as a speculative financial asset, vehicle for criminal activity, alternative monetary policy instrument, and a low-cost payment instrument for merchants to accept. However, relatively little attention has been devoted to measuring its adoption and use by consumers for payments—the main purpose for which Bitcoin was designed (Nakamoto, 2008). The 2014-2015 Survey of Consumer Payment Choice (SCPC) indicates that about half of U.S. consumers had heard of Bitcoin or the other roughly 700 virtual currencies by the end of 2015. The vast majority of consumers who are aware of virtual currencies are unfamiliar with them, and they struggle to answer survey questions accurately. Less than 1 percent of U.S. consumers (2 percent of consumers aware of virtual currency) have ever owned (adopted) virtual currency, but most adopters of virtual currency used it to pay a person (most commonly) or merchant in the past month. Awareness, adoption, and use of virtual currencies are correlated with various demographic and economic characteristics of consumers. A typical Bitcoin owner is more likely to be a younger, non-white male with lower education who expects Bitcoin to appreciate, has adopted a higher number of other payment instruments, and has most of the responsibility for household shopping.

Keywords: Digital currency; virtual currency; cryptocurrency; Bitcoin; cash; money demand

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1. Introduction

Since its inception (Nakamoto, 2008), Bitcoin has grown steadily in stature and garnered increasing attention. As of March 2015, about two-thirds (14 million) of the intended long-run supply of bitcoins had been distributed worldwide, held in 109 million accounts and used for 62.5 million total transactions or about 200,000 per day (Böhme et al., 2015). Most attention toward Bitcoin has focused on its exchange rate with the U.S. dollar, which has exhibited breathtaking swings over short periods of time. It reached a peak of about $1,400 in 2013 (market capitalization of $12 billion, equal to 4.5 percent of the U.S. money stock M1) before falling back to $200-450 during the past year (market capitalization of $3-6.5 billion).

During its relatively short life, Bitcoin has struggled to gain credibility with the general public for many reasons. For most consumers, Bitcoin is hard to understand because it is new, unfamiliar, and technologically complex. It is also risky to hold because its exchange rate with sovereign currencies like the U.S. dollar is extremely volatile and not suitable for risk averse consumers. Like many new and volatile assets, Bitcoin has attracted considerable speculative investment while its financial infrastructure was being developed, as well as fraud, theft, and related activity causing financial losses for some owners. One of Bitcoin's key advantages—cryptographic security based on blockchain technology—is alleged to have attracted criminal and terrorist payment activity that requires anonymity in financial transactions. All of these challenges increasingly have motivated governments to regulate, restrict, or even ban virtual currencies, which have buffeted the value of Bitcoin further and hindered its goal of becoming a viable alternative to official government currencies.

Nevertheless, its potential as a speculative investment has fueled not only Bitcoin's rise to prominence but also naturally attracted market competition, as described in Gandal and Halaburda (2014). Since Bitcoin's value peaked in 2013, about 700 diverse other virtual currencies have emerged to compete in the market for private digital money characterized by cryptographic security. Bitcoin's competitors collectively represent less than 10 percent of the industry's market cap, and some may have been created primarily to score short-term speculative profits. However, others are making serious efforts build better digital payment systems, such as Ripple's meta net-

work on which Bitcoin and other currencies of all kinds could be used. The emergence of the virtual currency market also has stimulated attempts to develop cryptographic versions of official government currencies such as the Canadian and U.S. dollars.[1]

Virtual currency poses fascinating questions about its potential role as a form of private money, which is an unfamiliar concept to modern U.S. consumers. Economists disagree about whether Bitcoin and other virtual currencies exhibit the core features of money (store of value, unit of account, and medium of exchange) despite being supplied by the private sector.[2] The U.S. Internal Revenue Service (IRS) ruled that virtual currency is not a "currency" per se but property, on which capital gains taxes must be paid. Thus, virtual currency is an asset (store of value) but one with an expected return that so far has been unusually volatile for money. Like most government money today, virtual currencies have no intrinsic value but rather a fiat declaration and promise to sustain its usability. For Bitcoin, the fiat emerges from the democratic social consensus of the open-source community that owns and operates the system, but it does not have any legal or public authority. Virtual currencies are very divisible and precise (16 decimal places) units of account (typically a "coin") with variable exchange rates against the U.S. dollar similar to those of foreign sovereign currencies. Finally, virtual currencies such as Bitcoin are designed to serve as a medium of exchange—a form of payment instrument—that can be used at relatively low social cost and (so far) little or no transaction cost for either the payer or payee.

Although it is too early to tell whether the foothold gained thus far by private virtual currency will last, or grow to an economically significant magnitude, the future of private virtual currency depends crucially on the extent to which it is used and accepted for payment by agents. Much data are readily available on the Internet for the aggregate supply, market value, and transaction use (in volume and value) of virtual currencies. However, to date there has been very little data and research produced on particular consumers and merchants who use and accept virtual currencies for payments. Polasik et al. (2015) provides interesting evidence about merchants and their acceptance of bitcoin for payment obtained from a recent international survey, but it does not contain details about the actual consumers who paid these merchants in virtual currency. Another recent

[1] For examples, see MintChip, IBM, JP Morgan Chase, Tibado, etc.
[2] For example, Lo and Wang (2014) argue that Bitcoin is not money.

study by CoinDesk (2015) reports demographic features of Bitcoin users, but it is a proprietary study that does not reveal details about its statistical and sampling properties.[3]

To best of our knowledge, this paper provides the first nationally representative evidence on consumer adoption and use of virtual currencies, in this case for the United States. We use the annual (2008-2015) Survey of Consumer Payment Choice (SCPC) from the Federal Reserve Bank of Boston to estimate the diffusion of virtual currencies among U.S. consumers. The SCPC collects data on the adoption and use of all bank accounts and payment instruments for a longitudinal panel of consumers, as well as consumer preferences and assessments of those instruments. In 2014, the SCPC began to add questions about Bitcoin and other virtual currencies, which were supplemented by additional surveys during 2015. A key advantage of our analysis is that the SCPC contains comprehensive information on each consumer's payment behavior. These data allows us not only to characterize the types of consumers who adopt and use virtual currencies, but also to investigate their reasons and determine whether it produced any substitution for other payment instruments (such as cash) or practices (in-person versus online).

As of October 2015, still less than half (47 percent) of all U.S. consumers had heard of (were aware of) any virtual currency, up from about 39 percent the year before. Among consumers who are aware of virtual currencies, nearly nine in ten of them report being "slightly" or "not at all" familiar with them. In October 2014, nearly 4 percent of all consumers (or nearly 10 percent of those aware of virtual currency) misidentified the general term "other virtual currency" as referring to things that are not virtual currencies (e.g., sovereign currencies, PayPal, and other payment services). A majority of virtual currency owners were not able to consistently and accurately report the number of coins and dollar values of their virtual currency holdings.

In light of low awareness and familiarity with virtual currency, and its inherent challenges, it is not surprising that less than 1 percent of U.S. consumers (less than 2 percent of aware consumers) have ever owned (adopted) any virtual currency; even fewer currently own it because they have discarded what they had. However, most adopters have used their virtual currency to make a payment in the past month to a person (most common), merchant, or both. This result suggests

[3] Add other consumer studies here.

that Bitcoin and other virtual currencies are not being held primarily or exclusively for investment, but also for their originally intended function as an electronic-cash means of payment.

Awareness, adoption, and use of virtual currencies are correlated with various demographic and economic characteristics of consumers. Consumers who are male, white, and high income or highly educated are more likely to be aware of virtual currency than consumers without these characteristics. Conditional on awareness, however, a typical Bitcoin owner (adopter) is more likely to be a younger, non-white male with lower education who expects Bitcoin to appreciate and bears relatively more responsibility for household shopping. Far fewer consumer characteristics are correlated with the decision to use virtual currency to make payments (of any type), but nearly all self-reported reasons for adopting virtual currency are significant determinants of use. Interestingly, consumers who have adopted a higher number of other payment instruments are more likely to be aware of virtual currency, own it, and use it—further evidence that consumers view virtual currency as a viable payment instrument.

The remainder of the paper proceeds as follows. Section 2 defines terms and concepts, briefly reviews the nascent literature on virtual currency, and discusses the theories underlying the paper's econometric models. Section 3 describes the SCPC and other data used to report statistics and estimate econometric models. Section 4 analyzes the diffusion of information about virtual currency among U.S. consumers. Section 5 reports results for adoption and holdings of virtual currency, and Section 6 reports results for the use of virtual currency. Section 7 offers some tentative conclusions.

2. Theoretical Discussion

2.1 Literature review

Although some predecessors existed at the time of of the seminal Bitcoin publication, Bitcoin, (Nakamoto, 2008), can be credited with introducing and popularizing the concept we call "virtual currency" that has achieved widespread notoriety and recognition of potential broad-based appeal. As is often the case with innovations, the early stage of development of Bitcoin and other virtual currencies has been characterized by a lack of consensus about terminology and defini-

tions. So, before reviewing the academic literature, we offer some perspective on these fundamentals and explain our choice of terminology.[4] These issues are central to consumers' ability to understand the questions asked in the SCPC.

