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The Free Education Project: Higher Education Funding, E^2 Implementation, and Crowdsourcing Crypto Development

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EXCUTIVE SUMMARY
This short paper, written in three different sections, explores how a cryptocurrency's issuance and network effects could fund higher education. Synthesizing research from the Bronx Community College Cryptocurrency Research Lab, Bernard Lietaer's notion of creating money for the needs of society, lessons learned by Galia Benartzi and the Hearts Project, and an exploration of how communities coalesce around open-source cryptocurrency projects, the authors provide an overview of the problem of funding higher education, the ways in which money that is needed could be created, and the key components to building a highly effective developer community. These three distinct yet vitally interconnected facets lay the groundwork for the Free Education Project. Lastly, based on the models herein, this paper calls for academics, entrepreneurs, and financial professionals to work together in ways that facilitate and generate the needed capital, built outside of taxation, to fund the noble purposes of education writ large.

Keywords: crowdsourcing; cryptocurrency; higher education funding; masternodes; open source projects; staking coins.

AN ODE TO ANNA - AND ANNAS IN THE BRONX AND BEYOND

> *Finding a job is hard, and I need the right kind of training and support. Also, I need help paying for these resources, and I have a young son and family obligations. I don't always know where the money comes from.*

Anna[1], Class of 2020

The quote above describes the struggles faced by a single individual, 21 year-old aspiring teacher Anna. Yet, based on our experience, it could just as easily have come from any of the vast majority of students that we have taught at the Bronx Community College over our careers. Anna, like many others, is a student who is full of ambition and a desire for success, yet, due to both familial and financial concerns, as well as underprepation in secondary school, may have fewer than expected career opportunities in spite of her college attendance, perhaps relegating her to a career of underpaying jobs. This is not only an urban problem. Beyond the Bronx, students across the nation and around the world who are attempting to transition into careers that provide both vocational fulfillment and financial stability are challenged by the cost of receiving the requisite training and education.

Academics who study the factors that are currently limiting Anna's career trajectory call this phenomenon 'social reproduction.' That is, based on a number of economic, familial, and social factors, Anna is unlikely to overcome her circumstances and so will likely remain in her current economic and social 'roles.' Often, academic articulations of Anna's concerns within the field of education, including in many of the social sciences, can range from deterministic to disappointing. Most importantly, they evince a widespread lack of concrete, actionable solutions to the types of problems that Anna faces.

Broadly speaking, people, and particularly students, aspire to a better version of themselves and of the world. One feature of a better world is the recognition that education is a primary, fundamental human right. That is, students should have the right to the choice, the resources, and all available opportunities to equip themselves for their careers.

Higher education provides an indispensible space not only for intellectual growth but also for launching careers. Yet, and this is the problem, the costs of higher education have become so exorbitant that they are beginning to exclude students. Over the last thirty years, the cost of higher education has so profoundly increased compared to other market goods that it could be considered to be experiencing a type of hyperinflation. These ballooning costs have prompted students to take monumental educational loans, which may ignite a loan crisis in higher education and may have already financially impaired many graduates in their early career stages. Moreover, if higher education is not already amid what may be legitimately characterized as a funding crisis, then it inevitably will be. Particularly, there is a great concern about the sustainability of higher education's funding because of its dependence on tax dollars and expansive student debt.

Christensen, Horn, Caldera, and Soares (2011) argued that college and university education will be greatly transformed by technological change, potentially bringing a more affordable type of education to most Americans. According to their work, the nearly threefold escalation in fewer than 20 years of the average price of college tuition not only signals an unsustainable cost trajectory but also indicates that the academy is ripe for technological

[1] pseudonym

disruption. Christensen, with various co-authors, has repeatedly contended that colleges and universities will encounter such severe technological disruption that many will face bankruptcy and closure. Admittedly, the accuracy of Christensen's predictions that half of traditional colleges or universities would meet this fate within two decades, primarily due to online education, remains unclear.

Yet what can be seen with some clarity is that too few solutions are being offered to eliminate, or at least reduce, the exploding educational costs that are either excluding large numbers of students from higher education or, if they do attend, saddling them with debt far into middle age. Scholars, even prominent intellectuals such as Christensen, have not appeared to articulate a practical solution, and in certain ways, do not seem to have fully considered it. Many academics seem to write as if articulating a problem mirrors proposing a solution. Sadly, neither solely identifying the problem nor relying on existing frameworks offers a workable solution. The primary discourse in educational funding scholarship centers on how to stretch fewer federal and state dollars into a substantive educational experience, and calls and proposals for free universal higher education are countered with the question of how to afford such proposals.

The desire for free higher education is not new; however, up until this point, politicization of philanthropy and the limitations of traditional fiat returns have constrained economists and scholars from even envisioning such a goal. If such ideas were articulated, they were simply dismissed as utopian. In other words, historically, the funding of education has been strictly tied to taxation or other forms of funding such as philanthropy. It has been fully reliant on an outside forces, including parental support. As a whole, education funding has been, seemingly at all times, contingent on a precarious confluence of economic, governmental, philanthropic, and political circumstances.

In light of an ongoing and worsening student loan crisis, persistent funding cuts, and other economic pressures, it is time to seek new approaches to the complexities of financing higher education. Since few academics and fewer policy makers have proposed full-fledged solutions to social reproduction in education, we articulate one here. The E^2 implementation discussed in this paper has the goal of generating the money necessary to support the educations of the Annas of the world: in the Bronx; in Boise; in Brooklyn; and, with a crowdsourced effort and some luck, in Bangladesh and in Belarus.

This paper, in the spirit of Bernard Lietaer's idea of value creation and the pioneering research conducted by Galia Benartzi and the Hearts Project, centers on creating money to fund education, writ large, without borders. In the following sections, the authors offer a prototype solution, framing an initial model to fund higher education in ways that operate outside of current approaches.

PART I: CAN TECHNOLOGICAL INNOVATION FUND HIGHER EDUCATION?

Can you imagine a world where all students are granted access to a fully-funded, free college education? Before the advent of cryptocurrency, there were few financial

instruments, or asset classes, that possessed the technical complexity and wealth-generating capabilities to attempt to enact such a meaningful mission.

