Does Governance Have a Role in Pricing? Cross-Country Evidence From Bitcoin Markets

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Abstract

I investigate the effects of social technologies related to governance on cross-country differences in Bitcoin prices. Investors pay a persistent premium over global prices in countries with less economic freedom, particularly when there exist foreign exchange and capital controls limiting investment freedom. Using the Heritage Foundation's Economic Freedom Index and associated macroeconomic time-series, I find that a 10 point increase in the index leads to a 7.5 percent decrease in premium. Of the component indices, Financial Freedom has the largest marginal effect in that a 10 point improvement in its value decreases prices by 5.3 percent. From this perspective, Bitcoin can be seen as a disaster asset offering a new channel to evade domestic jurisdiction repression, a process resembling imperfect markets for catastrophe insurance inducing unexpectedly high premiums. Finally, a natural question arises as to whether this finding can be extended to other assets, in other words, whether endogenous social technologies effect systemic risk and manifest in the pricing kernel.

1 Introduction

I use Bitcoin (BTC) as an instrument to measure the impact of differences in governance, or social technologies, to pricing. Bitcoin is an ideal tool to test a variety of economic and financial theories because it is a homogenous asset with few barriers to use that trades freely around the world in a peer-to-peer fashion. It is difficult, to say the least, for governments to impose traditional barriers to acquisition, use, trade, and transmission within countries or across borders. For these reasons, when we observe significant and persistent differences in prices across countries for which we would expect arbitrage exploitation, we can apply econometric techniques to investigate underlying factors that might inhibit the market process. The factors I investigate relate to governance; in particular, various degrees of economic freedom are used as complementary variables to liquidity measures to explain price differences across countries.

The rapid explosion and fundamental nature of Bitcoin is providing one of the most interesting economic experiments in recent history. Bitcoin is one of the only deflationary currency experiments in the world today because its full time-path effective supply is contracting, which puts it on par with gold and other precious metals on at least one approximate dimension. Additionally, like gold and other metals, Bitcoin is a fundamentally decentralized open-source project and since it has financial value, it offers users the ability to trade and transmit funds across borders with almost no barriers or transaction costs. This characteristic is of primary interest in this paper because it enables cryptocurrencies to behave as disaster assets for those in politically unstable environments.

Cryptofinance has only recently entered the economic and finance literature, so the field is wide open to study. Harvey (2014) maps out the origins of the blockchain technology, some of its economics, and identifies a variety of risks. Evans (2014) complements this work with an economic description of decentralized public ledger currency platforms. Fink and Johann (2014) make use of publicly available pricing and exchange trade data to perform a variety of financial econometrics tests to characterize market microstructure, and Glaser and Zimmerman (2014) evaluate the revealed intentions of users to gauge whether they consider BTC to be an alternative currency, or a speculative asset. Brire, Oosterlinck, and Szafarz (2013) explore portfolio considerations when including small amounts of BTC in a well- diversified financial portfolio. My research adds to the existing literature by exploring the possibility of Bitcoin acting as a disaster asset in politically volatile markets.

In addition to the new Bitcoin literature, there are two other major branches of academic literature that influenced this research and to which this paper contributes: (1) Financial institutions and systems, and economic freedom and its role with growth; and (2) Banking and financial crises, and catastrophe assets and risk pricing. The first literature cluster suggests that governance plays a role in economics; in particular, I present evidence that governing institutions and social technologies related to economic freedom influence Bitcoin prices. This raises the question of whether the same factors might make their way into the pricing kernel of other assets? The second literature cluster shapes

the argument that investors consider Bitcoin to be a disaster asset to help avoid either predatory or volatile political jurisdictions.

Romer (1990) was the first to successfully incorporate endogenous technical change into the growth literature, which was later augmented by other economists, including Heckelman (2000), Dawson (1998), Haan and Diermann (1998), and Islam (1996) who found that social technologies, like those associated with economic freedom, positively influenced growth, even preceded it in broad cross-country panel studies. I consider economic freedom as a factor, not necessarily in growth, but that can manifest in the pricing kernel for, at least, disaster assets in markets with frictions exceeding potential arbitrage profits. Beck, Levine, and Loayza (1999) link financial intermediation to a positive impact on factor productivity growth, which I expand on in the negative, where lack of economic freedom adds systematic risk and influences pricing. Roubini and Sala-i-Martin (1994) pose a relationship between inflation, tax evasion, and financial repression, in which governments have incentive to repress the financial sector to maximize easy sources of resources for the public budget, but this comes at the expense of inhibiting social resource allocation efficiencies. Gupta (2011) shows how tax evasion worsens in financial repression when there are readily available currency substitutes, and here I add Bitcoin as just such a currency substitute that can be used to avoid wealth expropriation by policy.

The next influential literature cluster to note involves the financial crisis and catastrophe and risk pricing literatures. Reinhart (2012) documents common trends surrounding financial crises, including the use of financial repression to ease mounting debt burdens, currency interventions, and capital controls, or "macroprudential regulation" that are part of an evolving trend of financial repression. In this study, these measures manifest in Monetary Freedom, Investment Freedom, and Financial Freedom indices to which this research finds a link to cross-country Bitcoin pricing. Froot (2001) finds that catastrophe insurance is overpriced due to supply restrictions associated with market imperfections, Zanjani (2001) attributes catastrophe insurance price differences across countries to higher marginal capital requirements to maintain solvency, and Harrington and Niehaus (2002) introduce the effects of corporate income taxes to catastrophe insurance supply restrictions and hence relatively high premiums. I expand the notion of agent insolvency beyond the traditional corporate setting to that of private individuals who face personal or physical loss considerations in politically volatile environments, and who, because of a variety of mechanisms of government repression, have limited options to diversify internationally or across financial asset classes. For these agents, the introduction of a new disaster protection asset, such as Bitcoin, to either seamlessly transmit funds across borders, or to park capital into a financial vehicle with minimal covariance with the set of available assets in the local market, makes paying a premium over global prices attractive.

Bitcoin prices are analyzed in each country, the premiums calculated for the local markets over liquidity-weighted global prices, and then a series of econometric tests performed to try to explain the differences. Since Bitcoin offers an efficient way to diversify financial assets internationally with minimal transaction costs, countries with higher degrees of

economic repression should experience premiums over global prices, ceteris paribus. Findings suggest that, after accounting for market microstructure differences, such as trading volume and bid-ask spreads that are typically seen as causes of price differentials across markets, there are factors related to economic repression that are significant in explaining price differences. Economic freedom, in particular, the degree of freedom from capital or price controls, is a significant factor in explaining price differences. Countries with less freedom experience Bitcoin prices that trade at a premium relative to the global price. This makes sense in that Bitcoin offers a channel to escape financial, or other economic, repression that increases in value with the degree of repression.

This paper is organized as follows: Section 2 introduces the core innovation behind the Blockchain technology, Part 3 develops the hypothesis to be tested, Part 4 describes the data, sources, and econometric methodology used in the analysis, Part 5 presents the results, Part 6 summarizes robustness checks, Part 7 concludes with insights for future research, followed by tables, figures, and references.

2 Blockchain Technology

The world's first cyrptocurrency was created in 2008 with the anonymous release of a white paper describing a decentralized version of electronic cash, called Bitcoin (Nakamoto, 2008). The novelty was that the new system solved the double spending problem endemic to previous virtual currencies by introducing a hash-based proof-of-work algorithm to safeguard the network. The Bitcoin system is essentially a decentralized process for appending information to a public ledger, called the "blockchain". Any kind of information can be appended to the ledger, including change of ownership; owning a "Bitcoin" is basically just owning the private key to a segment of the blockchain, or, in other words, owning a slice of blockchain real estate.