2.1.1 Terminology and concepts

The title of (Nakamoto, 2008) "Bitcoin: A Peer-to-Peer Electronic Cash System," provides a starting point for discussing terminology and concepts. A central focus of that paper is creating a network ("system") for people to pay other people ("peer-to-peer" or P2P) using an online only ("electronic") form of cash that does not require the involvement of a financial institution as a third-party to validate the transaction. In essence, this proposal advances a form of private payment instrument, or money, that is not sovereign currency but has characteristics similar to cash—especially privacy or anonymity for the payer and payee. Nakamoto proposes relying on cryptographic proof instead of trusted third-party financial institutions to verify the transaction via a public ledger that tracks and records all transactions, which all members of the system can read and verify as correct.

Economists and other experts who study Bitcoin and similar currencies have proposed a number of terms to refer to these types of currencies. The ECB (European Central Bank, 2012) first proposed the term "virtual currency" (see especially Table 1, "A money matrix"), which also was used by Greene and Shy (2014). A more recent report by the Bank for International Settlements (BIS 2015) favored the term "digital currency," with digital intended to be synonymous to electronic, although it acknowledged the essential interchangeability of the term with virtual currency (see BIS footnote 2). As emphasized by the ECB, digital currency is a broader term that can also be applied to electronic forms of sovereign currencies like the U.S. dollar, such as a debit card or the Automated Clearing House (ACH). Furthermore, in all countries, digital sovereign currency can be transformed into physical currency (cash, or coins and notes), whereas virtual currency conveys the notion that it remains digital and cannot be converted to the physical realm. For this reason, we prefer the term virtual currency.

However, both terms (virtual or digital) are imperfect short-hand descriptors because they do

[4]We thank Hanna Halaburda for suggesting the need for this discussion.

not adequately reflect all important characteristics of these currencies. For example, neither one explicitly reflects the cryptographic security, which is why some prefer the term "cryptocurrency," yet not all virtual or digital currencies have cryptography. Neither term reflects the ownership of the currency (public or private), even though the expected returns vary dramatically, or the intrinsic value (fiat or asset-backed), even though it varies considerably as well. The ECB classification provides a related but different distinction: regulated versus unregulated, which seems to imply a mapping to public versus private currency, respectively. One can further distinguish between type of fiat: centralized (as in sovereign currencies) versus decentralized (as in Bitcoin).

As one can see from this discussion, there are multiple dimensions along which one can classify Bitcoin and similar currencies so there is considerable ambiguity not only about how Bitcoin works but also about how to think about what it is. This ambiguity is even more severe among the general public of consumers and respondents to surveys. Therefore, in the SCPC, we define multiple terms (virtual currency, digital currency, and cryptocurrency) in hopes of reaching all consumers. We further ask respondents about Bitcoin, which is likely the most common "brand name," and a short list of the most valuable and well know competitors to Bitcoin (e.g., Ripple and Dogecoin), to maximize respondent understanding. Nevertheless, if economists have not proposed and settled on a consensus term, it is likely that many consumers may be confused about the concept.

2.1.2 Other research

TO BE COMPLETED

- Virtual currency as technology, payments, and money: Velde (2013), Lo and Wang (2014), Böhme et al. (2015), Greene and Shy (2014)
- Virtual currency as asset and pricing: Glaser et al. (2014), Hencic and Gouriroux (2015), Donier and Bouchaud (2015), Dwyer (2015), Bolt and van Oordt (2015).
- Network economics of virtual currency industry: Halaburda and Gandal (2014), Möser and Böhme (2015).

- Virtual currency acceptance and use: (merchants) Polasik et al. (2015), (consumers) Tsanidis et al. (2015), Saito (2015), Christin (2013), CoinDesk (2015).

2.2 Underpinnings of econometric results

The first step in modeling consumer adoption and use of virtual currencies involves handling the incomplete diffusion of knowledge about about them among consumers. Unlike traditional payment instruments like credit cards, which have existed since the 1950s and reached steady state adoption rates of around 70 percent by the 1980s, virtual currencies are relatively new and not widely disseminated. By late 2015, not all consumers were even aware that Bitcoin had been created seven years earlier, much less understood the conceptual similarities and differences between e-money and virtual currency. Even many who had heard of virtual currency via the media and had read about the concept of virtual currency were unfamiliar with the basic mechanics of Bitcoin described in the primer by Velde (2013), much less experts in blockchain technology underlying virtual currency. For these reasons, we first estimate the diffusion of awareness of virtual currency.

Next we model the ownership of virtual currency by consumers. To do so, we restrict our population of study to consumers who are aware of virtual currency and exclude those who are not. This restriction is logical because a consumer who does not know virtual currency exists cannot be reasonably expected to have made a rational decision to adopt it or not.

There are at least two potential ways to model demand for virtual currency, depending on whether it is viewed as money or not. If we ignore the potential monetary aspect of virtual currency, we can follow the literature on adoption of payment instruments and treat the decision as a discrete choice and estimate the latent probability of adoption using logit regressions.[5] Alternatively, if we assume that virtual currency is private money, it may be more appropriate to specify a model of the demand for money in terms of the dollar value of holdings. Absent a structural model of money demand that distinguishes between sovereign and private currencies, we follow the traditional literature that uses reduced-form econometric models in the spirit of Baumol (1952) and Tobin (1956); in particular, we adopt the specification in Briglevics and Schuh (2013), which also uses SCPC data to estimate the demand for U.S. currency (or "cash").

[5]For examples of this approach, see Schuh and Stavins (2010, 2012, 2015) and the references therein.

A key differences between the demand for sovereign and virtual currencies is their opportunity costs. Demand for sovereign currency depends on the nominal interest rate—a real interest rate and expected inflation (the devaluation of the currency)—available to holder of sovereign currency. For this measure, we can use interest provided on bank checking or savings accounts, or short-term investments like money market mutual funds. However, banks are not able to hold or transmit virtual currencies because their cryptographic security prevents them from complying with the Bank Secrecy Act (1970), which requires adherence to anti-money laundering (AML) and know-your-customer (KYC) regulations. New types of depository institutions have emerged to hold virtual currency stocks (e.g., CoinBase, Circle, etc.), but so far they do not fractionally reserve balances and issue loans to earn interest. However, there appear to be some innovative ways of earning interest on Bitcoins, such as margin trading exchanges.[6] Demand for virtual currency depends on exchange (or principal) risk due to its floating exchange rate with the U.S. dollar. Therefore, expectations of future exchange rates (the "price" of virtual currency) should influence the demand for virtual currency in a way that it does not influence the demand for sovereign currency.

Finally, for the population of consumers who have adopted virtual currencies, we model the use of them on the extensive and intensive margins. We model the incidence of using virtual currency (extensive margin) as a discrete decision and estimate the latent probability of use with logit regressions. These results provide an estimate of the extent to which consumers hold virtual currency just for investment purposes or for payments as well. Also following the literature on consumer payment choice cited earlier, we model the virtual currency share of consumer payments (intensive margin) using OLS regressions. These regressions include consumers' assessments of virtual currency characteristics (cost, convenience, security, etc.), relative to the characteristics of other payment instruments, as explanatory variables; for details, see Schuh and Stavins (2010).

[6]See "How to Earn Interest on Bitcoin 5 Different Ways," *Cryptorials, June 27, 2015, http://cryptorials.io/how-to-earn-interest-on-bitcoin-5-different-ways/*

3. Survey Data

3.1 Survey of Consumer Payment Choice

We use the Survey of Consumer Payment Choice (SCPC) from the Federal Reserve Bank of Boston to report statistics and estimate econometric models. The SCPC is a 30-minute annual (2008-2015) recall-based survey of U.S. consumers that measures their adoption and use of payment instruments, including cash, and their associated transaction accounts (bank and non-bank); see Schuh and Stavins (2012, 2014) for more details. Each year except 2008, the SCPC included about 2,000 respondents who form an unbalanced longitudinal panel. The SCPC was administered to members of the RAND Corporation's American Life Panel (ALP) from 2008-2014 and the University of Southern California's (USC) Understanding America Study (UAS) from 2014-2015.[7] These Internet survey panels are designed to be approximately representative of U.S. consumers but may exhibit unobserved selection effects. Aggregate survey results are weighted to match the U.S. population as measured by the Current Population Survey.

Questions about virtual currency were first introduced in the 2014 SCPC (ALP and UAS versions) and then expanded in three additional surveys in 2015, all of which are summarized in Table 1. Because the adoption rate of virtual currency by U.S. consumers is so low, the 2014 SCPC yielded only 26 adopters out of 3,047 total respondents (ALP plus UAS) and it was not feasible to do statistically precise analysis. Consequently, the Boston Fed used Qualtrics to administer the 2014 SCPC to a targeted over-sample of 611 virtual currency adopters in the summer of 2015.[8] Although this over-sample version of the 2014 SCPC was completed in July 2015, nine months after the official SCPC (October 2014), we combine the two samples and refer to them as the 2014 SCPC. Finally, the 2015 SCPC (UAS version only) was conducted in October and included an over-sample of about 125 virtual currency adopters from Qualtrics. [NOTE: All aggregate 2015 survey results appearing in tables are not weighted yet.]