Towards a New Funding Model

Over the past few years, Bronx Community College's Cryptocurrency Research Collaborative (BCC's Crypto Collaborative) has been researching the issue of wealth generation, and, more precisely, how to deploy newly created wealth for the purposes of higher education and science research. Lehner, Hunzeker, and Ziegler (2017), Lehner and Ziegler (2018), and Lehner, Ziegler, and Carter (2019), in various iterations of BCC's Crypto Collaborative 's scholarly work, have proposed how cryptocurrency could fund higher education based on a dividend reinvestment approach predicated on Proof-of-Stake (PoS) mining. Yet these models were time-bound in their wealth-generation opportunities, and despite operating cryptocurrency nodes yielding compounding interest, if an exit strategy to migrate to safe-haven assets had not been articulated and implemented prior to the December 2017 Bitcoin (BTC) price escalation, the substantial amount of wealth that was generated between 2016 and late October 2017could have been destroyed. Even with a research group populated by members with significant Wall Street and institutional financial research experience, the wealth-generation opportunities were limited, and a crypto-to-USD rebalancing framework needed to be deployed in order to capture wealth.

However, in spite of market conditions, significant wealth was indeed generated from the research group's early models. In retrospect, it is likely that the most salient lesson from our early prototypes is that PoS-mining-based wealth-generation opportunities are subject to extreme volatility. Because of these extreme fluctuations in market prices, more nuanced models were developed and deployed, and these methods are fully rooted in crypto-to-USD frameworks. This is a particularly noteworthy and somewhat paradoxical issue since most in the 'crypto world' view BTC, and other crypto assets, as a safe haven asset against USD, and not the inverse. However, in practice, at least up until this point, USD is the safe-haven asset, although it is not altogether clear how long this will remain the case. While articulating this point may be redundant, part of the work in front of BCC's Crypto Collaborative will be to more fully research models that capture the wealth-generating aspects of cryptocurrency while mediating its volatility with safer assets.

Background on E^2

E^2 is an implementation of a blockchain project that was abandoned by its original, anonymous development team in late 2018 but continues to function based on the resources of network participants. The E^2 implementation, as we will call it from here on, was not hacked, nor was its codebase comprised; rather, the protocol was 'broken' by the exchanges that allow an enormous about of wash trading. This wash trading eventually created a lack of synchrony between the actual blockchain and the exchanges' databases. The developers of Exclusive Coin, on which the E^2 implementation is based, ultimately decided to fork away from what is now E^2. This decision, which was seemingly based on the developers' desire to not lose any additional value and on wanting to avoid the risk of a full delisting, eventually led to a new genesis block for E^2 in late spring 2019. The E^2 implementation is not currently listed on any exchange. Its network participants are now actively crowdsourcing its beta, beta/alpha stages of development.

Developing Second-Generation Models

Over the last four years, with submitted publications and focused research groups dating back to 2015, BCC's Crypto Collaborative , headed by Edward Lehner, has centered its efforts on investigating ways that cryptocurrency could fund higher education. With recent partnerships with Louis Carter's Best Practice Institute and a development partnership with Ovidiu Purice's ProLedo, BCC's Crypto Collaborative assembled a type of lean start-up for FreeEd.io's Free Education Project.

This paper outlines a framework for funding education at Bronx Community College, part of the City University of New York, using the E^2 implementation's block rewards and network effects. Focused on an understanding of Metcalf's and Reed's laws, this work frames the financial methodology, rooted in network effect, for generating wealth via a highly engaged developer community. Additionally, as noted above, this model needs to continually rebalance its holdings between crypto-to-USD because of the volatility of the underlying asset. The model presented here assembles three distinct parts: 1) shared block rewards in order to fund education 2) maintaining a robust codebase for the technical stability of the coin, and 3) valuation metrics and rebalancing techniques to capture the wealth of the model.

This work and, moreover, its E^2 implementation acknowledge the central concerns in higher education funding and vividly and purposefully demonstrate a new model. Yet, as an implementation cohering to a consensus mechanism with a protocol launched by anonymous developers, the E^2 implementation goes beyond a simple conceptual framework for funding education. It is also a live and 'in the wild' project that currently yields block rewards in real time with the potential to be used as a form of money.

Central among the reasons that we have chosen the E^2 implementation is that, as an anonymously launched and now live cryptocurrency with costs shared by network participants, E^2 does not conform to the framework of the Security and Exchange Commission's (SEC) Howie Test, and therefore likely cannot be considered a security. That being said, at least from an Austrian-school economic perspective, cryptocurrency will likely compete as money in that it may more fully retain its value compared to USD and other currencies by fiat. It should be acknowledged that the hard money features of many cryptocurrencies may eventually lead to more oversight from bodies such as the SEC, yet such considerations exceed the scope of this paper.

PART II: MINING THE MONEY THAT IS NEEDED

A question central to our goal of funding higher education is whether a PoS network can create 'hard money.' Here, we define hard money as a unit of account that maintains or increases in value relative to other units of account. Historically, gold has proven to be the world's premier hard money, as its purchasing power has remained relatively unchanged over hundreds, even thousands of years. A quality men's suit, for instance, has always been available at a cost of about one ounce of gold. As gold relates to cryptocurrency, Ammous

(2018) outlines the hard money qualities of BTC, comparing its value proposition to that of a digital version of gold.

The discussion of money creation often sets off alarms because it is thought to infringe upon the sovereign right of the nation state to oversee its own currency. However, money should not be seen simply as an instrument that is solely tied to governments. In fact - as clearly illustrated by extreme examples from the Weimar Republic, to Zimbabwe, and now Venezuela - while a government can require that its official currency be used for all transactions, the market itself in fact ultimately decides what real money is. Herein lies the pivotal attraction of many cryptocurrencies: they have the potential to be a superior type of hard money.

As a form of money by consensus, a cryptocurrency's protocol can potentially set the rules for its issuance such that the currency functions as a harder form of money than anything previously in existence. BTC serves as the perfect example of this. In addition to being fungible, censorship-resistant, and effectively impossible to counterfeit, BTC has a fixed maximum supply as agreed upon by consensus. On top of that, as demonstrated by Ammous (2018), BTC has a gradually increasing stock-to-flow ratio as its inflation rate decreases over time. In May 2020, BTC's inflation rate will roughly equal that of gold, the global standard for 'hard money.' In 2024, the rate will decrease again to half that of gold.

BTC's properties of hard money make it a good candidate for wealth-generation when compared to fiat currencies. The monetary policy that determines the issuance of every major fiat currency is, in fact, very much at odds with the notion of hard money. The US dollar, as an example, has lost 96% of its purchasing power since the Federal Reserve began printing money in 1913. It is becoming increasingly apparent that quantitative easing, once a temporary measure employed by central banks in times of crisis, has now emerged as the permanent default state of affairs. This does not bode well for the long-term value of fiat currencies relative to other, harder forms of money.

