GOVERNANCE DECENTRALIZATION AND PERFORMANCE OF BLOCKCHAIN PLATFORMS

by

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ABSTRACT

With blockchain technology getting wide adoption, digital platforms built on blockchains have also dramatically increased in scale. One crucial determinant of platforms' performance is its governance structure, specifically, its degree of decentralization. Distinct from the most prevalent centralized governance in most corporations, blockchain platforms naturally carry certain elements of decentralization, which provides a unique opportunity to examine and compare the effectiveness of governance decentralization. In this study, using regression and machine learning, I show the inverted U-shaped relationship between blockchain platforms' degree of decentralization and their performance, measured by several proxy variables such as developer engagement and market capitalization. Semi-decentralization is shown to be the ideal degree of decentralization. However, the decentralization score or governance type does not improve the accuracy of predicting the change in market valuation. Besides, differences in the results for layer-1 and layer-2 applications indicate characteristic differences between the two blockchain layers. The results suggest that there are benefits for both centralized and decentralized platforms to incorporate elements from the other end.

ACKNOWLEDGEMENTS

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INTRODUCTION

The 2007-2008 financial crisis brought unprecedented challenges to financial institutions and governments all around the world. Besides macroeconomic factors, studies empirically show that corporate governance also affected firms' performance during the crisis (Erkens, Hung, and Matos 2012). Only weeks after the Emergency Economic Stabilization Act was passed, a crucial point marking the repair of the crisis, Nakamoto (2008) introduced a peer-to-peer digital currency, Bitcoin, that is secured by cryptographic proof and built on a distributed ledger named blockchain. Since the groundbreaking invention of blockchain technology, its unique characteristics such as transparency and immutability have shed new light on innovative applications in various fields both in and out of the blockchain world.

Since the first blockchain application, Bitcoin, is a digital currency or cryptocurrency, it is no wonder that finance remains to be the most popular field for blockchain innovation. While blockchain technology is the backbone of decentralized applications (dApps), it is Ethereum and other smart contract platforms that give rise to dApps, which greatly extend the application scenarios of blockchain technology (Harvey, Ramachandran, and Santoro 2021). Smart contracts are essentially code on blockchains that can execute certain functionalities and interact with other smart contracts. the field of decentralized finance (DeFi) has thrived in recent years with numerous emerging DeFi applications, some famous examples including Uniswap, MakerDAO, and Compound. There are also dApps dedicated to gambling, gaming, collecting, auction, etc.

Besides finance, blockchain may have a significant impact on any traditional aspect of the world where decentralization, security, and transparency are needed. For instance, Thomas et al. (2019) propose a general smart contract to help decentralize energy management. In the healthcare industry where personal records must be kept securely, Hölbl et al. (2018) find increasing blockchain-based applications in healthcare, mostly used for record-keeping and data sharing. Saberi et al. (2018) claim that blockchain is promising in helping ease the sustainable supply chain issue. Another key area where blockchain has shown potential is governance in both the public and private sectors. Kshetri and Voas (2018) argue that blockchain-based e-voting can reduce voter fraud and better engage voters. Lafarre and Van der Elst (2018) shed light on the benefits of employing blockchain for corporate governance such as faster decision-making, and argue that it is feasible to use blockchain for shareholder participation. Moreover, new governance structures like liquid democracy that used to be unviable have emerged on blockchains. Liquid democracy can be viewed as a combination of direct and representative democracy where a voter can delegate her vote to a trusted proxy while also having the power to terminate the delegation at any time (Blum and Zuber 2015). Such innovative voting mechanisms are part of blockchain's impact on governance, which might ultimately be used to revolutionize traditional governance in the future.

For both blockchains and blockchain-based decentralized applications, governance is a crucial component of a project's sustainable development because governance on the blockchain is to manage and coordinate an entire community toward the same goal (Nilsson and Garagol 2018). In contrast to the great significance of governance of blockchain platforms, relevant literature is still scarce (Beck, Müller-Bloch, and King 2018). Such scarcity is reasonable given the field of blockchain can be seen as in its infancy with few widely recognized experts and established theories (Atzori 2017). Pelt et al. (2020) introduce a comprehensive framework for comparing and analyzing blockchain governance. De Filippi and Loveluck (2016) specifically analyze the decentralized governance structure of Bitcoin from a political-economic perspective, concluding that the development power of Bitcoin ultimately falls into a small group of core developers despite the network's strong market-driven approach to coordination and trust. Overall, the study of governance on blockchain platforms is still at an early stage, which has been the main motivation of this research.

This study focuses on the degree of decentralization in blockchain platform governance, more specifically, how governance decentralization is related to a platform's performance. Chen, Pereira, and Patel (2020) argue that semi-decentralization is a high-performing governance structure for digital platforms. They give empirical results showing that decentralization has an inverted U-shaped relationship with platforms' market capitalization, developer attention, and development activity, which are the variables they use to measure platform performance. As discussed earlier, most of the current literature focuses on centralized governance. Boudreau (2010) studies the impact of opening up technology platforms on innovation, which draws data from handheld computer devices. Rietveld, Schilling, and Bellavitis (2019) shed light on the platform strategy of managing its ecosystem value by examining console games on two established gaming consoles. Wareham, Fox, and Giner (2014) also focus on examining the governance design of technology ecosystems through an extensive case study on business software ecosystems.

My work examines governance decentralization as a feature of a blockchain platform. With regression and machine learning, I attempt to understand the importance of decentralization in blockchain governance and its influence on the performances of blockchain platforms. I first use polynomial regression to verify the inverted U-shaped relationships between the degree of governance decentralization and blockchain performances. Then I use machine learning to predict the change in market capitalization, adding governance decentralization as a novel feature. The results also serve as evidence of how governance can influence other aspects of blockchain projects' development.

MATERIAL AND METHODS

Data

Two datasets were produced for this research. One includes basic information on 253 blockchain platforms and their decentralization score, calculated by Coincheckup.com, a crypto research platform. Another dataset includes time series data on features that measure the performance of these platforms. This includes 3-year (732 days) data of 8 performance metrics for the 253 digital platforms. The date ranges from 2019-12-11 to 2021-12-10. This dataset is gathered through the Santiment API. There are in total 185196 observations which is the product of 732 days and 253 platforms.

