Ethereum Ecosystem Index: A Comprehensive Study of Index Construction and Performance

by

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Final Project Presented to the Faculty of the Human Sciences and Technology School, at IE University in partial fulfilment of the requirements for the Degree of

Bachelor in Information Systems Management (BIS)

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May 2023

Abstract

The accelerated expansion of cryptocurrencies has increased the demand for universal benchmarks to evaluate investment strategies, monitor ecosystem growth, and guide market participants. This research proposes an index for the Ethereum ecosystem that employs two distinct index methodologies, examining capitalisation-weighted (CW) and equal-weighted (EW) indices constructed with varying numbers of constituents. Utilising historical daily price data of Ethereum ecosystem tokens from January 2021 to April 2023, the study conducts backtesting and empirical examination to offer valuable understanding for researchers and market players alike.

The findings reveal that CW indices consistently outperform EW indices in terms of return and risk measures. Precisely, the CW indices surpassed the EW indices by an average of 127.63% in terms of total return. Moreover, the suggested CW30 index exhibits considerable benefits compared to existing popular benchmarks. In particular, CW30 surpasses DPI, the foremost Ethereum ecosystem index, as a result of its wider array of constituents and a more inclusive methodology that encompasses various market sectors. As such, the CW30 index could prove to be a useful reference point for investors and market players in both the Ethereum ecosystem and the broader cryptocurrency community. The index may also serve as a benchmark for potential index products. In fact, this study establishes the groundwork for Ruemmele (2023), who suggests a practical implementation of an index protocol based on the findings.

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1. Introduction

1.1 Background and Motivation

Cryptocurrencies have gained rapid traction and growth in recent years and fundamentally reshaped the contemporary financial landscape. The driving force of the new asset class was the Bitcoin white paper published by Nakamoto (2008). Over the years, developers and cryptographers inspired by the project have contributed to numerous currencies, protocols and tokens. Buterin (2014) introduced Ethereum, which now leads the technical paradigm shift. Ethereum has emerged as the leading smart contract platform, powered by its own digital currency, Ether. In this study, we use the term "Ethereum" interchangeably to represent both the platform and its associated currency, following the common industry usage. The platform exceeded Bitcoin's functionality by leveraging decentralised applications and protocols through smart contracts. Despite the downward trend in asset values, the number of smart contract deployments on Ethereum has continued to rise, with Q4 2022 witnessing 4.6 million deployments and a year-over-year growth of 293% (‘Alchemy’, 2023).

Index investing has been a long-established practice in traditional finance, mainly shaped by the early works of Sharpe (1964) and Fama (1970). However, the founding of index fund issuers such as Vanguard made indices and index products successful. With the growing relevance of crypto, index investing has found its way into the cryptocurrency space, leading to the development of indices that track the performance of different market segments. Most prominently, CRIX, a cryptocurrency index reflecting the total market introduced by Trimborn & Härdle (2018).

A noticeable scarcity of academic literature exists on crypto indices, and CRIX stands as one of the few significant studies in this domain. Moreover, CRIX predominantly consists of native payment and settlement currencies, including Bitcoin, as well as alternative coins such as Ripple, Dogecoin, and Litecoin. Researchers have paid relatively little attention to specific ecosystems like Ethereum, leading to a lack of academic focus and scholarly exploration. Despite the significant growth and widespread adoption of the Ethereum ecosystem, the existing literature lacks comprehensive studies and analyses of its unique characteristics, dynamics, and performance. This highlights the need for further research and investigation to deepen our understanding of the Ethereum ecosystem and its distinct attributes, providing valuable insights for investors, market participants, and policymakers.

This study aims to bridge this knowledge gap by constructing the Ethereum Ecosystem Index (EEI). This study develops an index consisting of tokens that represent ownership rights, rather than focusing on payment and settlement currencies. Consequently, this study aims to contribute to the ongoing discussion on cryptocurrency indices and ultimately offer an index suitable for potential future index products.

1.2 Research Objective

Cryptocurrency indices have surfaced as instruments to improve transparency within the ever-changing digital currency market. These indices act as benchmarks, tracking the performance of a curated selection of cryptocurrencies listed on reputable and accessible exchanges. To ensure representation and reliability, these indices adhere to strict eligibility criteria.

The primary objective of this study involves proposing an EEI that accurately represents the Ethereum ecosystem. To achieve this, the index construction will utilise well-established methodologies from traditional finance, specifically comparing capitalisation-weighted (CW) and equal-weighted (EW) approaches. The study constructs indices with varying numbers of constituents (10, 20, and 30) to assess their performance across an array of financial metrics, such as total returns, risk measures, and risk-adjusted returns. The best performing index will undergo rigorous statistical testing against established benchmarks to assess its performance.

Ultimately, the goal is to propose an index that accurately embodies a broad representation of the Ethereum market while also providing practical utility as a benchmark for investors and forming the basis for index-based funds and products. Indeed, this study serves as the foundation for a practical feasibility and implementation analysis carried out by Ruemmele (2023). Ruemmele puts forth an index protocol based on the EEI outlined in this research, demonstrating its potential for real-world application. The study also seeks to add to the body of knowledge on cryptocurrency indices and offer insightful data to investors, asset managers, and other market participants.

1.3 Contribution and Significance of the Study

This study makes several significant contributions to the existing body of knowledge on index construction and performance, particularly in the context of the Ethereum ecosystem. The significance of this research can be attributed to several dimensions. First and foremost, this study becomes the first to conduct a comprehensive analysis of an index that reflects the Ethereum market, which has attracted significant attention in recent years. Simultaneously, Ethereum stands as the preeminent smart contract platform, possessing the capacity to serve as the infrastructure layer for innumerable protocols. By focusing on this emerging market, the research contributes to the understanding of the dynamics of Ethereum and its broader implications on the whole crypto industry.

Additionally, this study ranks among the first to conduct a thorough analysis of index construction methodologies within the emerging asset class of cryptocurrencies. It employs various analytical techniques to compare the performance of different index methodologies, which allows for a robust and nuanced understanding of the factors that drive index performance. Likewise, the findings of this study offer a practical approach to index construction and ultimately propose an index that can be used as a benchmark for index products. By identifying the index methodology that yields superior performance regarding financial indicators, this study can lead to the development of successful index-based products that find real-world application.

By shedding light on the distinctive elements of the Ethereum ecosystem, this study contributes significantly to the current understanding of cryptocurrencies. As a result, the findings have broader implications for investors, other market participants, and future research in the field of digital assets.

2. Literature review

2.1 Evolution of Index Funds

The ongoing debate between proponents of active and passive investment strategies in asset management has been a topic of considerable discussion and contention. While active fund managers seek to allocate and shift their assets in response to market opportunities, passive investors opt for broader, diversified market indices to capture the market's return. The theoretical foundation of index funds can be traced back to Sharpe (1964) and Fama (1970). Those scholars provided compelling empirical evidence demonstrating that security prices at any given moment incorporate all extant information. Thus, they posited that a market portfolio represents the optimal investment choice for any investor. Over the course of several decades, influential contributions by Sharpe (1991), Fama & French (2010), and other scholars (e.g., Carhart, 1997; Malkiel, 2005) have suggested that active asset managers, in view of fees and transaction costs, are unable to outperform the market's return in the long term. Consequently, Fama's Efficient Market Hypothesis and Sharpe's Capital Asset Pricing Model continue to be essential theoretical frameworks in the contemporary asset management landscape (Amenc et al., 2012). The theory further provided a foundation for the exponential expansion of index funds witnessed in recent decades.

Vanguard, currently the largest issuer of Exchange-Traded Funds (ETFs), was founded on the principles of Fama and Sharpe. Bogle, the founder of Vanguard, first introduced passive index funds that provide a simple and cost-effective way to invest in the broader market and capture the market's return. In the years since, index funds have grown exponentially and become one of the fastest-growing asset classes (Hill et al., 2015). Currently, there are more than 8700 ETFs in circulation across the globe, accounting for almost $10 trillion in managed assets (*ETFs - Statistics & Facts*, 2022).

2.2 Index Methodologies

The proliferation of ETFs has been accompanied by a significant expansion in diversity. A vast array of new index construction methodologies have emerged. To date, the majority of indices are based on the CW approach (Bolognesi et al., 2013), a methodology largely grounded in the groundbreaking Capital Asset Pricing Model established by Sharpe (1964). Asset management firms predominantly use market CW indices because of the inherent operational advantages they offer. The index maintenance demands minimal effort as the constituents' weightings automatically adjust in response to stock price fluctuations.