Cryptocurrencies, with their monetary policies *agreed upon* by consensus (rather than *declared* by fiat), offer a release valve that is likely to be used with more frequency in the years to come. The monetary policy of the E^2 implementation makes it, like BTC, a harder form of money than competing fiat currencies. While the inflation rate of E^2 currently exceeds that of most fiat currencies, E^2's inflation rate is set, like BTC's, to gradually decrease, with the block rewards cutting in half by the summer of 2020. Currently, E^2 has roughly nearly 6 million coins in circulation and when the last block reward is mined in over one hundred years, 35 million will be the total supply.

The value of a currency is, of course, determined by more than just its inflation rate. A currency is only as valuable as the network that it can be used in. Here, we consider the notion of value creation as developed by Bernard Lietaer with various co-authors. Lietaer and Dunne (2013) point out that there have always been a wide variety of innovative currencies (i.e., currencies not declared by fiat) in use by communities around the world. Such currencies, which often work in tandem with fiat currencies, can, in addition to the usual functions of a currency such as stimulating local trade, also provide value by, for

example, acknowledging skills not recognized by the dominant market system, reinforcing social ties and community cohesion, and enhancing democratic control of trade.

Galia Benartzi, in her 'Heart Market' pilot project conducted in Israel in 2015 as part of research leading up to the launching of the Bancor network, demonstrated on a small scale the ability of a cryptocurrency to perform exactly the functions described by Lietaer. The project consisted of approximately 20,000 mothers who were issued digital tokens called "hearts" to use as payment to one another for services like babysitting, school pickups, and cooking. Benartzi (2018) shows that within a year, USD 24 million worth of commerce was conducted in just one small community. This commerce can be considered an addition to the GDP of Israel, seemingly created out of thin air.

The work of Lietaer as demonstrated by Benartzi proves that a cryptocurrency, merely by providing a means of exchange in a given community (network), can create value in that community. The E^2 implementation, we suggest, can do the same for a network of stakeholders in the 'community' that is higher education.

This project envisions that E^2, in time, will be as fully liquid as a global money; yet such claims are at this stage simply that: claims. In the process of research centered on this project, the team will be able to more fully vet whether E^2 can function as a money and whether it can embody any of the properties ascribed to money.

Mining New Money to Fund Education

Central to the E^2 implementation is the investment of PoS cryptocurrencies to yield dividends. This is mapped out conceptually by Lehner et al. (2017) and illustrated in the figures below, which underscore the wealth-generation potential of a PoS cryptocurrency such as the E^2 implementation.

Figure 1 depicts how a farming model generates new cryptocurrency. While Lehner et al. (2017) provided two examples of cryptocurrencies to deploy in this fashion, this type of framework can be deployed with E^2. The investor (represented by the box in Figure 1) can be either an individual, an institutional investor, or a type of hedge fund, such as a sovereign wealth fund. For example, with the E^2 implementation, only 5,000 coins are required to run a masternode. As the node accrues coins, the dividends can be saved to start a new node or spent by the investor.

Figure 1.

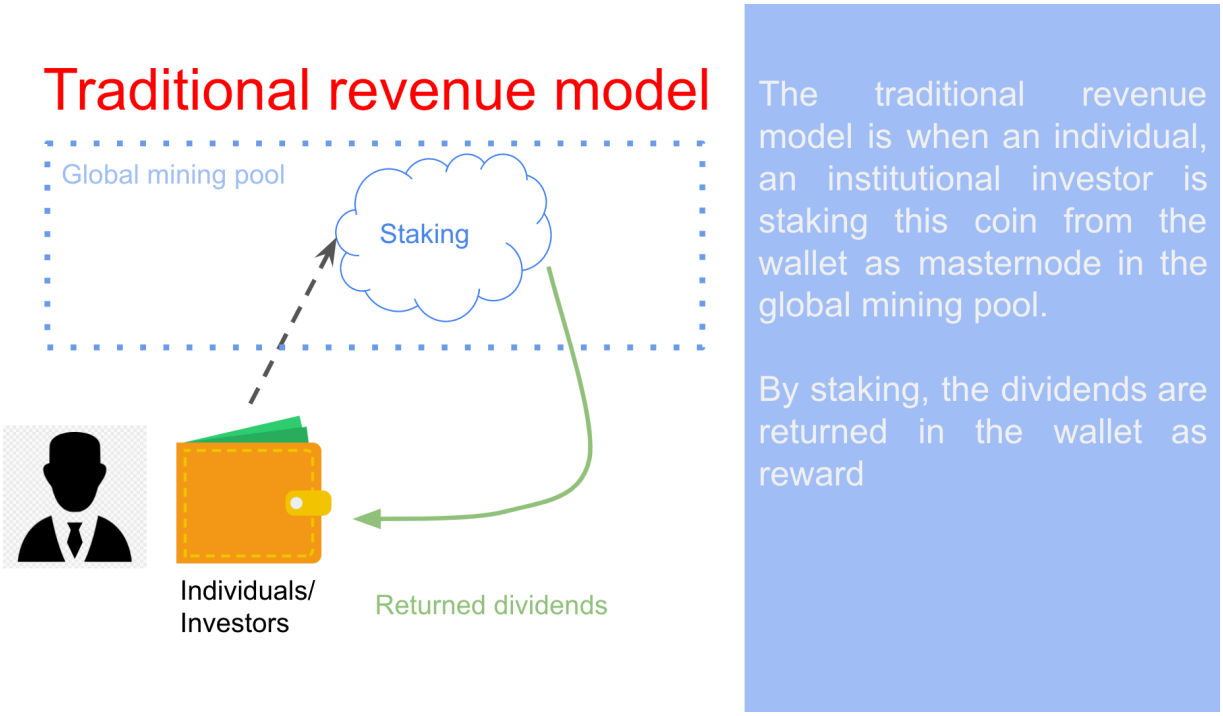


Figure 2 presents a broad framing of the intricate process of acquiring coins, setting up nodes, and monitoring their progress. The first, critical step is to use funds to acquire E^2 coins.

Figure 2.