As mentioned earlier, the decentralization scores are calculated by Coincheckup.com. To the best of my knowledge, this is the only source that examines the governance decentralization of blockchain projects. The second dataset on performance time series is gathered from Santiment, a crypto data provider that offers numerous metrics ranging from development activity to social sentiment. The coverage of these two datasets is the 253 blockchain platforms with complete data, including 167 layer-1 applications and 86 layer-2 applications. Layer 1 is often referred to as the infrastructure layer that allows other decentralized applications to build on top of it, and layer 2 is the layer where decentralized applications are built, hence the application layer. For instance, the most widely adopted ERC-20 is a technical standard issued by Ethereum. Numerous projects that were built using ERC-20 have emerged, including some famous dApps such as Tether, Chainlink, and USDC. I noticed that there are significantly more missing data for layer-2 applications.

The data acquisition pipeline consists of the following steps shown in figure 1. After acquiring raw data, the data was preprocessed mainly to remove blockchain platforms with significant missing data. Tables 1 and 2 are metadata tables for the two datasets acquired.

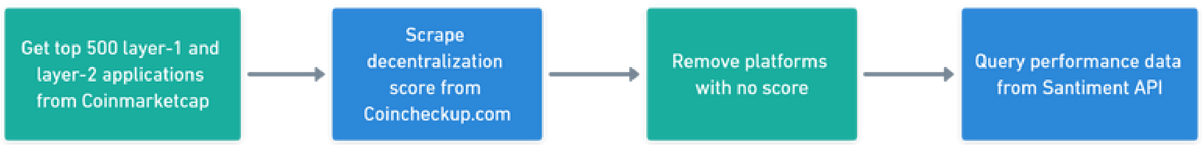

Figure 1 Data acquisition processes

Table 1 Metadata of the Profile Dataset including basic platform information

Feature Name	**Type**	**Description**	**Example**	**Obs.**
type	Categorical	Type of the platform: layer 1 (coin), layer 2 (token)	coin	253
platform	Text	The platform that this application is built on; none for layer 1 applications	Ethereum	253
name	Text	The name of the platform	Bitcoin	253
symbol	Text	The symbol or ticker of the platform	BTC	253
slug	Text	The lower-case name for the platform, usually the ending of its URL	bitcoin	253
mkt_cap	Float	Market capitalization as of 2021.12.12	9.14E+11	253

market_cap_dominance	Float	The measure of a cryptocurrencies market dominance provided by Coinmarketcap	40.9107	253
dec_score	Ordinal	Decentralization score scraped from Coincheckup.com	Decentralized	253

Table 2 Metadata of the Performance Dataset

Feature Name	**Type**	**Description**	**Example**	**Obs.**
marketcap_usd	Float	Market capitalization	914000000000	185196
amount_in_top_holders	Float	the amount of coins/tokens held by the top holders. By default, the top 10 holders are taken.	121709200	185196
social_volume_total	Float	The total number of text documents that contain the given search term at least once. This metric is an aggregate of all social platforms like Reddit and Twitter	11	185196
sentiment_positive_total	Float	The total sum of positive sentiment scores of a given set of documents over time	2.382749	185196
sentiment_negative_total	Float	The total sum of negative sentiment scores of a given set of documents over time	0	185196

dev_activity	Float	The 'pure' development activity such as commits.	11	185196
github_activity	Float	The total GitHub activity - counts all events. It is always equal to or bigger than the dev activity.	1	185196
dev_activity_contributors_count	Float	Number of contributors contributing to the development	17	185196

Figure 2 gives an overview of the features included in the data.

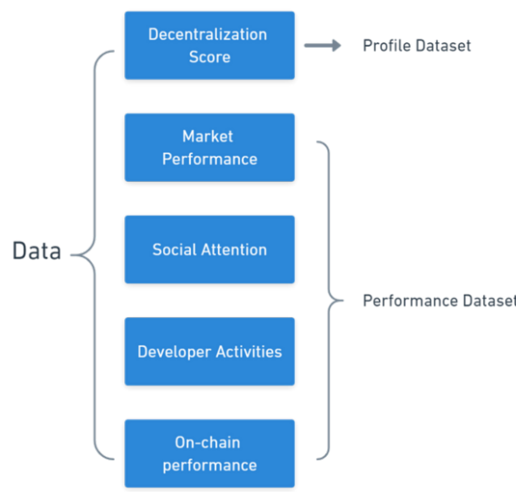

Figure 2 Feature categories

To elaborate on the decentralization score[1] variable, the decentralization score ranges from 1 to 4. The lowest score of 1 is labeled as *Centralized-Hierarchical*, meaning that the platform hierarchically makes decisions. Similar to the hierarchical organizational structure, CoinCheckup marks a slightly more decentralized structure as 2, the *Centralized-Flat* governance structure. As its name suggests, the blockchain platform is controlled by a flatly

[1] A detailed scoring methodology provided by Coincheckup.com can be accessed at here.

organized group or decision-making process. A score of 3 is labeled as *Semi-Centralized*. Blockchain platforms labeled as semi-centralized have an organizational structure between centralized and decentralized while having a community or individuals leading the platform governance. Lastly, a score of 4 is labeled as *Decentralized*, meaning that the platform runs entirely by a decentralized organization, which could be its community. A decentralized organization structure is represented by fully decentralized decision-making power and a process of reaching consensus through voting.

The eight features in performance metrics can be categorized into four aspects: market performance, social attention, developer activities, and on-chain performance.

As for market performance, a direct and commonly used measure for market performance is the platform's market capitalization. Similar to how public traded companies have market capitalizations valued by their outstanding shares, blockchain platforms often issue their own coins or tokens for various functionalities, such as governance and security. These coins or tokens, like stocks, can be traded on exchanges, allowing us to measure their market values. Market capitalization is a critical indicator of platform performance since key stakeholders often pay particular attention to it (Burniske and Tatar 2018).

Social attention can be measured by the number of a platform's social media followers, such as Twitter, YouTube, and Facebook. A platform's followers may include developers, users, and potential investors who are interested in the project to keep updated on its developments (Fisch 2019). I use the total social volume metric provided by Santiment as a measure of social attention. Additionally, the positive and negative sentiment scores are also used.

