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Bitcoin Microstructure and the Kimchi premium

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Abstract

Between 2013 and 2018, Bitcoin were in Korea on average 3.2% more expensive than in the United States, a fact commonly referred to as the Kimchi premium. We argue that frictions within the microstructure of the bitcoin network as well as capital controls imposed by the Korean government limit the ability of arbitrageurs to take advantage of persistent price differences. We find that the Bitcoin premia are positively related to confirmation times in the blockchain and to bitcoin volatility in line with the idea that the delay and the associated price risk during the transaction period make trades less attractive for risk averse arbitrageurs and hence allow prices to diverge. A cross country comparison shows that Bitcoin tend to trade at higher prices in countries with lower financial freedom.

Keywords: Bitcoin, Limits to Arbitrage, Crypto-Currencies, Fintech

preliminary and incomplete

1 Introduction

> I think the internet is going to be one of the major forces for reducing the role of government. The one thing thats missing but that will soon be developed, is a reliable e-cash.
>
> Milton Friedman in 1999 - Nine years later, Bitcoin was created.

Many proponents of crypto-currencies such as Bitcoin list independence from government influence as key advantage of this new technology. In an ideal world payments can be made and funds exchanged globally without any central authority or government regulation.[1] Yet we argue in this paper that government regulations in fiat currencies, especially capital controls, create new and amplify existing frictions in the global Bitcoin market. In Korea, for example, Bitcoin frequently trade at a higher price than in other markets, a phenomenon referred to as the Kimchi premium. Between September 2013 and February 2018 the average Kimchi premium was 3.2% but it reached levels as high as 54.48% in January 2018. Figure 1 shows a time series plot as well as a histogram of the Kimchi premium in this time period. In friction-less financial markets such a price difference could not persist as it would be immediately arbitraged away. Traders could buy bitcoin in another market, say the US, then transfer them to a Korean Bitcoin exchange, sell them for Korean Won, and convert the Won to US-dollars for an instant profit. However, institutional frictions prevent arbitrageurs to keep bitcoin prices in Korea aligned with the rest of the world. Divergence in Bitcoin prices are not only a Korean phenomenon. As we document in this paper international differences in Bitcoin prices can be high and persist over longer periods of time. Even within the US prices differ substantially between exchanges.[2] In this paper we analyze two main frictions that can contribute to a potential misalignment of Bitcoin prices

[1] Satoshi Nakamoto, a pseudonym for the legendary inventor of Bitcoin, included the headline of the Financial Times on Jan 3, 2009, "Chancellor on brink of second bailout for banks" in the first block, the geneis block, of the Bitcoin Blockchain. Many see this as an expression of distrust in the current financial system. As the first reason for the existence of Bitcoin, Bitcoin-Wiki states that ''Bitcoin is P2P electronic cash that is valuable over legacy systems because of the monetary autonomy it brings to its users."

[2] Websites allow users to monitor spreads and identify possible arbitrage opportunities. See e.g., www.tokenspread.com, data.bitcoinity.org/markets/arbitrage. Figure 4 in the appendix shows such an arbitrage matrix.

across major markets: capital controls and frictions emanating from the microstructure of the bitcoin network.

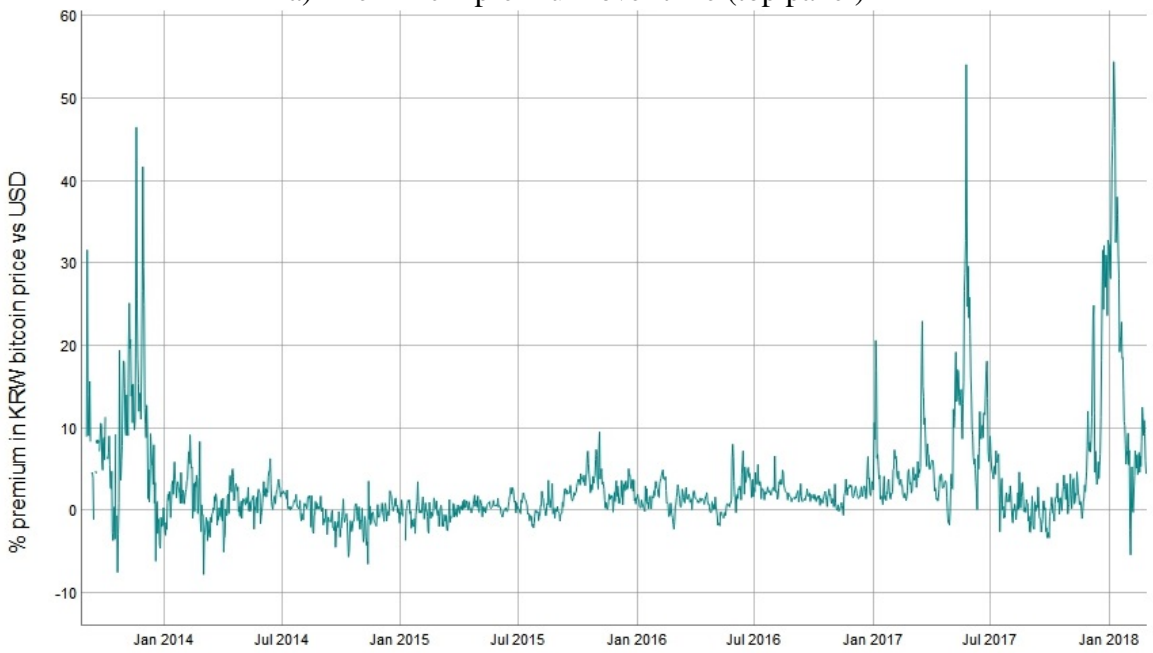
Due to microstructure of the Bitcoin network arbitrageurs are confronted with obstacles that are absent in many traditional markets. An arbitrageur faces two main sources of risk when executing the arbitrage trade described above. First, the transfer of bitcoin from a foreign exchange to a Korean exchange takes time during which the price of bitcoin can change dramatically. Since bitcoin can usually not be shorted the premium cannot be locked in; bitcoin at a Korean exchange can only be sold once the transfer is complete. Because bitcoin can be much more volatile than many transitional assets, price risk can pose a significant deterrent for arbitrageurs. Second, time varying transaction costs can erode potential arbitrage profits. Demand for transactions fluctuates over the day and over time. As fees increase, profits from arbitrage decrease allowing the price difference between bitcoin in Korea and the rest of the world to rise.

Frictions in traditional capital markets add limitations to arbitrage. Korean capital controls limit the amount of money that can be sent abroad or at least complicate the transfer of funds and thus create a friction for the fiat currency part of the arbitrage trade. In the aftermath of the global financial crisis and the European sovereign debt crisis, Korea introduced capital controls that create administrative burden and additional time delay when sending money abroad.