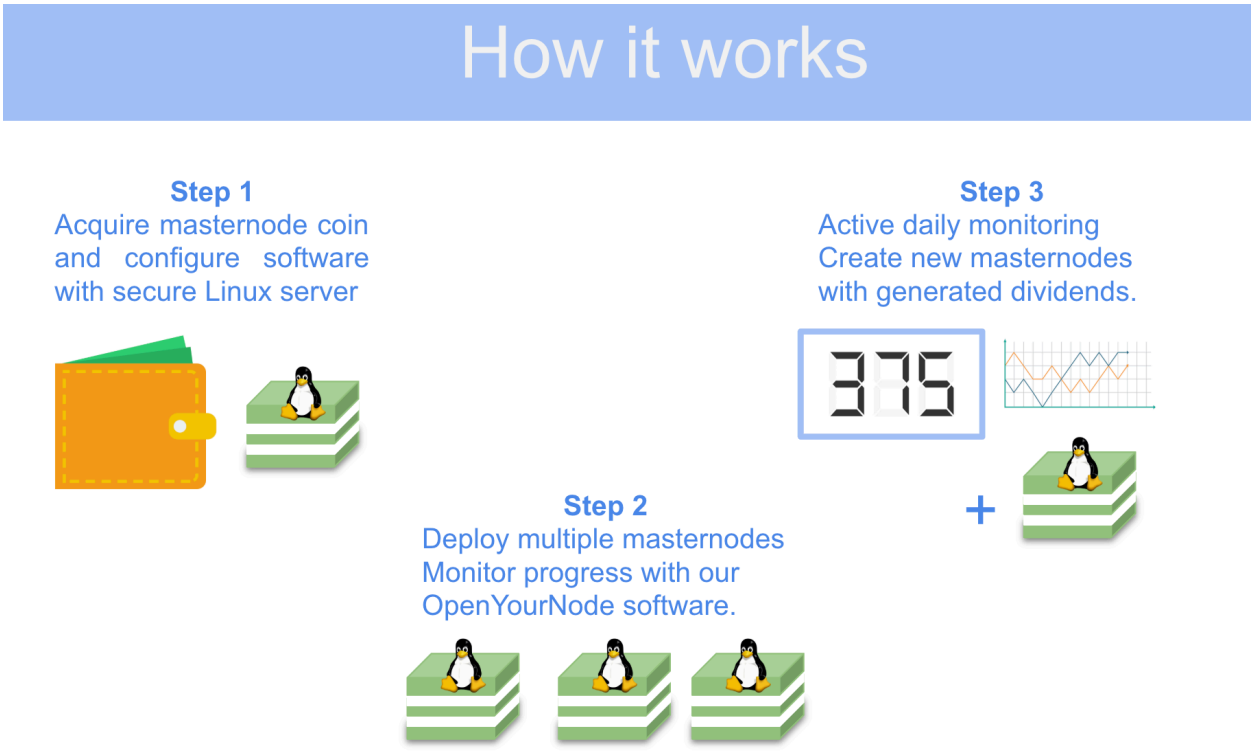
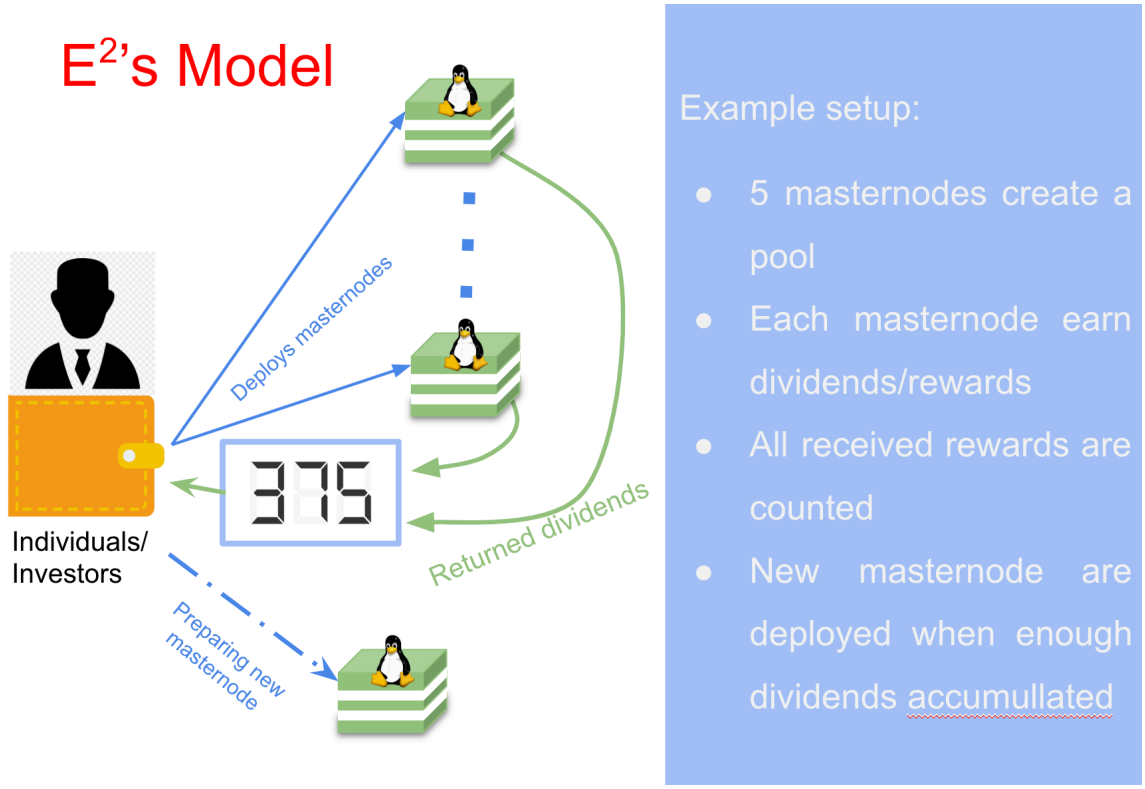


Figure 3 underscores some of the details of the processes represented in Figures 1 and 2. The figure notes how a coin farm (here represented by the five masternodes) dedicated to a single network could provide compound interest. The middle section of the model shows how the nodes' collective dividends can be used to create a new node. The dividends then, as shown to the right, can be reinvested or spent. Researchers working with software engineers and bankers have tested prototypes of similar frameworks and were successful in generating value.