Internet survey panelists (ALP and UAS) and Qualtric survey participants exhibit some poten-

[7] By and large, the ALP and UAS panels have similar composition. However, the ALP was originally constructed

[8] Qualtrics works with a number of partners who maintain, or can gain access, to a large number of potential respondents. Initially, Qualtrics administered a brief screening question to a large and broad sample of respondents that asked whether the respondent had (owned) virtual currency. If so, the respondent was offered the opportunity to take the entire 2014 SCPC. This pre-screen sampling strategy signficantly reduces the survey costs.

tially important differences. First, the composition and recruitment methodology of the Internet survey panelists are well-known and designed to be as representative as possible. However, some Qualtrics respondents may come from survey vendors who do not invest in same quality of survey and sampling methodologies as the ALP and UAS, and some of their respondents may come from convenience samples or marketing firms. Thus, in general, it is not possible to estimate precisely the Qualtrics sampling frame or its relation to the U.S. population; hence it is difficult to construct accurate sampling weights. Also, the Internet survey panelists are paid a much higher incentive ($20 for 30 minutes) than the Qualtrics respondents (typically $5 or even less), so participation and response rates are generally better for the ALP and UAS members.

3.2 Survey questions

While most of the SCPC questions and structure were very similar between 2014 and 2015, Table 2 shows that the virtual currency questions varied across surveys. The table reports the survey questions in the first column and then indicates with an "X" which questions were included in the questionnaires in the next four columns: (1) 2014 SCPC (ALP and UAS); (2) 2014 over-sample (Qualtrics); (3) 2015 SCPC (UAS) and 2015 over-sample (Qualtrics).[9] The official 2014 SCPC (October 2014) included the fewest questions.

The 2014 and 2015 SCPC questionnaires first ask respondents whether they had heard of Bitcoin, then they asked whether they had heard of any other virtual currencies. If a respondent answered "yes" to either question, he is defined to be "aware" of the respective virtual currency. In the case of other virtual currencies, the 2014 SCPC respondents also had to indicate specifically which other virtual currency(ies) they had heard about, and we are able to verify whether their answers correctly identified virtual currencies. Because we found a high frequency of errors in the 2014 SCPC, we added a specific list of the top 5 virtual currencies (in terms of market capitalization) after Bitcoin before asking the open-ended question about other virtual currencies.[10] In the 2015 SCPC, we added a question for everyone who was aware of virtual currency about their degree of familiarity (1-5 scale) with virtual currency.

[9] The third questionnaire (2015) was the same for the UAS and Qualtrics respondents because USC recruited the 2015 Qualtrics over-sample respondents to take their online UAS survey.

[10] The top 5 other virtual currencies were Ripple, Litecoin, Dash, Stellar, and Dogecoin.

Unfortunately, the pre-screening questions for the Qualtrics over-samples made it infeasible to ask awareness questions because only one question could be asked and the question was whether the respondent currently owned (adopted) any virtual currency. For this reason, the over-samples use a longer list of other virtual currencies (top 14 by market capitalization).[11] However, given that it is very difficult to identify the composition of the full Qualtrics sample, it is not really feasible to estimate awareness (as a percentage of the population) from the over-samples anyway. So, the over-samples are primarily used to supplement the 2014 and 2015 SCPC samples for the regression analyses; when they are used in tables, the SCPC sample weights are adjusted for the over-sampling.

In both years, the SCPC asked basic questions about adoption, holdings, and use of virtual currencies (Bitcoin and each specific other ones). The questionnaires ask about current adoption ("Do you have...") and historical adoption (If not, "Have you ever had...") because holdings of virtual currency, like cash (and unlike payment cards), can be depleted through spending and must be replenished. The questionnaire also asked how much virtual currency adopters have (own), measured by both the number of coins and the U.S. dollar-equivalent value of their holdings to increase the quality of measurement and implicitly test for consistency relative to market exchange rates. The questionnaires also asked whether adopters had used virtual currency to make a payment during the past 12 months.

However, the 2015 SCPC and both over-sample questionnaires contain some additional questions to improve understanding of the initial 2014 results. These questionnaires asked the primary and second reasons for owning virtual currency. They also asked about the intensity of use of virtual currency (number of payments) and asked about payments in the past 30 days as well as past 12 months, and expectations of price ($/bitcoin exchange rate) changes over the next week, month, and year.

Finally, because the 2014 results for virtual currency holdings raised concerns about possible measurement error (described in detail later), respondents to the 2015 SCPC were also asked whether they used web sites or their financial records in reporting the estimates of coins, dollar

[11] The top 14 other virtual currencies included the top 5 mentioned earlier plus Bitshares, Nxt, BanxShares, Peercoin, MaidSafeCoin, NameCoin, ByteCoin, Monero, BlackCoin.

values, or both. For the consumers who reported both the number of coins and the dollar value of holdings, the SCPC offers the chance to test the internal consistency of their data by comparing the implied exchange rate (dollar value divided by number of coins) of the two estimates with the market exchange rate on the day of the survey. For Bitcoin, approximately 79 percent of respondents reported both the number of coins and dollar value.[12]

4. Awareness of Virtual Currency

This section examines the degree to which information about virtual currency has disseminated among consumers using data on Internet search activity and the 2014-2015 SCPC.

4.1 Internet search data

One potential proxy for consumer awareness of Bitcoin over time is the number of Google search hits in the United States on the term ("Bitcoin"), which is plotted in Figure 1.[13] By this measure, it appears that some consumers first began to show awareness of Bitcoin in mid-2011, about two years after Bitcoin was first made operational. The intensity of searching for Bitcoin surged again in early 2013 and early 2014. Interestingly, Figure 1 shows that the intensity of searches for Bitcoin is highly correlated ($\rho = .80$) with movements in the dollar value of Bitcoin. This result suggests that early awareness of Bitcoin may have been primarily related to store of value and speculative investment rather than its use for payment.

In any case, if search intensity proxies for information accumulation, it appears that awareness of Bitcoin is roughly following the standard S-shaped diffusion pattern, as depicted by the cumulative intensity of search for the term "Bitcoin" shown in Figure 2. In principle, we can treat awareness of other virtual currencies the same way as awareness of Bitcoin, though there are many more of them and each is much less well known than Bitcoin. The total number of virtual currencies in existence, also shown in Figure 2, appears to follow a remarkably similar S-shaped diffusion pattern as well, lagging Bitcoin awareness by roughly a year.

[12] Another 11 percent reported only coins, 2 percent reported only dollar values, and 8 percent reported neither (conditional on reported having adopted Bitcoin).

[13] The Google search intensity is an index for which units are not available.

4.2 Consumer survey data

Turning to the SCPC results, we find that about half (47 percent, unweighted) of U.S. consumers were aware of any virtual currency by October 2015, up from about 39 percent (weighted) in October 2014, as shown in Table 3. By far (and not surprisingly), the vast majority of consumers who are aware of virtual currency are aware of Bitcoin, not other virtual currencies. Note that the individual estimates of awareness for Bitcoin and other virtual currencies do not sum to the total virtual currency number because some respondents were aware of both Bitcoin and other virtual currencies.

While it has taken seven years since (Nakamoto, 2008) for half of the U.S. population at least to have *heard* of virtual currency, not everyone who is aware of virtual currency is intimately familiar with the complicated new technology. Table 3 shows that 87 percent of respondents to the 2015 SCPC reported being "not at all" or "slightly" familiar with virtual currency. Thus, our discrete measure of awareness (aware versus not aware) overlooks important variation in the extent to which consumers actually understand virtual currency—many are aware but don't really understand. In the future, it would be better to measure the specific degree of consumer's understanding of virtual currency.

Nevertheless, it is interesting and feasible to estimate the pace of diffusion of information about virtual currency in the United States. Given our two observations on awareness (October of 2014 and 2015) and a reliable estimate of the initial condition (zero percent of the population prior to the Bitcoin paper in October 2008), we use the Bass (1969) diffusion model to fit and forecast Bitcoin awareness. Figure 3 plots the estimated process, which suggests that it could take a total of 15 years (2008 to 2023) to reach nearly complete awareness of Bitcoin in the United States.

Another sign that consumers lack full and accurate information about virtual currency can be found in the row of Table 3 labeled "incorrectly identified," which indicates that about 3 percent of consumers (or nearly 10 percent of those aware) do not truly know what virtual currency is. Table 3 contains the types of other virtual currencies respondents identified when asked what they were. Some consumers correctly named virtual currencies, even the closed-loop Linden Dollar, which is quite different from Bitcoin and other open-loop virtual currencies. However, some

consumers mistake online payments (PayPal, Google Wallet, etc.), sovereign currencies (such as the Euro, Peso, etc.), and other things for virtual currency. Henceforth, we exclude erroneous responses from definitions of awareness, adoption, and other measures from our analysis.

To determine the types of consumers who are more likely to be aware of virtual currency, we use a dummy variable for awareness (aware = 1, otherwise = 0) to run logit regressions and estimate the latent probability of being aware of Bitcoin or other virtual currencies (corrected for erroneous responses). The results appear in Table 4. Estimates for Bitcoin are most significant; estimates for other virtual currencies are qualitatively similar but much less significant given the small number of non-zero observations.[14] Bitcoin awareness does not depend on age, but it is increasing in income and education, and decreasing in household size. Men and white consumers also are much more likely to be aware of Bitcoin. Interestingly, awareness of Bitcoin (but not other virtual currencies) increases with the number of payment instruments adopted by consumers, suggesting that a preference for having more ways to make payments is correlated with knowledge of new payment methods.