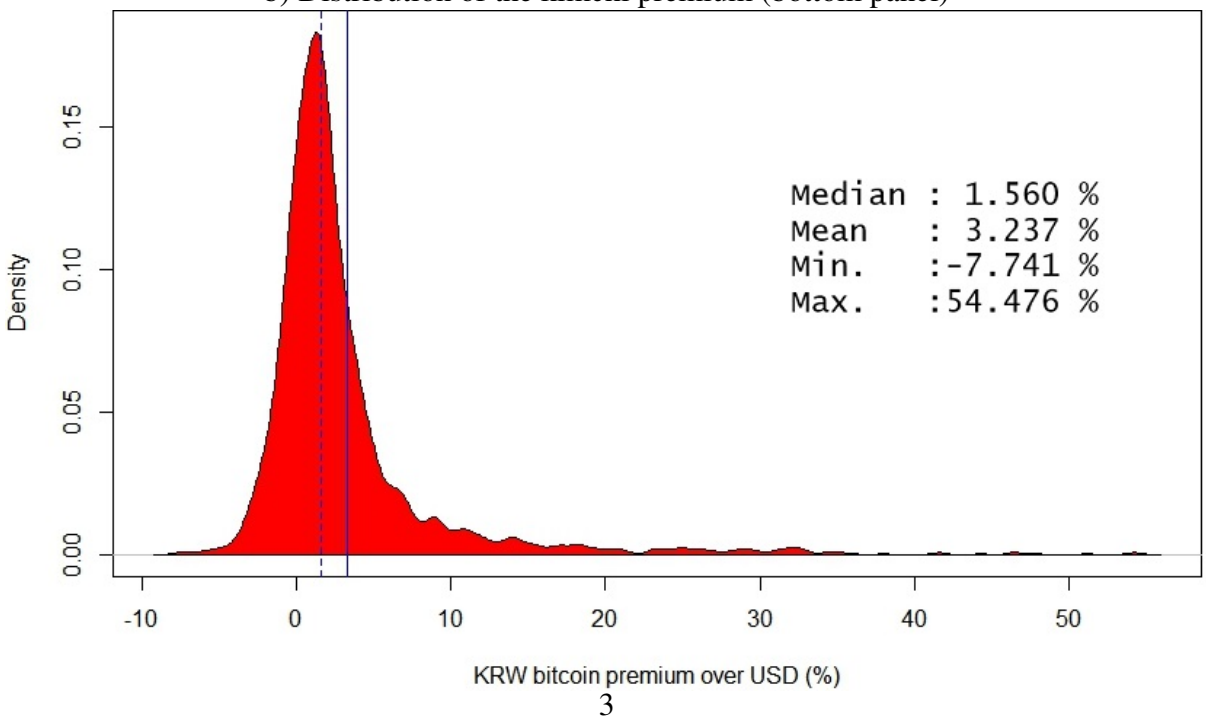
We find that both Bitcoin microstructure effects as well as exchange controls explain the bitcoin premium. We start out with an in depth comparison of the Korean with the European market where more detailed data is available and markets are well developed and liquid. We find that in both markets microstructure effects are correlated with price deviations. Price deviations relative to the US market are significantly positively related to bitcoin volatility, supporting our idea that price risk for traders limits arbitrage activity. The Kimchi premium is also positively related to the median confirmation time in the block chain, supporting the idea that longer transaction times create more uncertainty for arbitrageurs allowing prices to diverge. Finally price differences are also increase in transaction fees, consistent with the idea that higher fees reduce the attractiveness of the arbitrage trade.

Figure 1. The Bitcoin Kimchi Premium: Bitcoins frequently trade at a higher price in Korea than in other markets. The premium for purchasing bitcoins with Korean Won (KRW) versus US Dollars (USD) is calculated: $(\text{KRWBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in KRW is similarly defined from the Korbit exchange. Conversion from KRW to USD is done using the OANDA daily average rate.

a) The kimchi premium over time (top panel)



b) Distribution of the kimchi premium (bottom panel)



Comparing the European to the Korean market, however, we find two important differences. First, the impact of microstructure effects on price divergences are several times larger for Korea than for the European market. Second, we find the Kimchi premium to be positive while the average premium for the European market is zero. We argue that capital controls are the reason why the average premium in positive and also make the the premium more sensitive to microstructure effects. Because of the asymmetry of capital controls (it is easier to move funds to Korea than the other way around) arbitrage is harder on one direction, allowing the Kimchi premium to be positive on average. Because of the capital controls arbitrage is more costly and hence the premium in Korea is more sensitive to transaction costs, volatility, and transaction times compared to the European market.

To further analyze the impact of capital controls we collect data on Bitcoin premia for an international sample and analyze how premia vary with various measures of financial freedom. Controlling for microstructure effects we find that countries with higher financial freedom have on average lower premia. Figure 2 plots the median bitcoin premium from March 2017 to the end of February 2018 as a function of financial freedom. As a stylized fact the graph shows higher average premia in financially more restrictive countries which is consistent with our view that financial restrictions are causing higher bitcoin prices in some countries.

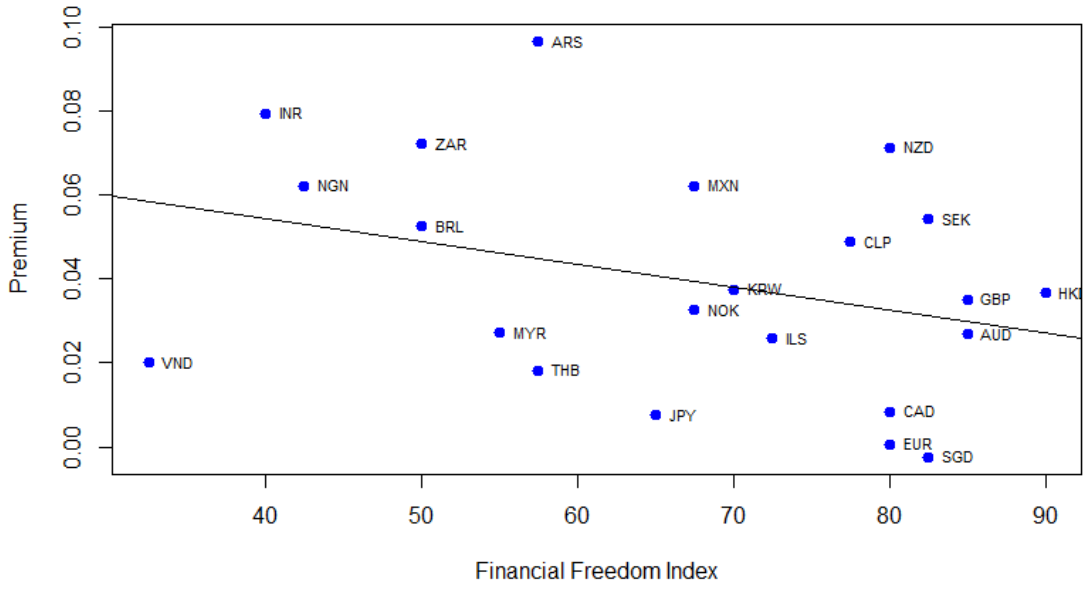
As a robustness check we also examine Korean premia in other Crypto-currencies such as Ethereum, Lite-coin, and Ripple. Instead of using fiat currency arbitrageurs could complete the arbitrage trade by buying other crypto currencies with the proceeds of selling Bitcoin in Korea and sending them abroad without being subject to capital controls. We find that other crypto currencies have practically identical premia to Bitcoin at Korean exchanges and those premia are highly correlated over time with the Kimchi premium.

Our work is related to a broad literature on the bubble and limits of arbitrage.[3] There are various constraints and limitations known in the literature to impede arbitrage trading. Among such constraints[4], the following four factors are the most relevant to the bitcoin price difference:

[3] See Xiong (2013) and Gromb and Vayanos (2010) for a survey.

[4] The constraints include information asymmetry, short-sale constraints, leverage margin constraints, constraints

Figure 2. Bitcoin Premia and Financial Freedom: The bitcoin premium is measured as the median percentage price difference to the USD price from March 2017 to the end of February 2018. Bitcoin transaction prices are from bitcoincharts.com, foreign exchange data from the Federal Reserve Bank of St. Louis (where available) and OANDA otherwise. To measure financial freedom we average the to index components 'Investment freedom' and 'Financial Freedom' as published on a country level by the Heritage Foundation.



(i) risk (or the price volatility in our case), (ii) the international trading frictions, (iii) short-sale constraints, and (iv) opportunity cost (holding costs). For the first and the second factors, we find that the Kimchi premium has a significant positive relation to bitcoin price volatility and the capital control index, as mentioned before.[5]

For the third factor, there has been a large literature investigating the joint effect of short-sale restrictions and heterogeneous beliefs in the stock market (e.g. Miller (1997), Harrison and Kreps (1978), Chen, Hong, and Stein (2002), Scheinkman and Xiong (2003), and Hong, Scheinkman, and Xiong (2006)). Under a short-sale constraint, the optimists are more likely to be marginal buyers and the stock price tend to reflect optimists' valuation more than that of

on equity capital and so on.

[5]See, e.g. Edwards (1999) on the effectiveness of capital controls

pessimists. Based on this theoretical insight, Mei, Scheinkman, and Xiong (2009) investigate the price difference between the local A- and foreign B-share market in China. They show that A-share turnover had a significant and positive correlation with the A- and B-share price difference in the China market.[6] Consistent with this stream of research we also find a positive relationship between the Kimchi premium and the bitcoin trading volume in Korean exchanges.