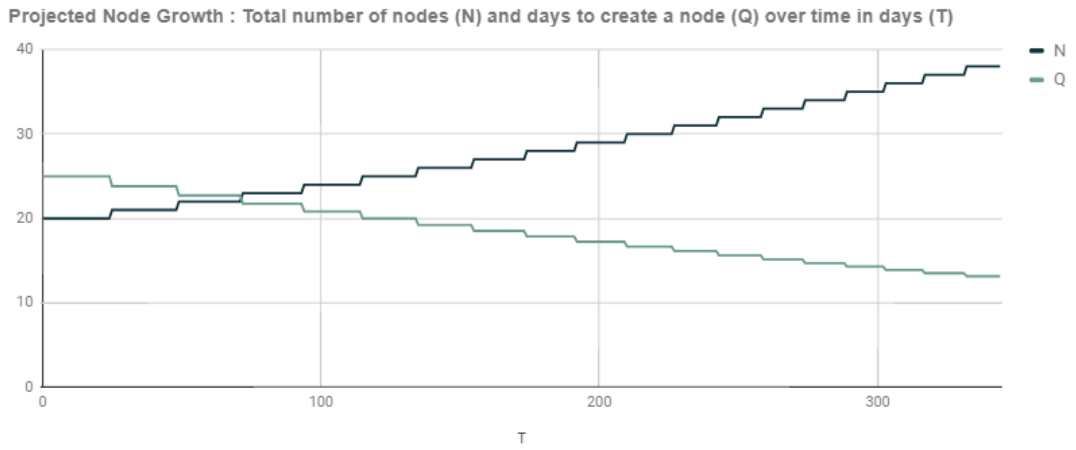
Figure 3.



As Figure 4 shows, new nodes can be generated rapidly. The mathematical model of dividend management below employs very conservative investment assumptions and presumes linear coin generation amounts. Initial values of its variables are noted parenthetically.

N = total number of nodes (starts at 20 nodes)
E = average number of coins generated per node per day (fixed : 10)
M = coin collateral required to run a node (fixed : 5000)
Q = days to create a new node from generated coins on existing nodes, literally M/(E * N) in this formula (starts at 25 days)

Figure 4. Total Number of nodes (N) and days to create a node (Q) over time in days (T)



The number of days to create a new node (Q) decreases as time passes in days (T) and the number of nodes (N) increases. The larger N is, the fewer days are necessary to generate a new node. If the number of initial nodes is large enough, they will generate a new node in under 25 days. New nodes are then added to the existing pool to generate yet more coins and, because of compounding dividends, grow exponentially over time.

As seen in Figure 1, the process of dividend growth relies on the dynamic, reciprocal interaction between generating new coins and sweeping new coins into new nodes in a species of compound interest. However, the E^2 implementation generates dividends to all nodes based on the consensus mechanism, and rewards can be earned by all stakeholders. Wealth generated needs to be periodically rebalanced into non-collorated safe-haven assets like the US dollar, gold, or another cryptocurrency.

Enacting the farming model required the development of our own codebase to monitor dividend growth, interface with various virtual private servers, and deploy new master nodes. Open-source tools play a crucial role in coin farming, distributing both the implementation of the protocol and any future improvements to the community.

Nodes are set up using open-source tools, and wrapper scripts or another type of automated reporting are used to monitor the progress of the nodes or farm of nodes. The automated reporting need not be simply for an institutional investor that may be running its own nodes, but, depending on the way that it is coded, could also report to several institutions, thereby creating an accountability measure to ensure that those who committed to running nodes are in fact doing so. This idea of group accountability may vastly increase the value of the network. Although deeper investigation is needed of Metcalfe's (2013) and Reed's (2001) laws in application to the staking-coin ecosphere, the general heuristics of the laws suggest that cryptocurrency accrues value predicated on a network effect. Peterson (2017), for instance, has postulated that BTC's value adheres to the social network laws touched on above. Thus, sharing newly generated coin and/or new nodes would increase the power of the network and consequently the funding benefits to all participating institutions.

While the E^2 implementation is live, it is very far from experiencing any type of network effect. The large-scale potential of the E^2 implementation, therefore, rests in collaboration. Were institutions to work together while running their own coin farms, each coin could greatly increase its value. Collaboration in the realm of funding is not the norm, and might thus run up against institutional inertia, but the potential benefits are significant, as it would boost dividends substantially.

Unsurprisingly, institutions do not share fiat currency. This tends to perpetuate funding inequalities, as noted in the Council for Aid to Education (2018) endowment report, which found that already-well-funded institutions tended to receive the higher endowments very much at the expense of under-funded institutions. In this regard, a key innovation of a PoS network such as the E^2 implementation is that the sharing of node dividends by wealthier institutions would not only profit the wealthier institutions, but would also profit less wealthy network participants through the value added by network effect.

Since BTC reached its all-time high in 2017, crypto moved slowly into a bear market, engendering pessimism about its potential. At the time of writing, in Fall 2019, BTC is at approximately half of its all-time high, but the model described above still holds significant promise. The underpinning frameworks of the model – dividend reinvestment, game theoretics, hard-money, network infrastructure deployment, and open-source software – depend neither on BTC's price nor on the market in general. Moreover, in more fully aligning with Lietaer's work, this type of model could create an alternative decentralized money even if the staking coin is only trading on one exchange or, for that matter, even if the coin did not have a BTC pair and was not redeemable for USD. A decentralized money does not need to be coupled with a fiat currency to be widely deployed for educational funding. In our case, if the City University of New York were simply to accept the staking coin as a form of payment, that provision of making a medium of exchange liquidity and creating a type of need on the market may provide validation to E^2 and create an opportunity for higher market appraisals.

PART III: BUILDING A HIGHLY EFFECTIVE DEVELOPER COMMUNITY

The Development of a Cryptocurrency

Staking and developing a cryptocurrency raises a lot of technical questions. From the outset, stakeholders must decide whether the codebase is robust enough to be more fully developed. BCC's Crypto Collaborative , and now the Free Education Team, has functioned under the notion that open-source crypto projects have the potential for wealth generation based on robust codebase, even if that codebase dates back to the Satoshi C++ implementation of 2009. This notion was reinforced by Electric Capital's Dev Report (2019), authored by Maria Shen, underscoring how few developers exist in open-source crypto.

