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Unlocking DeFi Literacy: Understanding NFT Market Microstructure in the Decentralized Finance Landscape

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***Abstract*—Decentralized finance (DeFi) is an emerging technology that empowers individuals to manage their assets without relying on centralized institutions. This paper examines the nexus between DeFi & the NFT market. It delves into DeFi with concepts like Liquidity Pools & DEXs, while clarifying concepts like fungible tokens & stablecoins within NFT ecosystems. Exploring primary & secondary markets, along with NFT royalty structures, it aims to enhance understanding & empower individuals to navigate these landscapes effectively. This paper delves into the intricate relationship between the NFT market & the broader DeFi landscape, offering practical insights for NFT marketplace owners & in-depth analysis for academic researchers.**

***Index Terms*—DeFi literacy, Crypto Investment, NFT market Microstructure, OpenSea**

I. Introduction

The Global Decentralized Finance (DeFi) Market is experiencing rapid growth due to the rise of decentralized blockchain-based systems, valued at $20 billion in 2023, with a growth rate of 45.36% [1]. DeFi aims to integrate open-source financial components into sophisticated products, to provide frictionless experiences & enhanced user value [2]. However, financial literacy is already scarce, with only 33% of adults possessing it [3]. This scarcity is further amplified by introducing advanced technologies such as blockchain, decentralized exchanges (DEX), non-fungible tokens (NFTs), stablecoins, & secondary marketplaces.

Navigating the NFT marketplace requires integrating wallets, minting NFTs, and reselling within the DeFi ecosystem. As interest in opening NFT marketplaces grows [4][5], individuals must familiarize themselves with these concepts to effectively utilize available functionalities.

We thank Brain Station 23 PLC. for their invaluable support in writing this paper.

This paper aims to be a valuable resource for NFT marketplace owners & bridge the DeFi literacy gap by clarifying various concepts within the DeFi ecosystem.

The key contributions of this paper are as follows:

- Explanation of DEXs, & AMM algorithm.
- Clarification of the functioning & purposes of different fungible tokens, including stablecoin, their reserves & decimal scaling.
- Deciphering the process of primary & secondary marketplaces, & revenue distribution.
- Royalty Structure for NFT tokens.

The paper provides a comprehensive analysis of the NFT market within the DeFi landscape, catering to both industry practitioners & academics, offering a structured approach & detailed explanations to understand DeFi & NFT marketplaces.

II. Related work

A variety of research studies have explored DEXs & NFT marketplaces. Advances in economics, business, & management research [6] examined the impact of financial literacy, risk perception, & overconfidence on cryptocurrency investment decisions. Jean-Michel Chabot [7] examined the digital asset investment landscape, operational risks for cryptocurrency investors, & institutionalization of digital asset investment, including risks in cryptocurrency & blockchain opportunities. The landscape of the NFT market presents a rapidly evolving domain with implications for investors & regulatory bodies. Mukhopadhyay [8] highlights the challenges of differentiating authentic and fraudulent NFTs, emphasizing the need for due diligence. White [9] conducted a detailed examination of the OpenSea NFT marketplace, shedding light on the impact of select users on price fluctuations & the emergence of user communities. Their study analyzed 5.25 million sales over 3 years (2019-2021). Furthermore, Madhavan [10] delivers an extensive survey of market microstructure,

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emphasizing the role of information in price determination, market configuration, & its intersection with other financial realms. Overall, NFTs offer diversification opportunities with substantial risk-bearing potential.

Related works suggest a lack of literature to assist new & emerging NFT marketplace owners & investors entering the world of blockchain. There is a shortage of literature on the market microstructure of NFTs & how marketplace owners can navigate this market.

III. Problem Statement

To provide comprehensive information, we have chosen a narrative format. Our story follows an NFT patron who wants to acquire & sell an NFT. The narrative is shown in "Fig. 1".

ERC20 tokens are needed for transactions on the blockchain & to mint NFTs. The patron must purchase cryptocurrency (1). If the user already has cryptocurrency but it is not native to the platform, they will need to exchange it (2). Section IV(A) explains this process & introduces DEX.