Bitcoin was created to solve a central trust issue with digital payments. The way payments worked before was to have a trusted third party adjudicate transactions to verify that the people spending money actually had it in the first place. The third party served several key functions in addition to verifying ownership of assets prior to transfer; they also assumed the risk of fraud, chargebacks, and bore the cost of information collection and safeguard to enhance system security. This all came at a cost that essentially set a minimum threshold for feasible transaction size, and required significant capital and regulatory compliance to enact, which limited competition and kept costs high on merchants and consumers.

The way Bitcoin gets around having a central third party is by using cryptography, proof-of-work, and a fully open public ledger. Bitcoin is a system with a preset supply of 21.5 million units that are released to the market at defined intervals and apportioned

to network participants called "miners." Everyone who "owns" a Bitcoin has possession of a private key that allows them to sign transactions using that currency unit. Without the private key there is no way to spend the corresponding Bitcoin. Every block of newly released Bitcoins is appended to the public ledger, or blockchain, using a proof-of-work process that miners perform that apportions the block to the winner of a competition to decipher an increasingly complex SHA256 hash algorithm[1]. This process of awarding new blocks to miners provides the economic incentive to participate in the network and process transactions, the proof-of-work method of solving a complex hash algorithm makes the process of appending to the blockchain sufficiently difficult to prevent fraud, and the public nature of the ledger prevents double spending.

In addition to solving the trust issue, Bitcoin's design as a decentralized peer-to-peer payment system provides a new channel for international asset diversification and movement of funds. People in countries with higher than average economic repression, such as trade barriers, limited property rights, or capital controls combined with high inflation, now have an easy way of transmitting funds out of currencies that are at risk of losing significant value, or are politically unstable. Historically, it was difficult for people in politically unstable countries to preserve their assets and get them out of country without confiscation; now with Bitcoin, people in risky political jurisdictions who face regulatory barriers to transmitting funds can do so as easily as sending an E-mail. It is this safe haven value coupled with the peer-to-peer permission-less use that will be explored in this study.

3 Hypothesis Development

Since Bitcoin offers a new low-cost channel to diversify outside of one's domestic financial system, agents in economically repressive countries have more of an incentive to move assets into Bitcoin. For instance, countries that experience price controls, capital controls, trade barriers, high levels of taxation, unstable prices, or lack of independence of financial institutions from government control would be prime candidates for this phenomenon because investors undergo a higher than normal degree of asset confiscation with limited legal ability to protect themselves by moving funds outside of the local currency, or political jurisdiction.

Prices can be different across markets even when the asset traded is homogeneous. For instance, gold trades at slightly different prices across the major global markets, such as New York, Zurich, Singapore, etc. Standard explanations in finance theory are that market frictions, such as liquidity (e.g. trading volume and bid-ask spreads), or transaction costs can cause the same asset to trade for different prices. There are large differences in trading volume and bid-ask spreads across Bitcoin markets, as well as potentially other

[1]Harvey (2014) does an excellent job describing the role of hash algorithms in Bitcoin.

country-specific effects that could influence supply or demand for assets, so if there is a meaningful premium over global prices, these differences first need to be ruled out as sufficient explanation. Fundamentally, we need to get at the question of why arbitrageurs are not trading away cross-country differences in prices?

I test whether the degree of economic repression in a country can explain differences in Bitcoin trading premium over the global price. Investors in highly repressive environments have a higher incentive to buy Bitcoin, this extra demand justifying local market prices significantly higher than a global average price. Economic repression also causes market distortions that, if large enough, could limit arbitrage trading. Conversely, investors in relatively free and open markets with lower transaction frictions or access barriers to asset diversification internationally, would not have the same incentive to pay a premium over global prices, and they would likely have additional mechanisms to take advantage of price deviations in their local markets in the absence of capital controls.

Formally, the hypothesis to be tested is:

H_0: Economic Freedom has no effect on premiums

Rejection of H_0 as measured by the proxy variables, would provide evidence that the degree of economic freedom in a country contributes to Bitcoin prices trading at a premium over the global average.

The econometric model used to explain premiums exploits the cross-section of premiums with liquidity variables (trading volume and bid-ask prices), domestic currency returns, economic repression proxies, and controls for lagged dependent variables, market maturity, and the US market:

$$\pi_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i LIQ_{i,t} + \delta_i CURR_{i,t} + \zeta_i ECON_{i,t} + \epsilon_{i,t}$$

Here, $\pi_{i,t,}$ represents the Bitcoin premium over global average prices for market i at time t, $X_{i,t}$ represents a set of control variables that include various combinations of stock market returns, inflation, interest rates, real interest rates, tariffs, income tax rates, corporate tax rates, overall tax burden as a percent of GDP, government expenditures as a percent of GDP, a time variable representing the months of maturity for the local Bitcoin market, and a USA dummy to control for the dominance of U.S. trading, and lagged premiums; $LIQ_{i,t}$ represents liquidity variables–percent of global trading volume, total trading volume for country i, and the bid-ask spread–$CURR_{i,t}$ is country i's currency return relative to the U.S. dollar from period t-1 to period t, $ECON_{i,t}$ is the value of the Heritage Foundation Economic Freedom Index for country i at time t, and $\epsilon_{i,t}$ is the model error term.

In addition to investigating the relationship between the Economic Freedom Index, I break the index into its most relevant components–Property Rights, Business Freedom, Monetary Freedom, Trade Freedom, Investment Freedom, and Financial Freedom–and analyzes how each one relates to Bitcoin premiums independently. The model specification for each of these tests is identical to what is done for the composite index.

This study uses a generalized method-of-moments (GMM) dynamic panel estimator that uses pooled cross-country and time-series data to exploit the additional information provided by the over-time variation in the premium and its determinants. Given the econometrically complex nature of this data set the estimator was chosen to address problems induced by unobserved country-specific effects and joint endogeneity of the explanatory variables in lagged dependent variable models often encountered in growth literature (Levine, Loayza, and Beck, 1999). The data includes Bitcoin, currency, stock market, and macroeconomic observations across 22 countries at a monthly frequency.

The GMM estimator comes from the dynamic panel techniques pioneered by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The Arellano-Bover/Blundell-Bond estimator includes lags in the dependent variable, but also uses lagged observations of the explanatory variables as instruments. In particular, it differences the regression equation to remove possible omitted variable bias created by unobserved country-specific effects, and then instruments the right-hand-side variables using lagged values of the original regressors to eliminate potential parameter inconsistencies from simultaneity bias. Finally, the version of the estimator used in this study employs the Arellano and Bover (1995) efficiency improvements by complementing the difference specification with the original regression specified in levels.

4 Data and Descriptive Statistics

Bitcoin transaction data is publicly available and includes price, volume, and bid-ask information across 22 countries. Quandl provides a convenient database aggregating Bitcoin prices across the 22 countries, and includes daily average price, volume, bid and ask prices, and last traded price. The data range used in this study is from July 17, 2010 to March 31, 2015. Prices are quoted in local currency, which are then matched to the Federal Reserve's H.10 Foreign Exchange Rates to normalize into USD. USD-normalized Bitcoin prices are aggregated across exchanges to derive a baseline world price that is weighted by trading volume.