Moreover, fewer rebalancings are necessary leading to diminished transaction costs. The S&P 500, which uses the CW methodology, ranks as the most popular index (Schnitzler, 2018).

Despite the rise of CW indices, Bolognesi et al. (2013) first thoroughly compared the CW methodology with the EW approach. The authors focus on the constituents of the DJ Euro Stoxx index from January 2002 to December 2011 and provide empirical evidence of the higher risk-adjusted returns achieved by EW portfolios in comparison with CW indices. The authors show that the difference in performance between the two methodologies is not solely attributed to a 'size effect,' which typically explains the variance in their outcomes. They confirm their results by performing a Fama-French three-factor regression analysis. Bolognesi et al. (2013) found that within the European equity market the EW methodology shows higher excess returns in comparison to the CW approach.

Next to the popular CW and EW approach, other construction methodologies have attracted interest in recent decades. Those methodologies include fundamental-weighted (Arnott et al., 2005), momentum-weighted (Jegadeesh & Titman, 1993), volatility-weighted (Cazalet et al., 2013), and multi-factor indices (Amenc et al., 2012). All approaches come with trade-offs, such as factor exposure, diversification, turnover, and tracking error. Therefore, market participants must evaluate each methodology's objectives, assumptions and implications before choosing an adequate index.

2.3 The New Paradigm

Amidst the financial crisis of 2008, marked by the disintegration of the global financial infrastructure, an anonymous computer scientist unveiled a groundbreaking paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System." The primary aim was to establish a programmable currency devoid of reliance on centralised institutions, but opting for code as the foundation of trust. Pioneering advancements in digital signatures, data structures and cryptography enabled seamless peer-to-peer transactions on the Bitcoin blockchain (Nakamoto, 2008). Hence, the advent of blockchain technology gave rise to a new asset class characterised by remarkable growth potential.

After the rise of Bitcoin, the emergence of Ethereum marked a pivotal advancement in technology and cryptocurrencies. Ethereum first introduced smart contracts written in the native programming language Solidity. Thus, the native currency serves a critical function enabling the execution of smart contract code. The possibility of running code on a blockchain laid the foundation for the development of decentralised applications, protocols, and decentralised autonomous organisations (Buterin, 2014). Ethereum serves as a technical infrastructure for those products and services. Next to Ethereum, a multitude of smart contract platforms, such as Solana, Avalanche, and Binance Smart Chain, have surfaced. Despite this proliferation, Ethereum maintains its preeminence as the leading platform, commanding the lion's share of liquidity (*Total Value Locked All Chains*, n.d.).

Smart contracts were first proposed by Nick Szabo in 1994 as computerised transaction protocols that aim to accomplish pre-defined objectives agreed upon by involved parties (Meier & Sannajust, 2021). These digital agreements facilitate automated code execution upon the fulfilment of established conditions, resulting in improved transparency, security, and efficiency. Ethereum-based smart contracts, in particular, consist of code scripts deployed onto the network, which, once embedded, autonomously execute code. The accessibility of the contract code to all network participants serves to validate its legitimacy and accuracy, thereby fostering trust among parties. Consequently, these individuals can engage with one another exclusively on the basis of confidence in the code, obviating the need for a trusted third-party intermediary (Hewa et al., 2021). In essence, the self-executing nature of smart contracts removes the need for external entities, simplifying transactions and mitigating potential risks.

The advent of smart contracts and the inherent characteristics of cryptocurrencies have given rise to an alternative financial infrastructure constructed upon smart contract platforms such as Ethereum. Decentralised finance (DeFi) replicates traditional financial services by utilising protocols and products that are essentially smart contracts. These smart contracts provide increased openness, interoperability, and transparency in the DeFi ecosystem. (Chu et al., 2023). This sector expands the applications of cryptocurrencies beyond mere payment transactions, encompassing lending, borrowing, trading, investing, and asset management (e.g., Uniswap, Aave, YearnFinance, etc.). Leveraging the immutability, verifiability, and composability of the foundational blockchain infrastructure, the DeFi industry strives to enhance financial inclusion, promote open access, and diminish transaction costs. In recent years, the rapid proliferation of protocols, including over 800 decentralised exchange protocols, has rendered the crypto markets increasingly complex and challenging to navigate (*Protocol Categories*, n.d.). Consequently, investment in tokens necessitates a meticulous examination of the markets. In response to this growing complexity, the demand for cryptocurrency indices and index funds has emerged as a critical aspect of the evolving DeFi landscape.

2.4 Crypto Indices

In recent years, index investing has surged significantly within the conventional finance sector. However, when it comes to cryptocurrencies, most researchers primarily focus on market efficiency and short-term investment horizons (e.g., Kellner & Maltritz, 2021). Notwithstanding this, there remains a lack of academic investigation regarding cryptocurrency indices. Navigating the complex landscape of cryptocurrencies proves to be a significant challenge, given the distinctive market features, such as volatility, constant emergence, and the frequent disappearance of tokens.

The most notable research in the current landscape pertains to the Cryptocurrency Index (CRIX), an innovative index developed to reflect the overall market returns of cryptocurrencies. The genesis of CRIX can be traced back to the seminal work of Trimborn & Härdle (2018), who introduced the index in their paper entitled "CRIX an Index for cryptocurrencies", with the aim of constructing a more comprehensive, stable, and diversified representation of the cryptocurrency market landscape. The methodology supporting CRIX relies on both the market capitalisation and trading volume of cryptocurrencies and exhibits a dynamic nature. This dynamic approach is evident in the fluctuating number of index constituents that respond to market conditions. Researchers compute and maintain the index through a series of intricate steps that might initially resemble the methodology used in traditional market capitalisation indices. However, the incorporation of a dynamic approach to ascertain the optimal number of currencies introduces a degree of complexity that far surpasses that of conventional indices.

The CRIX project was not the only one to progress index studies in the context of cryptocurrencies. Building upon the foundation laid by the CRIX paper, Kim et al. (2021) introduced a volatility index known as VCRIX - A Volatility Index for Cryptocurrencies. The primary objective of this index was to capture the sentiment of investors within the cryptocurrency market. VCRIX is similar to the benchmarks VIX and VDAX, which measure volatility for the popular equity indices S&P 500 and DAX, respectively. They are frequently referred to as "fear indices" because of their tendency to rise when investors are uncertain about the direction that the markets will take in the future. To build VCRIX, the authors used a heterogeneous autoregressive (HAR) model. VCRIX thus shows the potential to be a useful indicator in capturing the complex dynamics of the fast-changing cryptocurrency market.

2.5 Crypto Index Products

Numerous enterprises, including prominent cryptocurrency exchanges such as Binance and Bitpanda, have introduced index products to their offerings (e.g., *Binance CMC Cryptocurrency Top 10 Equal-Weighted Index*, n.d.). Bitpanda, for instance, provides a diverse array of indices based on various asset classes, encompassing the top ten cryptocurrencies by market capitalisation, smart contract platforms, decentralised finance leaders, and media and entertainment leaders (*BCI*, n.d.). The proliferation of crypto index products has even extended to neobanks and traditional brokers, with Germany's broker Comdirect being one notable example (*Crypto Market 10 Index (Price) (USD)*, n.d.). Nonetheless, these market participants rely on centralised custody and infrastructure for the management of their crypto indices. To integrate these products into the conventional financial system, they are often securitised, thereby enabling trading on widely utilised stock exchanges. This approach has facilitated the expansion of the crypto asset class and its interaction with established financial markets.

In addition to the indices issued by exchanges and brokers, a growing number of index products have emerged in the form of smart contract-based indices. The most prominent example is the DeFi Pulse Index (DPI), which exclusively targets investments in DeFi protocols (*Defi Pulse Index*, n.d.). This innovative index represents a significant milestone, having amassed at maximum over $200 million in assets under management by November 2021 (*DeFiPulse Index*, n.d.). Index Coop, the organisation responsible for the deployment of the DPI smart contract, has also introduced alternative indices, including the Metaverse Index (*Metaverse Index*, n.d.). An analysis conducted by DeFi Llama, a prominent analytics tool, identified over 40 decentralised protocols with a focus on either index infrastructure or index curation (*Indexes TVL Rankings*, n.d.). Moreover, social trading platforms, such as TokenSets, facilitate access to a plethora of indices (*Asset Management for a DeFi World*, n.d.). TokenSets allows individuals to create and launch bespoke indices, which other investors can then pursue and invest in. However, it is important to note that most of these indices have not achieved substantial assets under management.