When choosing an ERC20 token to purchase, the patron must decide between native & stable coins (2). Native coins can be volatile, while stablecoins have a stable price. Section IV(B) addresses this. With their chosen ERC20 token, the patron can select a digital asset to mint from a primary marketplace (4), which our protagonist proprietor owns.

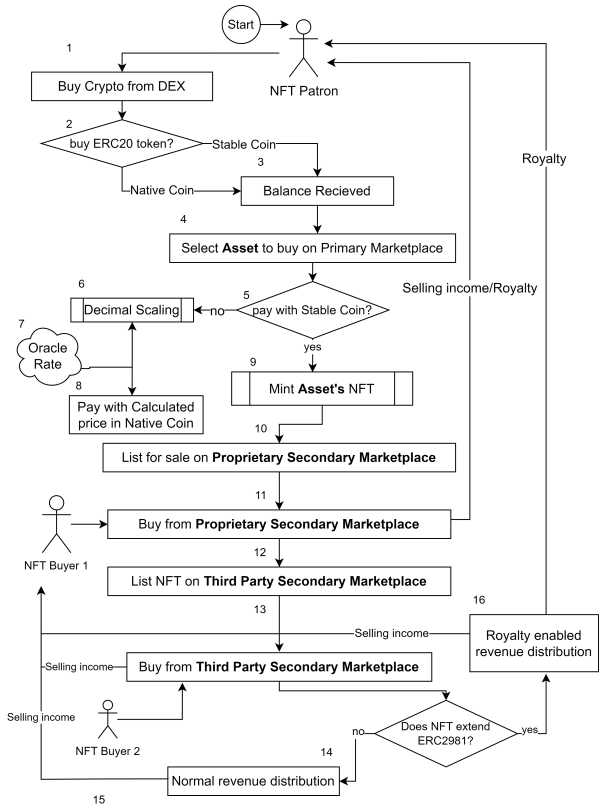

Fig. 1. Diagram For Narrative

Minting an NFT requires native coins (5). Even if marketplace owners list prices in stablecoin, they still need to convert them to the native coin to pay gas fees when minting NFTs. To obtain real-time price conversion rates, Oracles are used (7). However, it is worth noting that Oracles may not always provide the expected decimal places, which can create issues with decimal scaling (6). Section IV(C) provides more information about Oracles & delves into this challenge.

When the artist confirms the payment, a new NFT corresponding to the asset is minted (9). These NFTs follow the ERC721 token standard & are unique & indivisible. They are registered on all secondary marketplaces within the Web3 eco space (10). Section IV(D) thoroughly explores the concept of NFTs. When an NFT is distributed to a different market, the control over revenue distribution is lost, posing a challenge for marketplace owners (11) (12) (13). This will be discussed further in Section IV(D), which explains the concept of listing & trading NFTs on secondary marketplaces. When a buyer purchases a token from a secondary marketplace, revenue distribution will depend on the NFT's royalty standard (14). The royalty standards (15) (16) are explained in Section IV(D). It also includes our novel royalty-enabled revenue distribution.

IV. Methodology

A. Decentralized Exchange

Decentralized exchanges (DEXs) enable direct peer-to-peer cryptocurrency trading without intermediaries like banks [11]. Users pay network & trading fees, collected by the protocol, liquidity providers, or token holders. DEXs operate via smart contracts, establishing prices algorithmically & liquidity pools.

- **Liquidity pool**: A liquidity pool is a smart contract holding a reserve of two or more cryptocurrency tokens in a DEX [12]. The term liquidity pool refers to the creation of liquidity for faster transactions. The transaction fee for each trade executed on the platform is shared by the liquidity providers based on their contributions [13].
- **Automated Market Maker**: Automated Market Makers (AMMs) are algorithms like the Constant Product Market Maker (CPMM) to set asset prices in liquidity pools, by maintaining a constant, denoted as 'k,' ensuring stability. This constant is initially set at 1 dollar & remains unchanged. Most AMMs are represented by the equation:

X * Y = K

Where: **X** is Supply of Token A, **Y** is Supply of Token B, & **K** is Constant. Essentially, the product of token quantities in the pool is always constant.