The Heritage Foundation publishes an annual Index of Economic Freedom that measures economic freedom in 186 countries based on a composite of trade freedom, business freedom, investment freedom, property rights, and monetary freedom. Values range from 0 to 100 for the indices. Hong Kong, Singapore, and New Zealand rank as the most economically free countries, while North Korea, Cuba, and Venezuela rank as the least free. Hong Kong, Singapore, and New Zealand have Bitcoin markets and therefore are included in this study; the least free countries included in the study are Argentina, Russia, and China. Several variables from this index are used as proxies for economic repression in this study. Table 1 shows average index values for countries included in the sample.

Table 1: List of Countries and Average Index Values

Countries	Economic Freedom	Property Rights	Business Freedom	Monetary Freedom	Trade Freedom	Investment Freedom	Financial Freedom
Argentina	45.1	15.0	55.6	60.0	68.4	33.3	30.0
Australia	82.0	90.0	94.7	83.2	86.3	81.7	90.1
Brazil	57.1	50.0	53.5	71.2	69.5	51.7	60.0
Canada	79.6	90.0	90.0	76.5	88.3	78.3	80.0
China	52.4	20.0	50.0	73.0	71.9	26.7	30.0
Euro Zone	67.9	77.9	83.1	80.0	86.4	81.8	68.9
Hong Kong	89.7	90.0	99.3	82.0	90.0	90.0	90.0
Israel	68.6	73.3	70.6	80.3	84.8	80.0	70.0
Japan	72.5	80.0	81.8	88.3	82.3	66.7	50.0
Mexico	66.7	50.0	76.6	77.6	84.0	70.0	60.0
New Zealand	81.6	95.0	97.2	85.7	86.8	80.0	80.0
Norway	71.1	90.0	91.7	79.1	89.3	73.3	60.0
Poland	67.2	60.0	67.1	78.9	87.5	68.3	70.0
Romania	65.7	40.0	70.4	76.4	87.5	80.0	50.0
Russia	51.7	23.3	71.8	66.7	75.7	25.0	30.0
Singapore	88.9	90.0	96.9	82.4	90.0	81.7	80.0
South Africa	62.3	50.0	74.1	75.3	76.3	50.0	60.0
Sweden	72.9	90.0	90.7	83.4	87.5	90.0	80.0
Switzerland	81.0	90.0	76.4	85.9	90.0	83.3	80.0
Turkey	63.7	48.3	65.6	72.5	84.8	70.0	60.0
United Kingdom	75.2	90.0	92.4	73.4	87.5	90.0	80.0
United States	75.9	81.7	89.5	75.7	86.7	70.0	70.0

Values represent index averages for 2013, 2014, and 2015.

Table 2: Summary Statistics

Variable	Min	Max	Mean	p25	p50	p75
Premium	-34.95	53.61	0.97	-0.78	0.43	3.41
Bitcoin Return	-46.57	282.51	12.04	-13.30	-0.05	15.92
Inflation	-1.70	20.89	2.73	0.50	1.50	3.60
Real Interest	-4.70	5.34	0.48	-0.60	0.10	1.31
Tariff	0.00	7.86	2.24	1.00	1.60	3.54
Income Tax	13.00	57.00	36.64	29.00	39.60	45.00
Corporate Tax	15.00	35.00	25.09	20.00	25.00	30.00
Tax Burden	10.00	45.77	28.93	24.83	29.50	34.80
Gov. Expenditure	14.40	51.90	38.48	34.86	41.50	44.60
Economic Freedom	44.10	90.10	70.07	62.60	70.90	79.10
Property Rights	15.00	95.00	68.86	50.00	80.00	90.00
Business Freedom	48.00	99.90	79.86	70.10	82.95	92.00
Monetary Freedom	59.60	90.60	77.32	74.20	77.40	81.50
Trade Freedom	68.80	90.00	83.61	77.40	86.80	88.00
Inv. Freedom	25.00	90.00	68.94	55.00	75.00	83.53
Fin. Freedom	30.00	90.00	66.05	60.00	70.00	80.00

Data range: Jan 2013 - Jul 2015, sample frequency in months. Rates are in percent.

Summary statistics are provided in Table 2 for key variables in this study. Extreme values in the sample come from Argentina, Russia, China, and Brazil, which have average Economic Freedom values of 45.1, 51.7, 52.4, and 57.1, respectively. The high end of the sample includes Hong Kong, Singapore, and New Zealand with averages of 89.7, 88.9, and 81.6, respectively.

Investment Freedom is the component index of most interest because it includes foreign exchange controls and capital controls as penalty measures in its computation. These factors most directly relate to the hypothesis that Bitcoin is being priced as a disaster asset by people in repressive jurisdictions who are willing to pay a premium to diversify through a new channel. The countries with the worst Investment Freedom ratings in the sample are Russia, China, and Argentina with average values of 25.0, 26.7, and 33.3, respectively. On the other side of the spectrum are Hong Kong, Great Britain, and Sweden all with average values of 90.0.

Bitcoin prices tend to be extremely volatile, e.g. Harvey (2014) notes that prices are 20 times more volatile than the US dollar, and experience a 95 percent confidence level of daily price moves of +/- 10 percent. Within this sample, monthly BTC returns ranged from -46.6 percent to 282.5 percent. Cross-country differences in prices varied broadly from a 35.0 percent discount to a 53.6 percent premium.

Table 3: Cross-correlation Table

Variables	Premium	Economic Freedom	Property Rights	Business Freedom	Monetary Freedom	Trade Freedom	Investment Freedom	Financial Freedom
Premium	1.00							
Economic Freedom	-0.32	1.00						
Property Rights	-0.22	0.91	1.00					
Business Freedom	-0.15	0.86	0.86	1.00				
Monetary Freedom	-0.38	0.72	0.71	0.57	1.00			
Trade Freedom	-0.40	0.85	0.81	0.81	0.67	1.00		
Investment Freedom	-0.26	0.83	0.89	0.74	0.68	0.86	1.00	
Financial Freedom	-0.19	0.88	0.92	0.76	0.65	0.75	0.90	1.00

Table 3 presents the cross-correlation of Bitcoin premiums with Economic Freedom and each of the component indices. Premiums are negatively correlated with every index, which is consistent with the notion that investors are willing to pay more for a potential disaster asset in countries with less freedom and more economic uncertainty. Trade Freedom, which is a measure penalized by tariffs and non-tariff trade barriers (NTB), has the highest magnitude relationship with a -0.40 correlation to premiums. The Economic Freedom Index is most correlated to Property Rights and Financial Freedom with correlation coefficients are 0.91 and 0.88, respectively.

Most Bitcoin trading has occurred in US dollars, but transactions recorded in other currencies are available after Sep 2013. Liquidity measures and a "USA" dummy are used as control variables to more accurately measure the effects of the index values on market premiums, given that most trading volume has occurred in US dollars. Figures 5 and 6 show the percentage of global trading volume transacted in US dollars, as well as a visual breakdown of trading volume in foreign currency markets excluding US dollar trades. China represents about 74.4 percent of non-US trading volume throughout the sample, while Euro zone trading accounts for 14.0 percent of volume.

Two major fluctuations in percent of global trading volume distribution occurred in the sample, both corresponding to significant fluctuations in Chinese markets. The initial opening of Chinese markets saw a surge in volume resulting in 67 percent of global transactions occurring in Yuan, but then regulatory caution by the government induced a collapse in volume. Volume picked up one more time in China, but was quickly followed by additional governmental regulation that dropped volume.