Development activity is related to a blockchain project's technical development and implementation. Having a community of developers contributing to a project is a sign that the project is continuously improving to increase the robustness of the project. Since blockchain projects are open-source projects, on GitHub, developers can contribute to an open-source project by committing to it. The platform's development activity is largely represented by the number of commits. Commits are essentially bundles of proposed changes to the core technology of a platform on open-source repositories (Grewal, Lilien, and Mallapragada 2006). Note that I focus only on the recent commits rather than total commits because the better can better reflect the recent developer activities. The abovementioned GitHub activities are captured and aggregated by the *Github activity* metric gathered by Santiment. In addition, considering not all activities on GitHub may be instrumental or relevant to project development, the metric development activity, which excludes activities not related to development, is also used.

I assume that different governance structures may incentivize token or coin holders' on-chain actions. Therefore, I include the number of coins/tokens held by top holders as a proxy to find the relationship between decentralization and token holding behavior.

From a preliminary data analysis, the below visualizations are produced from the datasets. Figure 3 shows Bitcoin's market capitalization time series along with the positive sentiment series. In figure 4, the four lines are the average time series of market capitalizations of projects with the same decentralization score. While each score has different numbers of projects, we can observe that the higher the decentralization score, the higher the market capitalization. Also, the line decentralized appears to be the most volatile while the line centralized is the least volatile in market capitalization. Figure 5 shows the distribution of development activities per decentralization score for the full sample including both layer-1 and layer-2 platforms. Semi-centralized platforms appear to have the highest number of development activities among all decentralization scores. However, comparing figures 5 and 6 we see that *centralized hierarchical* and *decentralized* also have high development activities. The difference in the distributions of the full sample and layer-1 applications may indicate the difference in layer-1 and layer-2 platforms. The preliminary data analysis, while does not offer a comprehensive view of how variables interact with one another, is effective in giving an overview of the data.