Finally, the literature on the cross-listed stock price difference shows that the price deviations are positively related to holding costs that impede arbitrage (Pontiff (2006), Gagnon and Karolyi (2010), and Strambaugh, Yu, and Yuan (2015)). There are several proxies for holding costs such as idiosyncratic risk, stock's dividend yield, and the interest rate. We will explore this angle in future versions of the paper.

2 Institutional background

2.1 Bitcoin microstructure

The microstructure of bitcoin markets stands out in many ways from traditional markets. Transactions, i.e. the transfer from one wallet to another wallet, get posted within the Bitcoin peer-to-peer network in the mem-pool, from where miners pick transactions to be mined into a block, which gets then added to the blockchain. Many exchanges require a certain number of confirmations to credit the Bitcoin to an account. A transaction with n confirmations means that this transaction has been included in a mined block and that there have been $n-1$ subsequent blocks mined in the blockchain. Time delay arises from the time it takes for a transaction to be included in a mined block and from the time it takes to mine the required number of subsequent blocks. The time to be included in a block can vary substantially. The average confirmation

[6]There are other papers to study the price difference between the Chinese A- and B- share prices (e.g. Chakravarty, Sarkar, and Wu (1998) and Chan, Menkveld, and Yang (2008)). For example, Chan, Menkveld, and Yang (2008) investigate how information asymmetry affects on equity prices. The information asymmetry in the Bitcoin market matters in the world wide level, but it is unlikely to have specific impact on the Bitcoin premium in the Korean market.

time reached 11,453 minutes (7.9 days) on January 22, 2018 and in the period of Feb 14 2017 to Feb 14 2018 the average confirmation time was above 2 hours 31% of the time.[7] The average time between successfully mined blocks is 10 minutes.

Transaction fees are endogenously determined in the bitcoin network. When posting a transaction to the Mem-pool the originator can set a fee that he or she is willing to pay to the miner for the transaction to be included in the block. Miners can select transactions from the pool and keep the fee upon successfully mining a block. Transactions with higher fee have a higher probability to be included in a block. An arbitrageur thus faces a tradeoff between offering a high fee that will get the transaction processed faster and mitigate price risk and the cost of the higher fee which will directly reduce the arbitrageur's profit.

When trading on bitcoin exchanges another layer of delay arises. Most exchanges offer clients accounts similar to an account with a traditional stock broker. Trades are usually only possible between account holders at the same exchange and a trade is just recorded in the ledger of the exchange, not on the blockchain. The bitcoins transferred from the seller to the buyer are held in the name of the exchange on the blockchain before and after the trade; the exchange just records a change of ownership in its internal records. Account holders can request a transfer to a private walled out of the exchange account which will trigger a ledger entry on the blockchain. While there is no data available on processing times by exchanges, anecdotal evidence on several bitcoin forums shows that processing times can be substantial with traders waiting up to several days before exchanges transfer bitcoins from their exchange-account to a private wallet from which a transfer (to another exchange) can be initiated. In particular, 5-10 hours of processing time from a U.S. exchange to a Korean exchange is commonly reported by major mass media in Korea. For example, Chosun Ilbo, a Korean newspaper, tested the arbitrage and reported a processing time of 9 hours from Coinbase to Bithum on December 26, 2017 when the Kimchi premium was about 28%.[8] Also the deposit and withdrawal of fiat money can be

[7] source: `https://blockchain.info/`

[8] Chosun Ilbo (Daily Chosun) is the # 1 news paper company in South Korea in terms of the total number of daily printing. See the following news article by the Chosun Ilbo on January 4: `http://news.chosun.com/site/data/html_dir/2018/01/04/2018010400441.html`.

subject to considerable delay. For example in Canada processing times for deposits and withdrawals can take several months. In part the delay is caused by banks' refusal to deal with crypto-currency companies. Quadriga, one of the two established exchanges in Canada has to rely on a Portuguese bank to process many of its fiat currency transfers.[9]

2.2 Capital Controls

On June 13, 2010, in the aftermath of the global financial crisis and the European sovereign debt crisis, Korea introduced capital controls that were revised several times since. The Korean foreign exchange transaction law has been very restrictive. According to the most recent law revision (valid since July 18th, 2017)[10], an individual can send money up to 3,000 USD per transfer and up to 20,000 USD in total between January 1st and December 31st through a particular financial institution. The total maximum is limited to 50,000 USD a year through different institutions.[11] There are several alternative ways to send cash abroad. First, one can use a Korean credit card when buying Bitcoin at an exchange in the U.S.. However, the maximum amount of purchases outside of Korea is limited to 10,000 USD per year. In addition, this transaction is considered as commodity purchase, which means the buyer should pay customs on buying Bitcoin. One can send US dollars to someone (e.g. relatives or friends in the U.S.) who can help arbitrage trading through Paypal. In this case, however, Paypal automatically reports this transaction to the US Internal Revenue Service (IRS) and the IRS normally considers this money inflow to the receiver as taxable income if the transfer amount is sufficiently large or the transfers occur on a regular basis. In addition, many Korean lawyers[12] say that in the current South Korean law it is not very clear if transferring Bitcoins between a Korean exchange

[9] See article *'I just want my money back. Couple had $100K wire stuck for months after trying to buy Bitcoin'*, GlobalNews, March 27, 2018.

[10] See the government website on small foreign remitment: `http://www.mosf.go.kr/nw/nes/detailNesDtaView.do?searchBbsId1=&searchNttId1=MOSF_000000000009556&menuNo=4010100`.

[11] There are some exceptions. For example, the maximum per year is up to 100,000 USD for educational reasons such as tuition with proper evidence.

[12] See, e.g. `http://hongbyun.tistory.com/22`.

and exchanges in other countries is considered as capital in- and out-flow or commodity export/import. This legal interpretation issue might pose an additional risk since the government might investigate transfer activities ex-post and accuse market participants of violation of the law depending on how they interpret the law.

3 Data Sources and Model Variables

Bitcoin is very popular in Korea. As of February 1st, 2018, there are 16 cryptocurrency exchanges in South Korea. The five largest exchanges, in terms of trading volumes, are Upbit (#1 world ranking), Bithumb (#7), Coinone (#14), Korbit (#18), and Coinnest (#21).[13] Korbit was the first Korean bitcoin exchange that opened in April, 2013. Then, Bithumb (January, 2014), Coinone (August 2014), Coinnest (July 2017) and Upbit (October, 2017) followed. Until Upbit started an exclusive partnership with Bittrex (a major U.S. based exchange) on October 2017, Bithumb, Coinone, and Korbit had been the three major exchanges.[14]

Our primary variable of interest is the Bitcoin premium in local currency over the Bitcoin price in USD. For Korea the KRW Bitcoin premium over USD, the kimchi premium, is defined as

$$Premium_{KRW} = \frac{\text{KRW/BTC price} \times \text{USD/KRW exchange rate} - \text{USD/BTC price}}{\text{USD/BTC price}} \quad (1)$$

The premium for the European market is defined similarly based on EUR prices.

For daily Bitcoin prices in USD, KRW, and EUR we look at all transactions on specific Bitcoin exchanges (data accessed via bitcoincharts.com). Exchanges were selected due to data availability, length of trading history, and both current and historical market share. USD data is from Bitstamp. Bitstamp has offices in Luxembourg, London, and Berkeley. They are currently

[13]The number inside the parenthesis is the world ranking in trading volumes (all the cryptocurrencies) by Coinhills on February 1st, 2018 (see `https://www.coinhills.com/market/exchange/`.

[14]Among the top three, Korbit is the only one who provides a history of all the trades in unix-time

the 3rd largest exchange for USD trades by volume and have the longest trading history of the current major players. In the early days of bitcoin trading the USD leader was Mt. Gox which famously went bankrupt following a security breach. The dataset contains 21,699,339 total trades with the first trade occurring on 2011-09-13. The total notional value (valued at the time of each trade) is USD 39.6b. KRW data is from Korbit. Korbit was South Korea's first bitcoin exchange and is currently third by volume for KRWBTC. The data-set contains 5,179,836 total trades with the first trade occurring on 2013-09-03. The total notional value (at the time of each trade) is KRW 14.4t. EUR data is from Kraken. Kraken is currently the largest exchange for EURBTC by volume, with more than half the total volume. The data-set contains 17,561,577 trades with the first trade occurring at 2014-01-08. The total notional value (valued at the time of each trade) is EUR 19.7b.