5 Regression Results

The first set of regressions tests Bitcoin premiums against the Economic Freedom index and a variety of macroeconomic variables, including inflation, real interest rates, tax burden as a percent of GDP, and government expenditure as a percent of GDP. Table 4 presents the results with coefficient estimates for Economic Freedom being negative and significant at the 5 percent level. Marginal effects in a dynamic model with a lagged dependent value as a regressor need to account for the contributions from the lags. The long run marginal effect in this case is:

$$\frac{dy}{dx} = \frac{b}{(1-a)}$$

with b being the coefficient for the regressor of interest, and a being the coefficient for the lagged dependent variable. The marginal effect of a 10 point increase in Economic Freedom is a 7.5 percent decrease in premium.

Table 4: Regression Results for Economic Freedom and Macro Variables

Variables	I	II	III	IV	V
Economic Freedom	-0.3867				
	(2.35)**				
Inflation		0.3133			
		(0.77)			
Real Interest			0.7697		
			(3.08)***		
Tax Burden				0.2554	
				(2.43)**	
Gov. Expenditure					0.2477
					(2.43)**
Lagged Premium	0.4817	0.5492	0.5651	0.5319	0.5271
	(9.06)***	(7.27)***	(7.62)***	(7.30)***	(7.81)***
Percent Global Volume	-0.1367	-0.1216	-0.1390	-0.1039	-0.1004
	(1.86)*	(1.97)**	(2.22)**	(1.94)*	(1.79)*
Trading Volume	1.3186	1.2827	1.2606	1.1984	1.1314
	(2.33)**	(2.44)**	(2.99)***	(2.53)**	(2.05)**
Market Maturity	-0.0625	-0.0437	-0.0768	-0.0407	-0.0410
	(1.19)	(0.64)	(1.29)	(0.75)	(0.85)
Currency Returns	-0.1798	-0.1411	-0.2198	-0.1680	-0.1602
	(1.66)*	(1.31)	(2.00)**	(1.48)	(1.40)
Stock Market Returns	0.0249	0.0277	0.0292	0.0564	0.0547
	(0.59)	(0.59)	(0.62)	(1.29)	(1.22)
Constant	17.7996	-10.3202	-9.0989	-16.0236	-17.2944
	(1.36)	(2.14)**	(2.86)***	(4.88)***	(6.79)***
Chi-squared	137.45	107.48	105.85	138.65	265.33
No. of groups	22	22	22	22	22
No. of observations	342	336	332	342	342

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regressions use Arellano-Bover/Blundell-Bond dynamic panel data estimation. Real interest rates are calculated as the difference between benchmark interest rate and inflation.

Inflation is not significant, while real interest rates, computed simply as nominal benchmark interest rates for each country less CPI inflation, are positive and significant at the 1 percent level. Tax burden is positive and significant at the 5 percent level, which is consistent with the notion that Bitcoin can act as a disaster asset, or new channel to protect assets from predatory governments. Investors in countries with higher resource confiscation via taxation are willing to pay more for Bitcoin than investors in lower tax countries. The marginal effect of a 10 percent increase in tax burden is a 5.5 percent increase in Bitcoin premiums. Since the real rate of taxation is equal to the real rate of spending, it is no surprise that government expenditures as a percent of GDP carry almost the exact same coefficient and t-statistic as Tax Burden.

Table 5 presents results from the second set of regressions, which are of premium against each of the constituent indices–Property Rights, Business Freedom, Monetary Freedom, Trade Freedom, Investment Freedom, and Financial Freedom. As would be expected, particularly because each of these indices has a negative correlation with premiums, each of the regression coefficients are negatively signed. Investment Freedom has the most significant relationship with premiums and has a t-statistic that gives it significance at the 5 percent level. Property Rights, Business Freedom, and Financial Freedom are all significant at the 5 percent level; Trade Freedom, despite having the highest magnitude correlation with premiums, is only significant at the 10 percent level, and Monetary Freedom comes in as negative, but not significant.

Table 5: Regressions for Component Indices

Variables	I	II	III	IV	V	VI
Property Rights	-0.1654					
	(2.25)**					
Business Freedom		-0.2258				
		(2.03)**				
Monetary Freedom			-0.3116			
			(1.28)			
Trade Freedom				-0.6046		
				(1.78)*		
Investment Freedom					-0.2544	
					(2.48)**	
Financial Freedom						-0.2536
						(2.02)**
Lagged Premium	0.5070	0.5246	0.5436	0.4940	0.5051	0.5174
	(9.61)***	(8.63)***	(8.87)***	(7.63)***	(11.65)***	(10.13)***
Percent Global Volume	-0.1414	-0.1448	-0.1239	-0.1353	-0.1234	-0.1379
	(1.91)*	(1.93)*	(1.92)*	(1.83)*	(1.85)*	(2.04)**
Trading Volume	1.3052	1.2690	1.2253	1.3987	1.0326	1.2084
	(2.21)**	(2.33)**	(2.29)**	(2.43)**	(1.80)*	(2.35)**
Market Maturity	-0.0767	-0.0694	-0.0335	-0.0673	-0.0501	-0.0467
	(1.26)	(1.19)	(0.52)	(1.09)	(0.95)	(0.83)
Currency Returns	-0.1470	-0.1673	-0.1384	-0.1678	-0.1755	-0.1702
	(1.41)	(1.56)	(1.27)	(1.59)	(1.69)*	(1.61)
Stock Market Returns	0.0148	0.0275	0.0319	0.0278	0.0176	0.0187
	(0.34)	(0.64)	(0.70)	(0.66)	(0.41)	(0.43)
Constant	2.1853	9.1643	15.1057	40.2863	10.4162	8.3530
	(0.40)	(0.98)	(0.81)	(1.44)	(1.20)	(0.93)
Chi-squared	172.45	143.09	128.26	157.06	205.68	180.11
No. of groups	22	22	22	22	22	22
No. of observations	342	342	342	342	342	342

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regressions use Arellano-Bover/Blundell-Bond dynamic panel data estimation.

A 10 point improvement in the Investment Freedom Index lowers premiums by 5.1 percent, and a similar 10 point improvement in Property Rights decreases premiums by 3.4 percent. Qualitatively, by Heritage Foundation descriptions, this would mean a country improving such that:

- 80–Private property is guaranteed by the government. The court system enforces contracts efficiently but with some delays. Corruption is minimal, and expropriation is highly unlikely.
- 90–Private property is guaranteed by the government. The court system enforces contracts efficiently. The justice system punishes those who unlawfully confiscate private property. Corruption is nearly nonexistent, and expropriation is highly unlikely.

Courts play a prime role in protecting property and maintaining the social contract between citizens and their government, so one important differentiating factor across countries in the Property Rights index comes from how well courts function. Delays, inefficiencies, and corruption negatively impact property rights, and are related to higher Bitcoin prices as one mechanism to move property to safer jurisdictions.

Financial institutions lay at the heart of a market economy, and the degree to which credit is allocated via economic versus political considerations plays a role in Bitcoin pricing. The marginal effect of a 10 point improvement in Financial Freedom is a 5.3 percent reduction in premiums. Qualitatively, from a sample median of 70, this would mean a country's financial institutions shifting along these lines:

- 70–Limited government interference. Credit allocation is influenced by the government, and private allocation of credit faces almost no restrictions. Government ownership of financial institutions is sizeable. Foreign financial institutions are subject to few restrictions.
- 80–Nominal government interference. Government ownership of financial institutions is a small share of overall sector assets. Financial institutions face almost no restrictions on their ability to offer financial services.

