Abstract

Index funds are a fundamental tool of traditional finance, allowing investors to gain diversified access to broad markets at minimal cost. However, the decentralized finance (DeFi) ecosystem has so far lacked a fully decentralized, transparent, and robust mechanism for creating, updating, and using indexes without the need for centralized issuers or administrators.

In this paper, we propose a decentralized index protocol—an open, permissionless architecture that allows anyone to create, subscribe to, and interact with crypto indexes that are generated, balanced, and stored entirely on the blockchain. This approach eliminates the need for trusted parties, ensures transparency in index calculations and balancing, and lowers the barriers to access to complex investment strategies.

The protocol is based on smart contracts that automatically manage asset weighting, rebalancing, and reward participants who maintain the index. We describe the key components of the architecture, the governance mechanism, the incentives for managers, and potential vectors for extending functionality. Thus, we propose a new financial primitive that combines the advantages of index investing with the principles of decentralization, self-regulation, and open access.

Introduction

In 1975, John Bogle, founder of investment company Vanguard, launched the first index mutual fund open to retail investors. His approach was innovative for its time: instead of actively managing a portfolio, investors were offered access to the broad market through passive investment in market indexes with low fees. This strategy reduces costs, simplifies investing and provides long-term performance for a wide range of participants.

This approach ushered in a new era in finance. The transparency, simplicity and accessibility of index investing led to a rapid growth in the popularity of index funds around the world. As of June 30, 2024, Vanguard managed over $7.71 trillion in index products, and the company's total assets reached $10.4 trillion as of January 2025. This vividly demonstrates how Bogle's ideas transformed the global financial ecosystem.

We see a direct connection between these ideas and the current development of decentralized finance (DeFi). Just as index investing made traditional markets more accessible, our decentralized index protocol aims to bring similar benefits to the world of cryptoassets — by providing simplicity, openness, and efficiency without centralized intermediaries. This paper describes the mechanisms, architecture, and core principles of a decentralized index protocol that allows anyone to create, maintain, and invest in indexes generated by smart contracts and governed solely by blockchain logic. It is the next stage in the evolution of investing — decentralized, automated, and globally accessible.

Problem Statement

Index investing, despite its effectiveness in traditional finance, is still underdeveloped in the field of decentralized finance (DeFi). Although there are already products on the market that offer index-like tokens, most of them remain centralized in nature. Index formation, balancing, asset management and decision-making in such systems are controlled by a narrow circle of individuals or centralized structures. This contradicts the principles of DeFi: transparency, accessibility and decentralization.

Centralization creates a number of problems:

- **Lack of transparency:** investors do not always have access to clear information about the rules for index formation, asset allocation, and rebalancing frequency.

- **Lack of control:** Users are unable to independently create or customize indexes according to their investment strategies or beliefs.

- **Regulatory risks:** Centralized index providers are often subject to jurisdictional restrictions, which can limit access to products in different countries.

From the perspective of a retail investor, the situation becomes even more complicated:

- **High entry thresholds:** some index products have complex structures, require KYC or high minimum capital.

- **Unequal access conditions:** rules may vary for different categories of investors depending on the jurisdiction or platform.

- **Lack of customization:** Investors cannot choose or change the asset weights in their portfolio, even if they have strategic reasons to do so.

In addition to individual use, indexes have enormous potential as a portfolio or fund management tool. With the right approach, decentralized indexes can serve the role of:

- Cryptocurrency ETF on the blockchain

- Automated fund managed by a DAO or trader

- A delegated management mechanism where users invest in a specific portfolio, trusting its logic or manager.

However, the lack of an open infrastructure solution that would allow for the flexible creation, publication, and management of such indexes without centralized intermediaries is holding back the development of this important category of financial instruments in DeFi.

Our protocol solves these problems by creating an open environment for decentralized index creation and use that anyone can benefit from, from a retail investor to a DAO or crypto fund.