3. Conceptual Framework and Research Questions

3.1 Rationale for Constructing Ethereum Ecosystem Index

Given the tremendous growth in protocols and tokens in recent years and months, the demand for the EEI has increased significantly. The following section will shed light on the justification of constructing such an index.

3.1.1 Enhanced Accessibility and Participation

The EEI can promote broader participation in the blockchain and crypto space by being tracked by index products, thus simplifying the investment process. For novice investors or those who lack the time or expertise to research individual projects, investing in an index can provide a more accessible entry point into the new asset class.

3.1.2 Diversification and Risk Management

Crypto products that track the index proposed in this study, offer potential investors a multifaceted exposure to a diverse array of sectors and constituents within the Ethereum market. This approach encompasses an array of protocol categories, including those within the realm of DeFi, infrastructure protocols, as well as media and entertainment-oriented protocols. By investing in an index that covers multiple segments, investors can potentially reduce their portfolio's risk associated with investing in this emerging asset class.

3.1.3 Performance Benchmarking

The EEI can be used as a benchmark for the broader Ethereum community to be able to judge the performances of specific protocols or projects. By comparing a protocol's performance against the index, market participants can ascertain whether their strategies have yielded alpha or outperformance in their investments. Concurrently, organisational leaders can evaluate this index to assess the relative success of their projects, while regulators can utilise the index as an insightful market indicator for guiding policy decisions.

3.1.4 Market Transparency and Information Discovery

Constructing EEI can contribute to increased market transparency and improved information discovery. By aggregating data and performance metrics from various projects and sectors within the Ethereum network, the index can provide valuable insights into the overall health and growth of the ecosystem. This information can be useful for market participants, such as traders, analysts, and researchers, as they assess the market's dynamics and develop their investment strategies.

3.1.5 Supporting the Growth and Development of the Ethereum Ecosystem

Finally, building EEI can considerably contribute to the Ethereum network's growth and development. As potentially more index products track the proposed benchmark, the many constituent projects and sectors covered by it stand to profit from an influx of capital and increased interest. This, in turn, can ignite a chain reaction of cascading consequences, accelerating creativity, fostering technical improvements, and ultimately enabling the ecosystem's boundless development.

In summary, constructing the EEI can provide numerous benefits to investors, market participants, and the broader blockchain community. By offering enhanced accessibility for a diversified index, as well as performance benchmarking and increased market transparency, the index can help promote informed decision-making and support the continued growth and development of the Ethereum network.

3.2 Research Questions

The goal of this study is to develop the EEI, an index designed to track the market return of the Ethereum ecosystem. Based on the literature review and the rationale for constructing the EEI, this study aims to investigate the following research questions:

RQ1: What is the optimal approach for reflecting the Ethereum ecosystem in the EEI, considering a comparison of CW and EW index methodologies?

This research question explores the possibility of determining the most effective methodology for constructing the EEI, which yields superior performance by analysing and comparing different index methodologies.

RQ2: Can the EEI serve as a valuable benchmark for evaluating the performance of investment strategies in the Ethereum ecosystem and the broader cryptocurrency community?

This research question investigates whether the EEI can be utilised as a performance benchmark and as a foundation for potential index products.

4. Data and Methodology

This section provides an overview of the data and methodologies employed in the construction of the EEI. To ensure reliable and accurate price data, reputable sources like CoinMarketCap and Coingecko are utilised. Additionally, the eligibility criteria for the tokens included in the index are outlined, ensuring that only qualified tokens are incorporated. The index methodologies adhere to established financial best practices (Bolognesi et al., 2013; Sharpe, 1964), encompassing CW and EW approaches. To validate the performance of the indices, three different versions with varying constituent counts are backtested. Python scripts facilitate the implementation of the indices and enable the backtesting of historical index performance.

As illustrated in Figure 1, the Python scripts initially process the historical snapshots supplied by CoinMarketCap. Subsequently, the script evaluates the eligibility criteria for each token and incorporates them into the index construction. Price data is then obtained from Coingecko, and the index calculation is performed.

Index Construction Process Flowchart

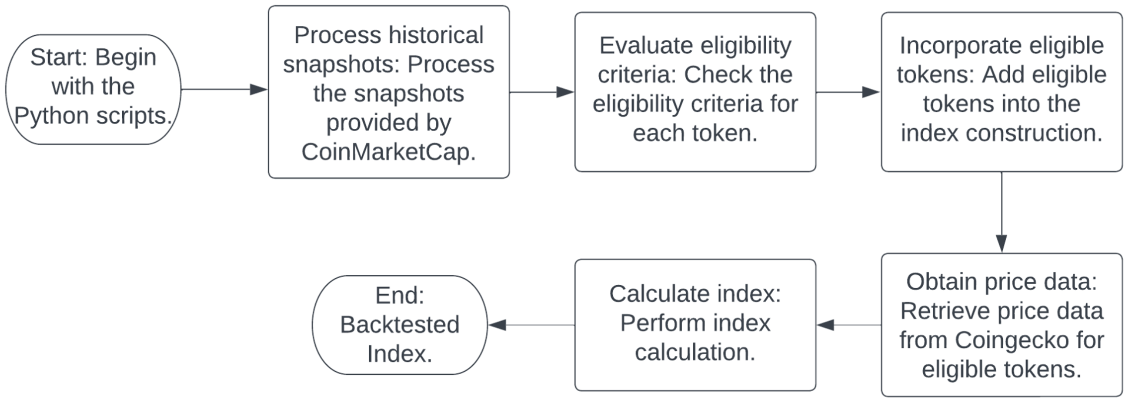

Figure 1: The flowchart outlines the sequential steps involved in constructing the cryptocurrency index using Python scripts. It demonstrates the process from processing historical snapshots to calculating the index, incorporating data from reputable sources and evaluating eligibility criteria for each token.

4.1 Data

The employment of high-quality data is of high importance in conducting rigorous backtesting of the computed indices. As the cryptocurrency industry, especially the Ethereum ecosystem, is still in its early stages, with the initial wave of protocols and associated tokens appearing in 2020, backtesting only covers the years 2021, 2022, and 2023.

Two reliable data sources supply the necessary data. First of all, CoinMarketCap provides historical snapshots of token prices, as seen in Appendix 1. The snapshots contain relevant information about the reconstitution and rebalancing of the underlying index tokens at the end of period. Given that historical snapshots from CoinMarketCap are exclusively captured on Sundays, the backtesting of the index will commence on the initial Sunday of 2021 (03.01.2021) and conclude on the final Sunday of Q1 2023 (02.04.2023). Next to that, I utilise the Coingecko Pro API to obtain accurate historical price data. As a widely recognised and trusted API, Coingecko consistently delivers accurate price data, thereby ensuring the robustness of the study. Figure 2 displays exemplary price data for the Aave token obtained from Coingecko. By leveraging these two data sources, both the CW and EW indices can be effectively backtested, thereby guaranteeing a methodologically sound approach in terms of data availability and quality.

Sample Price Data for Aave Token

timestamp	***price***	***market_cap***
1672531200000	51.93	738,478,432.26
1672617600000	51.99	739,535,655.86
1672704000000	53.13	757,374,704.34
1672790400000	53.05	754,392,167.03
1672876800000	56.83	807,998,606.68

Figure 2: Price data snapshot of the Aave token, displaying daily price and market capitalisation values obtained from Coingecko over a span of five consecutive days (Sunday, January 1, 2023 - Thursday, January 5, 2023).

In financial analysis, experts often estimate the potential performance of an index before its official launch. However, researchers and analysts must recognise back-tested data's limitations, as it represents hypothetical index performance rather than actual data. Consequently, caution must be exercised when interpreting back-tested data due to potential discrepancies between historical simulations and future projections of the index performance.

4.2 Token Classification Dimensions

The EEI should serve as a benchmark reflecting the Ethereum ecosystem. To maintain the index's validity and reliability, it is essential to employ rigorous inclusion criteria for selecting secure, valuable, and viable tokens. The criteria comprise four dimensions, each assessing distinct aspects of the tokens and their underlying projects. The following section delves into the token inclusion criteria for the EEI, encompassing token descriptive characteristics, token supply characteristics, project traction characteristics, and protocol user safety characteristics. Utilising this multifaceted approach allows for a comprehensive evaluation of tokens, ultimately leading to an accurate representation of the Ethereum ecosystem's performance.