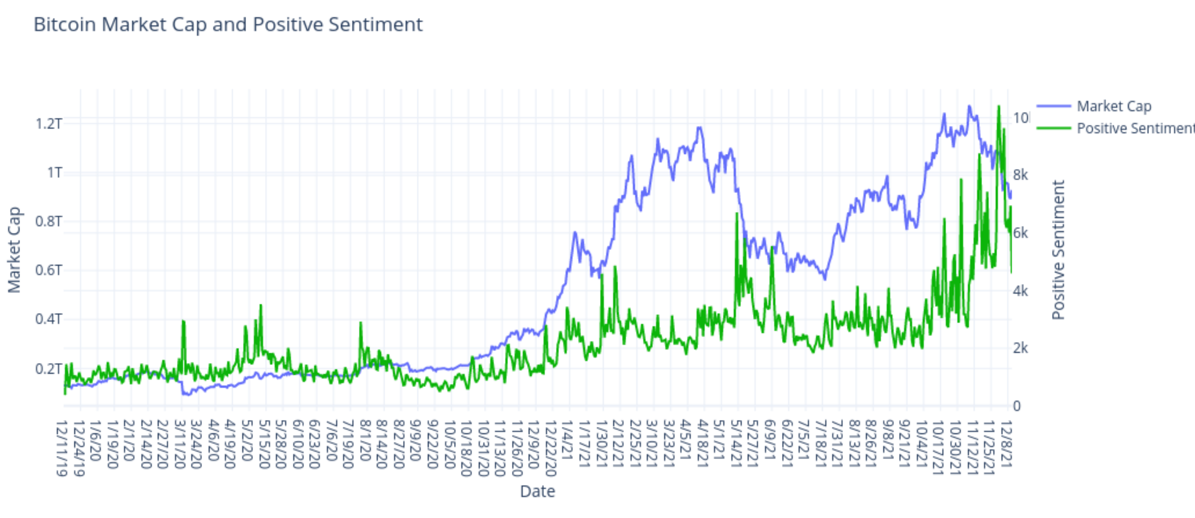

Figure 3 Bitcoin market capitalization and positive sentiment

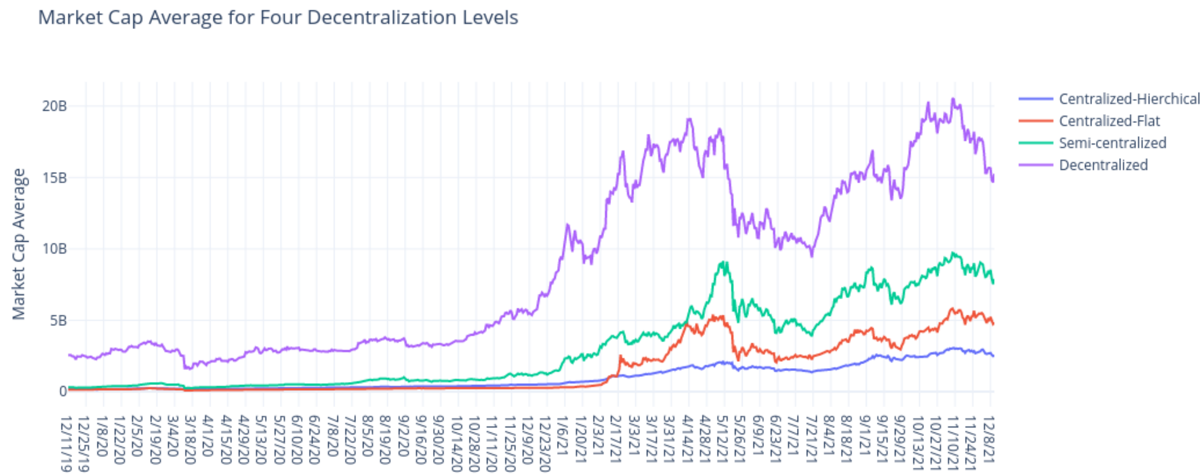

Figure 4 Market capitalization average for four decentralization levels

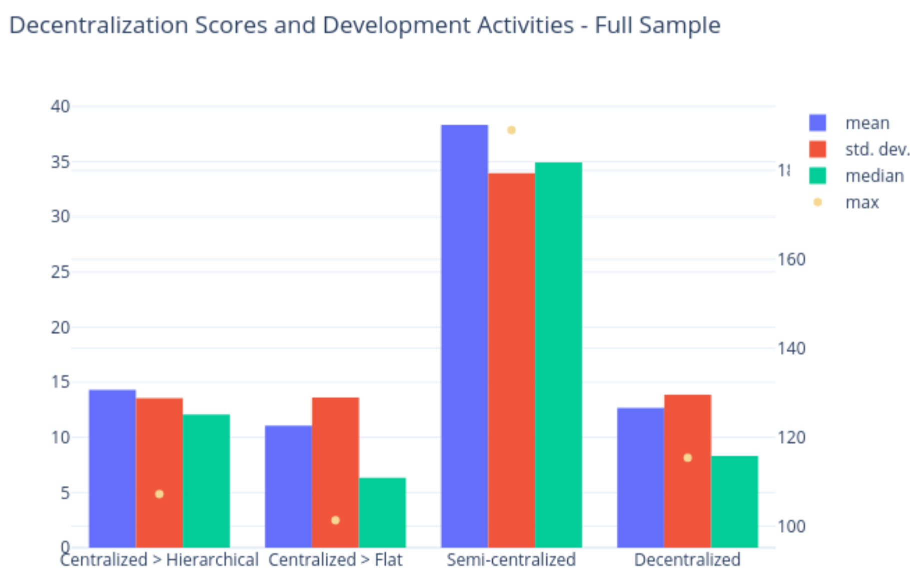

Figure 5 Development activities distribution per decentralization level (full sample)

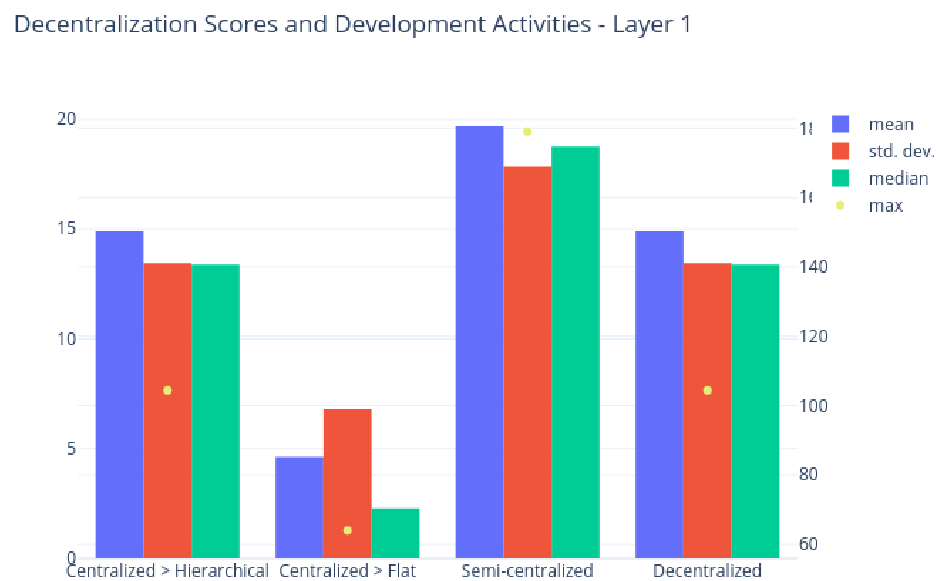

Figure 6 Development activities distribution per decentralization level (layer 1)

Methodology

Polynomial Regression

As I aim to answer the question of the ideal degree of decentralization for blockchain projects, I attempt to find the relationship between decentralization and performance variables. The most intuitive method to determine relationships between variables is regression analysis. Here, I first test the relationship between decentralization and market capitalization using second-order polynomial regression.

$$market\_cap = a_1 dec^2 + a_2 dec + a_0$$

Before running the regressions, I also note that there are market cycles in the cryptocurrency market and the blockchain community in general. Ether and Bitcoin, the two largest blockchain projects, are the most influential indicators for the whole market due to their sheer dominance (Fisch 2019). I therefore partial out such potential market cycles by denominating the market capitalization measure using Bitcoin price. Moreover, the data used for running polynomial regressions is the cross-sectional data on December 1, 2021, because the missing data on this date is less and it is relatively more recent.

Machine Learning

To discover potential non-linear relationships between decentralization and performance metrics, I also used the machine learning method, random forest, to see if having decentralization as a feature can help accurately predict the percentage change in market capitalization. The independent variables (X) here include all features except for market capitalization. The outcome variable (y) is the percentage change in market capitalizations. After data imputation and cleaning, 212 projects are included after the filtering. In addition, since the name of projects is essentially a categorical variable, 212 dummy features are added to the dataset to distinguish between different projects. The model was trained with 75% of the original data as training data and 25% as testing data.

Four models are used in this project to compare results, including multi-layer perceptron (MLP), random forest, support vector regression (SVR), and Ridge regression.

The multi-layer perceptron is a simple neural network proposed by Hinton (1989). The feedforward artificial neural network (ANN) consists of at least one input layer, one hidden layer, and an output layer, all of which are fully connected. MLP can effectively capture non-linear relationships and produce accurate numerical predictions.

Random forest is a widely applied ensemble learning method that yields prediction based on a number of decision trees, using averaging to improve model accuracy and solve overfitting to some extent (Breiman 2001). A notable advantage of random forests is that they are usually robust to overfitting, noises, and can scale to large datasets, which fits the situation of this study (Wu et al. 2019).

Support vector machines are first designed as a robust classification method. Drucker et al. (1996) extended the support vector techniques to solve regression problems. Lastly, ridge regression is a method to estimate coefficients of multiple regression models where independent variables are correlated. It prevents overfitting and underfitting by introducing a penalizing term (Hoerl and Kennard 2000).