The daily USD price we utilize for analysis is the mean price of all USD transactions on the Bitstamp exchange for that day. The KRW and EUR daily prices are similarly defined using Korbit and Kraken exchanges, respectively. To convert the KRW and EUR prices to USD we utilize data from OANDA. The daily prices utilized are the average price (not the close) over the 24-hour period (UTC time standard) aggregated from multiple exchanges. We find this the best fit for our purpose as the bitcoin markets operate 24/7.

We estimate short term volatility for Bitcoin prices as the sum of 10 minute squared returns over one day. Microstructure noise can arise from spreads between bid and ask prices and from shifts in transaction prices die to the random execution of large trades at either end of the 10 minute interval. We take two measures to mitigate potential biases doe to microstructure noise. First, we compute daily volatility for a given exchange as the average of two volatility measures, based on 10 minute returns shifting the time interval by 5 minutes. Second, we define volatility as the median volatility over several exchanges.[15] To test for robustness we also compute long term volatility for a given exchange as the sum of squared 12 hour returns over a period of 20

[15]Data availability differs per time period as data is not available for all exchanges at all times. We include data from the following exchanges: bitfinex, bitstamp, BTCC, btc-e, coinbase, Gemini, hitbtc, itbit, kraken, OK-Coin, Poloniex as available on bitcoinchain.com.

days. We then define long term volatility as the median volatility over several exchanges. Our results are robust with respect to this alternative volatility measure.

The Bitcoin blockchain median confirmation time data is from www.blockchain.info. This is the median time in minutes for a Bitcoin transaction to be accepted into a mined block and added to the public ledger (note: only includes transactions with miner fees). For days with missing data (of which there are none in the most recent 2 years) we interpolate linear between days. The maximum gap in the data set was 1 day. Results were unchanged when using the previous day's value or removing missing days completely from analysis.

The mean blockchain transaction fee is measured in USD and calculated from data from blockchain.info. It is the total value of all transaction fees paid to miners converted to USD (not including the value of block rewards), divided by the number of daily confirmed Bitcoin transactions on the blockchain for that day.

For the KRW and EUR volumes we look at the daily total number of exchange transactions (in thousands) on Korbit and Kraken respectively. This approach was taken rather than volume in bitcoins due to the wildly differing Bitcoin prices at the start versus the end of the sample period. Alternative measures considered included daily local currency total valuation and daily USD total valuation. For the KRW-USD and EUR-USD foreign exchange volatilities we use the standard deviation of 1-day logarithmic returns in the daily average KRW-USD and EUR-USD exchanges from OANDA, over the most recent 20 days.

The 1-day Bitcoin return variable is the 1-day logarithmic return in the USD-BTC price, where USD-BTC daily price is calculated as described above for the Kimchi premium calculation. The FOMC week variable is a dummy variable which takes a value of 1 if that day is within 3 days of a US Federal Reserve Federal Open Market Committee (FOMC) meeting start date (one week centered on the start date of the FOMC meeting). Results are unchanged if a leading week is used instead of centered. The FOMC sets monetary policy for the US (including a target for the overnight interbank interest rate).

A summary of the variables used in our empirical analysis can be found in Table 8 in the appendix.

4 Empirical Results

To analyze the determinants of the kimchi-premium we regress daily observations of the relative price difference for bitcoin in Korea and the US on several factors poxing for potential frictions inhibiting the arbitrage. All bitcoin for fiat currency transaction times are converted to UTC time standard. Days with missing trading data are excluded. All results were robust to testing on a sample with linear interpolation between missing days.

Regression results are shown in Table 1. These initial results lend support to the view that bitcoin price risk is a significant component to the kimchi premium size. In periods of high volatility, the cost of waiting for blockchain confirmations could be very significant and deter arbitrageurs. Model (1) documents a positive relation between the kimchi premium and short term BTC volatility. Model (2) documents that higher fees make the arbitrage less profitable and thus coincides with higher premia. As shown in model (3) higher median confirmation times on the block chain are also associated with higher bitcoin premia. An arbitrageur could potentially jump the queue get her transaction processed faster by offering a higher transaction fee to miners, yet such a higher transaction fee would also cause a direct reduction in arbitrage profits and hence allow for a larger premium. Considering all three factors we document in model (4) that only short term volatility and transaction fees stay significant. Median confirmation time seems to be a similar proxy for bottlenecks in the blockchain to transaction fees and becomes insignificant. FX-volatility is not a driving factor behind the kimchi premium as FX-volatility is substantially smaller than BTC volatility.

In model (5) we add bitcoin volume data and find that it is negatively associated with the Kimchi premium. One potential explanation is that higher volume coincides with higher liquidity which benefits the market in the form of a kimchi premium reduction once blockchain

transaction fees and confirmation times are controlled for. In model (6) we find that a one day lagged BTC returns are associated with a higher kimchi premium, perhaps because of momentum in BTC prices.

Despite a larger coefficient the economic significance of the FX-vola is much lower as it is orders of magnitude smaller than the bitcoin volatility. Model (7) adds in mean blockchain transaction fee to help separate the positive and negative effects on the kimchi premium from bitcoin exchange volume. Higher volume may help reduce the kimchi premium through increased liquidity in the Korean bitcoin market, while at the same time increase blockchain transaction fees and/or blockchain confirmation times (and potentially exchange cash-out times) thus reducing ability to arbitrage and increasing the kimchi premium. Model (7) demonstrates that news events are important for the kimchi premium. It is lower in weeks of FOMC meetings and when more news articles on Bitcoin get published in Korea.

To separate the effect of frictions emanating from within the microstructure of the bitcoin network from Korea specific factors like the capital controls we perform a similar analysis for the European market. Figure 3 plots the relative price difference of bitcoin in the EURO market relative to the USD market. Price differences are substantial, yet the divergence of bitcoin prices are smaller then in the Korean market and fairly symmetric in its distribution (average 0.27%, minimum -4.37%, maximum 4.07%). In our regression analysis for the European market we explain the absolute value of the premium as we are are primarily interested in explaining the cause of price divergences.[16] Regression results for the EUR premium can be seen in Table 2.

The coefficients for the short term volatility, transaction fee, and confirmation time have the same sign but are at least ten times smaller than in the case of the Korean market. These findings are consistent with an interpretation that bitcoin price divergences are in part driven by microstructure effects within the bitcoin network and that increased volatility makes arbitrage more risky and hence allows prices to diverge more. Yet the smaller amount of frictions in the European market facilitates arbitrage and hence price divergence is much smaller. Increased

[16] In the Korean case regression results are very similar for explaining the absolute premium since the premium is positive almost for the entire sample.

volume in European Bitcoin markets seems to be associated with smaller divergence but the effect is of small economic significance.

5 Bitcoin Premia and Financial Freedom

Comparing Korea to the Euro zone the results in Secton 4 show that price divergences between markets exist and their magnitude is related to the microstructure of the bitcoin network that create time varying costs to arbitrage price differences away. Our results also show that the premium is on average close to zero for the Euro-market while it is positive for the Korean market. We also see that the premium in Korea is at least ten times more sensitive to factors associated with arbitrage risk such as short term volatility, fees, or confirmation time. The anecdotal evidence suggests that this is due to the capital controls imposed by the Korean government. To examine in greater detail how open access to financial markets impacts Bitcoin premia we extend our analysis to an international sample and relate premia to measures of financial freedom.