The E^2 implementation, as noted, originates from the genesis block in 2016, when it was the PoS Exclusive Coin, and is developing on that original codebase. By not building a token on Ethereum, as many projects have done, E^2 does not run into the complexities of securities law. Additionally, since the project has at least a foundational codebase, the project's

developers can focus on the possibility of offering unique code to the implementation. This will nevertheless require considerable time and resources to implement and sustain. Components to be considered include: 1) communication protocol between wallets, 2) wallet encoding and encryption, 3) network consensus via the model for PoS, 4) blockchain structure (block and transaction design), 5) integrity (the blockchain cannot be corrupted), 6) security (ranging from how hard it is to tamper with the blockchain to the anomalies that can appear in the network), 7) trust, 8) support, 9) diversity of available platforms (mobile wallets, hardware wallets), 10) continuous development (adding new features or improving performance), and more.

Since all of the above components existed in the 2016 genesis block, the initial developer workload for the E^2 implementation is already considerably reduced. This solution affords time for developers to concentrate on the important items on the list. Further, developers can draw on the resources of other communities that are using the similar codebases. Such communities may be able to offer support and even new features.

Maintaining the E^2 Implementation: What's Needed?

When developing on anonymously launched chain like the E^2 implementation, there are, thankfully, few regulatory hurdles; yet there *are* profound development concerns. Development issues will appear over time, and some of them will have to be remedied as quickly as possible. Unsolved issues can have a high impact on the users, community, and cryptocurrency price, so the reaction time of the community functions as an extra layer of trust and security for the cryptocurrency. Further, maintaining a cryptocurrency is not only about responding to issues. Ongoing development is required to create higher levels of security, improve network speed, implement transaction analytics, and more.

While the E^2 implementation continues to propagate blocks, a good portion of development on the protocol waned when the project was abandoned by its anonymous creators in late 2018. If E^2 is to grow into a blockchain that functions as one way to fund a portion of higher education costs, then a new team of developers is needed to take up the mantle. However, given the very limited pool of qualified developers in open-source crypto noted by Electric Capital's (2019) report and the thousands of cryptocurrency projects in need of essential work, the matter of crowdsourcing developers to the E^2 project is critical. This section, therefore, explores what is needed to attract highly effective developers to an open-source software (OSS) cryptocurrency. This section also explores what attracts a wider community of users and funders (stakeholders) to a cryptocurrency project. Our objective is to determine 1) whether the E^2 implementation is an attractive cryptocurrency for developers and other stakeholders, and 2) what, if anything, we can do to support, first, the developer community and then the wider community around E^2.

Our main contention is that the nature of a cryptocurrency, its opportunities for wealth generation, and its ability to be a hedge against fiat are the primary factors driving OSS projects and the participation from developers. In addition to the intention of the OSS project, how the community of stakeholders enacts it mission is also of the utmost importance. In light of the central banks' undermining the hardness of money on a global scale, cryptocurrencies are needed, wanted, and worthwhile in the eyes of a sufficiently

large group of holders. However, in order to organically grow the project, three communities are required, which feed off each other to build long-term value: developers, users, and funders.

The thesis that the OSS mission as an enacted ethos is a central factor in whether the project can grow may be connected to and supported by the psychology that drives first developers, then users, and finally investors to latch on to and contribute in their respective ways to the E^2 implementation. It is the same psychology as that which enables teams more generally to perform at the highest levels – namely "emotional connectedness." Carter (2018) showed that the best performing teams in the workplace have a high level of emotional connectedness. This is brought on by "great collaboration, a positive vision of the future, alignment of values, respect for each other, and achieving killer outcomes" (p. 31). In the context of the E^2 implementation, emotional connectedness refers to the degree to which first and primarily developers, but then also other stakeholders, have a feeling of belonging, a higher purpose, respect for each other, and the ability to gain learning from the community.

The psychology of emotional connectedness is important for understanding which cryptocurrency projects will fail and which will succeed. It is also useful for informing the strategies that we can employ to encourage developers to take up the E^2 mantle, thereby enabling the long-term growth of a wider and more complete ecosystem of stakeholders. We can think of an open-source cryptocurrency and the community of developers, users, and funders surrounding it along the same lines as an OSS project more generally. Both are environments where stakeholders naturally coalesce out of the cloud, so to speak. In other words, the open-source environment, by its nature, is very good at self-selecting for people who share the same values. The origins and nature of OSS are important for establishing the structural reasons for this. In this regard, Midha and Palvia (2012) provide a useful "definition" of sorts: "A typical open source project starts when an individual (or a group) feels the need for a new feature or entirely new software and someone in that group eventually writes one. In order to share it with others who have similar needs, the software is released under a license that allows the community to not only use it, but to also see the source code and modify it to meet local needs and improve the product by fixing bugs" (p. 895). In other words, OSS starts with an individual or small group who identifies a need, begins work on a solution, and makes the solution freely available to others. This is supported by Schweik and English's (2012) research on correlations between OSS success and the early conditions of the OSS project, which demonstrated that open-source projects flourish when developers themselves are the primary initial users of the software.

While OSS starts from identification of a need, its long-term success can be predicted to some extent by whether the project has vocal early proponents. Schweik and English (2012) note that "a relatively clearly defined vision and a mechanism to communicate the

vision early in the project's life" are critical for OSS success (p. 60). This is important in our context because it tells us that for E^2 to succeed, it needs proponents to clearly outline and disseminate the vision. The need for dissemination of a clear vision, in turn, speaks to the underlying psychology behind what makes an OSS project "sticky" for the wider community. This is important because it can help us to craft the right vision. Note that E^2's vision of self-funding for higher education can be considered to have a certain base-level of worthiness to a large contingent of people.

Since the E^2 implementation needs developers first and foremost to take up the mantle, it is useful to consider the nature of the OSS profession in order to understand the underlying psychology of developers. We contend that OSS leads from the start towards over-representation of certain personality traits. Without a boss or any type of traditional hierarchy, developers in the OSS environment are required to produce work independently. Casalnuovo et. al (2015) and Middleton et. al. (2019) showed that successful OSS developers tend be those who independently build something that works, often without pay. This leads to peer recognition and, finally, paid job offers from other stakeholders in the wider ecosystem. In the merit-based, self-reliant work environment that is OSS, micro-management, it seems, is replaced with the motivating factors of recognition by peers and independent financial return. Further, Yoshikawa, Iwata, and Sawada (2014), in their study on the importance of collaboration to the success of OSS, found that projects in which key developers responded to pull requests and also worked on other, non-related projects, had higher success rates. At the developer level, therefore, the nature and ethos of OSS, again, maps closely to Carter's (2019) contributing factors of emotional connectedness for workplace success. Regarding the E2 implementation, this knowledge can be leveraged to inform strategies for fostering the organic growth of a developer community. Where the opportunity exists to promote a sort of "work culture" in E^2's developer community, we therefore should encourage a merit-based approach in which developers who, ideally, work together on other projects actively respond to pull requests.