RESULTS

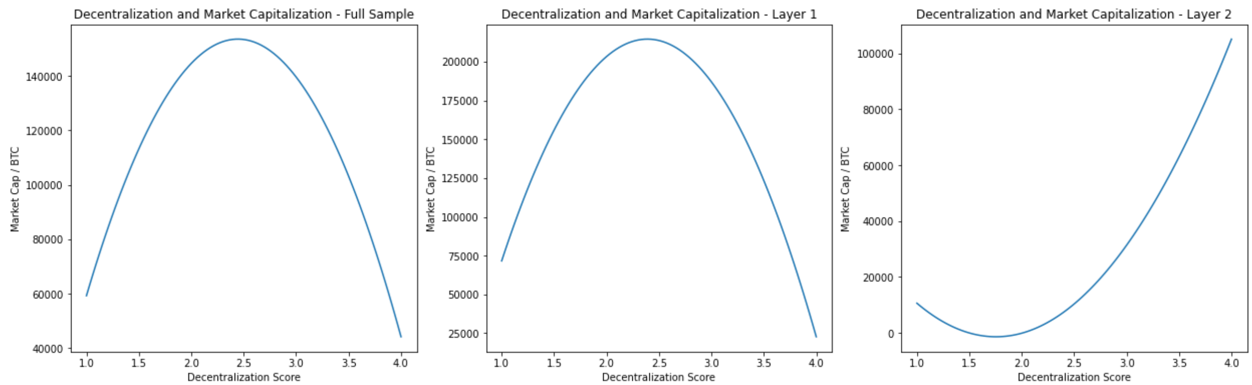

Figure 7 Decentralization and market capitalization

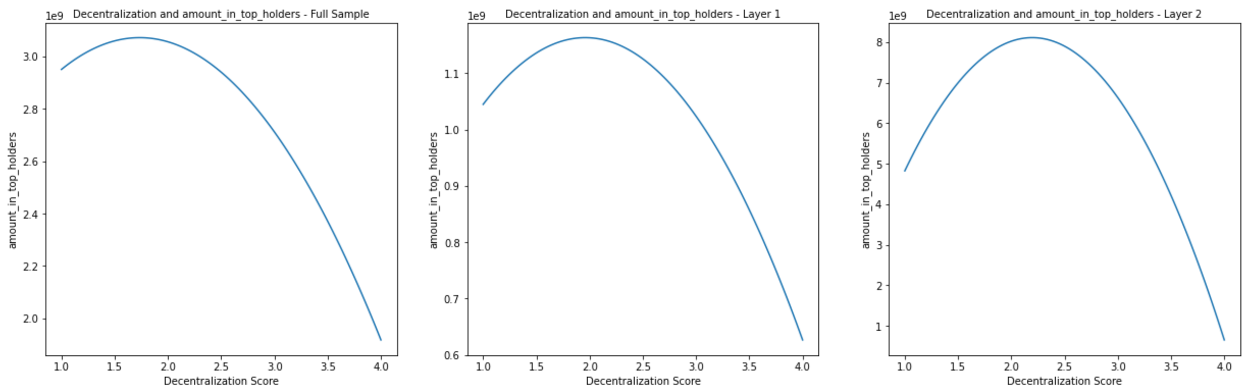

Figure 8 Decentralization and amount in top holders

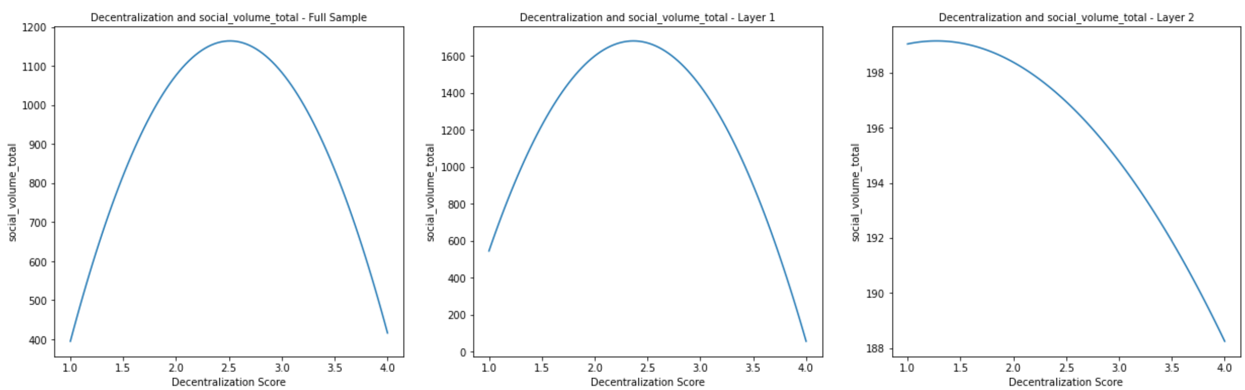

Figure 9 Decentralization and total social volume

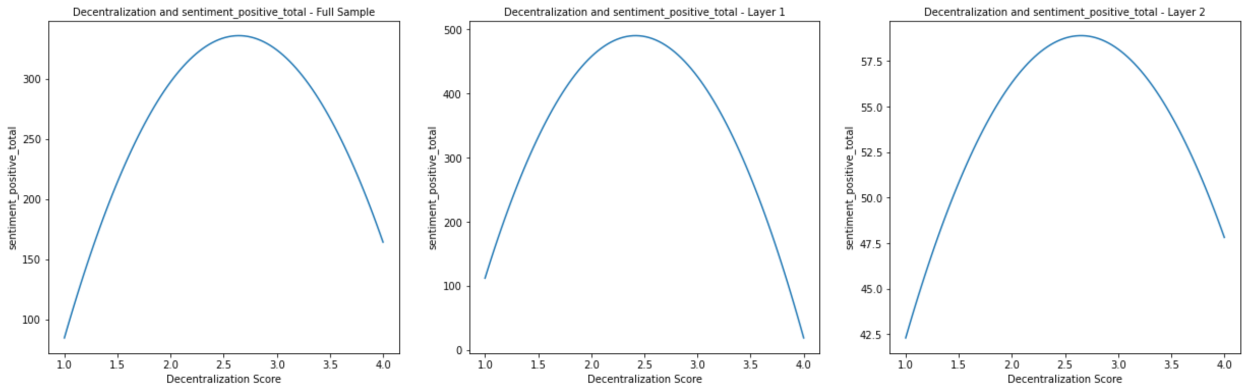

Figure 10 Decentralization and positive social sentiment

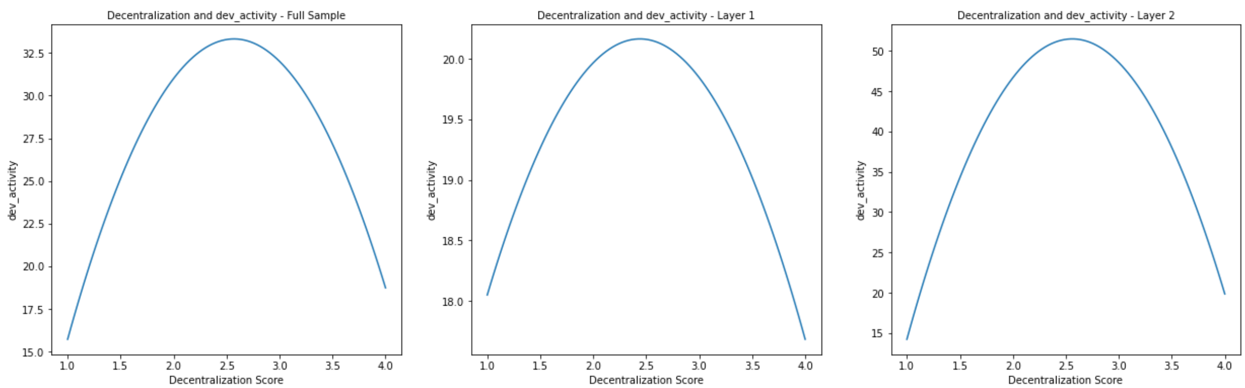

Figure 11 Decentralization and development activity

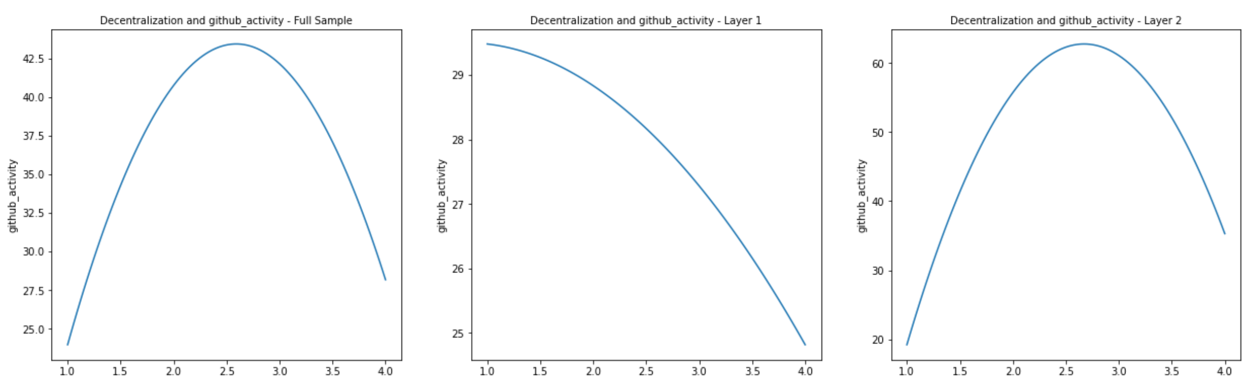

Figure 12 Decentralization and Github activity

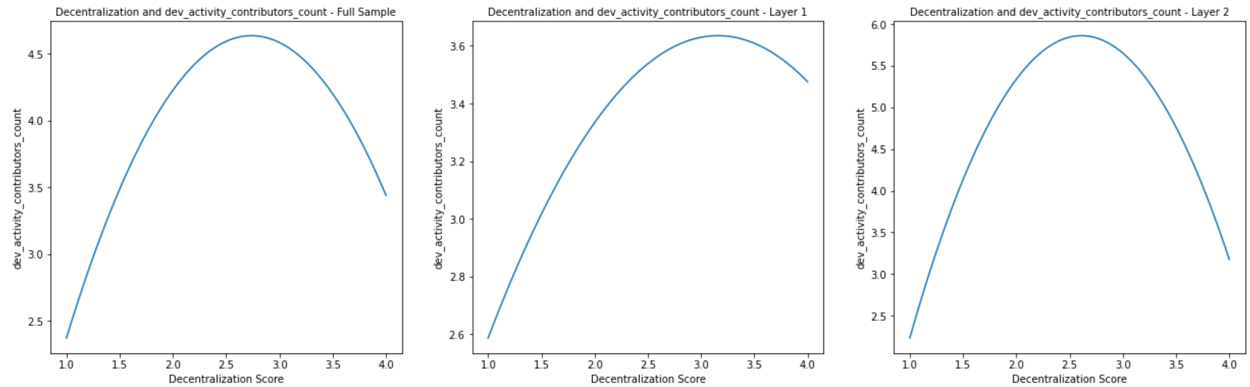