Moreover, the eligibility criteria are substantiated through the utilisation of the International Token Classification (ITC) framework, developed by the International Token Standardization Association (ITSA). This deliberate application of the ITC framework underpins the strength and reliability of the eligibility criteria, further ensuring the robustness and effectiveness of the selection process. Appendix 2 provides an illustration of classified tokens, demonstrating the application of the ITC framework. The standardised ITC framework organises cryptocurrencies and tokens according to their inherent characteristics. It encompasses six dimensions: Economic Purpose, Issuer Type, Issuer Industry, Technological Setup, Legal Claim, and Regulatory Status EU (*International Token Classification (ITC) Framework Documentation*, 2021). Each dimension consists of several categories and subcategories that describe the properties of a token in a granular and comprehensive manner. The ITC framework may serve as a helpful tool for regulators, companies, investors, funds, and users alike. According to ITSA, the framework could be especially beneficial for token issuers as it allows them to convey token features to users and investors effectively (*International Token Classification (ITC) Framework Documentation*, 2021).

The EEI project has been fortunate to receive a generous contribution from ITSA tailored to our project's needs. This invaluable resource contains token classifications, empowering us to efficiently categorise tokens based on the established criteria. The EEI places significant emphasis on the Economic Purpose dimension, which serves as a primary factor for inclusion. In cases where tokens are not represented in the provided data source, they will be manually added and classified. Consequently, the EEI meticulously examines each token to assess its eligibility for inclusion in the indices, aligning with the criteria outlined in the subsequent section.

4.3 Eligibility Criteria

The following sections outline the eligibility criteria for tokens included in the EEI. I carefully considered these criteria, drawing inspiration from the ITC framework and incorporating other relevant metrics for index classification. Establishing these criteria is essential for constructing an EEI that accurately represents the Ethereum ecosystem.

4.3.1 Token Descriptive Characteristics

A. The token must be part of the Ethereum ecosystem.

B. The token must not be classified as a security by the regulatory authorities in the respective jurisdictions of the United States and the European Union.

C. The token's Economic Purpose (ITC) dimension must be one of the following:

1. Utility Token
    a. Governance Token
    b. Ownership Token
    c. Settlement and Governance Token

D. The token must be a bearer instrument, excluding the following Economic Purpose (ITC) dimensions from index inclusion:

1. Payment Token
2. Utility Token

   a. Settlement Token
   b. Access Token
   c. Settlement and Access Token
3. Investment Token
4. Token with Other Economic Purpose

The Economic Purpose (ITC) dimensions ensure that the tokens included in the EEI exclude various categories such as payment and settlement tokens, wrapped tokens, tokenised derivatives, synthetic assets, tokens tied to physical assets, or tokens representing claims on other tokens. The tokens eligible for the inclusion of the index must be bearer instruments and represent protocol ownership and participation in any form.

4.3.2 Token Supply Characteristics

A. The token's supply must be reasonably predictable over a five-year period.

B. At least 10% of the anticipated five-year supply must be currently circulating.

C. The token's economics must not entail locking, minting, or other patterns that would substantially disadvantage passive holders.

4.3.3 Project Traction Characteristics

A. The project must be widely acknowledged as developing a useful protocol or product.

B. Projects that primarily focus on competitive trading or holding, exhibit characteristics of a Ponzi scheme, or are predominantly designed for entertainment purposes are ineligible for inclusion.

C. The project's protocol must exhibit significant usage exhibited by total value locked (TVL) or user metrics.

D. The protocol or product must have been launched a minimum of 180 days prior to being eligible for inclusion in the index.

E. The protocol or project must not be insolvent.

4.3.4 Protocol User Safety Characteristics

A. Security professionals must have reviewed the protocol to ensure adherence to best security practices for maintaining user assets' safety under various conditions. Alternatively, the protocol must have operated long enough to establish a consensus regarding its safety within the Ethereum community.

B. In the event of a safety incident, the team must promptly and responsibly address the situation, providing users with a reliable solution and transparent documentation of the incident.

C. The selected tokens must demonstrate sufficient liquidity across a diverse range of trading platforms.

The EEI relies on a comprehensive set of inclusion criteria spanning multiple dimensions utilising at par the ITC framework and the data source provided by ITSA to determine the tokens that will be incorporated. This rigorous approach ensures the selection of secure, valuable, and well-supported tokens, thus providing a reliable and accurate benchmark for the Ethereum community. The integration of the ITC framework equips the EEI with enhanced capabilities to navigate the ever-changing token landscape and respond effectively to regulatory developments. This integration promotes greater transparency and safety within the global cryptocurrency market, ensuring that the index remains aligned with evolving industry standards.

4.4 Capitalisation-Weighted Index

The subsequent section focuses on outlining the construction of the EEI through the application of the CW index methodology.

4.4.1 Index Construction

A CW index, also known as a value-weighted index, assigns individual constituents based on the market capitalisation of the underlying assets. This results in an index that gives greater prominence to constituents with larger market capitalisations, effectively reflecting their relative impact on the overall Ethereum market.

To explore the effects of varying index constituents on the overall representation of the Ethereum market, three separate index versions will be constructed, containing 10, 20, and 30 constituents, respectively. The choice of more constituents is avoided, as it could make the index difficult to replicate in index products because of high transaction costs. This approach permits a thorough analysis of the advantages and disadvantages of diverse index compositions, thereby enabling the identification of the optimal number of constituents for the most accurate representation of the Ethereum ecosystem.

The maintenance of the EEI will include a reconstitution and rebalancing interval of three months, allowing for the periodic adjustment of index constituents and their respective weights. This interval ensures that the index remains up-to-date and accurately reflects the most recent market trends and developments in the Ethereum ecosystem. Bolognesi et al. (2013) suggest that a three-month rebalancing period is optimal, which aligns with standard practices in finance. Comparing different rebalancing periods for indices is beyond the scope of this paper.

Employing a normalising divisor allows for a comprehensible representation of the index price. This divisor, set at the time of index issuance as a fixed value, undergoes adjustments during each reconstitution, rebalancing phase, and in response to other market events that influence the underlying components of the index. In these situations, the divisor accounts for those changes in the index's underlying components. This action is undertaken to uphold the consistency of the index price and ensure that informed market participants can interpret it effectively.

4.4.2 Index Calculation

The CW index calculation methods assign weights to each constituent based on their respective market capitalisation. The Laspeyres index serves as the foundation for the EEI's index calculation, measuring the relative price changes of a fixed basket of goods and services over time. This economic indicator proves relevant to the CW index methodology by using base period quantities, such as market capitalizations, to calculate the price change of the index level and represent the overall market's movement.

For a basket of k constituents at time t relative to the base period 0, we can denote a Laspeyres (P^L) index as follows.

$$P^{L}_{0t}(k) = \frac{\sum_{i=1}^{k} P_{it} Q_{i0}}{\sum_{i=1}^{k} P_{i0} Q_{i0}}$$

In this equation, P_{it} represents the price of constituent i at time t, and Q_{i0} denotes the quantity of constituent i at time 0. The free-float quantity of tokens, Q_{i0}, is multiplied by the asset's price, resulting in the market capitalisation of the token. The numerator thus represents the total market capitalisation of all index constituents summed up at a specific point in time t. On the other hand, the denominator represents the base period of the total market capitalisation of all constituents.

In index mathematics, the base period is commonly known as the divisor. Consequently, the Laspeyres equation can be simplified using the "base-weighted aggregative" method and obtain the following:

$$Index\ Level\ = \frac{\sum_{i} P_i Q_i}{Divisor}$$

Here, P_i is the price of constituent i, and Q_i represents the free-float quantity of constituent i at a specific time. The sum of all constituents results in the total market capitalisation of the index constituents, which positions the numerator as a measure of the current market value. The denominator is the divisor, which initially refers to the base period of the Laspeyres index until the divisor is adjusted. A detailed explanation of the divisor calculation and its subsequent adjustments will be provided in the following section.

4.4.3 Divisor Adjustments

The divisor plays a critical role in the calculation of the index value by ensuring consistency and continuity throughout reconstitution, rebalancing, and other market events. For example, if the EEI has a value of $500 and one constituent is replaced by another, the index must remain at $500 after the replacement. This continuity is achieved by making precise adjustments to the divisor.

In the context of a CW index, the initial divisor ($Divisor_0$) can be mathematically defined at the time of index creation as follows:

$$Divisor_0 = \frac{\sum_i P_i Q_i}{Starting\ Value}$$

Here $\sum_i P_i Q_i$ represents the initial total market capitalisation of all constituents. The divisor at period 0 depends on the specific starting value that the index issuer aims to set when creating the index. Most commonly, the starting value of an index is chosen to be \$100.