We characterize the types of consumers who are more likely to erroneously classify something as a virtual currency using a logit regression (dependent variable is a dummy variable with error = 1). Table 5 shows a somewhat paradoxical result: consumers with higher education (college degree or post-graduate study) are less likely to erroneously classify virtual currency, but lower income consumers also are less likely to make a classification error. Older consumers are more likely to make a classification error, but the effect is an order of magnitude smaller than for income and education.

To determine the types of consumers who more familiar with virtual currency, we use the degree of familiarity (1 to 5 scale) to run OLS regressions and estimate the effects of consumer characteristics on familiarity with virtual currency. The results appear in Table **??**. Only two characteristics are significant: older consumers are less likely to be familiar with virtual currency, and male consumers are more likely to be familiar.

[14]The dependent variables in these regressions are fewer and simplified to conserve on degrees of freedom in the other virtual currency regressions. The Bitcoin regression dependent variables are the same for comparability.

5. Demand for Virtual Currency

This section reports empirical and econometric results on two measures of consumer demand for virtual currency. First, the extensive margin of demand is measured as the discrete state of holding (owning) virtual currency or not. Second, the intensive margin of demand is measured as the amount of virtual currency holdings, a continuous variable in the U.S. dollar value of virtual currency.[15]

5.1 Adoption of Virtual Currency

Table 7 shows that adoption of virtual currency by U.S. consumers is quite low. In 2014, only .52 percent of consumers reported having virtual currency (current adoption; more had Bitcoin (.47 percent) than other virtual currencies (.16 percent).[16] Historical adoption of virtual currency, which includes consumers who previously owned virtual currency but did not have any at the time of the survey, was .82 percent; thus .32 percent of consumers had discarded virtual currency at some point. A reasonable case may be made for measuring adoption as a percentage of only consumers who are aware of virtual currency, but even then only 1.3 percent of consumers may be said to have adopted virtual currency (or 2.1 percent historically).

A key issue for consumers adopting virtual currency is their expectation of future exchange rates (price), which determines the principal (or exchange rate) risk of virtual currency holdings.[17] The SCPC asks respondents for their qualitative (decrease, stay the same, or increase) expectations of virtual currency exchange rates over the next week, month, and year. Expectation questions were asked only of respondents who were aware of virtual currency, and Table 8 contains the results. Perhaps not surprisingly, there is a marked difference in expectations between adopters and non-adopters of virtual currency. Well more than half of non-adopters expect the exchange rate to stay the same, with a reasonably distribution of expected increases and decreases, though slightly more seeing a decline. In sharp contrast, a large majority of Bitcoin and non-Bitcoin adopters ex-

[15] Alternatively, virtual currency holdings could be expressed in units of the currency ("coins"), but the two measures should be essentially the same due to the existence of an exchange rate ($/coin).

[16] Note that the 2015 estimates of adoption rates in the table are not weighted yet and thus may not be accurate estimates of the population.

[17] Expectations of future exchange rates also is related to consumer awareness and familiarity with virtual currency, or consumer financial literacy more broadly.

pect the exchange rate to stay the same, at worst, but most expect the exchange rate to increase at all horizons.[18]

To determine the types of consumers who have more optimistic price expectations, we use the degree of optimism (-2 to 2 scale) to run OLS regressions and estimate the effects of consumer characteristics on virtual currency price expectations at each horizon (week, month, year). The results appear in Table 9. Three characteristics are significant explanatory variables for expectations. Older consumers have lower price expectations for some reason(s), but consumers who have more responsibility for making investment decisions in their household have higher price expectations. Consumers who have adopted relatively more other payment instruments also have higher price expectations.

To determine the types of consumers who are more likely to adopt virtual currency, we use a dummy variable for adoption (adopt = 1, otherwise = 0) to run logit regressions and estimate the latent probability of adopting virtual currency of any type, and individually for Bitcoin and other virtual currencies.[19] The results, which appear in Table 10, are highly significant and generally similar for Bitcoin and other virtual currencies. Unlike awareness, age is correlated with adoption as older consumers are considerably less likely to adopt virtual currencies. Likewise, although white consumers are notably more likely to be aware of virtual currencies they are somewhat less likely to adopt them, and men are not more likely to adopt virtual currencies conditional on being aware of them. Consumers who have adopted more payment instruments, and consumers who have higher shares of cash payments, are more likely to adopt virtual currencies as well, even though virtual currency may be a substitute for other payment instruments.

Perhaps the most interesting—but certainly not surprising—adoption results are the large and highly significant coefficients on price expectations. All three horizons are important independently, so the shape of the forecast matters. A higher expected change in price over the next week

[18] Future drafts of the paper will explore the role of exchange rate expectations in the adoption and holdings of virtual currency.

[19] This regression is based on a pooled sample of the July 2015 oversample and the 2014 SCPC sample, excluding consumers who are not aware of virtual currency (and therefore cannot be expected to adopt something they don't know exists). Although the virtual currency adoption measure was different in the oversample because it did not ask awareness questions first, we believe that directly asking respondents if they had any Bitcoin is likely to produced similar results. Furthermore, the oversample questions asked about 14 specific types of other virtual currencies and thus is likely to have measured adoption better than the 2014 SCPC questions.

raises the probability of adoption by 9 to 10 percent. Because consumers' expected changes over each horizon are almost surely correlated, next two expectation variables are the differences from the the immediately earlier horizon, which reduce problems of multicollinearity. Both changes in price expectations (week to month and month to year) also are highly significant and of similar magnitude.

Although illuminating, the adoption regressions do not reveal the specific reasons for consumers adopting or not adopting virtual currency. To obtain this information, the SCPC directly asked consumers to identify their primary reasons for adopting or not adopting virtual currency, and their secondary reasons for adopting (only in the 2014 SCPC oversample). The results appear in Table 11. The single most common reason for consumers owning virtual currency is that more than one in five consumers are "interested in new technologies" which corresponds well with the technological sophistication of the product. However, combining answers into common groups reveals that more than one in three consumers adopts virtual currencies for reasons related to making payments (i.e., to buy goods and services, to make remittances, or to make payments anonymously). In contrast, less than one in five consumers holds virtual currency for investment. Furthermore, only one in ten consumers holds virtual currency because they distrust banks or sovereign currency. Consumers who do not adopt virtual currency cite a wide range of reasons with roughly similar frequencies.

5.2 Holdings of Virtual Currency

The 2014–2015 SCPC asked all current adopters of virtual currency to estimate the amounts of their holdings, which are reported in Table 12. Unfortunately, the results shows signs that there may be significant measurement error in the responses. The first panel of the table shows that in 2014 the median Bitcoin adopter held about 3–7 bitcoins and the mean holding was about 75 bitcoins.[20] The second panel shows that median Bitcoin adopter held about $150-500 in bitcoin, with a mean of $800-1,600. Individually, the coin and value numbers seem plausible, but viewed together there appears to be an inconsistency in the reporting. With an approximate exchange rate

[20]The mean number of coins for other virtual currency seems implausibly large and may require data cleaning so we ignore them for now.

of $300 per bitcoin, the median coin holdings suggest considerably higher value holdings than the owners' reported estimates. To verify this conjecture, the third panel of the table reports the implied value of coin holdings using the actual official exchange rates at the time of the survey. Indeed, these value estimates are much larger than the owner estimates.

The wide disparity in dollar-value estimates of holdings can be further illuminated by looking at the implied exchange rates of consumers who reported both components of Bitcoin. The bottom panel of Table 12 shows that the 2014 SCPC sample estimates of Bitcoin exchange rate (mean $193, median $333) are reasonably close to the actual market exchange rate during this time (roughly $250 to $400). However, the 2014 oversample estimates of the Bitcoin exchange rate (mean $4,151 and median $9) are much further from the actual range in July 2015. Apparently, many consumer estimates of virtual currency holdings are not particularly trustworthy.

However, to refine the estimates a bit, we identified and reported a set of "best" estimates in the fourth panel of the table. The best estimates use information about whether respondents checked their financial records when reporting coin and value estimates, and limited the exchange rate error (difference between implied rate and actual market rate) to 10 percent in absolute value. Using these "best" responses the mean and median estimates of Bitcoin value fall between the full sample of owner reported holdings and the coin estimate evaluated at actual market exchange rates.[21]

In light of considerable uncertainty about the quality of the data on virtual currency holdings (both coins and dollar values), we do not estimate models of money demand (holdings of virtual currency) at this time. If we are able to better verify and clean these data, we will report these econometric results in future versions of the paper for comparison with models of consumer demand for U.S. currency.

6. Use of Virtual Currency

This section explores the propensity of virtual currency adopters to use the currency to make payments and, if so, who they pay and what they buy. Like adoption, there are two margins of

[21] In future work, we will benchmark these estimates of coin and value holdings to online data on virtual currency holdings by account.

virtual currency use. First, the extensive margin of use is measured as the discrete state of having made a payment with virtual currency during the past 12 months (past month or otherwise). Second, the intensive margin of use is measured by the number of payments made with virtual currency during a typical month, which can also be expressed as the share of monthly payments for each consumer, the latter having econometric advantages demonstrated in previous research. Although the SCPC clearly asks respondents about virtual currency payments for goods and services, it is possible that some respondents may include strictly financial payments made with virtual currency, such as exchange virtual currency for sovereign currency (buying dollars, for example). Furthermore, knowing the payee (merchant versus person) does not necessarily reveal what consumers paid for with virtual currency or the type of payment (bill versus non-bill).