Figure 13 Decentralization and development contributor count

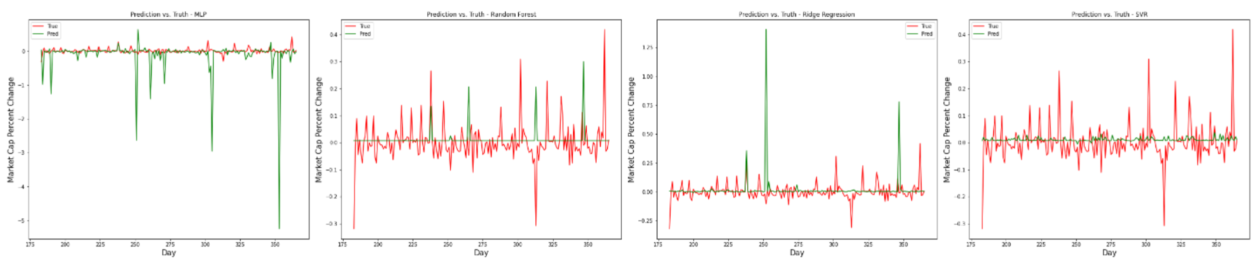

Figure 14 Machine learning results without decentralization as a feature

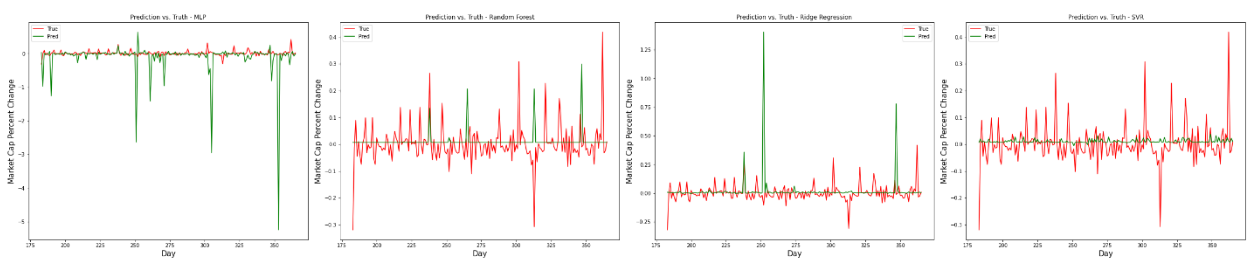

Figure 15 Machine learning results with decentralization as a feature

	MLP	**Random Forest**	**Ridge Regression**	**SVR**
MSE - Including decentralization	10.82951	1.26871	1.03361	1.04171
MAE - Including decentralization	0.45229	0.07668	0.06783	0.05891
MSE – Excluding decentralization	1.13648	1.26871	1.03361	1.04171
MAE - Excluding decentralization	0.11743	0.07668	0.06783	0.05891