We collect daily bitcoin price at data for 22 countries from bitcoincharts.com. Since trading volume is low in some markets we take the median Bitcoin price in local currency per day. Due to data availability we restrict our sample from the beginning of 2015 to the end of our sample period on Feb 23, 2018. In case of more than one exchange with available data we take the average price across available exchanges. Where available we use foreign exchange data from the Federal Reserve Bank in St. Louis, otherwise we use data from OANDA to convert local currency Bitcoin prices to USD. Premia are computed as in Section 4 as the percentage deviation from the USD price. Table 3 summarizes our sample. As we can see premia vary by country. Nigeria stands out with a median premium of 20.45%, which is the result of high premia following an unexpected devaluation of the Nigerian Naira by President Buhari in June 2016. In the following ten month high premia are observed which could be the result of people buying Bitcoin as trust in the national currency erodes. In unreported results we repeat our regression analysis without Nigeria and find that our main findings still hold.

Table 1: Regression results for the KRW Bitcoin premium over USD. Daily time series regressions: the dependent variable is the premium for purchasing bitcoins with Korean Won (KRW) versus US Dollars (USD) and is calculated: $(\text{KRWBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in KRW is similarly defined with data from the Korbit exchange. Conversion from KRW to USD is done using the OANDA daily average rate. The independent variables are defined as in Table 8.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bitcoin short term volatility	0.0667^{***}			0.0266^{***}	0.0348^{***}	0.0374^{***}	0.0436^{***}
	(0.0041)			(0.0041)	(0.0047)	(0.0049)	(0.0051)
Mean blockchain transaction fee		0.0069^{***}		0.0059^{***}	0.0065^{***}	0.0066^{***}	0.0069^{***}
		(0.0003)		(0.0003)	(0.0004)	(0.0004)	(0.0004)
Blockchain median confirmation time			0.0027^{***}	0.0002	0.0006	0.0005	0.0004
			(0.0007)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
KRW-USD volatility				1.2913	−0.4514	−0.5734	−0.8579
				(1.9188)	(1.9711)	(1.9664)	(1.9429)
KRW-BTC volume (thousands of transactions)					-0.0014^{***}	-0.0017^{***}	-0.0018^{***}
					(0.0004)	(0.0004)	(0.0004)
Bitcoin 1-day lagged return						0.1353^{**}	0.1249^{**}
						(0.0589)	(0.0581)
FOMC week							-0.0182^{***}
							(0.0055)
BTC news Korea							-0.0001^{***}
							(0.00003)
Constant	−0.0008	0.0242^{***}	0.0172^{**}	0.0008	0.0046	0.0049	0.0078
	(0.0038)	(0.0022)	(0.0087)	(0.0115)	(0.0115)	(0.0115)	(0.0114)
Observations	788	790	790	788	788	788	788
R^2	0.2500	0.4525	0.0166	0.4823	0.4901	0.4935	0.5078

Note: *p<0.1; **p<0.05; ***p<0.01

Figure 3. The Bitcoin EUR Premium: Bitcoins sometimes trade at a higher price even between relatively frictionless markets (here EUR vs. USD) The premium for purchasing bitcoins with Euros (EUR) versus US Dollars (USD) is calculated: $(\text{KRWBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in EUR is similarly defined from the Kraken exchange. Conversion from EUR to USD is done using the OANDA daily average rate.

a) The EUR premium over time (top panel)

b) Distribution of the EUR premium (bottom panel)

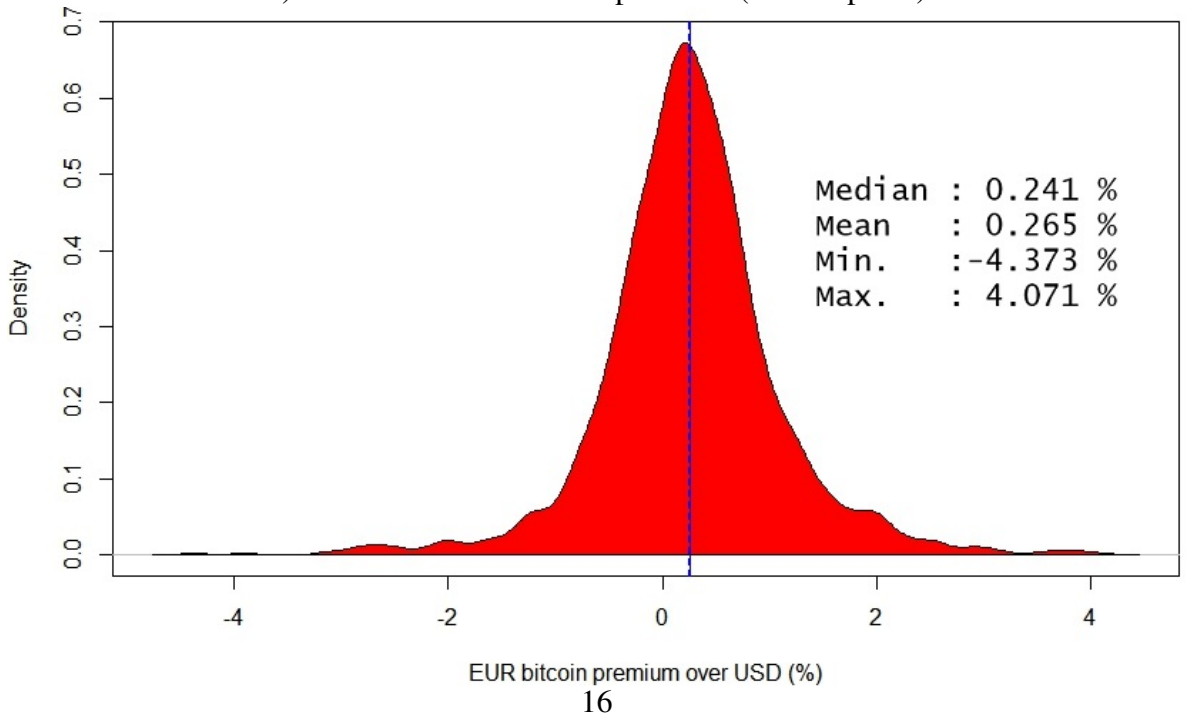


Table 2: Regression results for the EUR Bitcoin premium over USD. Daily time series regressions: the dependent variable is the absolute value of the premium for purchasing bitcoins with Euro (EUR) versus US Dollars (USD) and is calculated: $(\text{EURBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in EUR is similarly defined with data from the Kraken exchange. Conversion from EUR to USD is done using the OANDA daily average rate. The independent variables are defined as in Table 8.

	Dependent variable:						
	abs(y)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bitcoin short term volatility	0.0041^{***}			0.0032^{***}	0.0042^{***}	0.0041^{***}	0.0040^{***}
	(0.0003)			(0.0004)	(0.0006)	(0.0006)	(0.0006)
Mean blockchain transaction fee		0.0003^{***}		0.0001^{***}	0.0001^{***}	0.0001^{***}	0.0001^{***}
		(0.00003)		(0.00003)	(0.00003)	(0.00003)	(0.00003)
Blockchain median confirmation time			0.0001^{**}	-0.00001	0.00001	0.00002	0.00002
			(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
EUR-USD volatility				0.2128	0.1623	0.1536	0.1514
				(0.2680)	(0.2682)	(0.2673)	(0.2675)
EUR-BTC volume (thousands of transactions)					-0.00004^{**}	-0.00004^{**}	-0.00004^{**}
					(0.00002)	(0.00002)	(0.00002)
Bitcoin 1-day lagged return						-0.0135^{**}	-0.0135^{**}
						(0.0056)	(0.0056)
FOMC week							-0.0003
							(0.0006)
Constant	0.0034^{***}	0.0055^{***}	0.0050^{***}	0.0030^{***}	0.0031^{***}	0.0031^{***}	0.0031^{***}
	(0.0003)	(0.0002)	(0.0007)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
Observations	740	742	742	740	740	740	740
R^2	0.1619	0.1076	0.0062	0.1823	0.1880	0.1943	0.1945
Note:							*p<0.1; **p<0.05; ***p<0.01

Table 3. Summary statistics international sample: Median, mean, and standard deviation of bitcoin premia in percent over the USD price for a sample of international markets collected from bitcoincharts.com. Column 3 shows the source of the foreign exchange data used to convert local currency Bitcoin prices to USD.

