Phillip An
ECN-338
Game Theory Paper
12.08.17

The Game Theory Approach Towards Cryptocurrency Regulation by Governments

The idea of cryptocurrency was introduced in 2008 by Satoshi Nakamoto, who proposed a decentralized peer-to-peer electronic cash system— Bitcoin [1]. The ambition behind the project was to decrease transaction costs by eliminating third-party mediators that overlook our financial transactions today. To do so, Nakamoto highlighted the concept of proof, mechanisms that allow two parties to engage in direct transactions without a trusted third-party, such as banks. Today, the concept of proof has been successfully implemented in blockchain technology, in which transactions can be verified via digital signatures (keys), timestamps, and encryptions. The specific mechanisms behind an operational blockchain is beyond the scope of this paper. Its benefits, however, are promising. First, the blockchain is immutable: once a transaction occurs, it is permanently recorded. Although there are theoretical methods to change the history of the blockchain, such as the 51% attack [2], the magnitude of computational power required infers that the capability to do so is near nonexistent. Second, the blockchain can facilitate the transfer of information— not just digitized forms of wealth. This characteristic of the blockchain carries significant implications, and can change the way we interact with data in our everyday lives. For example, if you're selling your car, a smart-contract (lines of code that function on the blockchain) may describe a transaction in which once you and the buyer agree on a price, you receive payment and the buyer receives ownership of the car— both of which are encoded into data as cryptocurrency.

Unfortunately, like any other technology in its early stages, the blockchain and cryptocurrency have been under great scrutiny. Given a level of anonymity in blockchain transactions, the rise of Bitcoin has been associated with black-market/dark-web purchases [3] and money laundering practices [4]. Furthermore, there have been multiple hacks that have taken advantage of experimental applications of third-party wallets and insecure programming that have stolen millions of USD [5] [6] [7]. On top of that, the cryptocurrency market is known for its volatility, and multiple governments have warned their citizens away from investing [8], sometimes going as far as to shutting down and banning exchanges [9]. In contrast, some governments have welcomed the rise of this new technology [10], foreseeing a future in which blockchain technology and cryptocurrency shape our everyday interactions.

In this paper, I would like to explore the interactions between governments in regulating cryptocurrency. To simplify things, I will consider a two-player, simultaneous game. Both players will represent a government, and each player will have three strategies: ban cryptocurrency investments/exchanges (B), allow cryptocurrency investments/exchanges (A), or regulate them with caution (R). These strategies are used by national governments today, with a representative of each strategy being China [9], Switzerland [11], and the United States [11], respectively.

In designing the payoff matrix, there are a few assumptions I've made. The first assumption is that the cryptocurrency market has evolved beyond its "baby-phase", in which popularity was maintained by its functional value in the aforementioned illegal activities [3] [4]. This suggests that alternative uses of cryptocurrencies have been recognized and are currently being experimented. Thus, allowing cryptocurrency platforms to exist will boost the economy without any major drawbacks. Second, the cryptocurrency market is volatile. Although this is already a commonly held belief in the media [12], I wish to make the claim that by allowing cryptocurrency trading and investing, market volatility will decrease as the

number of market participants increase. Third, as we have assumed that cryptocurrency possesses technological functionality and can boost the economy through applications on the blockchain, banning cryptocurrency will negatively affect a country's economy by increasing opportunity cost, preventing private entities from: conducting research, developing utilizable applications, and inhibiting technological progress. Given these assumptions, the payoff matrix between two governments can be deduced:

	B	A	R
B	0 , 0	-2 , 3	-1 , 1
A	3 , -2	5 , 5 *	4 , 3
R	1 , -1	3 , 4	2 , 2

* = NE

Payoffs within the simultaneous two-player game have been quantified under the assumptions listed above. To justify the payoffs, we will assume that the market for cryptocurrency has existed prior to the government's decision. Under (B, B), cryptocurrency is banned and any existing markets/exchanges have disappeared. Although those who may have possessed cryptocurrency may experience some loss due to the market's disappearance, I will assume that these individual losses are negligible on a nationwide scale, giving a payoff of (0, 0) (realistically, said individuals can join operational exchanges in different countries and continue trading). Under (A, A), R&D into cryptocurrency take place, useful applications are made, and the number of market participants increase in reaction to the governments' decisions— reducing market volatility and giving a payoff of (5, 5). By allowing

cryptocurrency, there may be a rise of illegal activities that negatively affects players' utilities. However, the government can eliminate such concerns by actively participating in the market, monitoring any suspicious utilizations. Under (R, R), R&D is controlled and supervised. This strategy profile limits the influence of private entities and slows down technological progress. Additionally, as the public is aware of the government's cautionary stance against cryptocurrency, there would not be as big of an increase in market participants as the increase experienced under (A, A), and the market will be comparatively more volatile. These factors lead to a payoff of (2, 2). Under (B, A), player 1 loses out on technological progress, leading to a payoff of (-2, 3). Player 2 still receives positive utility, but not as much due to the inability to share information and cooperate with player 1 in R&D. Additionally, there is no influx of market participants from player 1's country, making the market more volatile than under (A, A). Under (B, R), player 1 is not as behind in technological progress as player 2 is proceeding with caution, giving a payoff of (-1, 1). Under (A, R), both players gain utility in a payoff of (4, 3), neither player receives as much as they would under (A, A) as R&D cooperation is more limited and the influx of market participants is slightly lower. As the game is symmetric, payoffs (A, B) (R, B), (R, A) are deduced with the same justifications.