When an adjustment to the divisor is required (for instance, during a rebalancing and reconstitution), the new divisor at period i ($Divisor_i$) is calculated as follows:

$$Divisor_i = Divisor_{i-1} * \frac{\sum_i P_i Q_i}{\sum_{i-1} P_i Q_i}$$

In this equation, $Divisor_{i-1}$ represents the divisor from the previous period ($i - 1$). The total market capitalisation of all constituents at period i ($\sum_i P_i Q_i$) is multiplied by the divisor from the previous period and this product is then divided by the total market capitalisation of all constituents at the previous period ($\sum_{i-1} P_i Q_i$).

In conclusion, this section has outlined the construction and calculation methodology for the EEI using a CW approach. By constructing three separate index versions with 10, 20, and 30 constituents, the study aims to identify the optimal index composition for accurately representing the Ethereum ecosystem. By employing the Laspeyres index as the basis for calculation and making appropriate divisor adjustments, the EEI offers a consistent and comprehensible representation of the Ethereum market's movement. This CW index construction sets the stage for a comparison with the EW methodology.

4.5 Equal-Weighted Index

Similar to the CW index construction methodology, the primary aim of the EW index is to reflect the Ethereum market and ecosystem in the best possible way. In fact, in traditional financial markets, studies have shown that an EW index can indeed better represent the market and yield superior performance (e.g., Bolognesi et al., 2013). The following section focuses on outlining the construction of the EEI through the application of the EW index methodology.

4.5.1 Index Construction

An EW index assigns equal importance to all individual constituents, regardless of the market capitalisation of the underlying assets. This results in an index that treats each constituent with equal significance, providing a more balanced representation of the overall Ethereum market without emphasising larger market capitalisations but rather giving more weight to tokens with smaller market capitalisation. The index construction will encompass three different numbers of constituents, specifically 10, 20, and 30, chosen to represent a range of variations within the index. Furthermore, there will be a reconstitution and rebalancing period every three months. The EW index will follow the same methodology regarding index mathematics for computing the divisor.

4.5.2 Index Calculation

EW index calculation methods assign equal weights to each constituent asset. In this methodology, the index level is calculated by first determining the equal weight assigned to each constituent. The equal weight for each constituent can be found by dividing one by the total number of constituents in the index.

$$W_i = \frac{1}{n}$$

Where n represents the total number of index constituents, and W_i denotes the equal weight assigned to constituent i.

The index level is calculated by summing the product of each token's price and its equal weight. This sum represents the total adjusted value of all the index constituents, taking into account the equal weighting assigned to all the constituents.

$$Index\ Level = \frac{\sum_i P_i W_i}{Divisor}$$

Where P_i represents the price of constituent i, W_i is the equal weight assigned to constituent i, and the divisor is a constant value that normalises the index level.

The sum of all adjusted values represents the total weighted price of the index constituents, with the numerator acting as a measure of the current market value. This EW index calculation method provides a balanced representation of the overall Ethereum market, as it does not emphasise larger market capitalisations but rather assigns equal importance to all constituents, regardless of their market capitalisation. In order to maintain the index price continuity, the divisor must be adjusted accordingly.

4.5.3 Divisor Adjustments

The procedure for divisor adjustment in the EW index will mirror the mathematical principles applied to the CW index. The initial index value, set prior to index incorporation, serves as the basis for divisor calculation. Subsequent changes in the index, including reconstitution, rebalancing, and other events, necessitate corresponding adjustments to the divisor. These adjustments ensure the continuity and comparability of the index level over time.

In the context of an EW index, the initial divisor ($Divisor_0$) can be mathematically defined at the time of index creation as follows:

$$Divisor_0 = \frac{\frac{\sum_i P_i}{n}}{Starting\ Value}$$

Here, $\sum_i P_i$ represents the sum of the initial prices of all constituents, and n is the number of constituents in the index. The divisor at period 0 depends on the specific starting value, usually \$100.

When an adjustment to the divisor is required (for instance, during a rebalancing and reconstitution), the new divisor at period i ($Divisor_i$) is calculated as follows:

$$Divisor_i = Divisor_{i-1} * \frac{\frac{\sum_i P_i}{n}}{\frac{\sum_{i-1} P_i}{n}}$$

In this equation, $Divisor_{i-1}$ represents the divisor from the previous period ($i - 1$). The sum of the prices of all constituents at period i ($\sum_i P_i$) is divided by the number of constituents (n), and this result is multiplied by the divisor from the previous period. This product is then divided by the sum of the prices of all constituents at the previous period ($\sum_{i-1} P_i$) divided by the number of constituents (n).

In conclusion, this section has outlined the construction and calculation methodology for the EEI using an EW approach. By constructing three separate index versions with 10, 20, and 30 constituents, the study aims to identify the optimal index composition for accurately representing the Ethereum ecosystem. By employing an EW index as the basis for calculation and making appropriate divisor adjustments, the indices offer a consistent and comprehensible representation of the Ethereum market's movement.

5. Empirical Results

The aim of this research is to propose an accurate representation of the Ethereum ecosystem through the EEI. To achieve this, this section examines the performance of the six constructed indices. These indices fall into two categories based on their index methodologies: capitalisation-weighted and equal-weighted. The indices differ in terms of constituent numbers while following the same rebalancing intervals, as shown in Figure 3. The timeframe is from The following analysis will shed light on the superior index methodology reflecting the Ethereum ecosystem.

Summary of Constructed Indices

Name	*Index Methodology*	*Number of Constituents*	*Rebalancing Interval*
CW10	capitalisation-weighted	10	three months
CW20	capitalisation-weighted	20	three months
CW30	capitalisation-weighted	30	three months
EW10	equal-weighted	10	three months
EW20	equal-weighted	20	three months
EW30	equal-weighted	30	three months

Figure 3: Summary of the six constructed indices in this study, highlighting Name, Index Methodology, Number of Constituents, and Rebalancing Interval.

The CW indices assign weights to their constituents based on market capitalisation, resulting in higher weights for larger market-cap tokens. The three CW indices in this study are CW10, CW20, CW30, comprising 10, 20, and 30 constituents, respectively. All CW indices are rebalanced every three months to maintain their respective weightings. On the other hand, the EW indices allocate equal importance to each constituent, irrespective of market capitalisation. This approach leads to a more balanced representation of the market segment. The EW indices in this study include EW10, EW20, and EW30, with each index consisting of 10, 20, or 30 constituents. The EW indices are also rebalanced every three months.

By comparing the performance of these indices (Figure 4), this study determines the advantages and disadvantages of each index methodology, identifies the index best suited to reflect the Ethereum ecosystem, and provides valuable insights for investors and market participants.