System Overview

Our decentralized index protocol is built on a modular principle that ensures security, transparency, and scalability. Its main goal is to provide managers and investors with a tool to create and participate in decentralized index products without having to trust centralized structures.

Components of the system

1. Index Factory Contract

This is the main smart contract that acts as a centralized point for index creation. **Index Factory Contract**:

- Deploys new index contracts according to a single logic
- Records metadata for each index
- Controls access to whitelist tokens
- Can be updated through Governance mechanisms or multi-signature
- Administers commission amounts

2. Index Contract

Each index is a separate smart contract containing:

- **ERC-20 index token** that reflects the investor's stake
- IIO (Initial Index Offering) functionality
- Asset preservation in specified shares
- Pre-order mechanisms
- Rebalancing mechanism

> All index contracts operate on a single standard logic, ensuring predictability, compatibility, and transparency.

3. ERC-20 index token

- Issued to investors during IIO or pre-order execution
- Is a full-fledged standard token suitable for use in DeFi protocols
- Represents the user's share of pool in the index

Initial Index Offering (IIO)

Once the index manager has created the index, the protocol provides a time-limited period for initial capital raising — an **Initial Index Offering (IIO)**. During this phase:

- Investors send stablecoins (e.g. USDT) into the index contract
- Receive the corresponding number of index tokens in a 1:1 ratio (1 USDT = 1 index token)
- The funds raised are held in the contract and used for further purchase of assets according to the shares

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Rebalancing

Throughout the life cycle of the index, the manager initiates **decentralized rebalancing processes** in accordance with the investment strategy. At the time of rebalancing launch:

- The manager updates the shares of assets in the portfolio (or changes the composition of assets within the whitelist)
- The protocol performs asset exchange, conversion, and balancing in a decentralized manner
- The new index state is recorded in the smartcontract

Pre-orders

Between rebalancing periods, investors can place **pre-orders** — applications to purchase index tokens:

- Funds are frozen in the contract until the next rebalance.

- After the rebalance is completed, the investor gets the opportunity to claim index tokens according to the new shares.

Security principles

1. **Asset Storage:** All assets are stored exclusively in the index smart contract.
2. **No trust in third parties:** No individual or legal entity has access to the funds.
3. **Asset whitelist:** The manager can only include in the portfolio those tokens that are pre-approved by the protocol through a whitelist.
4. **Unified logic:** All indexes operate on a single code base, tested and open for audit.

The main goal of the system is **to ensure maximum trust through architecture**, not through intermediaries. The protocol provides tools for both the mass crypto investor and professional asset managers, DAOs, or financial strategists.

Decentralized rebalancing mechanism

Rebalancing is a key process in maintaining the index's alignment with its strategic asset allocations. Unlike centralized solutions, our protocol implements a **fully decentralized mechanism** that relies not on external price feeds but on an **internal arbitrage market** that independently identifies fair market prices.

The goal of rebalancing is to restore asset proportions to their specified weights, without centralized intervention, solely through market action.

Main stages of rebalancing

1. Choosing an underlying asset

At the beginning of the cycle, the underlying asset is determined - the **token with the largest target weight** in the index. If several tokens have the same weight, one of them is chosen deterministically. The underlying asset is used as a unit of measurement for recalculating the prices of other tokens.

2. Obtaining reference prices.

All tokens receive decentralized reference prices from a verified decentralized oracle such as Chainlink, Pyth, RedStone, or other approved sources. These prices are used in the index smart contract as a baseline for further verification.

Reference prices are not used directly for calculations when performing rebalancing (e.g., for asset swaps or weight recalculations). Instead, they serve as a mechanism to protect against market manipulation.

Objectives of using reference prices:

- **Checking the correctness of index initialization:** when launching a new rebalance or creating an index, it is checked that the market prices of assets transmitted by the manager do not deviate significantly from the support prices.