Country	ISO	FX-Data	number	Premium (in %)		
			observations	median	mean	std.dev.
Argentina	ARS	OANDA	788	9.46	19.42	20.88
Australia	AUD	St. Louis Fed	788	0.96	1.37	2.38
Brazil	BRL	St. Louis Fed	788	4.41	5.54	5.53
Canada	CAD	St. Louis Fed	788	-0.02	-0.11	1.71
Chile	CLP	OANDA	683	2.56	3.50	5.81
Euro-Zone	EUR	St. Louis Fed	788	0.06	-0.02	0.86
Great Britain	GBP	St. Louis Fed	788	3.65	3.88	1.56
Hong Kong	HKD	St. Louis Fed	753	2.50	2.10	5.16
Israel	ILS	OANDA	787	0.57	0.80	3.34
India	INR	St. Louis Fed	788	2.63	3.80	6.20
Japan	JPY	St. Louis Fed	788	0.42	0.72	1.74
Korea	KRW	St. Louis Fed	788	1.39	2.97	6.42
Mexico	MXN	St. Louis Fed	788	5.58	6.29	3.61
Malaysia	MYR	OANDA	782	0.40	0.63	12.31
Nigeria	NGN	OANDA	543	20.45	26.35	24.69
Norway	NOK	St. Louis Fed	788	3.67	3.96	2.41
New Zealand	NZD	St. Louis Fed	788	6.75	6.95	3.66
Sweden	SEK	St. Louis Fed	788	5.38	5.51	2.26
Singapore	SGD	St. Louis Fed	747	-0.42	-0.49	1.26
Thailand	THB	St. Louis Fed	788	0.63	1.16	3.73
Venezuela	VND	OANDA	605	1.17	1.95	4.09
South Africa	ZAR	OANDA	613	6.84	7.74	4.48

We use two indices to measure capital controls and other regulatory restrictions. First we take the Index of Economic Freedom (IEF) which is published by the Heritage Foundation, which covers rule of law, government size, regulatory efficiency, and market openness.[17] Second, we use the economic Freedom Ranking (EFR) by the Fraser Institute. They aggregate 42 distinct variables in five major areas: size of government, the legal system and security of property rights, sound money, freedom to trade internationally, and regulation.[18] We used Germany

[17] see www.heritage.org/index/, as a robusness check we repeated our analysis with the sum of the two subindices on investment and financial freedom and found our results confirmed.

[18] see www.fraserinstitute.org/economic-freedom/approach

as a proxy for the Euro area.

Since our sample only comprises a bit more than two years and the indices of economic freedom are only published annually and do not vary much we cannot use a fixed effect panel model as the fixed effect would absorb heterogeneity in economic freedom. We therefore use a random effects panel model with daily observations and year fixed effects to analyze the impact of economic freedom on bitcoin premia. Table 4 presents our results. The general results without measures of economic freedom (column 1) show the same signs as in our analysis of the Korean market. Higher volatility, longer confirmation time, and higher fees make it harder to complete the arbitrage coinciding with higher premia.

Both the IEF and the EFR have a significant negative sign, showing that countries with greater economic freedom have lower Bitcoin premia. The difference in score of the IEF between the median country (Samoa, rank 90, score 61.5) and the 75% quantile country (Poland, rank 45, score 68.5) is 7 points, the difference between Poland and the best country (Hong Kong, score 90.2) is 21.7. Any country moving from median to the 75% quantile and then moving to the top would show a reduction in its Bitcoin premium by 0.7 and 2.17 percentage points, respectively. Similarly in the IEF a move from the median (Turkey) to the 75% quantile (Peru) and to the top (Hong Kong) would result in a reduction of in its Bitcoin premium by 1.4 and 3.2 percentage points, respectively. Our findings are therefore consistent with the idea that restrictions Bitcoin premia are more likely to occur in countries that impose restrictions on financial markets.

6 Other Cryptocurrencies

As a robustness check we analyze how the Kimchi premium is related to the premiums of other cryptocurrencies such as ethereum (ETH), ripple (XRP), and litecoin (LTX).[19] For example,

[19]On May 16th, 2018, the total market cap of bicoin, ethereum, ripple and litecoin is about 143.0, 71.0, 27.9, and 7.9 Billion USD, respectively.

Table 4: Regression results The dependent variable is the premium for bitcoins with local currency (LC) versus US Dollars (USD) and is calculated: $(\text{LCBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in local currency is the median price of exchanges on bitcoincharts.com. Conversion from LC to USD is done using FX data from the St. Louis fed and using the OANDA daily average rate. The independent variables are defined as in Table 8.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bitcoin short-term volatility	0.013^{***}	0.017^{***}	0.018^{***}	0.013^{***}	0.017^{***}	0.018^{***}	0.013^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Blockchain median confirmation time	0.0004^{**}		0.0004^{*}	0.0004^{**}		0.0004^{*}	0.0004^{**}
	(0.0002)		(0.0002)	(0.0002)		(0.0002)	(0.0002)
Mean blockchain transaction fee	0.001^{***}			0.001^{***}			0.001^{***}
	(0.0001)			(0.0001)			(0.0001)
Index of Economic Freedom		-0.001^{***}	-0.001^{***}	-0.001^{***}			
		(0.0004)	(0.0004)	(0.0004)			
Economic Freedom Ranking					-0.022^{***}	-0.022^{***}	-0.022^{***}
					(0.005)	(0.005)	(0.005)
Constant	0.034^{***}	0.110^{***}	0.106^{***}	0.108^{***}	0.194^{***}	0.190^{***}	0.191^{***}
	(0.006)	(0.026)	(0.026)	(0.027)	(0.039)	(0.038)	(0.039)
Observations	11,628	11,628	11,628	11,628	11,628	11,628	11,628
Adjusted R^2	0.029	0.023	0.023	0.030	0.023	0.024	0.031
Note:							*p<0.1; **p<0.05; ***p<0.01

if the ethereum premium (defined by the same way of the Kimchi premium) in South Korea would be lower than the Kimchi premium, one can undertake arbitrage by buying bitcoin in a U.S. exchange, sending it to a Korean exchange, selling the bitcoin to buy ethereum in the Korean exchange, sending those ethereum to the U.S. exchange, and selling those ethereum for a profit. Such a transaction would only involve crypto-currencies and hence not be subject to government fiat capital controls. We can apply similar arguments to any cases when the ethereum price difference is not equal to the bitcoin price difference in both countries.

We use the hourly closing price data in USD and KRW for Bitcoin (BTC), Ethereum (ETH), Litecoin(LTC), and Ripple (XRP) from CryptoDataDownload.com. For the KRW exchange Bithumb was used, and Kraken for the USD exchange. Exchanges were selected for ability to trade the desired cryptocurrencies, as well as volume, and the length of sample. Daily price for each cryptocurrency was calculated as the arithmetic mean of the hourly closing prices for each hour that day. The Kimchi premium for each cryptocurrency was then calculated as above for the main regressions. It should be noted that the trading days of January 11-13, 2018 are excluded from the sample as Kraken had a trading halt of approximately 48 hours due to a system upgrade and associated bugs which included those days. Results are robust to using a sample which utilizes Bitstamp data to replace those 3 days.

Consistent with the absence of arbitrage opportunities we find that premium differences across coins are very small. Table 5 shows that the average premiums across cryptocurrencies are very close to each other. The standard deviation tends to be higher if the premium is higher, which further mitigates the premium difference (when one wants to try arbitrage trading for such a small premium difference). Given that most exchanges in the world charge minimum 0.5% and up to 1-2% transaction costs, the premium differences are not enough to cover the the total transaction costs to execute the arbitrage. In addition, Table 6 shows that the correlation between the Kimchi premium and each cryptocurrency is very high. Similarly the pairwise correlation between all those premia are very high as shown by Table 7.

The results are consistent with our assumption of capital controls driving the Kimchi pre-

Table 5. Summary statistics of Korean Crypto currency premia 2017-10-01 to 2018-04-30.