Comparison of Index Performance

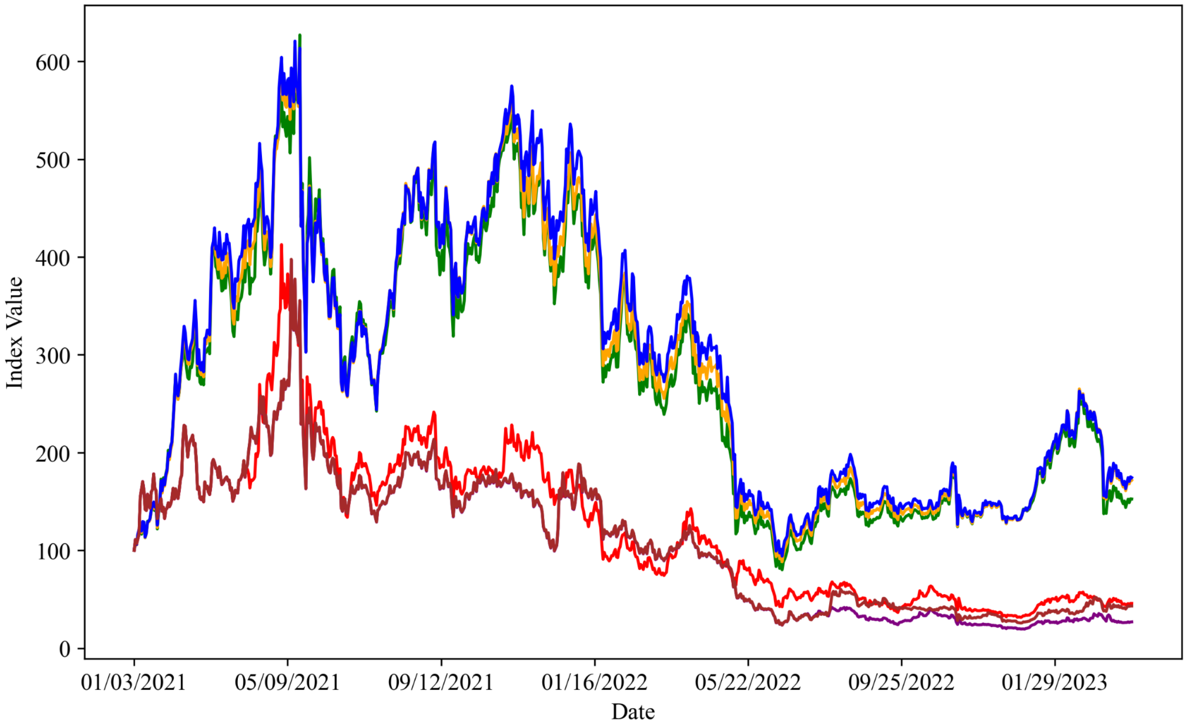

Figure 4: A visual representation of the performance of indices (***CW10***, ***CW20***, ***CW30***, ***EW10***, ***EW20***, and ***EW30***) from January 3, 2021, to April 2, 2023, showcasing their performance throughout 2021, 2022, and the first quarter of 2023. Data is derived from calculations performed using a custom Python script.

5.1 Performance Metrics Analysis

In this section, the paper will examine the performance metrics of the three CW and three EW indices, respectively. The three distinct index versions are constructed based on the number of constituents (10, 20, or 30) and will incorporate a rebalancing period of three months.

Summary Descriptive Statistics

Index	*Total Return*	*Mean Return*	*Median Return*	*Standard Deviation*	*Sharpe Ratio*	*Sortino Ratio*	*Max Drawdown*
CW10	0.52461	0.00218	0.00491	0.05746	-0.19770	-0.29032	0.87228
CW20	0.71665	0.00216	0.00458	0.05440	-0.20827	-0.30058	0.85645
CW30	0.74345	0.00214	0.00544	0.05367	-0.21101	-0.30361	0.84857
EW10	-0.54273	0.00076	-0.00097	0.05946	-0.21459	-0.36886	0.92396
EW20	-0.73165	0.00022	0.00083	0.06108	-0.21789	-0.35423	0.95102
EW30	-0.56969	0.00087	0.00081	0.06207	-0.20530	-0.32633	0.94078

Figure 5: A summary of the key descriptive statistics for each of the six indices examined in the study, encompassing Total Return, Mean Return, Median Return, Standard Deviation, Sharpe ratio, Sortino ratio, and Maximum Drawdown, covering the time frame from January 3, 2021, to April 2, 2023. The daily risk-free rate is sourced from Yahoo Finance using the ticker "^IRX". The data presented is derived from calculations performed using a custom Python script.

As seen in Figure 5, CW indices demonstrate higher total returns and mean returns compared to EW indices. This trend is consistent across all the indices, regardless of the number of constituents. Specifically, the CW10, CW20, and CW30 indices had total returns of 52.46%, 71.67%, and 74.35%, respectively, while the EW10, EW20, and EW30 indices exhibited negative returns of -54.27%, -73.17%, and -56.97%. Overall, the CW indices outperformed the EW indices by an average of approximately 127.63% in terms of total return. The median returns for the CW indices are also higher than those for the EW indices. Among the six, the index with the highest total return is the CW index with 30 constituents (CW30).

The performance metrics suggest that the larger the number of constituents in a CW index, the better the overall performance in terms of total returns. The superior performance of CW indices can be attributed to the fact that these indices give more weight to companies with larger market capitalisations, which tend to be more established and stable. As a result, CW indices are more likely to capture the growth and returns generated by these larger and more dominant companies in the market. On the other hand, EW indices assign the same weight to all constituents regardless of their market size, which results in a less favourable performance.

In terms of risk, the standard deviation is lower for CW indices, implying that they are less volatile than their EW counterparts. However, the Sharpe and Sortino ratios, which measure risk-adjusted returns, are negative for both types of indices. The Sharpe ratio equals the average excess return of an investment over the risk-free rate divided by the standard deviation of the excess return. A higher Sharpe ratio implies better risk-adjusted performance. In this case, the negative Sharpe ratios suggest that the average excess return for both types of indices is lower than the risk-free rate, indicating an unfavourable risk-adjusted performance. Only considering the downside risk, or the negative deviation of returns, the Sortino ratio is similar to the Sharpe ratio. It equals the average excess return of an investment over the risk-free rate divided by the downside deviation of the excess return. A higher Sortino ratio implies better performance, especially when considering downside risk. The negative Sortino ratios for both types of indices signify that their downside risk-adjusted performance is also unfavourable in the given sample.

The maximum drawdown, a measure of the largest peak-to-trough decline in the value of an index, is lower for CW indices. This indicates that the CW indices experience smaller declines in value compared to EW indices.

In conclusion, the CW indices outperform EW indices in terms of total returns, mean returns, and risk measures, such as standard deviation and maximum drawdown. However, both types of indices exhibit negative risk-adjusted performance, as evidenced by their Sharpe and Sortino ratios. The findings indicate that CW indices may offer a better reflection of the Ethereum market characterised by significantly greater return metrics as well as lower risk measures. Moreover, the CW30 index demonstrates superior performance compared to CW10 and CW20 indices, suggesting that indices with a larger number of constituents yield better results. Consequently, the EEI that most accurately reflects the Ethereum ecosystem would be a CW index comprising 30 constituents.

5.2 Correlation Analysis

The Pearson correlation analysis provides useful supplemental information for understanding the relationships between the different index approaches. The coefficient measures the linear relationship of two time series datasets. The correlation matrix shows how the CW and EW indices move together or apart under various market conditions and segments and whether there are any significant diversification benefits.

Pearson Correlation Matrix for Ethereum Ecosystem Indices

	CW10	*CW20*	*CW30*	*EW10*	*EW20*	*EW30*
CW10	1					
CW20	0.998	1				
CW30	0.994	0.998	1			
EW10	0.876	0.867	0.854	1		
EW20	0.865	0.858	0.848	0.965	1	
EW30	0.867	0.860	0.849	0.965	0.998	1

Figure 6: The Pearson correlation matrix displays the pairwise correlation coefficients between the six indices (CW10, CW20, CW30, EW10, EW20, and EW30), covering the time frame from January 3, 2021, to April 2, 2023. The data presented is derived from calculations performed using a custom Python script.

The correlation matrix shows that the CW indices (CW10, CW20, and CW30) have a very high positive correlation with each other, ranging from 0.994 to 0.998. This means that the CW indices move in a similar direction and magnitude under various market conditions and segments.

Likewise, the EW indices (EW10, EW20, and EW30) have a strong positive correlation with each other, ranging from 0.965 to 0.998. This means that the EW indices also move in a similar direction and magnitude under different market conditions and segments.

When comparing the CW indices with the EW indices, the correlations are lower, ranging from 0.854 to 0.876. This indicates a lower degree of similarity in their performance, suggesting that there might be some diversification benefits across CW and EW indices.

The average pairwise correlation for all the indices is 0.926. This relatively high value suggests that the performances of the indices are, on average, strongly correlated with each other. The overall correlation structure indicates that the potential for diversification is limited, while some diversification benefits may exist across the methodologies.

In conclusion, the correlation analysis shows how the CW and EW indices move together or apart under various market conditions and segments. It also reveals their different exposures to various factors that affect their performance. Although this analysis does not directly address the identification of the optimal index methodology, it provides valuable context for understanding the relationships between different index methodologies and their potential diversification benefits. Investors seeking greater diversification may need to consider other asset classes, or the incorporation of alternative weighting methodologies. This supplementary analysis can be helpful for investors who seek a more comprehensive understanding of the Ethereum ecosystem.

5.3 Benchmark Performance Comparison

This section compares the performance of the best-performing index from our previous analysis, the CW index with 30 constituents (CW30), with other market indices and assets, specifically Bitcoin, Ethereum, DPI (DeFi Pulse Index), and CRIX (Cryptocurrency Index), as seen in Figure 7. By comparing the performance of CW30 to these benchmarks, this study evaluates its relative performance within the broader cryptocurrency and digital asset market.