Table 3 Machine learning results for predicting market cap percentage change

DISCUSSION

From running a series of polynomial regressions, I get the results shown in figure 7 through figure 13. Each figure consists of three parts which are results based on the full sample, layer-1 sample, and layer-2 sample, from left to right accordingly. The results are largely aligned with the results of Chen, Pereira, and Patel (2020), who run a series of OLS polynomial regressions and find the inverted U-shaped relationship between decentralization and other performance metrics. Most of the figures above exhibit an inverted U-shaped relationship between decentralization and other variables. This empirical finding implies that semi-decentralization is the ideal degree of decentralization since platforms with semi-decentralized governance tend to perform better as measured in market capitalization, development activity, and social attention.

Specifically, decentralization and market capitalization exhibit an inverted U-shaped relationship for the full sample and layer-1 applications, where semi-decentralization has the highest market capitalization. For layer-2 applications, however, the relationship seems not to hold as it shows a skewed U-shape. While the layer-2 result does not agree with the inverted U-shape relationship, it could be due to the difference in the scope of applications included in this analysis. However, this U-shaped relationship could also be an empirical indication that centralized and decentralized governance, especially decentralization, are important for layer-2 applications to have high market value, whereas semi-decentralized governance is not as instrumental. The inverted U-shaped relationship also fails to hold for decentralization with the total social volume on layer 2 platforms. The decreasing relationship means that the more centrally governed, the higher social attention that a layer 2 platform may get. A similar relationship is found for decentralization with GitHub activities on layer 1 platforms. Besides, another finding can be drawn from the fact that a lot of the relationships are somewhat skewed, while this again could be due to the limited number of data points, it could also mean that for certain variables, a good degree of decentralization is not necessarily semi-decentralization but somewhere in-between, either toward centralization or decentralization but not in extreme forms.

For the machine learning approach, to reiterate, the goal is to use machine learning to examine if decentralization is a valuable feature for boosting the accuracy of predicting the percentage change of market capitalization. In this study, the results show that adding decentralization as a feature does not improve the accuracy of predicting market capitalization. As shown in figure 14 and figure 15, the comparisons between prediction and actual values are the same. Surprisingly, adding decentralization as a feature does not reduce the errors even slightly, as shown in table 3. The results using MLP are worse when decentralization is included. Moreover, the feature importance of the decentralization score is 0 in the random forest model. Therefore, decentralization does not appear to help the accuracy of predicting the percentage of market capitalization. This could be due to the form and quality of governance data, or potentially that governance structure is not an effective predictor for market performance. Combining the finding from this machine learning approach with the inverted U-shaped relationship between decentralization and performance metrics, it can be concluded that while relationships exist between decentralization and performances of blockchain platforms, decentralization does not significantly help the prediction of market performances.

In light of the results above, I argue that semi-decentralization can enable blockchain platforms to have superior performances because it has beneficial elements from both centralized and decentralized governance (Kyprianou 2018). In semi-decentralized platforms, all community members can participate in decision-making processes, which allows for diversity and creativity of proposals and ideas. Meanwhile, having certain individuals who can make valuable inputs can make decision-making processes more efficient. In other words, I believe that semi-decentralization allows for a diversity of input while maintaining efficiency in achieving consensus on important decisions. For centralized and decentralized platforms, it might be helpful to incorporate elements from the other end. For instance, by giving up certain control and being more decentralized, centralized platforms show that they are committed to acting in the interests of all stakeholders of the platform. On the other hand, purely decentralized platforms should also consider centralizing certain power to a select group of people to improve the efficiency of decision-making (Chen and Bellavitis 2020). Since blockchain platforms are known for their decentralized nature, most of them are decentralized in governance. However, I would argue that decentralization to the extreme can be counterproductive to many aspects of platform growth. One prime example of purely decentralized governance is the Bitcoin project. Since its creation by Satoshi Nakamoto, Bitcoin has faced several times when the community cannot reach an agreement, some of which eventually resulted in hard forks and created completely new projects like Bitcoin Gold and Bitcoin Cash. As no individual can be more powerful than others in decentralized governance, critical decision-making can easily end in deadlocks or very slow, inefficient processes. Therefore, decentralized platforms also have incentives to be more centralized to some extent.

This research is mostly limited by data availability. To empirically assess the relationship between decentralization and other variables, it is necessary to have an extensive and reliable dataset of decentralization scores. However, the governance structure of a blockchain platform is not numerical, and evaluating it requires human intelligence and even expertise. The governance type, or decentralization score, is acquired from Coincheckup.com, which happens to provide such research data services. Ideally, the governance type data should be a time series that allows researchers to see how the governance structure of a project evolves with other variables. However, the governance data provided by CoinCheckup.com is mostly from three years ago. Unfortunately, to the best of the author's knowledge, there is no other source that provides such evaluations on governance types focusing on the aspect of decentralization. In addition, the methodology used to examine the effectiveness of decentralization as a feature for predicting market capitalization change can be more robust. Besides adopting a more extensive governance dataset and more robust methodology, future studies should consider exploring other aspects of governance beyond decentralization and examine their relationships with platforms' performances.

CONCLUSIONS

The degree of decentralization is a crucial aspect of governance (Bresnahan and Greenstein 2014). However, centralization and decentralization in their extreme forms are not effective (Posner and Weyl 2018, Hardin 1968). Finding an ideal degree of decentralization is therefore important for a platform's governance design and its overall sustainability. Current literature lacks in the study of governance structure on digital platforms as existing studies mostly focus on centralized governance, while paying less attention to decentralized structures. In addition, the exiguous study of decentralized governance structure is partly because different digital platforms have similar centralized governance structures while they are hardly comparable. This study contributes to the growing literature on the governance of digital platforms, specifically blockchain platforms. It also aims to narrow the academic gap on decentralized governance and its comparison with centralized governance structure. Most importantly, this study attempts to discover the ideal degree of decentralization for blockchain platforms by uncovering the relationship between decentralization and platform performances.