- **Arbitrage Trading**: Arbitrage traders engage in the practice of purchasing tokens from pools where prices are lower & selling them to pools where prices are higher, thereby balancing token supply & promoting ecosystem stability. Restrictions on their capital flow can disrupt liquidity & hinder price convergence [14].

B. ERC 20 Tokens (Fungible Tokens)

DEXs operate with ERC-20 tokens, providing access within a broader crypto-economic system. [15]. ERC-20 tokens, fungible like fiat currency, hold the same value & are easily exchanged. They follow the ERC-20 standard, governed by

smart contracts developed by OpenZeppelin, facilitating various applications like exchange, voting, & staking [16]. ERC-20 tokens offer standardized functions, security [17], reduced costs, & liquidity on exchanges. Native coins are essential, as they are used for NFT minting, liquidity pool investing, & acquiring digital assets within the DeFi ecosystem.

• **Native Coins**: Native coins are fungible ERC-20 tokens native to a specific blockchain network [18], such as Ether for Ethereum and MATIC for Polygon[19].

• **Stablecoins**: Stablecoins are ERC20 tokens that maintain a stable value by being pegged to another asset, usually a fiat currency [20]. They require extra functionalities to control supply, offering an alternative to the volatility of cryptocurrencies, making them suitable for daily transactions.

Stablecoins pegged to fiat currency are called fiat-collateralized stablecoins. They operate under a centralized model, where a centralized entity holds an equivalent amount of fiat currency in reserve as the circulating token in the market. However, they compromise decentralization as a central entity manages the reserves. The two other types of stablecoins are Cryptocurrency collateralized stablecoins (use cryptocurrency as collateral & require over-collateralization to remain stable) & Algorithmic stablecoins (Algorithmically adjust supply to stabilize prices based on market dynamics).

C. Decimal scaling between tokens

Cryptocurrencies may have different decimal precision points. For example: MATIC has up to 18 decimal places, & USDC has 6 decimal places.

To convert between USDC & MATIC (tokens with different decimal places), we multiply or divide based on the difference in decimal places. In this instance, to convert from USDC to MATIC, we multiply the value by $10^{18 - 6}$. To convert from MATIC to USDC, we would divide the value with $10^{18 - 6}$.

When weaving pricing into scaling, the decimal precision is adjusted to match the token with the larger decimal precision. This ensures we do not truncate a value, & lose precision.

D. NFT market microstructure

NFT Token standards: NFTs are blockchain-based assets representing ownership of a single digital or physical item [21].

• **ERC-721:** ERC-721 is the standard for NFTs. Unlike fungible tokens, ERC-721 tokens are unique. The standard ensures that each token within a smart contract has a globally unique combination of the contract address & a uint256 tokenId, and is governed by smart contracts developed by OpenZeppelin [22], ERC-721 allows ownership of the token & transfer, balance inquiry of the Token, ownership lookup for specific token ID, & approval for third-party accounts to transfer tokens. The contract can emit three events **Transfer**, **Approval** & **ApprovalForAll**.

• **ERC 1155:** ERC-1155 is a multi-token standard that combines ERC-20 & ERC-721. It represents both fungible and non-fungible tokens, making it a semi-fungible token. Key features of ERC-1155 are Batch Transfer, Batch Balance, Batch Approval, Hooks, NFT Support & Safe Transfer Rules. The events are **TransferSingle**, **TransferBatch**, **ApprovalForAll** & **URI**. Each token can be unique & have a balance.

1) NFT marketplace: There are marketplaces like OpenSea, Rarible, Magic Eden, etc. Whenever an NFT appears in the blockchain ecosystem, they are immediately displayed on the marketplaces. This adds to the democratization of the blockchain ecosystem, allowing owners to create NFTs & sell them. If an NFT is sold at a marketplace, the marketplace keeps a royalty fee from the buyer.

• **Primary Marketplace:** The primary marketplace is where NFTs are minted, serving as their place of origin.