Comparative Performance of CW30 and Key Benchmarks

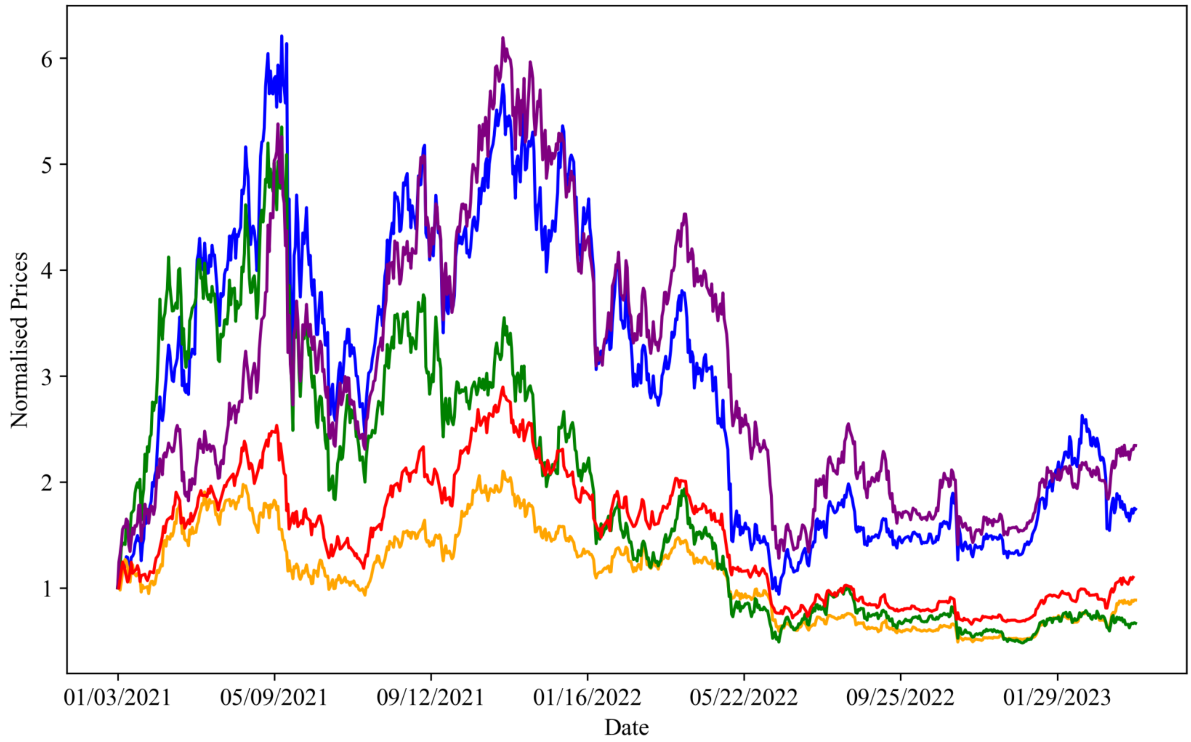

Figure 7: A chart illustrating the normalised performance of the ***CW30*** index in comparison to prominent benchmarks, such as ***Bitcoin***, ***Ethereum***, ***DPI*** and ***CRIX***, from January 3, 2021, to April 2, 2023. This visualisation highlights their performance throughout 2021, 2022, and the first quarter of 2023. The data presented is a result of calculations conducted using a custom Python script.

5.3.1 Performance Metrics Analysis

Conducting a thorough comparative assessment between CW30 and the selected benchmarks, this study evaluates their efficacy using multifaceted performance measures that encompass return, risk, and risk-adjusted return metrics.

Comparative Descriptive Statistics for CW30 and Benchmarks

Index	*Total Return*	*Mean Return*	*Median Return*	*Standard Deviation*	*Sharpe Ratio*	*Sortino Ratio*	*Max Drawdown*
CW30	0.74345	0.00214	0.00544	0.05367	-0.21101	-0.30361	0.84857
Bitcoin	-0.11394	0.00054	-0.00027	0.03704	-0.33257	-0.51275	0.76718
Ethereum	1.34410	0.00224	0.00171	0.04882	-0.22762	-0.35232	0.79330
DPI	-0.33342	0.00111	0.00119	0.05638	-0.21934	-0.33562	0.91005
CRIX	0.10029	0.00115	0.00141	0.04424	-0.27288	-0.41790	0.77302

Figure 8: A summary of key descriptive statistics for the CW30 index alongside benchmark cryptocurrencies, including Total Return, Mean Return, Median Return, Standard Deviation, Sharpe ratio, Sortino ratio, and Maximum Drawdown, covering the time frame from January 3, 2021, to April 2, 2023. The daily risk-free rate is sourced from Yahoo Finance using the ticker "^IRX". The data presented is derived from calculations performed using a custom Python script.

Evaluating the total returns, CW30 outperforms Bitcoin, DPI, and CRIX but falls short when compared to Ethereum. This indicates that the index has generated higher cumulative returns than most of the selected benchmarks over the period under review, as visualised in Figure 8. In terms of mean returns, CW30 exhibits slightly lower returns than Ethereum but higher mean returns than Bitcoin, DPI, and CRIX. This suggests that, on average, the index has generated moderately higher returns than most of the benchmarks. When assessing median returns, CW30 presents the highest value among the benchmarks. This implies that the index has consistently provided higher returns than the other benchmarks at the midpoint of the distribution, showcasing its potential as a suitable benchmark.

In terms of volatility, as measured by standard deviation, the CW30 index exhibits a higher level of volatility than Bitcoin, Ethereum, and CRIX, but a lower level than DPI. This suggests a moderate level of volatility for CW30 when compared to the selected benchmarks.

Hence, when evaluating the maximum drawdown, the CW30 index presents a higher value than Bitcoin, Ethereum, and CRIX, but a lower value than DPI. This reflects the extent of potential loss an investor may experience in a worst-case scenario.

Analysing the risk-adjusted performance, the CW30 index exhibits negative Sharpe and Sortino ratios, implying unfavourable results. Nevertheless, the index shows relatively better risk-adjusted performance compared to Bitcoin, Ethereum, and DPI, as evidenced by less negative values for these ratios. On the other hand, CRIX demonstrates less negative Sharpe and Sortino ratios compared to CW30, indicating slightly better risk-adjusted performance.

In conclusion, the CW30 index exhibits significantly better performance when compared to Bitcoin, DPI and CRIX. Especially regarding the return metrics, CW30 shows superior financial gains when comparing it to the benchmarks. It is only against Ethereum, where CW30 shows partial underperformance over certain periods. Based on the performance metrics, the CW30 might be a superior benchmark and may serve as a solid index to be tracked by index products. Nevertheless, the comparison may have somewhat limited meaningfulness because of variations in asset nature and the specific focus of the CRIX index. Understanding performance drivers and determining optimal investment strategies considering asset characteristics and investor objectives requires further investigation.

5.3.2 Correlation with Benchmarks

After comparing the performance of our best-performing index, CW30, with other market indices and assets such as Bitcoin, Ethereum, DPI, and CRIX in Section 5.3.1, the correlation between CW30 and these benchmarks will be examined in this chapter. The Pearson correlation coefficient measures the linear relationship between the index and the selected benchmarks.

CW30 Correlation with Major Benchmarks

	Bitcoin	*Ethereum*	*DPI*	*CRIX*
CW30	0.892	0.872	0.857	0.941

Figure 9: Pearson correlation coefficients demonstrate the relationship between the CW30 index and four major benchmarks - Bitcoin, Ethereum, DPI, and CRIX - spanning the time frame from January 3, 2021, to April 2, 2023. The data presented originates from calculations conducted using a custom Python script.

CW30 has a strong positive correlation with Bitcoin (0.892), Ethereum (0.872), and DPI (0.857). Thus, these assets tend to follow similar trends in their price movements, and CW30's performance relates closely to these benchmarks. As a result, diversifying into these assets may not significantly reduce inherent risk. The correlation between CW30 and CRIX (0.941) is even stronger. This suggests that CRIX may not offer substantial diversification benefits, as its price movements are closely aligned with those of CW30.

In conclusion, the correlation analysis indicates that the best-performing index, CW30, shares a strong linear relationship with prominent cryptocurrencies and indices like Bitcoin, Ethereum, DPI, and CRIX. This finding indicates a strong correlation between the movements of these assets and the performance of CW30. It should be noted that this correlation analysis provides valuable insights into the relationship between CW30 and the selected benchmarks, although it does not directly address the main research question.