Table 6: Impact of Tax Policy on Bitcoin Premiums

Variables	I	II	III	IV
Tariff	0.8145			
	(1.44)			
Income Tax		-0.0146		
		(0.17)		
Corporate Tax			0.5313	
			(2.22)**	
Tax Burden				0.2554
				(2.43)**
Lagged Premium	0.5514	0.5713	0.5314	0.5319
	(6.93)***	(7.44)***	(8.48)***	(7.30)***
Percent Global Volume	-0.1303	-0.1181	-0.1332	-0.1039
	(2.03)**	(2.16)**	(2.09)**	(1.94)*
Trading Volume	1.3747	1.1859	1.3932	1.1984
	(2.76)***	(2.48)**	(2.79)***	(2.53)**
Market Maturity	-0.0311	-0.0328	-0.0384	-0.0407
	(0.44)	(0.58)	(0.65)	(0.75)
Currency Returns	-0.1643	-0.1467	-0.1736	-0.1680
	(1.54)	(1.36)	(1.51)	(1.48)
Stock Market Returns	0.0365	0.0392	0.0362	0.0564
	(0.87)	(0.88)	(0.87)	(1.29)
Constant	-12.1098	-8.0826	-23.0448	-16.0236
	(2.81)***	(1.37)	(3.03)***	(4.88)***
Chi-squared	105.86	103.02	138.05	138.65
No. of groups	22	22	22	22
No. of observations	342	342	342	342

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regressions use Arellano-Bover/Blundell-Bond dynamic panel data estimation.

Table 6 takes a deeper look into tax policies and component effects on premiums. Corporate tax rates and total tax burden are both significant at the 5 percent level, while tariffs are positively signed, but are not significant; income taxes are neutral with a coefficient indistinguishable from zero. The biggest marginal effect comes from corporate taxes, which indicate that a 10 percent increase in corporate tax rates increases premiums by 11.3 percent. A 10 percent increase in total tax burden increases premiums by 5.5 percent. These results are interesting in that they suggest personal income taxes do not seem to be relevant in the sample for contributing to premiums, while corporate taxes matter quite a bit. Table 5 showed that Trade Freedom had a negative coefficient and was significant at the 10 percent level, so since tariffs are not statistically significant on their own, it must be non-tariff trade barriers playing a contributing role.

6 Robustness of Results

There are several reasons to be skeptical of these results, most of which have to do with reservations about variable liquidity between markets. US dollar markets clearly drive Bitcoin trade, with tertiary markets experiencing significantly less volume throughout the sample. Even though liquidity measures were used as controls, it would make sense to verify that results are consistent when removing outliers. Additionally, the most extreme data comes from Argentina, but there are no formal Bitcoin markets in that country throughout this sample range due to capital controls and restrictions on foreign exchange trading; therefore, the data from Argentina comes from decentralized trading off of Localbitcoins.com, which is like a Craigslist for person-to-person trade. So in addition to the factors controlled and tested in this study, it is quite possible that there are other market frictions present in the Argentinian data that do not manifest in other countries with formal exchanges. For instance, using the H.10 official exchange rates may not be appropriate, since the typical Bitcoin investor in Argentina is likely subject to the informal exchange economy and has an effective exchange rate different from the official one.

Table 7: Robustness Test Excluding Immature Markets

Variables	I	II	III	IV	V
Economic Freedom	-0.3284				
	(2.44)**				
Inflation		0.2683			
		(0.80)			
Real Interest			0.6653		
			(3.21)***		
Tax Burden				0.1208	
				(1.01)	
Gov. Expenditure					0.1367
					(1.71)*
Lagged Premium	0.5636	0.6402	0.6572	0.6330	0.6200
	(8.65)***	(6.93)***	(6.72)***	(6.35)***	(7.55)***
Percent Global Volume	-0.0453	-0.0419	-0.0547	-0.0423	-0.0401
	(1.42)	(1.50)	(2.21)**	(1.69)*	(1.46)
Trading Volume	0.9444	0.9643	0.8172	0.8505	0.8456
	(1.37)	(1.52)	(1.53)	(1.40)	(1.33)
Market Maturity	-0.0087	0.0081	0.0037	0.0036	-0.0007
	(0.14)	(0.12)	(0.09)	(0.07)	(0.01)
Currency Returns	-0.1204	-0.0840	-0.1713	-0.1067	-0.1030
	(1.25)	(0.92)	(1.64)	(1.02)	(1.04)
Stock Market Returns	-0.0089	-0.0047	0.0018	0.0102	0.0098
	(0.17)	(0.08)	(0.03)	(0.18)	(0.17)
Constant	15.5105	-8.5489	-7.0414	-10.2617	-11.7420
	(1.23)	(1.40)	(1.44)	(1.52)	(2.66)***
Chi-squared	623.57	219.25	303.41	479.30	490.45
No. of groups	19	19	19	19	19
No. of observations	168	162	159	168	168

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regressions use Arellano-Bover/Blundell-Bond dynamic panel data estimation. Observations with less than the median of 10 month maturity were excluded.

The first robustness check excludes observations with markets less than the median maturity, which was 10 months in this sample. This removes the entire Argentinian market from the subsample since there are only 6 months worth of trading data. Given that Argentina accounted for the widest swing in premiums with an average premium of 43.4 percent, this is an important test to see if results hold after removing the most extreme values from the sample. Table 7 reports results from this test, which are remarkably similar to results in Table 4 for the full sample. Economic Freedom remains significant at the 5 percent level and has a marginal effect of a 7.5 percent reduction on premium with a 10 point improvement in the index value. Real interest rates are again positively signed and significant at the 1 percent level, and government expenditures as a percent of GDP are positively signed and significant at the 10 percent level. Inflation is positively signed, but not significant.

The next robustness check uses this limited sample that only contains observations for markets with more than 10 months of maturity, but for the the component indices. Table 8 presents the results, which are quite similar to the comparable tests for the full sample in Table 5. Every coefficient is negatively signed, which remains consistent in that improvements to openness and economic freedom reduce premiums. Property Rights, Business Freedom, and Financial Freedom are all significant at the 1 percent level, Investment Freedom significant at the 5 percent level, and Monetary Freedom and Trade Freedom significant at the 10 percent level. Comparing marginal effects we have a 10 point improvement in Financial Freedom decreasing premiums by 6.0 percent; this is actually a bigger change than the Table 4 result, which was 5.3 percent. These results confirm that the general findings of the study remain intact after removing extreme values from the sample.

Another cause for concern is whether these results hold for different choices of estimation technique. For a variety of reasons including country-specific effects that could lead to omitted variable biases, premium autocorrelations inducing the use of lagged dependent variables in the regressions and the associated issues with joint endogeneity of the explanatory variables, etc. the best estimation technique seems to be the dynamic panel approaches described in Section 3. However, it is reasonable to consider other techniques, such as GLS with either random effects and country clustering of standard errors, or fixed effects with robust standard error clustering. Table 9 shows the results of the different approaches and the choice of estimation technique does matter. All of the Economic Freedom coefficients remain negatively signed, but the resulting standard errors in each technique influence significance. Standard GLS with random effects produces significance at the 1 percent level, GLS with random effects and country clustering of standard errors produces significance at the 10 percent level, and a fixed effects GLS does not produce significant results.