- **Protection against price gaps:** if sharp market fluctuations (gaps) are detected during rebalancing, which may indicate anomalies in decentralized exchanges (DEX), the system may stop or postpone the rebalancing until the situation normalizes.

- **Monitoring of managers' actions:** if the prices transmitted as part of rebalancing when changing the list of assets differ significantly from the resistance, this may indicate an attempt at manipulation or an error that is subject to further audit.

3. Formation of initial (artificial) prices

Based on the target shares of the index, the relative prices of other assets are calculated relative to the base. These prices are starting and intentionally "inefficient" to initiate arbitrage (i.e., an artificial bias in prices is created: some assets appear overvalued, others - undervalued).

Relative prices are calculated by the formula:

$$Pab = (Aa * Sb) / (Ab * Sa), \text{ where:}$$

Aa, Ab —the volume of assets A and B

Sa, Sb — target asset shares in the index

Pab — price of asset B in units of asset A

4. Spread goal

An artificial spread is created for each trading pair with an underlying asset. It:

- Simulates frictional liquidity;

- Prevents instant arbitrage;

- **It decreases over time** (linearly or exponentially) to zero, which stimulates market activity only when an arbitrage opportunity actually exists.

5. Arbitrage and price determination

As soon as the spread decreases to a level at which the arbitrageur sees a profit opportunity, he makes the exchange. The volume of the transaction is calculated by the formula:

$$Q=(Aa \cdot Sb - Pab \cdot Ab \cdot Sa) / (Sa + Sb), \text{ where:}$$

Aa, Ab —the volume of assets A and B before rebalancing

Sa, Sb — target asset shares in the index

Pab — price of asset B in units of A asset (including spread)

Q — the amount of asset B that can be exchanged for A asset

This formula ensures that the transaction volume will not push the index beyond the permissible deviations and will contribute to convergence to the target shares.

6. Asset price fixation

After the first successful arbitrage transaction for a particular pair (A–B), **the rate between them is fixed** at the transaction level. Further transactions with this pair no longer affect the price - it is considered market-determined within this cycle.

7. Completion of rebalancing

The cycle ends if:

- **All pairs have undergone at least one arbitrage transaction** and set a course;

- **All spreads disappeared,** but no arbitrage occurred (the market recognized the prices as fair).

8. Repeat iteration (if necessary)

If the deviation of the actual portfolio from the target shares exceeds 1%, the cycle is repeated with new calculations of the initial volumes. This ensures iterative convergence to the desired structure.

Flexibility in changing the structure

Before starting a rebalancing cycle, the manager can update the target weightings of the index. The new weightings take effect **at the start of the rebalancing cycle** and are used in all calculations. This allows the index to adapt to new market conditions or changes in strategy **without recreating the index.**

Decentralized oracles

The key innovation is that **no centralized oracle is used to determine market prices**. All prices are formed solely by the actions of arbitrageurs within the protocol.

As follows:

- Eliminates the possibility of manipulation
- Increases transparency
- Supports true decentralization

Roles in the system

In a decentralized index protocol, all actions are performed through smartcontracts, but each functional area has a defined role. The architecture allows for separation of responsibilities, minimizing centralization, and ensuring complete transparency.

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1. Protocol

The Protocol is the core of the system, a set of smart contracts and rules that define the logic of creating, managing, and trading indexes. Formally, the Protocol is the owner of the entire system, and all other roles operate according to its terms.

Functionality:

- Defines the structure of smartcontracts (factory, indexes, tokens, rebalancing logic)
- Establishes general rules for interaction between participants
- Provides technical storage of assets exclusively through smart contracts
- Defines a whitelist of tokens that can be used in indexes

The protocol has no private owner. Its “ownership” is the public rules written on the blockchain that cannot be changed without a community vote (Governance).

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2. Index Manager

The index manager is the initiator of the creation of the index and is responsible for its strategic management.