5.3.3 In-Depth Comparison with DPI

DPI, which stands for the DeFi Pulse Index, is the most prominent index that concentrates on the Ethereum ecosystem. The DPI index specifically captures the performance of DeFi projects, which are DeFi applications that aim to provide financial services without intermediaries. Some of the DeFi projects that are included in the DPI index are Uniswap, a decentralised exchange, Aave, a decentralised lending platform, Maker, a decentralised stablecoin issuer, and many others.

In previous sections, an extensive analysis was carried out to compare the CW30 index with DPI and other selected benchmarks, emphasising a range of performance metrics. The statistics in Figure 8 showcase that the CW30 index has outperformed DPI in terms of total return, mean return, and median return, while also exhibiting slightly lower volatility. The CW30's risk-adjusted performance, as measured by the Sharpe and Sortino ratios, is marginally better than DPI's. Additionally, the CW30 index has a lower maximum drawdown than DPI, indicating a smaller potential loss in a worst-case scenario. These factors contribute to a more favourable overall performance of the CW30 index compared to DPI, as highlighted in the previous sections.

Furthermore, one key difference between CW30 and DPI is the number of constituents. CW30 comprises 30 tokens, whereas DPI incorporates only 10. This difference in the number of constituents makes CW30 a more diversified investment option, potentially reducing portfolio risk while still providing exposure to the broader Ethereum market.

In terms of approach, DPI specifically focuses on DeFi protocols within the Ethereum ecosystem. On the other hand, the CW30 index incorporates all market segments, such as infrastructure or media and entertainment protocols, providing a more comprehensive representation of the entire Ethereum ecosystem. This wider scope offers investors broader exposure to the overall market and its diverse opportunities, rather than concentrating on a single market segment.

To sum up, the CW30 index demonstrates several advantages compared to DPI, including a larger number of constituents and a more comprehensive approach that encompasses various market segments. The distinctive traits of CW30 result in significantly better performance metrics compared to DPI. In conclusion, the CW30 index may prove to be a more effective tool for representing the Ethereum ecosystem and serve as a valuable benchmark for market participants seeking a comprehensive understanding of the market landscape.

6. Conclusion

This study presents a comprehensive construction and analysis of six indices in the Ethereum ecosystem, focusing on CW and EW index methodologies with varying numbers of constituents. Through a meticulous examination of their performance metrics, the research aims to identify the superior index methodology for the EEI and subsequently propose an index that can accurately reflect the Ethereum ecosystem. The findings of this study provide valuable insights to the ongoing discussions surrounding cryptocurrencies and can serve as a basis for the creation of innovative index products.

6.1 Findings

The performance analysis of the indices reveals that the CW indices consistently outperform EW indices in terms of total returns, mean returns, and median returns. The index with 30 constituents (CW30), in particular, demonstrates the highest total return among the indices, indicating that larger CW indices may provide superior overall performance. Furthermore, CW indices exhibit lower risk, as evidenced by their lower standard deviation and maximum drawdown values. Overall, the analysis suggests that CW30 may provide an accurate representation of the Ethereum market and offer greater performance compared to EW indices.

Moreover, the benchmark comparison evaluates the performance of CW30 against other prominent market indices and assets, including Bitcoin, Ethereum, DPI, and CRIX. The performance analysis demonstrated that CW30 outperformed Bitcoin, DPI and CRIX in terms of total returns, mean returns, and median returns. This result supports the suitability of CW30 as a valuable benchmark and foundation for index products, catering to the needs of investors and other market participants in the Ethereum ecosystem and the broader cryptocurrency community.

Finally, CW30 outperforms the current leading index, DPI, clearly showcasing its significant advantages and superiority. By incorporating a wider range of constituents and a more comprehensive approach that covers multiple market segments, CW30's unique attributes lead to superior performance metrics. As a result, the CW30 emerges as a potentially more accurate representation of the Ethereum ecosystem and could serve as a valuable benchmark for the market. Consequently, the CW30 represents the EEI.

The study findings indicate that the CW30 index, with its CW approach, 30 constituents, and three-month rebalancing intervals, effectively captures and represents the performance of Ethereum's ecosystem. In fact, Ruemmele (2023) demonstrated the feasibility and practical implementation of the proposed index as a basis for index products. Despite the practical approach and confident conclusions of this study, it is important to acknowledge its limitations, including the presence of potential backtesting bias. Nonetheless, the insights gained from designing and analysing an index reflecting the Ethereum ecosystem can serve as a valuable starting point for further research as well as the development of new index products.

6.2 Future Work

The findings of this study offer valuable insights into the construction and performance of the EEI. As a result, this study proposes a CW index containing 30 constituents. However, there are several areas where future research can expand and enhance these results.

To gain a more comprehensive understanding of the indices' performance across different market cycles, further analysis can be conducted by comparing more and less frequent rebalancing periods, as well as extending the time horizon of the analysis. This would enhance the resilience and adaptability of specific index methodologies in response to evolving market conditions. Secondly, future research can explore alternative index methodologies, such as fundamentally-weighted or momentum-weighted indices, to assess their impact on overall performance. By investigating a wide range of index methodologies, one may discover a more effective index approach that produces higher returns.

Moreover, one notable direction for future research is to examine the applicability of these findings to less developed network ecosystems, such as Solana, Avalanche, and Binance Smart Chain. Analysing the performance of indices with similar methodologies in these ecosystems could uncover similarities and differences across various blockchain networks, providing a more comprehensive understanding of index construction in the broader digital asset landscape.

By diving into these areas for future research, scholars and industry professionals can deepen their understanding of index construction and performance, fostering the development and widespread adoption of well-established benchmarks akin to the renowned S&P 500 in the US equity market.

7. Data and Code Availability

The data and code used in this study are publicly available to ensure transparency and facilitate the replication of the analysis. The provided resources, including the Python scripts and data files, can be accessed through GitHub. However, executing the scripts successfully requires a Coingecko Pro API key.

GitHub Repository: https://github.com/mkcschmidt/ethereum-ecosystem-index.git

The GitHub repository contains a README file with an overview of the repository's contents and instructions on how to run the code.

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9. Appendix

Top 5 Cryptocurrencies by Market Capitalization on January 1st, 2023

Rank	*Name*	*Symbol*	*Coingecko ID*	*Market Cap*	*Price*	*Circulating Supply*	*volume (24h)*	*% 1h*	*% 24h*	*% 7d*
1	Bitcoin	BTC	bitcoin	$320,025,834,692.40	$16,625.08	19.249.581 BTC	$9,244,361,699.89	0,07%	0,47%	-1,29%
2	Ethereum	ETH	ethereum	$146,966,709,631.13	$1,200.96	122.373.866 ETH *	$2,399,674,550.06	-0,04%	0,35%	-1,48%
3	Tether	USDT	tether	$66,243,294,943.48	$0.9997	66.263.713.431 USDT *	$11,344,984,017.59	0,00%	0,00%	-0,03%
4	USD Coin	USDC	usd-coin	$44,584,840,756.22	$0.9999	44.585.140.660 USDC *	$1,197,927,575.87	-0,01%	0,00%	-0,01%
5	BNB	BNB	binancecoin	$39,053,263,491.06	$244.14	159.964.553 BNB *	$278,651,736.60	-0,31%	-0,90%	0,41%

Appendix 1: Snapshot of the top 5 cryptocurrencies by market capitalisation on CoinMarketCap as of January 1st, 2023. The table displays information about the Rank, Name, Symbol, Coingecko ID, Market Capitalisation, Price, Circulating Supply, 24-hour trading volume, and price percentage change over 1 hour, 24 hours, and 7 days.

Selection of 5 Cryptocurrencies Classified by ITSA According to the ITC Framework

Rank	*data » name*	*Ticker*	*Coingecko ID*	*Key Person*	*USP*	*Economic Purpose*	
13	Amp	AMP	amp-token	Albert	Provide...	EEP22TU02	Settlement and Access Token
14	The Graph	GRT	the-graph	Jan	The Graph is...	EEP22TU03	Settlement and Governance Token
15	Huobi Token	HT	huobi-token	Marlene	Nnative token...	EEP22TU02	Settlement and Access Token
16	Waves	WAVES	waves	Aavneet	Designed to...	EEP22TU02	Settlement and Access Token
17	TrueUSD	TUSD	true-usd	Jan	The first...	EEP21PP01USD	USD-Pegged Payment Token

Appendix 2: A sample of 5 cryptocurrencies sorted by rank and classified by the International Token Standardization Association (ITSA) using the International Token Classification (ITC) framework. The table presents data on the name, Ticker, Coingecko ID, Key Person, unique selling proposition (USP) and Economic Purpose.