By finding the optimal degree of decentralization, this study sheds light on the effectiveness of governance structure on blockchain platforms. It also illustrates the characteristics of high-performing blockchain platforms. I recognize the importance of platform governance, especially decentralized governance, on emerging blockchain platforms and the digital economy. This study is believed to be able to contribute insights on the governance of blockchain platforms, specifically the degree of decentralization, through which I can examine the benefits and drawbacks of decentralized governance on blockchain platforms.

The research also contributes insights on how platform decentralization is related to the platform's performance using empirical analysis. First, the study focuses on decentralization in platform governance by drawing evidence from the increasing amount of blockchain platforms that haven't been widely studied. Second, by finding semi-decentralization as the ideal degree of decentralization for blockchain platforms, the study contributes to the understanding of the origin of high-performing governance structures. Third, the study recognizes the tradeoff between centralized and decentralized governance and sheds light on their benefits and limitations

(Ostrom 2010). While the study shows that an inverted U-shaped relationship exists between decentralization and most variables, the machine learning attempt in this study demonstrates that governance might not be sufficiently effective to improve the accuracy of predicting the percentage change in market capitalization.

In brief, I believe that this study can contribute to the understanding of the importance of decentralization in blockchain platform governance, and inform better designs of governance structures for blockchain platforms. For instance, this study can serve as the basis for the governance design of a high-performing blockchain platform. Future research could delve deeper into the causal relationships between blockchain governance and a platform's market performance. For instance, one could choose a specific type period or event and analyze how different governance characteristics, such as incentive and voting mechanism, affect the handling of the event and platform performances.

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APPENDICES

APPENDIX A: Article Published on SSRN

Tian, Lewis. 2021. "Unraveling the Relationship between ESG and Corporate Financial Performance - Logistic Regression Model with Evidence from China." Papers.ssrn.com. Rochester, NY. August 1, 2021. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3897207.

Abstract: With growing awareness of sustainability, the field of Environmental, Social and Governance (ESG), has been attracting mainstream investors and researchers. Many previous studies have found inconclusive or mixed results on the relationship between ESG ratings and firms' financial performance, which are mainly attributed to their varied markets, time horizons, and sources of ESG rating. Based on evidence from an emerging market, namely China, this paper examines whether ESG is an adequate indicator for firms' future financial performance. Given the divergence in ESG rating methodologies, I use ESG data from two ESG rating agencies, one based in China (SynTao) and the other based in Switzerland (RepRisk), for robustness. Specifically, I investigate 377 China A-share companies covered by both agencies and find that ESG rating, albeit divergent due to disparate methodologies, is instrumental in predicting the trend of corporate financial performance (CFP). This work verifies that the forward-looking nature of ESG makes it crucial for firms' long-term valuation and financial performance in emerging markets. Throughout the research, I observe four issues in the current ESG rating process: the opacity and inaccessibility of source data, the obscurity of ESG rating methodologies adopted by rating agencies, the lack of automated pipeline, and the unannounced historical data rewriting. I believe that the public blockchain ecosystem is promising to address these issues, and I propose future research on the ESG framework for blockchain to call for sustainability focus on this emerging technology.

Appendix B: Article Posted on Medium

Introduction: Governance is not only at the core of public and private sectors, but also in every blockchain project. This post first sheds light on the connections between traditional and blockchain governance, then discusses how blockchain and governance can be mutually empowering in creating a sustainable future.

Takeaways:

1. Traditional governance such as direct and representative democracy has an impact on shaping blockchain governance.
2. There is no one superior form of governance. Each type of governance played to the strengths of its nation/system.
3. Layers of blockchain governance mainly include on-chain and off-chain. Crucial dimensions of blockchain governance include incentives and decision making, etc.
4. Governance is crucial for blockchain projects' sustainability.
5. On-chain and off-chain governance have their own merits and flaws.
6. Emerging technologies like blockchain could revolutionize governance for the better.
7. Governance in blockchain, the private sector, and the public sector could together contribute to a sustainable future by making better and smarter decisions facilitated by technology.

Tian, Lewis. 2021. "Blockchain Governance for a Sustainable Future." SciEcon-Research. November 16, 2021. https://medium.com/sciecon-research/blockchain-governance-for-a-sustainable-future-881746a32099.

Appendix C: Presentation at the 2021 Fall CSCC Research Exhibition

Time: Thursday, September 23, 2021, 9:00 PM China Standard Time

Event Description:

The exhibition communicates and celebrates the participation of undergraduate students at DKU in scholarly inquiry, research, and creative endeavors. The aim is to give the students who have been involved in CSCC undergraduate research projects an opportunity to share their experiences, receive valuable feedback on their work, and contribute to the scholarly conversation.

Presentation Link: [Zoom Recording]

Poster:

Appendix D: 14th China UK Entrepreneurship Competition 2021 – Sustchain

Background: Inspired by my first stage of signature work, my fellow scholar Haoxin Yu and I proposed a practical business idea based on my research on sustainability and ESG, aiming to bring sustainability measurement to the blockchain space. With my signature work research outcomes complemented by some business planning, we were ultimately placed fourth (tie in third place) among over sixty contestants, only behind projects led by Ph.Ds. and professors.

Time: Monday, 10am to 2pm, February 28th, 2022 (UK time)

Event Description[2]**:**

The China-UK Entrepreneurship Competition was one of the "Prime Minister's Initiative" projects in the UK, aiming at promoting the exchanges and cooperation between China and Britain in such areas as economy, science, technology, education, etc., supporting the cultivation of Chinese and British students' competence of innovation and entrepreneurship, enhancing international integration and promoting the development of Sino-British friendship. Since its launch in 2006, the influence of the Competition has been increasing year by year. According to statistics, the Competition attracts about 200 teams from Chinese and British universities every year. The contestants include undergraduates, masters, fresh graduates, doctoral students, returnees from Britain, and so on. It has successfully supported more than 100 project teams to settle in China and Britain and received corresponding financial and policy support.

Presentation Slides: Sustchain Business Plan

[2] https://www.surrey.ac.uk/news/14th-china-uk-entrepreneurship-competition-officially-launches