6.1 Incidence of Use

Many virtual currency adopters used it to make a payment in the past 12 months, as shown in Table 13. The incidence of use estimates vary widely between the 2014 SCPC (28 percent) and the 2014 oversample (75 percent), and we have not yet constructed proper sampling weights for the combined sample yet. Given the dominant size of the oversample of adopters (about 500 compared to less than 30 in the SCPC), it is likely that more than half of them used virtual currency to pay. The 2014 oversample also indicates that the vast majority of adopters (about nine of ten) who made payments in the past 12 months also made a payment within the past month, so paying with virtual currency appears to be the norm, not a rarity, among adopters. Note again, however, that some of these reported payment could have been financial payments.

To determine the types of adopters who are more likely to make payments with virtual currency, we use a dummy variable for incidence of use (use = 1, otherwise = 0) to run logit regressions and estimate the latent probability of paying with Bitcoin or other virtual currencies.[22] The results, which appear in Table 14, yield many fewer significant results than the adoption regressions for the demographic and other common explanatory variables. Men are more likely to use Bitcoin for payments, but not other virtual currencies. Consumers who have adopted more pay-

[22]This regression is based on a pooled sample of the July 2015 oversample and the 2014 SCPC sample. The results for any virtual currency (Bitcoin and other virtual currency together) were qualitatively and quantitatively quite similar and not reported separately.

ment instruments are more likely to make payments with all types of virtual currency. But the other common variables do not contribute significantly to the probably of paying with virtual currency.

However, the incidence of use regressions also add reasons for adopting virtual currency as explanatory variables, and these are quite significant. All of the payment and investment reasons are economically and statistically significant correlates with use. However, the magnitudes of the coefficients are remarkably similar so no specific reason dominates. Payment security is very significant for Bitcoin, which is based on blockchain technology, but it is not for other virtual currencies, which use a variety of security technologies. Distrust of the government is marginally significant.

6.2 Type of Payee

From the perspective of two-sided market analysis, it is important to know who the payees are that receive virtual currency payments from consumers. Table 13 also shows the extent to which consumers used virtual currency to pay a person, a merchant, or both types of payees. More than half (56 percent) of virtual currency users paid another person, and two of five (39 percent) paid a merchant, while one in four (25 percent) made payments to both in the past 12 months.

To determine the types of payers who are more likely to make payments with virtual currency to each type of payee, we use a dummy variable for each payee (paid = 1, otherwise = 0) to run logit regressions and estimate the latent probability of paying each type of payee with virtual currency.[23] The results, which appear in Table 15, have very few significant coefficients. Only consumers who have adopted more payment instruments have consistent, significant correlation with payee choice. Men are more likely to pay a merchant. But in general we do not find many explanations for the choice of payee by consumers who pay with virtual currency.

6.3 Frequency of Use

In this section we report estimates of two-stage Heckman selection model of the adoption and use of virtual currency in the spirit of the literature exemplified by Schuh and Stavins (2010). The first-

[23] This regression is based on a pooled sample of the July 2015 oversample and the 2014 SCPC sample.

stage adoption model is analogous to, but simpler than, the model reported in earlier results. The second-stage model's dependent variable is the share of monthly consumer payments made with virtual currency, which implicitly controls for each consumer's heterogeneous adoption pattern. However, our preliminary results do not include the relative characteristics of virtual currency (cost, security, convenience, etc.), which have been shown to be important determinants of both adoption and use.

Table 16 reports the results of this preliminary estimation. The first-stage adoption estimates (bottom panel) are broadly similar to results reported earlier and most variables are statistically and economically significant. However, the second-stage use estimates (top panel) reveal far fewer significant variables—similar to the results reported earlier for the extensive margin of use (incidence). Perhaps the most notable estimates are for the two coefficients on reasons for adoption related to payments (buy goods and services, and make remittance payments) in the Bitcoin equation. The estimates are positive and large (3 percentage point effect on the share of Bitcoin payments), providing support for the hypothesis that Bitcoin is used as a means of payment. However, these results, like others throughout the paper, are very preliminary and subject to change after further refining and development.

7. Conclusions

This paper provides very preliminary empirical and econometric results that characterize U.S. consumers' experience with Bitcoin and other virtual currencies. The evidence is based on a respected, nationally representative survey that measures consumer adoption and use of all major U.S. payment instruments. However, the data and analysis are not complete and all results should be viewed circumspectly. Nevertheless, at this stage several basic results emerge.

First, information about Bitcoin and other virtual currencies still had only reached about half of the U.S. adult population by the end of 2015, and it may take another decade before the vast majority of consumers are aware. Moreover, most consumers who are aware of virtual currencies report being largely unfamiliar with them, and even those who own them exhibit errors in reporting their holdings. Men and consumers with high income and education appear to be more aware

of virtual currencies. In any case, incomplete and imperfect information about virtual currencies contributes to their limited dissemination in the U.S. economy.

Second, adoption of Bitcoin and other virtual currencies is remarkably low even among consumers who are aware of them. This finding suggests that virtual currencies still do not appeal to consumers enough to obtain, hold and use them. One key exception is that consumers who expect virtual currencies to appreciate in value are much more likely to demand them. This result may suggest that consumers demand virtual currencies as a financial investment. At the very least, high volatility in virtual currency values likely predisposes consumers toward owning them only if they do not pose a serious exchange rate (principal) risk.

Third, among those consumers who own virtual currency there appears to be considerable use of them to make payments for goods and services and to other consumers, roughly in equal proportions. This finding raises further questions about the extreme view that virtual currencies are merely speculative investment, especially given the relatively limited acceptance for payments among merchants and, presumably, consumers thus far.

Table 1: Description of surveys.

	2014		2015	
	SCPC	Oversample	SCPC	Oversample
Respondents	3,047	611	1800 (est)	125 (est)
Time period of implementation	Oct-14	Jul-15	Oct-15	Oct-15
Vendor	ALP + UAS	Qualtrics	UAS	Qualtrics
Awareness	Bitcoin, other	NA	Bitcoin, top 5, other	NA
Adoption	Same	Bitcoin, top 14	Bitcoin, top 5	Bitcoin, top 5
Summary of other questions	Ownership and records (1), Use (1)	Ownership and records (2), Use (7), Reasons (2), Expectations (2)	Ownership and records (2), Use (7), Reasons (3), Expectations (1), Familiarly (1)	Ownership and records (2), Use (7), Reasons (3), Expectations (1), Familiarly (1)

Table 2: Virtual currency questions in the 2014 SCPC (Oct), 2014 SCPC oversample (OS, Jul 2015), and 2015 SCPC (official and oversample, Oct 2015).

	2014		2015
	SCPC	OS	SCPC/OS
Awareness			
Have you heard of Bitcoin?	X		X
Have you heard of any other virtual currencies [Top 5]?			X
Have you heard of any other virtual currency? (if yes, please specify)	X		X
How familiar are you with Bitcoin and how it works?			X
Adoption (conditional on awareness)			
Do you have or own any Bitcoin?	X	X	X
Do you have or own any of these other virtual currencies? [Top 5]			X
Do you have or own any of these other virtual currencies? [Top 14]		X	
Do you have or own any other virtual currencies?	X		
Historical adoption (conditional on awareness)			
Have you ever had or owned any of these virtual currencies? [Bitcoin]	X		X
Have you ever had or owned any of these virtual currencies? [Top 5]			X
Have you ever had or owned any of these virtual currencies? [Other VCs]	X		
Reasons for (non-)adoption (conditional on (non-)adoption)			
What is the main reason that you do not own any virtual currency?			X
Please tell us your primary reason for owning virtual currency [9 options]		X	X
Please tell us your secondary reason for owning virtual currency [9 options]		X	X
Amount owned (conditional on adoption)			
How much virtual currency do you have or own? [coins, USD equivalent; Bitcoin, other]	X	X	X
Did you have to refer to records or websites to know the number of coins or the equivalent value in U.S. dollars?		X	X
Incidence and frequency of use (conditional on adoption)			
In the past 30 days, have you used virtual currency to make a payment or transaction? [Bitcoin, other]		X	X
In the past 12 months, have you used virtual currency to make a payment or transaction? [Bitcoin, other]	X	X	X
In the past 30 days, how many payments did you make using a virtual currency? [Bitcoin, other]		X	X
In the past 12 months, how many payments do you make using a virtual currency? [Bitcoin, other]		X	X
Location of use (conditional on adoption)			
Have you used virtual currency to pay a merchant (store, company, or other business)?		X	X
(If yes) Please list up to three merchants you have paid using virtual currency.		X	X
Have you used virtual currency to pay a person (somebody who is not a merchant)?		X	X
Price expectations and assessments (conditional on awareness)			
How do you expect the value of one bitcoin to change over the following time periods. [week, month, year]		X	X
Assessments of bitcoin/virtual currency [security, acceptance, cost, convenience, getting & setting up, payment records]24		X	

Table 3: Virtual currency awareness and familiarity.

Virtual Currencies Awareness and Familiarity
Percentage of consumers.