The origin and development of the Linux open-source operating system (OS) is a useful example of success in OSS in that it demonstrates all of the above properties. It fits Midha and Palvia's definition for how OSS starts, it is in line Schweik and English's research on correlations of success, and it demonstrates how the underlying psychology drives the birth and growth of open-source communities. Linux as an example is also useful in that it demonstrates the enormous potential of the OSS model to build value.

Linux started with a single developer, Linus Torvald, who wanted an alternative to Windows. Torvald primarily began work on the project because he personally wanted to use it (Moody, 2002). Torvald was the software's first user and its biggest early advocate. As with so many inventions born of necessity, others quickly discovered the utility of

Torvald's work. Many of them started contributing to the OSS that would become the Linux OS. Linux would eventually be adopted by non-developers (users), and before long, a whole ecosystem evolved, with enterprises building for-profit products on top of the open-source code. Linux and the ecosystem around it are now, of course, incredibly valuable, providing the software foundation for billions of Android devices.

As we have seen, developers must compose the first adherents to an OSS project. Without them, there is no project for others to latch on to. However, an OSS project must also attract users and funders if it is to achieve long-term success. In this regard, the utility of the project is certainly important. However, particularly for cryptocurrency projects - which are, by definition, built on money rather than software utility - the emotional connectedness of the wider ecosystem of stakeholders is arguably more important. For a cryptocurrency to succeed, users and funders must also "coalesce out of the cloud" and join the network so that 1) the value of the network increases in line with value aggregation theories connected to Metcalfe's law (for example see: Zhang, Liu, & Xu, 2015), and 2) funding for further development can be secured. In this case, we can say that the emotional connectedness of adherents to a cryptocurrency is driven by two of Carter's factors, namely a "positive vision of the future" and "alignment of values."

In the world of cryptocurrencies, BTC maps closely to Linux in terms of its origins, organic growth, and the value that it ultimately generates. However, the reasons for BTC's success, it can be argued, are also closely related to the emotional connectedness of *all* its adherents, not just early developers. The premise here is that a cryptocurrency, more than pure software like Linux, is more influenced by the emotional connectedness of the wider community. Further, this emotional connectedness is related to whether the cryptocurrency itself is considered truly "worthwhile" by that community. BTC is a useful example here because of the large number of like-minded individuals who have coalesced out of the cloud to support it. The BTC example is also instructive for helping us understand whether E^2 can ultimately succeed and how it should be promoted to encourage success. Again, note that E^2 - as an initiative for the funding of higher education - has a certain base-level of worthiness for a significant contingent of people.

BTC started when an individual (or, perhaps, a small group) known as Satoshi Nakamoto wanted an alternative to fiat money, so he/she/they built an open-source, decentralized, censorship-resistant protocol for money. The BTC white paper crystalised the vision of the project and, with Satoshi as an early advocate, other developers came onboard by contributing to the codebase (Champagne, 2014). Critically, the values of these early developers very closely aligned with the values outlined in the white paper and in statements from BTC's key advocate, Satoshi. Early contributors largely fell into the so called "cypherpunk" mindset, characterized by libertarian ideals including distrust of the

status-quo financial system and an emphasis on privacy (Champagne, 2014). Later, non-developers with a similar ideological bent, seeing the value and aligning in beliefs, latched on. BTC's growth, of course, continues (in waves) to this day by attracting like-minded individuals. At this stage, it has sufficient power to even influence the value sets of some newcomers. The lesson here for E^2 is that, in crystalizing the project's vision for the public, we should not hesitate to appeal to the core values of the people whom we consider our target adherents, not unlike Satoshi appealed to those frustrated with status-quo monetary policy.

It can be argued that BTC, as the first mover in the world of cryptocurrencies, is a special case. Let us examine, therefore, the much newer cryptocurrency Grin as another informative example for determining the path to E^2's success. Grin's niche in the cryptocurrency world is that, with a focus on privacy and scalability, the project staunchly rejects the need for an initial coin offering, pre-mine, founder's reward, or block reward for developers. In other words, the project embraces the concept of a "fair launch." For development, Grin must therefore rely – like BTC – entirely on donations. Note that E^2 also fits "fair launch" criteria.

The ability of a cryptocurrency to successfully rely entirely on donations for its development is indicative of the cryptocurrency's potential for long-term success. It proves, in a sense, that the vision of the cryptocurrency is "worthwhile" to a sufficiently large group of people. In this regard, Grin's success in receiving donations for development is telling. Grin developer Michael Cordner's story exemplifies the OSS process, especially as it relates to funding. Cordner started working on the Grin protocol in May 2017 without pay (Hsue, 2019). His contributions were judged by his peers, as well as by a growing network of interested stakeholders. After the "probationary period," Cordner had built sufficient social capital to merit funding from the community. Three funding campaigns in 2018 netted him close to USD 100,000 in donations from the Grin community, all before Grin was even live. In February 2019, Cordner launched another campaign to fund his developer efforts, raising a further USD 70,000 within days. Throughout 2019, Grin has consistently garnered large donations from its community, including an anonymous 50 BTC (approx. USD 300,000) in May (Kim, 2019).

The support for developers that has coalesced from the cloud that is the Grin community starkly contrasts with the lack of support for developers on the much larger (by market cap and brand recognition) cryptocurrency Litecoin. A fork of BTC differentiated by a few minor tweaks to the protocol (namely block size, issuance rate, and total supply), Litecoin is a cryptocurrency that is widely criticized as unnecessary; its primary use-case, some argue, is merely to operate as a testnet for BTC (which, incidentally, has a testnet of its own). Considering the above discussion on the importance of emotional connectedness to the success of OSS in general, it should be not surprising, therefore, that there is a lack of

robust support for Litecoin from its community relative to that of Grin from its community. The Litecoin Foundation, which manages funding for the cryptocurrency's developers, overwhelmingly relies on a single donor, Litecoin's founder Charlie Lee. Since 2017, Lee's donations have accounted for some 80 percent of the foundation's funding (Foxley, 2019). Development on Litecoin, in turn, seems to have mostly stopped, with nothing meaningful contributed to the codebase since October 2018 (Kajpust, 2019). Contrasting the organic support from the community for Grin (which has a community bolstered by its emotional connectedness) with the lack of organic support from Litecoin's community (which does not) tells us that E^2 - with its worthwhile goal of funding higher education - is on the right track for developing long-term value as a cryptocurrency.