Table 8: Robustness Test for Component Indices Excluding Immature Markets

Variables	I	II	III	IV	V	VI
Property Rights	-0.1729					
	(3.15)***					
Business Freedom		-0.2207				
		(2.68)***				
Monetary Freedom			-0.4083			
			(1.80)*			
Trade Freedom				-0.6668		
				(1.72)*		
Investment Freedom					-0.2524	
					(2.55)**	
Financial Freedom						-0.2346
						(2.67)***
Lagged Premium	0.5900	0.6121	0.6134	0.5579	0.5737	0.6096
	(7.55)***	(6.73)***	(8.24)***	(6.96)***	(7.77)***	(7.43)***
Percent Global Volume	-0.0496	-0.0488	-0.0439	-0.0420	-0.0330	-0.0514
	(1.62)	(1.69)*	(1.55)	(1.46)	(1.13)	(1.24)
Trading Volume	0.9323	0.7814	0.9122	0.9490	0.9441	0.7827
	(1.31)	(1.18)	(1.37)	(1.32)	(1.25)	(1.52)
Market Maturity	-0.0253	-0.0016	0.0467	0.0207	-0.0610	-0.0135
	(0.45)	(0.03)	(0.63)	(0.36)	(1.01)	(0.21)
Currency Returns	-0.0909	-0.1245	-0.0744	-0.1127	-0.1114	-0.1105
	(0.99)	(1.27)	(0.79)	(1.21)	(1.21)	(1.16)
Stock Market Returns	-0.0140	0.0003	-0.0030	-0.0024	-0.0179	-0.0210
	(0.27)	(0.01)	(0.05)	(0.05)	(0.33)	(0.40)
Constant	4.5854	11.4307	23.4883	47.4274	10.7486	9.4994
	(0.74)	(1.47)	(1.33)	(1.49)	(1.24)	(1.36)
Chi-squared	752.08	345.31	877.05	383.70	3,405.92	518.87
No. of groups	19	19	19	19	19	19
No. of observations	168	168	168	168	168	168

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regressions use Arellano-Bover/Blundell-Bond dynamic panel data estimation. Observations with less than the median of 10 month maturity were excluded.

Table 9: Robustness Check for Choice of Estimation Technique

Variables	I	II	III
Economic Freedom	-0.2959	-0.2959	-0.7885
	(5.18)***	(1.71)*	(1.38)
Laggged Premium	0.5670	0.5670	0.2740
	(12.56)***	(15.02)***	(2.24)**
Percent Global Volume	-0.0651	-0.0651	-0.0777
	(1.78)*	(1.29)	(1.16)
Trading Volume	0.7580	0.7580	1.7028
	(2.88)***	(1.42)	(2.58)**
Market Maturity	-0.0781	-0.0781	-0.1042
	(1.78)*	(2.26)**	(1.84)*
Currency Returns	-0.0879	-0.0879	-0.0962
	(0.82)	(1.37)	(1.56)
Stock Market Returns	-0.0078	-0.0078	-0.0030
	(0.14)	(0.17)	(0.09)
Constant	15.7554	15.7554	43.0055
	(3.40)***	(1.11)	(1.02)
Test statistic	273.4048	762.4338	3.6768
No. of groups	22	22	22
No. of observations	323	323	323

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regression I uses GLS random effects estimator, Regression II adds clustering standard errors by market, and Regression III uses fixed effects and robust standard errors.

Table 10: Robustness Check Using Fixed Effects on Component Indices

Variables	I	II	III	IV	V
Property Rights	-0.0813				
	(0.22)				
Business Freedom		-0.1802			
		(0.97)			
Monetary Freedom			0.3210		
			(1.45)		
Trade Freedom				0.0731	
				(0.36)	
Investment Freedom					-0.4314
					(3.84)***
Lagged Premium	0.2761	0.2725	0.2711	0.2760	0.2741
	(2.26)**	(2.22)**	(2.24)**	(2.26)**	(2.27)**
Percent Global Volume	-0.0851	-0.0883	-0.0891	-0.0857	-0.0719
	(1.25)	(1.28)	(1.30)	(1.26)	(1.22)
Trading Volume	1.8329	1.8247	1.9298	1.8419	1.7190
	(2.82)**	(2.76)**	(2.95)***	(2.81)**	(2.87)***
Market Maturity	-0.1240	-0.1245	-0.1434	-0.1219	-0.1319
	(2.37)**	(2.20)**	(2.29)**	(2.00)*	(2.53)**
Currency Returns	-0.0925	-0.1023	-0.1140	-0.0962	-0.1102
	(1.47)	(1.63)	(1.67)	(1.60)	(1.70)
Stock Market Returns	-0.0069	-0.0035	-0.0043	-0.0068	-0.0074
	(0.20)	(0.11)	(0.13)	(0.20)	(0.21)
Constant	-7.3443	1.5684	-38.2098	-19.0940	17.8600
	(0.29)	(0.10)	(2.14)**	(0.93)	(1.85)*
F statistic	2.3507	2.4045	2.3657	5.5841	4.8078
No. of groups	22	22	22	22	22
No. of observations	323	323	323	323	323

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Regressions use GLS with fixed effects estimation and robust standard errors to treat heterogeneity.
Dropped Financial Freedom due to insufficient variation to overcome collinearity issues with fixed effects.

Table 10 takes these tests further by looking at the constituent indices using the next best alternative estimation technique, fixed effects GLS with robust standard errors. Here we see that only Investment Freedom is significant at the 1 percent level and again negatively signed. This seems to be the most important component of economic freedom with respect to Bitcoin premiums under this estimation technique, which is generally consistent with the dynamic panel approach. Investment Freedom is the component that includes foreign exchange controls and capital controls, so it is important to note that its significance and economic interpretation remains robust regardless of the estimation technique.

7 Conclusion

This study contributes to the growing literature on Bitcoin in that it is the first to investigate the premium structure of prices across countries. The goal is to analyze Bitcoin as a possible disaster asset that investors can use to diversify across jurisdictions with minimal transaction costs. First, I establish that significant and persistent differences in Bitcoin prices do exist across the world. Standard finance theory would suggest inter-market price differences exist because of microstructure characteristics like trading volume and bid-ask spreads. These factors do explain part of the price differences, but there is a missing piece to the puzzle that seems to be explained by proxies to a variety of economic freedom measures that cause large enough frictions to limit arbitrage. The composite Economic Freedom Index seems to play an important role in prices investors are willing to pay for the same asset in different countries; this is at least true for Bitcoin, and would be interesting to investigate for other assets, like gold. Another interesting question comes from the results regressing premiums on real interest rates; are investors willing to pay more for potential disaster assets in countries with higher real interest rates, or time preferences? If so, are there social technology, or cultural factors underlying this connection?

Taxes also seem to play an important role in pricing of potential disaster assets. Bitcoin markets are likely still too small to make a convincing case that agents consider it a channel to avoid taxation, but there does exist an interesting link between high corporate tax rates, total tax burden, and premiums over global prices investors are willing to pay. There is, perhaps not surprisingly, a negative relationship between economic freedom and tax burden. Taken together, this could suggest that investors are using Bitcoin as a mechanism of escaping broader repression, of which excessive taxation is a component.

The disaster asset story holds for the full sample, but extreme differences in trading volume across countries raise an element of skepticism to the results. Robustness checks verify consistency when some of these extremities are removed by limiting observations to the median market maturity level. This effectively removes the most extreme market, Argentina, from the sample, which also has possible friction issues associated with there

being no formal exchanges in the country during the sample time range.