	2014 SCPC		2015 SCPC**
	Full	UAS	UAS
Awareness	**39.5**	**39.6**	**46.6**
Bitcoin	39.5	39.6	46.2
Other virtual currency*	1.1	0.9	3.5
Incorrectly identified	*2.9*	*3.5*	*1.2*
Other payment services (eg. Apple, Paypal, Google Wallet)	*1.1*	*1.4*	*0.2*
Sovereign Currencies (eg. Euro, Pesos, Pound)	*0.9*	*1.3*	*0.3*
Cannot remember/other	*0.9*	*0.7*	*0.7*
Familiarity with Bitcoin (among those that are aware)			**100.0**
Not at all familiar			57.5
Slightly familiar			29.6
Somewhat familiar			8.3
Moderately familiar			3.9
Extremely familiar			0.8

* Excluding incorrectly identified. Correctly identified VCs include Dogecoin, Litecoin, Linden dollars, Ripple, Namecoin, Eucador, game based coins, Isracoin, Darkcoin, Blackcoin, BAMstorm and Feathercoin.

** Preliminary and unweighted.

Table 4: Awareness of virtual currencies.

	Bitcoin			Other VCs		
	2014 Full	2014 UAS	2015 UAS	2014 Full	2014 UAS	2015 UAS
Age	0.00196	-0.00121	0.00128	-0.00161	-0.00168	-0.00195
Agesq (x 1000)	-0.0155	0.0194	-0.0177	0.00843	0.00917	0.0141
edu_c_pgs	0.158***	0.168***	0.154***	0.00720	-0.00372	0.000553
hh_size	-0.0403***	-0.0342***	-0.0474***	-0.00129	-0.000301	-0.00337
White	0.117***	0.106***	0.160***	0.00512	0.0115	-0.00591
male	0.201***	0.188***	0.207***	0.0164***	0.0116	0.0206*
log_income	0.0852***	0.119***	0.0476**	0.00822**	0.0312**	-0.00623
num_pi_adopt	0.0339***	0.0292**	0.0503***	0.00459*	0.00526	-0.00381
csh_sh	0.0978**	0.0427	-0.0829	0.00208	0.00592	-0.0212
cc_debt_revolver	-0.000181	0.00961	-0.0103	0.00727	0.00614	0.0102
cc_rewards_adopt	0.0410**	0.0151	0.0295	0.00408	-0.00648	0.0105
smartphone_adopt	0.00944	0.0141	0.0285	-0.00338	0	0.0253
Observations	2786	1081	988	2786	828	986
Pseudo R-squared	.14	.18	.17	.18	.17	.04
N Positive	1385	551	543	37	13	41

Marginal effects

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Erroneous responses to other virtual currency.

	vc_error
male	-0.0276
age	0.0110***
log_income	-0.122**
edu_c_pgs	-0.159**
cc_sh	-0.275*
num_pi_adopt	-0.0241
csh_sh	0.158
cc_debt_revolver	-0.138*
cc_rewards_adopt	0.0324
smartphone_adopt	-0.0348
Observations	118
Pseudo R-squared	.46
N Positive	101

Marginal effects

Sample: 2014 SCPC oversample and 2015 SCPC

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: OLS on familiarity (1-5 scale).

	familiarity
age	-0.0408**
agesq (x 1000)	0.336*
edu_c_pgs	0.0824
hh_size	-0.0263
White	0.172
male	0.402***
log_income	-0.0368
num_pi_adopt	0.0659
csh_sh	-0.212
cc_debt_revolver	-0.00974
cc_rewards_adopt	-0.0924
smartphone_adopt	0.141
Constant	2.427***
Observations	459
Rsquared	.09
Mean	1.599
SD	.847

Sample: 2015 SCPC.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Virtual currency adoption.

Virtual Currencies Adoption
Percentage of consumers.

	2014 SCPC		2015 SCPC**
	Full	UAS	UAS
Current adoption	**0.52**	**0.56**	**0.44**
Bitcoin	0.47	0.56	0.44
Other virtual currency*	0.16	0.00	0.00
Incorrectly identified	*0.37*	*0.73*	
Historical adoption	**0.84**	**0.92**	**0.96**
Bitcoin	0.71	0.77	0.88
Other virtual currency*	0.24	0.15	0.09
Incorrectly identified	*0.75*	*1.01*	
Discarding	**0.32**	**0.36**	**0.52**
Bitcoin	0.24	0.21	0.44
Other virtual currency*	0.07	0.15	0.09
Incorrectly identified	*0.38*	*0.28*	

* Excluding incorrectly identified.

** Preliminary and unweighted.

Table 8: Expectations of Bitcoin exchange value.

Expectations of Bitcoin exchange value
Percentage of those who are aware of Bitcoin, except as noted.

	Decrease a lot	Decrease some	Stay about the same	Increase some	Increase a lot
Bitcoin (week)					
Bitcoin Adopters.....	6.2	7.2	41.4	28.4	16.8
VC Adopters (no Bitcoin)....	13.8	12.6	36.8	25.3	11.5
VC Non-adopters.....	5.8	8.8	79.8	4.7	0.9
Bitcoin (month)					
Bitcoin Adopters.....	2.2	9.6	35.9	35.5	16.8
VC Adopters (no Bitcoin)....	6.9	10.3	40.2	23.0	19.5
VC Non-adopters.....	5.2	13.5	71.8	8.8	0.5
Bitcoin (year)					
Bitcoin Adopters.....	3.4	5.6	28.3	30.3	32.3
VC Adopters (no Bitcoin)....	8.0	9.1	36.4	28.4	18.2
VC Non-adopters.....	9.9	16.9	56.4	14.4	2.3

* All respondents in oversample are VC adopters.
** Preliminary and unweighted.

Table 9: OLS on Expectations (-2 to 2 scale).

	Week	Month	Year
age_1825	-0.177	-0.259**	0.00198
age_2534	-0.00741	0.0716	0.0673
age_4554	-0.176**	-0.134	-0.304***
age_5564	-0.217**	-0.251***	-0.385***
age_o65	-0.273***	-0.319***	-0.497***
edu_c_pgs	-0.0421	-0.0891	-0.0359
hh_size	-0.0356	0.00389	-0.0206
white	-0.0743	-0.0828	-0.103
male	-0.0655	-0.00608	-0.0481
inc_lt25	-0.173*	-0.0628	-0.0871
inc_2549	-0.0452	-0.0290	-0.0236
inc_7599	0.0755	0.0398	0.0528
inc_gt100	-0.0380	-0.0811	-0.196**
investing_res	0.0767***	0.0896***	0.102***
num_otherpi_adopt	0.149***	0.139***	0.192***
csh_sh	0.110	0.209	0.364**
cc_debt_revolver	0.0619	-0.00684	-0.0183
cc_rewards_adopt	-0.129	-0.0818	-0.137
smartphone_adopt	0.0254	0.0439	0.00951
Constant	-0.670***	-0.763***	-0.798***
Observations	1017	1018	1016
Rsquared	.13	.15	.18
Mean	.124	.202	.304
SD	.918	.903	1.089

Sample: 2014 SCPC oversample and 2015 SCPC.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Adoption of virtual currency.

	AnyVC	Bitcoin	Other
expectations_week	0.0992***	0.0934***	0.0901***
expectations_week_month	0.128***	0.0875***	0.102***
expectations_month_year	0.0842***	0.0911***	0.0367**
age_1825	0.0158	0.0462	-0.0283
age_2534	0.0140	0.0281	-0.00621
age_4554	-0.109***	-0.0872**	-0.108***
age_5564	-0.155***	-0.112***	-0.211***
age_o65	-0.356***	-0.290***	-0.420***
edu_c_pgs	-0.0356	-0.0703***	-0.0315
hh_size	0.0213***	0.0339***	0.0164**
white	-0.116***	-0.0863***	-0.0744***
male	0.0426*	0.0682***	0.0202
inc_lt25	0.0481	0.0428	0.0871**
inc_2549	-0.000761	-0.0260	0.0456
inc_7599	-0.0260	-0.0162	0.0178
inc_gt100	-0.0432	-0.0365	-0.0119
billpay_res	-0.0124	0.00205	-0.00600
shopping_res	0.0572***	0.0663***	0.0156
budgeting_res	0.00608	-0.000765	0.000450
investing_res	-0.0182	-0.00375	-0.0194
num_pi_adopt	0.100***	0.0847***	0.102***
csh_sh	0.159***	0.0574	0.152**
cc_debt_revolver	-0.0874***	-0.0957***	-0.0482*
cc_rewards_adopt	-0.0927***	-0.0781**	-0.0606*
smartphone_adopt	0.0134	0.0506	-0.0195
Observations	1010	1013	1010
Pseudo R-squared	.5	.4	.38
N Positive	592	502	483

Marginal effects

Sample: 2014 SCPC oversample and 2015 SCPC

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Reasons for owning and not owning virtual currency.

Reasons for owning and not owning virtual currency
Percentage of adopters.

	2014 SCPC		2015 SCPC
	Oct	Oversample	Oct**
		Primary	Secondary	Primary
Why Virtual Currency		**100.0**	**100.0**	
I am interested in new technologies		23.8	21.3	
It is an investment		19.2	14.0	
Payments		**37.5**	**38.6**	
I use it to buy goods and services in the United States		16.1	13.7	
It allows me to make payments anonymously		13.7	16.4	
I use it to make remittances or other international payments		7.7	8.5	
It uses secure blockchain technology to prevent loss and fraud		6.2	12.9	
Distrust		**10.3**	**12.4**	
I do not trust banks		5.7	7.2	
I do not trust the government or U.S. dollar		4.5	5.3	
Other		2.9	0.8	
Why Not Virtual Currency				**100.0**
I do not understand the technology				16.2
Not accepted for payment very often				13.4
My current payment methods meet all of my needs				15.1
The U.S. dollar value of the virtual currency varies too much				16.2
It is not guaranteed by the U.S. government				13.8
It is not easy to acquire or use				18.7
Other				6.6

** Preliminary and unweighted.

Table 12: Virtual currency holdings.