Statistic	N	Mean	St. Dev.	Min	Max
KRWBTCprem	209	0.072	0.100	−0.045	0.487
KRWETHprem	209	0.076	0.109	−0.044	0.550
KRWLTCprem	209	0.075	0.106	−0.045	0.525
KRWXRPprem	209	0.074	0.111	−0.044	0.535

Table 6. Regression of the Kimchi premium on other currency premia. 2017-10-01 to 2018-04-30. Jan 11, 12, 13 removed due to Kraken halting trading

	Dependent variable:		
	BTCprem		
	(1)	(2)	(3)
ETHprem	0.9108***		
	(0.0080)		
LTCprem		0.9312***	
		(0.0070)	
XRPprem			0.8864***
			(0.0103)
Constant	0.0033***	0.0028***	0.0067***
	(0.0011)	(0.0009)	(0.0014)
Observations	209	209	209
R^2	0.9841	0.9884	0.9726
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 7. Pairwise Correlation Matrix, Korean crypto currency premia.. 2017-10-01 to 2018-04-30

	KRWBTCprem	KRWETHprem	KRWLTCprem	KRWXRPprem
KRWBTCprem	1	0.992	0.994	0.986
KRWETHprem	0.992	1	0.998	0.995
KRWLTCprem	0.994	0.998	1	0.994
KRWXRPprem	0.986	0.995	0.994	1

mium. If one of the other crypto currencies had no premium or a lower premium than Bitcoin arbitrageurs could use that currency to move funds out of Korea and complete the arbitrage. Since crypto-currencies are not subject to capital controls no arbitrage opportunities between crypto-currencies should be possible. This implies that all crypto currencies should have very similar premia. Similar to the logic with Bitcoin other crypto currencies can trade at a premium since the arbitrage is restricted because of the capital controls. The analysis shows that the Kimchi premium is therefore not something unique to Bitcoin but rather a result of Korea's capital controls that prevent arbitrageurs from aligning Korean prices with those of the world market.

Anecdotal evidence shows that traders in Korea are closely following the premia in different crypto-currencies. Figure 5 shows a typical cryptocurrency trading discussion website in South Korea. As seen in the screen shot and its description, Korean investors keep track of not only the Kimchi premium on the bitcoin but also other coin premiums. If they find one premium is significantly lower (or higher) than another premium, they would sense it as the signal that the corresponding coin is under- or over-valuated within the Korean market, which leads to push up or down the coin premium. Consequently, the coin premiums are more and less the same in each time, as seen in the green number inside each parenthesis in Columns 3 to 7 in the table in the figure. Traders also watch out the premiums across major Korean exchanges. This mechanism would be a main reason why the Korea premiums stays more and less the same across coins over time.

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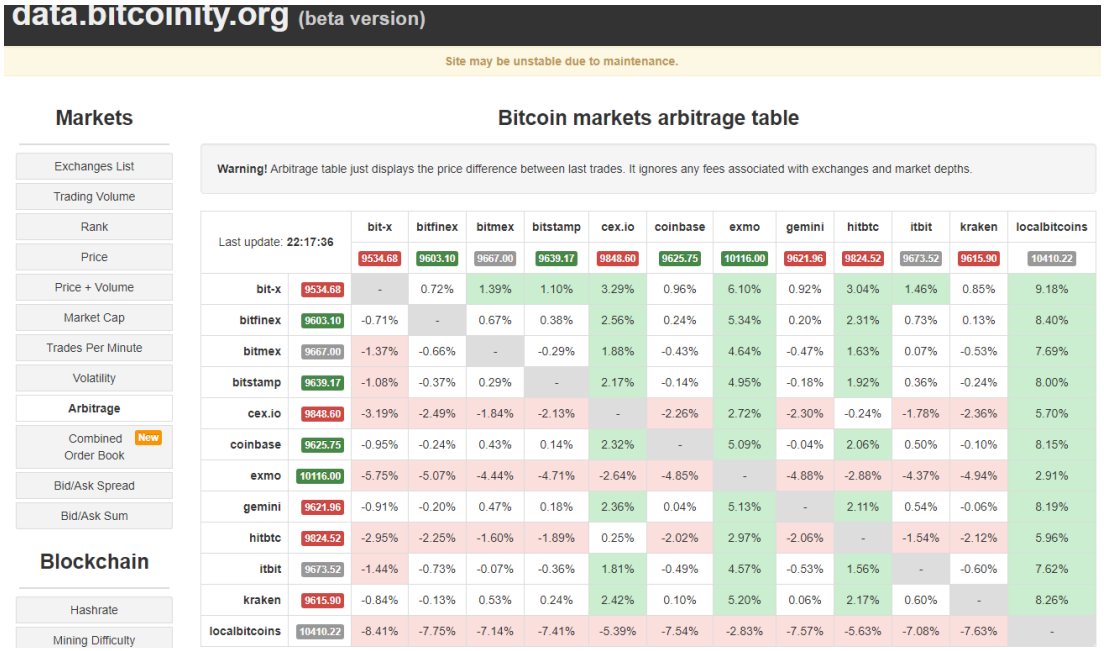
A Supplementary figures and tables

Figure 4. Bitcoin price differences across US exchanges: Screenshot from bitcoinity.org representing price differences in percent of Bitcoin across major US-Crypto exchanges.



data.bitcoinity.org (beta version)

Site may be unstable due to maintenance.

Markets

- Exchanges List
- Trading Volume
- Rank
- Price
- Price + Volume
- Market Cap
- Trades Per Minute
- Volatility
- **Arbitrage**
- Combined Order Book (New)
- Bid/Ask Spread
- Bid/Ask Sum

Blockchain

- Hashrate
- Mining Difficulty

Bitcoin markets arbitrage table

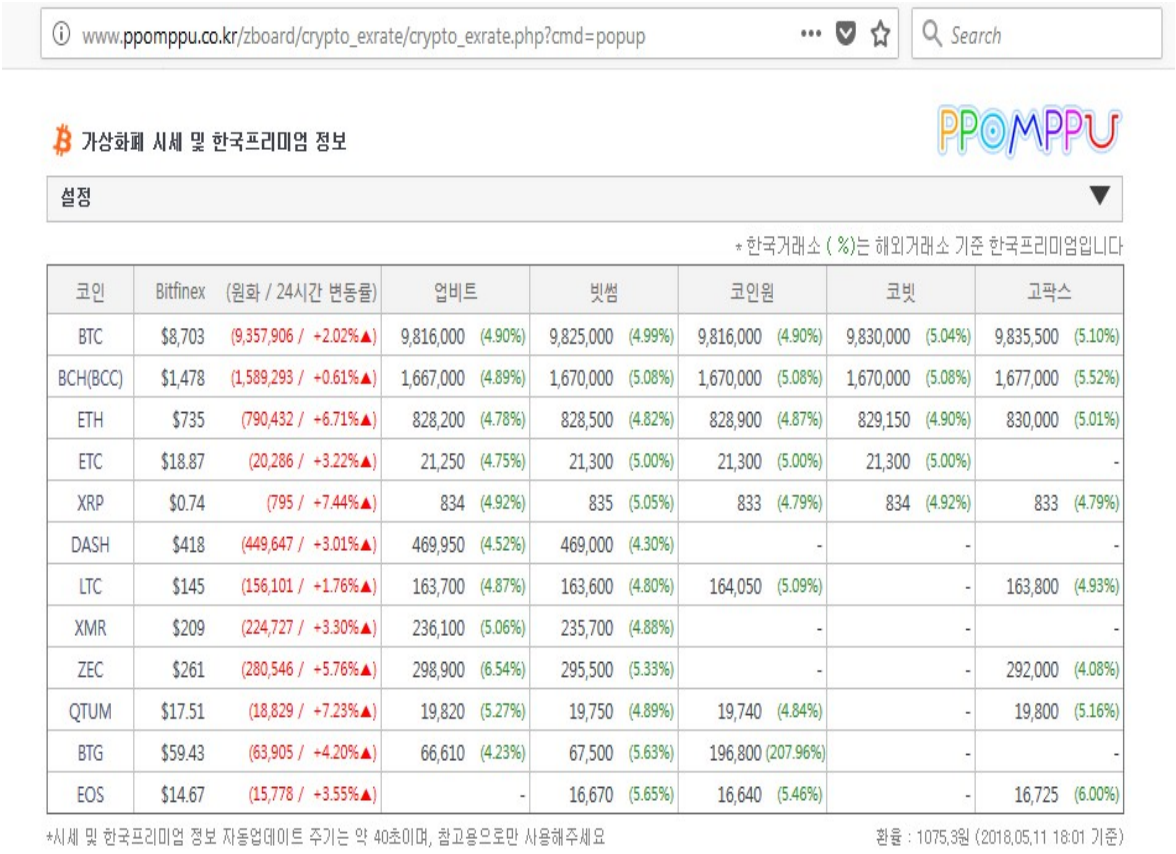
Warning! Arbitrage table just displays the price difference between last trades. It ignores any fees associated with exchanges and market depths.