In summary, for a cryptocurrency to succeed, it must, first and foremost, be worthwhile in the eyes of a large enough audience. E^2, we argue, satisfies that condition at a base level, but the project's vision must be made clear for it to have sufficient power to galvanize early adopters, particularly developers. Built upon this solid foundation, it is possible for a cryptocurrency to reach critical mass, grow its community of supporters, and build long-term value for all. However, particularly considering that E^2 currently has no active developers, work will have to be done to support the project's early developer community. Such work should focus on building the emotional connectedness of developers within the confines of the OSS workplace environment.

Conclusion, Limitations, and a Call for More Research

In this work, the funding thesis proposed underscores how using open-source staking coins could be one alternative to the relatively fixed way of understanding how to fund higher education. More specifically, we propose the E^2 implementation as a case study for examining the degree to which a cryptocurrency may generate capital for higher education's funding via dividend reinvestment and network effects. The dividend reinvestment approach may afford for the creation of a network effect, thus generating significant capital for the purposes of higher education.

The research presented was based on models developed in 2016 and has been amended over the last few years. However, the proposed model is only one way that wealth could be generated in order to fund higher education. Whereas the initial BCC Crypto Collaborative models underscored a strategy of staking coins, the framework discussed in this paper has the potential to generate substantial new capital by crowdsourcing one underdeveloped chain, E^2. With that point noted, PoS coins specifically can be deployed in such a way that other stakeholders can be invited into the project to encourage its development and stabilize the volatility of the coin on exchanges. Additionally, in newer models being developed, there may be a way that a number of coins, akin to a type of index fund, could be deployed in the interest of funding higher education, similar to how the E^2 implementation example functions in this paper.

The power of this enacted framework rests in the notion that if a number of institutions collaborate, or if hedge funds only seeking alpha joined, for example by running their own coin farms, the USD proceeds could be used as the stakeholders see fit. Since the coin would be on tradeable markets, the value of each coin could grow significantly. Higher value coins could subsequently be rebalanced into USD or reinvested into the network. A collaboration such as this is a full departure from the business-as-usual frameworks deployed by college development offices and university endowment strategies.

The wealth-generation aspects of this proposal describe the redeployment of wealth into education. For example, a well-funded institution - say any of the top ten endowments measured by USD - could dedicate its dividends, or portions thereof, to student scholarships or any domain of funding consistent with its vision. Beyond simply benefitting one institution, newly generated coins and/or new nodes could be shared. In line with network-effect principles, the sharing of nodes increases the value of the coins in the entire network. Node sharing can be seen, therefore, not merely as an egalitarian endeavor, although it *would* serve to address educational disparities. By contrast, the notion of an institution sharing its dividends in USD remains unheard of, primarily because fiat currency has already achieved its network effect. Of course, in a bear market, such as the one in 2018 through the spring 2019, network value will not always increase in terms of fiat. Nonetheless, the dividends continue to grow in this model, and the blockrewards are robust. Although network effect is not the focus of this work, in order to gain a deeper understanding of how Metcalfe's (2013) and Reed's (2001) social network laws can be applied specifically to the PoS environment and how the phenomenon of network effect can benefit higher education funding, the authors propose additional research.

In this paper, we put forward that the utilization of a network, with the goal of wealth generation via the achievement of a network effect, for the public good counterbalances any concerns about PoS coins within the fund, as the social intelligence and reputation often required to participate are already achieved within the prototype itself. Surely, leveraging a coin's potentially exclusionary characteristic for the greater good cannot be construed as harmful. We posit that a network such as the E^2 implementation may not only make higher education funding more egalitarian and accessible, but also may drive innovation by granting researchers an independence and ability to collaborate rather than compete. Such independence would benefit researchers, their colleagues, and the public good. Further research is required in order to understand the long-term viability of such a strategy. For instance, models that capture the wealth-generating aspects of cryptocurrency while mediating its volatility with safer assets should be more fully developed.

An additional point of discussion is in the call for a next generation of new research which should center on how the hard money characteristics of some cryptocurrencies compare to those of gold. Although the point is considered here briefly, the concept is worthy of intensive research. It is worth noting that gold will likely always be hard money based on chemistry. Bitcoin, although it is considered hard money, is perhaps more complicated in that it is reliant on social and computational factors that emerge as a set of risk-factors mediating against the asset class. Roy Sebag (2019) astutely addressed the hard-money

aspect of both commodities in a recent article. Sebag addressed Barry Silbert's Grayscale Investments' 'Drop Gold' campaign, underscoring that although BTC and gold can both be considered hard money, some distinctions urgently need to be made. Sebag's conception of hard money seemingly contrasts with Ammous's (2018) discussion of the same topic in the *Bitcoin Standard*. Nonetheless, the call for additional research related to money's hardness is required, since, in no small way, the timebound aspects of wealth generation as seen in Lehner et. al (2017) need to be mediated against.

In this paper, we have focused on the live blockchain E^2 as a potential implementation that can fund higher education. As a live blockchain, the development of E^2 must be closely monitored. In addition to more research and prototyping, new development tools such as better coin control tools and monitoring mechanisms are required and/or need to be made publicly available on Github or another developer forum. The authors are aware of the potential for fraud, but are optimistic that the type of research and reconnaissance done by the team in developing the prototype can guard against it. Further, more stakeholders - including node operators, investors, and invariably, exchanges - will need to be involved. In this regard, our research shows that the ethos of OSS should be embraced. We should leverage the emotional connectedness of, first, developers and then all stakeholders who coalesce out of the cloud to support the mission of funding higher education. To do so, it is essential, as a starting point, that we crystalize the importance of our vision to a sufficiently wide audience.

There are many entities, including state and federal governments, that can facilitate, and at times hamper, the funding of higher education within the United States and globally. Multiple stakeholders, including some financial interests, are involved in higher education's funding, all of which can complicate a proposal like this. Yet, historically, too few opportunities have been presented that ease the problems relating to the funding of education. Nor have there been successful proposals for ways to navigate beyond the discussion of traditional student and institutional funding means. At this point, however, cryptocurrency and the technologies and social constructs supporting it may present a non-traditional funding mechanism that is fully situated outside of government. While clearly adding a layer of complexity, this mechanism presents an unprecedented opportunity that is worth pursuing.

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