Virtual Currency Holdings
Dollars or coins per adopter, as specified. SCPC Tables 14-15.

	2014 SCPC				2015 SCPC	
	Oct		Oversample		Oct	
	Mean	Median	Mean	Median	Mean	Median
Number of coins owned	**75**	**8**	**1180**	**9**		
Bitcoin	74	7	75	3		
Other virtual currency*	1	1	1446	7		
Incorrectly identified	*112*	*20*				
Value of virtual currency owned (owner estimate)	**1551**	**1500**	**1425**	**321**		
Bitcoin	1638	500	793	169		
Other virtual currency*	553	30	729	69		
Incorrectly identified	*29*	*30*				
Value of coins owned (official exchange rate)**			**23539**	**629**		
Bitcoin	25345	2510	26755	919		
Other virtual currency*			41	2		
Incorrectly identified						
Value of VC owned (official exchange rate, "best")***			**13794**	**604**		
Bitcoin			15195	616		
Other virtual currency*			285	5		
Incorrectly identified						
Addendum						
Implied reported exchange rates						
Bitcoin	193	333	4151	9		
% Exchange rate error						
Bitcoin	-45	-9	1233	-97		

* Excluding incorrectly identified.

** In oversample, includes only those that used a reference for number of coins.

*** The criteria for "best" includes: (i) owner estimates of value with records, (ii) owner estimates of coins with records, converted using the official exchange rate, (iii) if no records were used, owner estimates of value if exchange rate error is less than 10%. If exchange rate error were greater than 10%, the observation is not kept.

**** All numbers, other than the "best", are cut off at the 98 percentile.

Table 13: Incidence of use and payee for virtual currency.

Incidence of use and payee for virtual currency
Percentage of adopters. SCPC Tables 19-27.

Incidence of use and payee	2014 SCPC		2015 SCPC
	Oct	Jul 2015	Oct
Used in last 12 months	**28.4**	**75.1**	
Bitcoin	26.2	65.7	
Other virtual currency*	21.6	51.8	
Used in last month		**69.3**	
Bitcoin		61.4	
Other virtual currency		44.8	
Payee			
Merchant		39.0	
Person		56.3	
Both		25.1	

* Excluding incorrectly identified

Table 14: Use of virtual currency in last 12 months.

	Bitcoin	OtherVC
age	-0.00893	0.00609
agesq	0.0000641	-0.0000701
edu_c_pgs	0.0175	0.0153
white	0.0734**	-0.0552
male	0.0462	0.0542
log_income	-0.0166	0.0157
employed	0.0650	0.00427
num_otherpi_adopt	0.0623***	0.0929***
csh_sh	-0.0478	-0.0303
cc_debt_revolver	-0.0134	0.0265
cc_rewards_adopt	-0.0304	-0.0344
smartphone_adopt	0.0594	0.155**
whyvc_buygands	0.148***	0.135***
whyvc_remitintl	0.128**	0.259***
whyvc_anonymous	0.134***	0.196***
whyvc_investment	0.0997**	0.106**
whyvc_blockchain	0.126**	0.0310
whyvc_notrustinbanks	0.0549	0.0830
whyvc_notrustingovt	0.127*	0.120*
Observations	479	447
Pseudo R-squared	.18	.2
N Positive	399	326

Marginal effects

Sample: 2014 SCPC with oversample, 2015 SCPC

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Respondent virtual currency payees.

	Paid merchant	Paid person	Paid both
age_u25	-0.139*	0.103	-0.0600
age_2534	0.0000548	0.0481	0.00365
age_4554	0.000474	-0.0483	-0.0469
age_5564	-0.160	-0.0658	-0.108
age_o65	-0.140	-0.0291	-0.182
edu_c_pgs	0.0269	0.0186	0.0428
white	-0.0285	0.0468	-0.0161
male	0.0718*	0.0268	0.0269
inc_lt25	-0.0584	0.00620	-0.0145
inc_2549	-0.0712	-0.0391	-0.0634
inc_7599	-0.0905	0.131**	0.0220
inc_gt100	-0.0549	-0.0214	-0.0428
employed	-0.00330	-0.0145	-0.0230
num_otherpi_adopt	0.0975***	0.0855***	0.107***
csh_sh	0.153	0.0291	0.140
cc_debt_revolver	-0.0204	0.122***	0.0698*
cc_rewards_adopt	-0.0179	-0.0582	0.0951
smartphone_adopt	0.134*	0.0730	-0.00376
whyvc_buygands	0.112**	0.0856*	0.0352
whyvc_remitintl	0.132**	0.162***	0.0576
whyvc_anonymous	0.0596	0.137***	0.0276
whyvc_investment	0.0813	0.0300	0.0510
whyvc_blockchain	0.0286	0.0768	0.0241
whyvc_notrustinbanks	-0.0363	0.0851	-0.0336
whyvc_notrustingovt	0.0288	0.0418	0.00426
Observations	578	577	572
Pseudo R-squared	.12	.16	.23
N Positive	246	332	146

Marginal effects

Sample: 2014 SCPC with oversample, 2015 SCPC

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

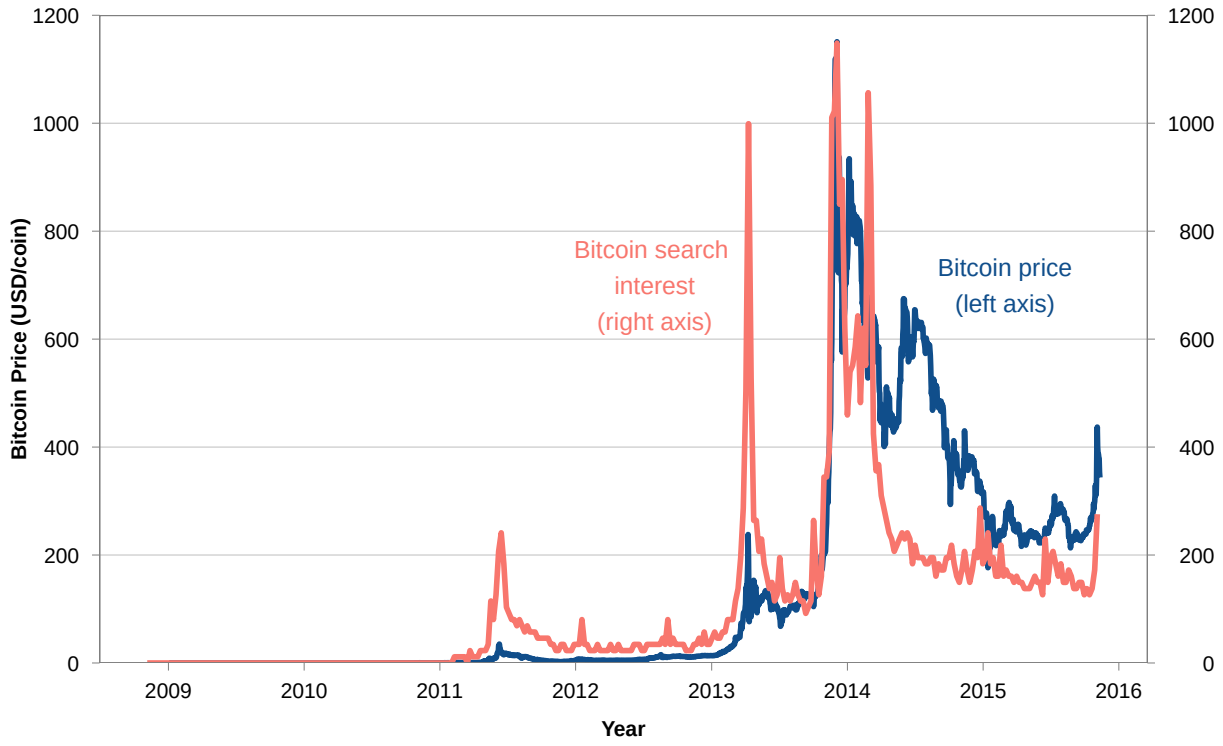
Table 16: Share of use Heckman regression.

	vc_sh	bitcoin_sh	othervc_sh
main			
male	0.0187	0.00676	0.0321**
age	-0.00193**	-0.000953	-0.00169*
log_income	-0.00114	-0.000866	0.00428
num_pi_adopt	0.00497	-0.0137**	0.0147
csh_sh	-0.129***	-0.146***	-0.0378
cc_debt_revolver	0.0449***	0.0317**	0.0426***
cc_rewards_adopt	-0.0223	-0.00493	-0.0199
smartphone_adopt	0.0227	0.00785	0.00438
whyvc_buygands	0.0427**	0.0343**	0.0356*
whyvc_remitintl	0.0346	0.0332**	0.0182
whyvc_anonymous	0.0144	-0.00369	0.0284
whyvc_investment	-0.0174	-0.0119	-0.00864
whyvc_blockchain	0.0200	0.00280	0.0192
whyvc_notrustinbanks	-0.0237	-0.00668	-0.00843
whyvc_notrustingovt	0.0257	0.00714	0.0348
Constant	0.119	0.215***	-0.0752
adopt_coin			
expectations_week	0.565***	0.441***	0.403***
expectations_week_month	0.716***	0.479***	0.458***
expectations_month_year	0.384***	0.386***	0.132**
male	0.110	0.148	0.0345
age	-0.0348***	-0.0267***	-0.0297***
log_income	-0.139**	-0.0499	-0.134**
num_pi_adopt	0.538***	0.401***	0.438***
csh_sh	0.832***	0.348	0.710***
cc_debt_revolver	-0.370***	-0.345***	-0.179*
cc_rewards_adopt	-0.568***	-0.508***	-0.320***
smartphone_adopt	0.0433	0.194	-0.0158
Constant	-0.00235	-0.892	-0.167
mills			
lambda	0.0103	-0.0112	0.0281
Observations	1079	1082	1084