Manager responsibilities:

- Creating an index through a factory contract
- Selecting assets from the whitelist and determining initial stakes
- Initiation of periodic rebalancing cycles
- Ability to change target asset allocations before rebalancing
- Receiving a management fee (if defined for a specific index)

Limitation:

- The manager does not have access to the assets
- The manager cannot change the protocol rules
- Manager actions are limited only to permitted functions in smart contracts

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3. Investor

An investor is a participant who invests in an index and in return receives an index token (ERC-20) that reflects their share in the portfolio.

Investor opportunities:

- Participation in Initial Index Offering (IIO)
- Providing pre-orders to buy between rebalances
- Storing, trading or using index tokens in DeFi
- Potential buyout or exchange of the index token

The investor does not depend on trust in the manager or third parties - all transactions go through the protocol's open smart contract.

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4. Arbitrageur

An arbitrageur is an independent user who makes profitable exchanges between index assets during rebalancing.

Its function:

- Identifying market inefficiencies
- Arbitrage operations during open rebalancing windows
- Promoting the restoration of target asset shares in the portfolio

Anyone can act as an arbitrageur. The protocol economically incentivizes such participants without requiring permits or registrations.

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5. Governance

Governance is a collective governing body that forms the will of the protocol through voting by community members. It consists of token holders of the project's main token (DEIS Token)

Token holder powers:

- Adding or removing tokens from the whitelist
- Approving changes to rules or smart contracts
- Setting global parameters (max. IIO volume, spread formulas, etc.)
- Evaluating proposals for integrations, strategies, or new features

Governance is the only mechanism through which the Protocol can evolve while remaining decentralized.

Economic model of the protocol

The financial architecture of the decentralized index protocol is built on the principles of automatic reward for active roles, and the exclusion of centralized intermediaries from the capital management process. The protocol implements commission mechanisms that ensure its self-sufficient functioning and development.

Commission model

All commissions are realized through periodic dilution of the index token (mint for reward)

1. Index manager fee

Each manager has the opportunity to receive their own individual index management fee of up to 1% per annum. The accrual base is the Total supply of the index token for the accrual period. This fee is calculated based on the number of project tokens (DEIS Token) in the manager's wallet (or in staking).

2. Protocol Fee

The protocol receives a fixed fee of 1% per annum from each index. The accrual base is the Total supply of the index token for the accrual period. These funds are automatically sent to the treasury.

Until the protocol collects liquidity in the amount of $100M, the fee will be distributed to operating expenses and protocol development, upon reaching the figure of $100M, 30% of the protocol's income will be redistributed to the staking pool for DEIS Token holders.

3. Management Fee

All index token holders automatically pay a 2% annual maintenance fee, which is distributed to the manager and the protocol.

Incentives for active participants

The protocol creates conditions for rewarding each active role:

- **Investors —** can receive bonuses for inviting new participants (referral system)
- **Index Managers —** remuneration through retention fees for attractive index strategies
- **Arbitrageurs —** profit from arbitrage transactions in the rebalancing phase

Self-sufficiency of the protocol

- Safe monetization without interfering with index assets;
- Full automation of all accruals through smart contracts;
- Zero operational risk for investors;

- Transparency and simplicity for all market participants.

Conclusion

We proposed a decentralized system for investing in cryptocurrency indexes that eliminates the dependence on trust in custodial structures. After analyzing international experience in the field of traditional finance (TradFi), we identified the main problems of current solutions, among which excessive centralization is key. Index formation, portfolio balancing, asset management and the decision-making process are often concentrated in the hands of a limited number of individuals or centralized organizations, which contradicts the fundamental principles of decentralized finance (DeFi), in particular transparency, openness and accessibility.

The protocol we developed is designed to eliminate these shortcomings by creating an open environment for decentralized formation, management and use of indexes. This approach provides equal opportunities for participation for both retail investors and decentralized autonomous organizations (DAOs) or cryptocurrency funds.