I start with a connection to the economic growth literature, which has shown that social technologies, like governance, culture, property rights, and other aspects of economic freedom, play a role in long run welfare. From there I extend these insights into pricing by carving out a role for disaster assets. I find evidence for the possible existence of cross-country effects related to governance that persistently limit arbitrage, induce systematic risk, and hence manifest into the pricing kernel. A benefit of using Bitcoin as an instrument to measure this effect is that it is a new asset class with volume likely insufficient throughout this sample period to provide enough incentive for arbitrageurs to overcome government-induced market frictions. This gives us a pure view of the effects of those frictions before the market can develop sufficiently to overcome them, if it ever proves profitable to do so.

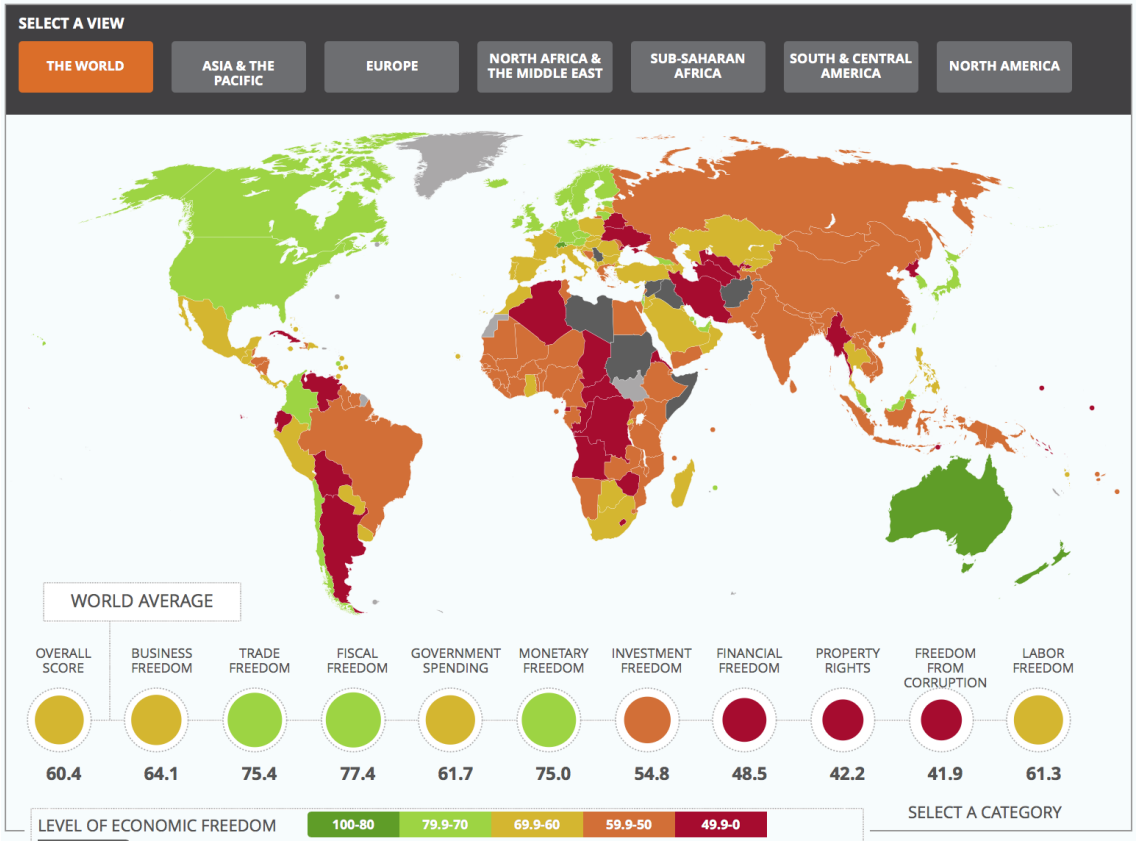

Figure 1: Visual overlay of the Economic Freedom Index around the world.

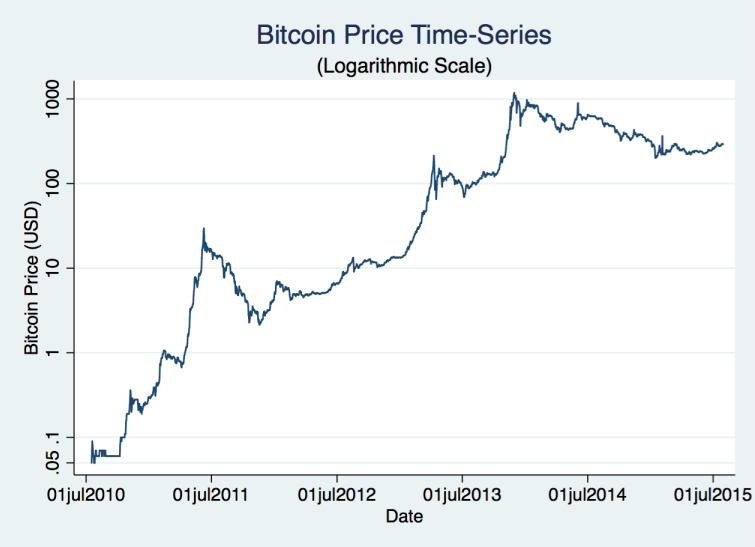

Figure 2: Bitcoin Price Time-Series in log scale.

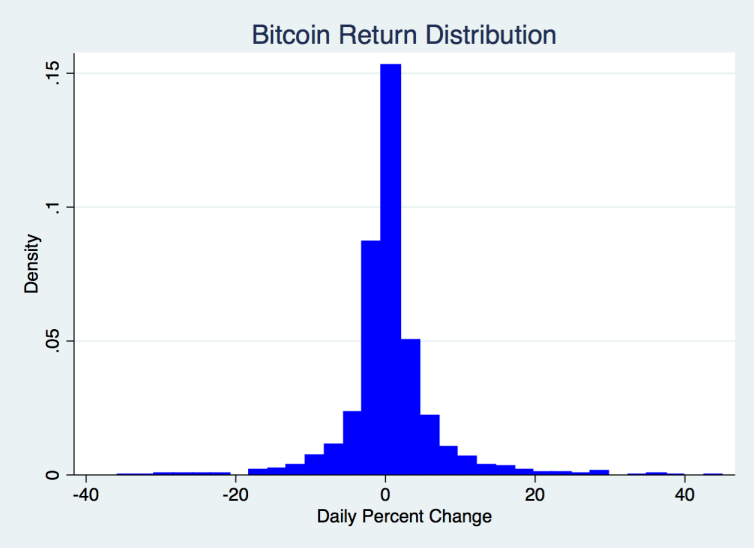

Figure 3: Distribution of Daily Bitcoin Returns.

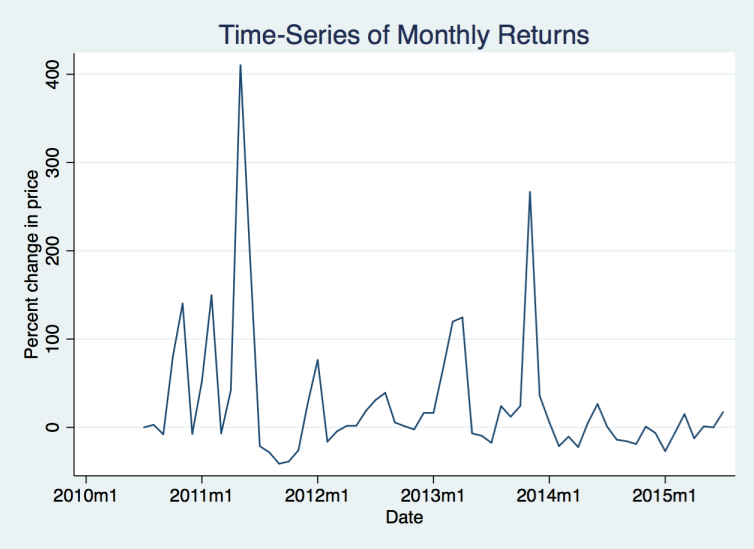

Figure 4: Bitcoin monthly return time-series.