Last update: 22:17:36		bit-x	bitfinex	bitmex	bitstamp	cex.io	coinbase	exmo	gemini	hitbtc	itbit	kraken	localbitcoins
		9534.68	9603.10	9667.00	9639.17	9848.60	9625.75	10116.00	9621.96	9824.52	9673.52	9615.90	10410.22
bit-x	9534.68	-	0.72%	1.39%	1.10%	3.29%	0.96%	6.10%	0.92%	3.04%	1.46%	0.85%	9.18%
bitfinex	9603.10	-0.71%	-	0.67%	0.38%	2.56%	0.24%	5.34%	0.20%	2.31%	0.73%	0.13%	8.40%
bitmex	9667.00	-1.37%	-0.66%	-	-0.29%	1.88%	-0.43%	4.64%	-0.47%	1.63%	0.07%	-0.53%	7.69%
bitstamp	9639.17	-1.08%	-0.37%	0.29%	-	2.17%	-0.14%	4.95%	-0.18%	1.92%	0.36%	-0.24%	8.00%
cex.io	9848.60	-3.19%	-2.49%	-1.84%	-2.13%	-	-2.26%	2.72%	-2.30%	-0.24%	-1.78%	-2.36%	5.70%
coinbase	9625.75	-0.95%	-0.24%	0.43%	0.14%	2.32%	-	5.09%	-0.04%	2.06%	0.50%	-0.10%	8.15%
exmo	10116.00	-5.75%	-5.07%	-4.44%	-4.71%	-2.64%	-4.85%	-	-4.88%	-2.88%	-4.37%	-4.94%	2.91%
gemini	9621.96	-0.91%	-0.20%	0.47%	0.18%	2.36%	0.04%	5.13%	-	2.11%	0.54%	-0.06%	8.19%
hitbtc	9824.52	-2.95%	-2.25%	-1.60%	-1.89%	0.25%	-2.02%	2.97%	-2.06%	-	-1.54%	-2.12%	5.96%
itbit	9673.52	-1.44%	-0.73%	-0.07%	-0.36%	1.81%	-0.49%	4.57%	-0.53%	1.56%	-	-0.60%	7.62%
kraken	9615.90	-0.84%	-0.13%	0.53%	0.24%	2.42%	0.10%	5.20%	0.06%	2.17%	0.60%	-	8.26%
localbitcoins	10410.22	-8.41%	-7.75%	-7.14%	-7.41%	-5.39%	-7.54%	-2.83%	-7.57%	-5.63%	-7.08%	-7.63%	-

Table 8. Analysis Variables

Variable Name	Variable Definition
Kimchi premium (KRW premium over USD)	Calculated as $(\text{KRWBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in KRW is similarly defined with data from the Korbit exchange. Conversion from KRW to USD is done using the OANDA daily average rate.
|EUR premium over USD|	The absolute value of $(\text{EURBTC}_{\text{price in USD}})/(\text{USDBTC}_{\text{price}}) - 1$, where the bitcoin price in USD is the mean price of all USD transactions on the Bitstamp exchange for that day. The bitcoin price in EUR is similarly defined from the Kraken exchange. Conversion from EUR to USD is done using the OANDA daily average rate.
Bitcoin short-term volatility	The sum of 10 minute USDBTC squared returns over one day. We define short-term volatility as the median volatility over several exchanges: bitfinex, bitstamp, BTCC, btc-e, coinbase, Gemini, hitbtc, itbit, kraken, OK-Coin, Poloniex.
Blockchain median confirmation time	The median time (in minutes) for a Bitcoin transaction to be accepted into a mined block and added to the public ledger (note: only includes transactions with miner fees). Source: *blockchain.info*. To interpolate missing days, the most recent known value is used (max gap in data set is 1 day).
KRWBTC volume	The daily total number of KRW and BTC exchange transactions on the Korbit exchange. Measured in thousands.
KRWUSD volatility	The standard deviation of 1-day logarithmic returns in the daily average KRWUSD exchange rate from OANDA, over the most recent 20 days.
EURBTC volume	The daily total number of EUR and BTC exchange transactions on the Kraken exchange. Measured in thousands.
EURUSD volatility	The standard deviation of 1-day logarithmic returns in the daily average EURUSD exchange rate from OANDA, over the most recent 20 days.
Mean blockchain transaction fee	Measured in USD. The total value of all transaction fees paid to miners converted to USD (not including the value of block rewards), divided by the number of daily confirmed Bitcoin transactions on the blockchain for that day. Source: *blockchain.info*.
Bitcoin 1-day return	One day log-return of the USD-BTC price.

Figure 5. Other Korea premiums for major cryptocurrencies: The figure is a screenshot from www.ppopmppu.co.kr, which is a typical cryptocurrency trading discussion forum site showing real time premium differences across Korean exchanges. The first column is the name of each coin. The second column is the USD Bitfinex prices with Korean KRW inside the parenthesis. Columns 3 to 7 present the KRW prices at Upbit, Bithum, Coinone, Korbit, and Gopax, respectively. The green number inside each parenthesis in Columns 3 to 7 is the Korea premium of the corresponding coin. The sentence below the table says that the price information is updated every 40 seconds. The current exchange rate (KRW/USD) is at the bottom right corner (1075.3 KRW/$ at 18:01 pm, May 11th, 2018). Check `http://www.ppomppu.co.kr/zboard/crypto_exrate/crypto_exrate.php?cmd=popup` for the real time information.



코인	Bitfinex	(원화 / 24시간 변동률)	업비트	빗썸	코인원	코빗	고팍스
BTC	$8,703	(9,357,906 / +2.02%▲)	9,816,000 (4.90%)	9,825,000 (4.99%)	9,816,000 (4.90%)	9,830,000 (5.04%)	9,835,500 (5.10%)
BCH(BCC)	$1,478	(1,589,293 / +0.61%▲)	1,667,000 (4.89%)	1,670,000 (5.08%)	1,670,000 (5.08%)	1,670,000 (5.08%)	1,677,000 (5.52%)
ETH	$735	(790,432 / +6.71%▲)	828,200 (4.78%)	828,500 (4.82%)	828,900 (4.87%)	829,150 (4.90%)	830,000 (5.01%)
ETC	$18.87	(20,286 / +3.22%▲)	21,250 (4.75%)	21,300 (5.00%)	21,300 (5.00%)	21,300 (5.00%)	-
XRP	$0.74	(795 / +7.44%▲)	834 (4.92%)	835 (5.05%)	833 (4.79%)	834 (4.92%)	833 (4.79%)
DASH	$418	(449,647 / +3.01%▲)	469,950 (4.52%)	469,000 (4.30%)	-	-	-
LTC	$145	(156,101 / +1.76%▲)	163,700 (4.87%)	163,600 (4.80%)	164,050 (5.09%)	-	163,800 (4.93%)
XMR	$209	(224,727 / +3.30%▲)	236,100 (5.06%)	235,700 (4.88%)	-	-	-
ZEC	$261	(280,546 / +5.76%▲)	298,900 (6.54%)	295,500 (5.33%)	-	-	292,000 (4.08%)
QTUM	$17.51	(18,829 / +7.23%▲)	19,820 (5.27%)	19,750 (4.89%)	19,740 (4.84%)	-	19,800 (5.16%)
BTG	$59.43	(63,905 / +4.20%▲)	66,610 (4.23%)	67,500 (5.63%)	196,800 (207.96%)	-	-
EOS	$14.67	(15,778 / +3.55%▲)	-	16,670 (5.65%)	16,640 (5.46%)	-	16,725 (6.00%)