Best responses for both players are underlined in the payoff matrix. We can see that (A) is the dominant strategy for both players, leading to a Nash Equilibrium strategy profile of (A, A) and a respective outcome of (5, 5). However, this outcome is inconsistent with what we see in real life today, as most governments are choosing to proceed with caution [11]. This is most likely caused by a difference in perception. The assumptions listed above and the payoff matrix agree with how I personally view and value cryptocurrency. From the perspective of real governments, the perceived risk attributed with cryptocurrency may be much greater. However, even with consideration of the risk involved, I believe governments

will be receiving a net benefit by allowing cryptocurrency and have deduced the outcomes accordingly.

In continuation of agreeing to the assumptions listed above, it is implied that governments have yet to fully realize the technological capabilities and functionalities of cryptocurrency. I do not believe this is a far-fetched implication, given that the utility of cryptocurrency is still continuing to be discussed— some governments going as far as indicating an interest in creating one of their own [13] [14]. In the near future, we may see policies slowly shifting from tight regulations (R) to a more free-market approach (A), as governments inch closer towards the Pareto optimal outcome (5, 5) under the NE strategy profile. As a crypto-enthusiast, I am excited to see such a transition occur, and will continue to wonder how the world around us may change until such a time comes.

References:

[1] Nakamoto, S. (2008). Bitcoin: a peer-to-peer electronic cash system. Retrieved from https://bitcoin.org/bitcoin.pdf

[2] Cawrey, D. (2014, June 20). Are 51% attacks a real threat to bitcoin? *Coindesk*. Retrieved from https://www.coindesk.com/51-attacks-real-threat-bitcoin/

[3] Finch, J. (2017, September 14). From silk road to atms: the history of bitcoin. *The Guardian*. Retrieved from https://www.theguardian.com/technology/2017/sep/13/from-silk-road-to-atms-the-history-of-bitcoin

[4] Buntinx, J.P. (2017, December 01). ICE agent claims bitcoin becomes more popular for money laundering purposes. *Live Bitcoin News*. Retrieved from http://www.livebitcoinnews.com/ice-agent-claims-bitcoin-becomes-popular-money-laundering-purposes/

[5] McMillan, R. (2014, March 03). The inside story of Mt. Gox, bitcoin's $460 million disaster. *Wired*. https://www.wired.com/2014/03/bitcoin-exchange/

[6] Siegel, D. (2016, June 25). Understanding the DAO attack. *Coindesk*. Retrieved from https://www.coindesk.com/understanding-dao-hack-journalists/

[7] Peterson, B. (2017, November 07). Someone deleted some code in a popular cryptocurrency wallet- and as much as $280 million in ether is locked up. *Business Insider*. Retrieved from http://www.businessinsider.com/ethereum-parity-wallet-hack-freeze-missing-code-2017-11

[8] Helmore, E. (2017, October 08). Warnings grow louder over cryptocurrency as valuations soar. *The Guardian*. Retrieved from https://www.theguardian.com/technology/2017/oct/08/cryptocurrencies-bitcoin-ethereum-bubble

[9] Rapoza, K. (2017, November 02). Cryptocurrency exchanges officially dead in china. *Forbes*. Retrieved from https://www.forbes.com/sites/kenrapoza/2017/11/02/cryptocurrency-exchanges-officially-dead-in-china/#699f94c52a83
[10] Sedgwick, K. (2017, November 28). After Japan and South Korea- these countries are primed for bitcoin mania. *Bitcoin*. Retrieved from https://news.bitcoin.com/after-japan-and-south-korea-these-countries-are-primed-for-bitcoin-mania/
[11] Medina, D. (2017, December 03). How governments are reacting to ICOs. *Coindesk*. Retrieved from https://www.coindesk.com/governments-reacting-icos/
[12] Sillars, J. (2017, November 30). Bitcoin volatile as the cryptocurrency's value falls 20% in 24 hours. *Sky News*. Retrieved from https://news.sky.com/story/bitcoin-volatile-as-the-cryptocurrencys-value-falls-20-in-24-hours-11150402
[13] Galeon, D. (2017, October 16). Vladimir Putin: Russia will issue its own cryptocurrency. *Futurism*. Retrieved from https://futurism.com/vladimir-putin-russia-will-issue-its-own-cryptocurrency/
[14] Chappell, B. (2017, December 04). Venezuela will create new 'Petro' cryptocurrency, president Maduro says. *National Public Radio*. Retrieved from https://www.npr.org/sections/thetwo-way/2017/12/04/568299704/venezuela-will-create-new-petro-cryptocurrency-president-maduro-says