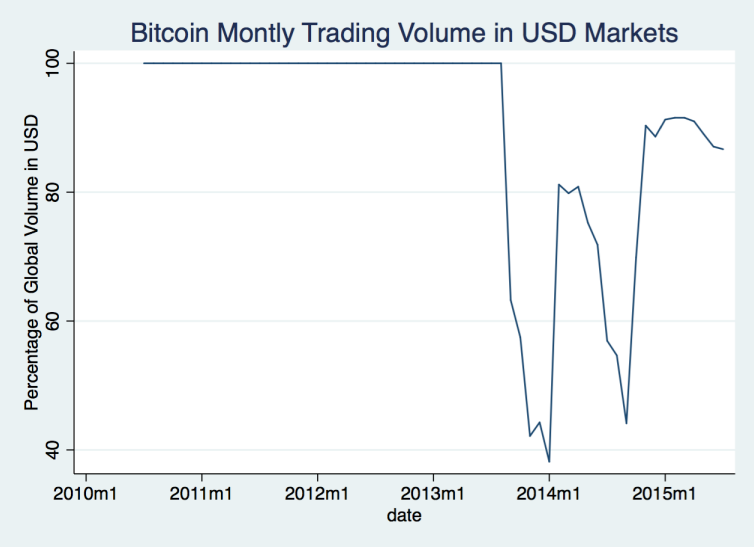

Figure 5: Percent of global trading volume in US marketes.

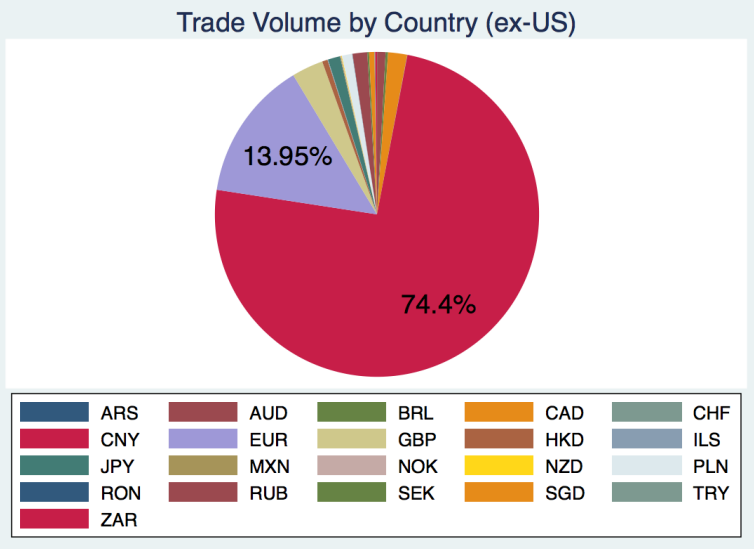

Figure 6: Volume in foreign currency markets.

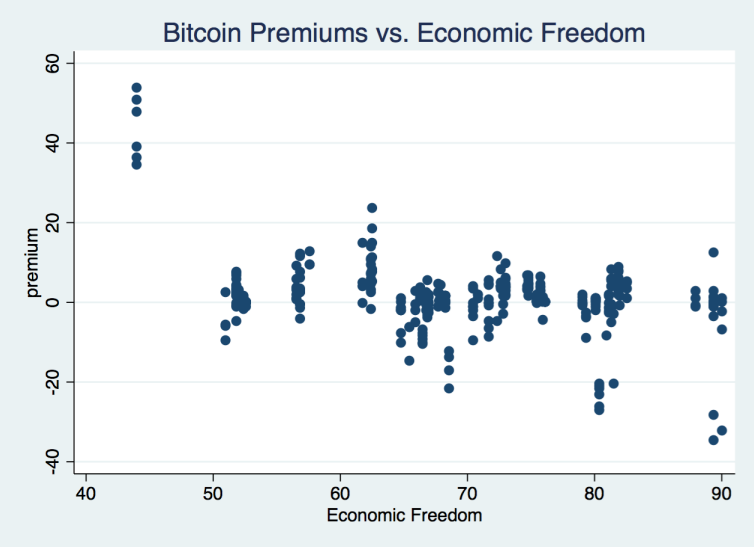

Figure 7: Bitcoin premiums versus Economic Freedom Index values.

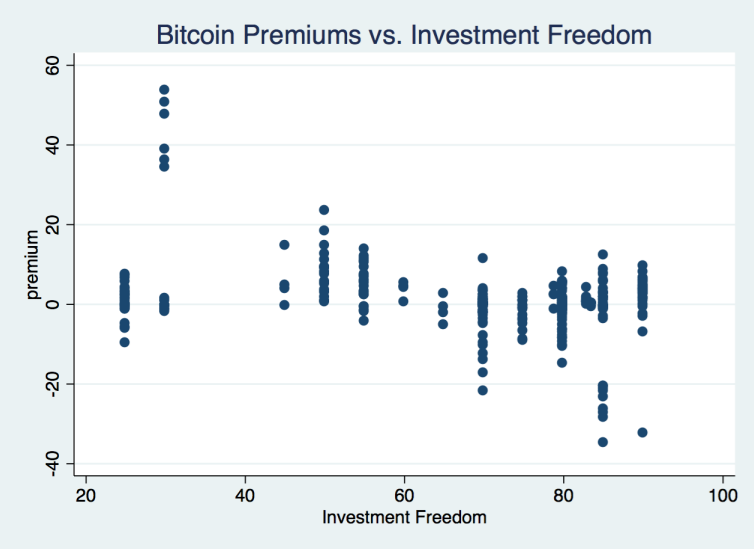

Figure 8: Bitcoin premiums versus Investment Freedom Index values.

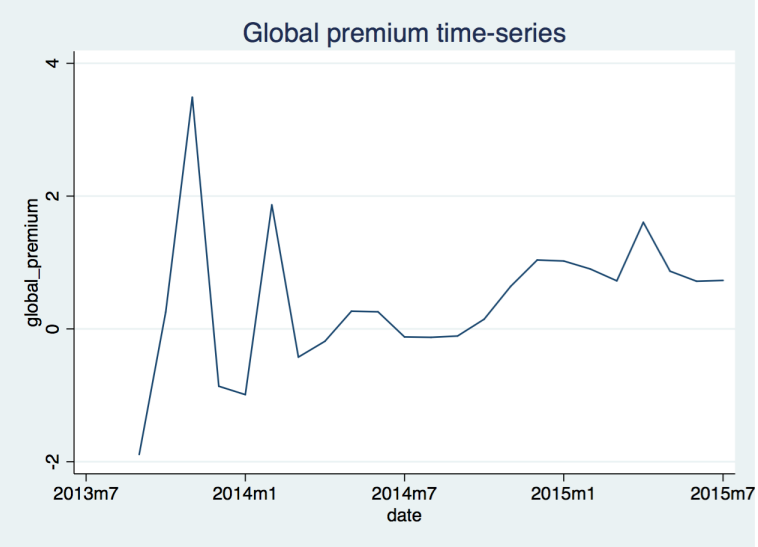

Figure 9: Difference in average price ex-US and average global price.

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