Sample: 2014 SCPC oversample and 2015 SCPC

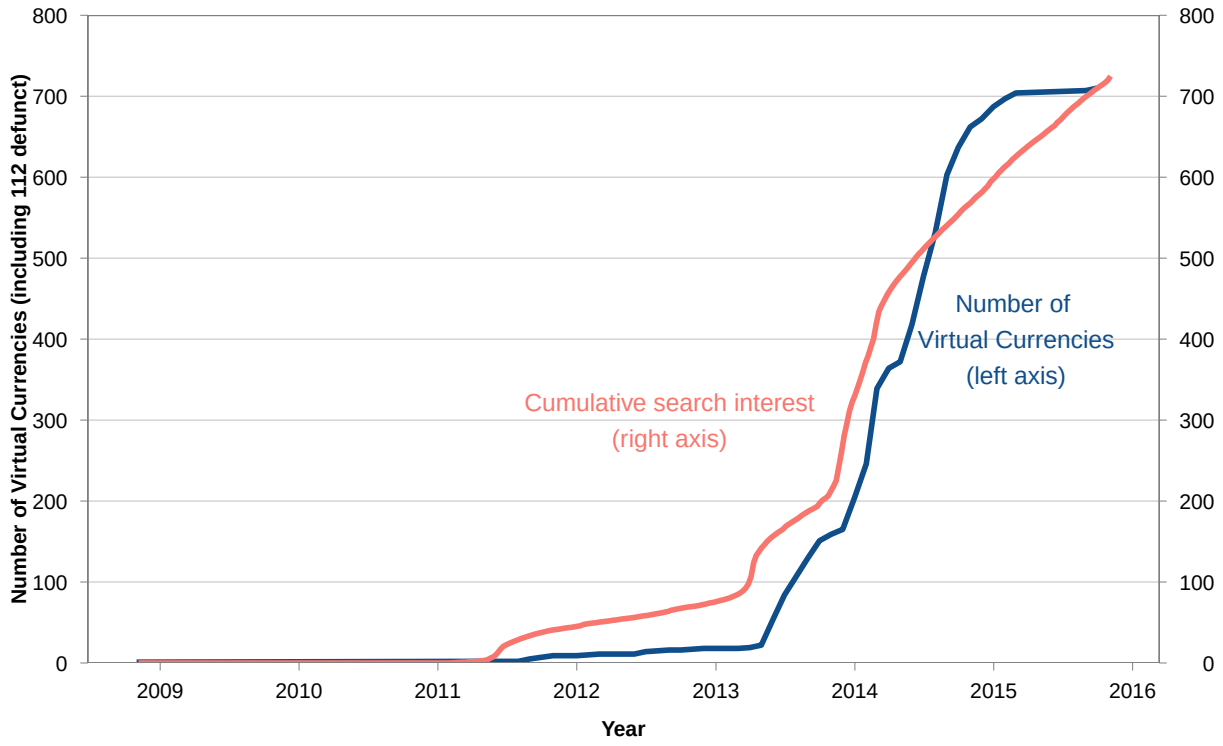
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Bitcoin price and search interest (Google trends).



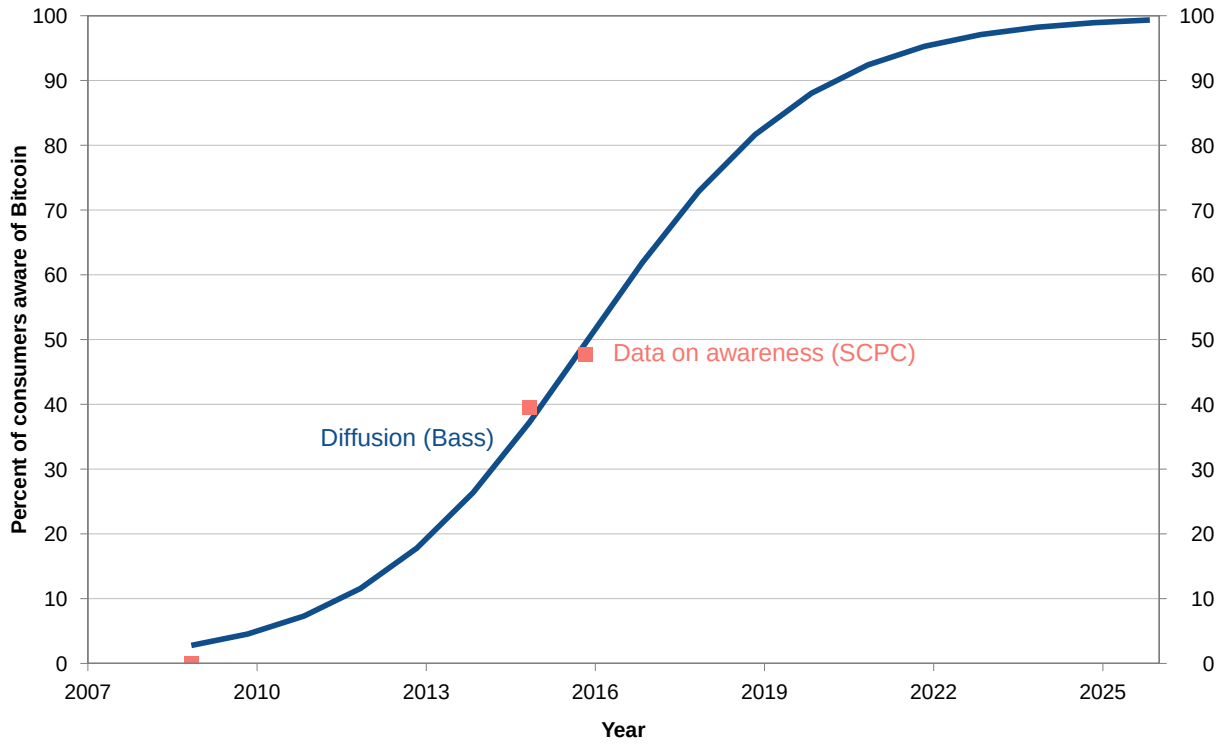
Note: Bitcoin search interest is based on US Google Trends, scaled to overlay with prices.

Figure 2: Number of virtual currencies and cumulative search interest.



Note: Cumulative search interest is based on US Google Trends for Bitcoin, scaled to overlay with number of coins.

Figure 3: Bitcoin awareness in a diffusion model.



A. Description of variables

Table 17: Description of independent variables.

Variable	Description
age	Age of respondent
agesq	Age of respondent squared
age_u25	Indicator variable for age of respondent <25
age_2534	Indicator variable for age of respondent >= 25 and <= 34
age_4554	Indicator variable for age of respondent >= 45 and <= 54
age_5564	Indicator variable for age of respondent >= 55 and <= 64
age_o65	Indicator variable for age of respondent >= 65
edu_c_pgs	Indicator variable for education of respondent at the college or post-grad level
hh_size	Respondent household size
white	Indicator variable for respondent race (white)
male	Indicator variable for respondent gender (male)
log_income	Log of respondent family income
inc_lt25	Indicator variable for respondent family income <$25k
inc_2549	Indicator variable for respondent family income >=$25k and <=49k
inc_7599	Indicator variable for respondent family income >=$75k and <=99k
inc_gt100	Indicator variable for respondent family income >=$100k
employed	Indicator variable for whether the respondent is employed or not
num_pi_adopt	The respondent's number of payment instruments adopted (out of 9)
csh_sh	The share of respondent's cash payments (out of all payments) by number
cc_debt_revolver	Indicator variable for whether the respondent revolves on credit card debt
cc_rewards_adopt	Indicator variable for whether the respondent adopted a rewards credit card
smartphone_adopt	Indicator variable for whether the respondent adopted a smartphone
expectations_week_num	Respondent's expectations of Bitcoin exchange rate growth/decline over the next week (1-5)
expectations_month_num	Respondent's expectations of Bitcoin exchange rate growth/decline over the next month (1-5)
expectations_year_num	Respondent's expectations of Bitcoin exchange rate growth/decline over the next year (1-5)

Table 18: Description of dependent variables.

Variable	Description
vc_error	Indicator variable for respondent mis-identifying virtual currency
Paid merchant	Indicator variable for whether the respondent used virtual currency to pay a merchant
Paid person	Indicator variable for whether the respondent used virtual currency to pay another person
Paid both	Indicator variable for whether the respondent used virtual currency to pay both a merchant and another person
vc_sh	The share of respondent's virtual currency payments (out of all payments) by number
bitcoin_sh	The share of respondent's bitcoin payments (out of all payments) by number
othervc_sh	The share of respondent's other virtual currency payments by number

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