• **Proprietary secondary marketplace:** The marketplace belonging to the NFT proprietor is the proprietary secondary marketplace. The resale value from this site goes to the NFT owner & commission is obtained by the original NFT minter.

• **Third party secondary marketplace:** Platforms like OpenSea, Rarible, & Magic Eden are third-party secondary marketplaces that list any tokens minted on-chain. Token owners can use these marketplaces to sell their tokens, with the resale value going to the owner & the commission being owned by the marketplace.

2) How Token Transfer works in OpenSea: As per the ERC-721 standard, a token can have a token operator. The token owner must approve the operator. A token operator has permission to transfer the token. When a token is listed for sale in the secondary marketplace by the token owner, a **SetApprovalForAllFunction** event is emitted from the **ApprovalForAll** function, as shown in "Fig. 2".

The **ApprovalForAll** function sets a contract named **Conduit.sol** as the token operator. The **Conduit.sol** contract can be found on polygonscan. As per the contract's NatSpec comments, the contract serves as the originator for proxied transfers, & serves as the transferrer for any ERC tokens. The contract executes the transfer using the **execute** function.

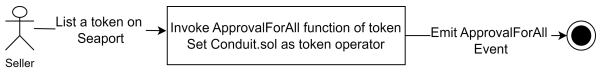

Fig. 2. Setting contract address as token operator flow

When the Buyer buys the token from OpenSea,the **fullfillBasicOrder** function of **Seaport.sol** is called. First, the order is validated & conduit data is loaded from the contract. Then the transfer is called using Conduit & the token transfer takes place. Afterwards, the fee distribution takes place. The seller receives 99.75% of the transfer amount & OpenSea receives 0.25% as shown in "Fig. 3". Figures display contracts designed by OpenSea and are a part of the Seaport market protocol.

3) Royalty Standard: In the Web3 eco-space, there should be effective monetization of NFT transfers to ensure creators' & owners' rights are properly preserved.

Users can buy or mint tokens from one place & sell them on various secondary marketplaces online. However, this can result in creators not receiving the royalty fees they are entitled to when the NFT is sold. Therefore, it is crucial to

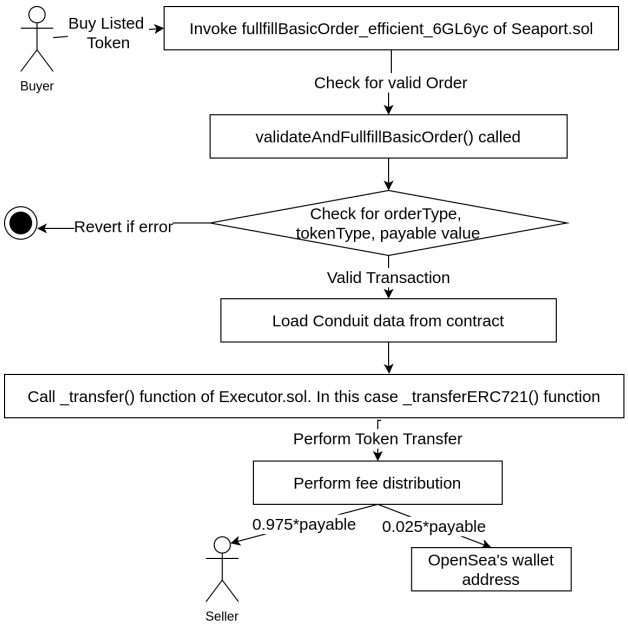

Fig. 3. OpenSea token buying flow

establish a standardized system that consistently incentivizes token creators for every transfer.

ERC-2981 is a royalty standard that incentivizes creators. Creators receive a percentage of secondary sales on NFTs, facilitating fair compensation. If a marketplace chooses not to implement this ERC, no funds will be paid for secondary sales. Adoption of this standard by NFT marketplaces supports artists and encourages buyers to consider royalties in their purchases. OpenZepplin has the royalty standardized using the ERC-2981 standard. If a smart contract inherits it, it will have access to setting royalty. “Fig. 4”, “Fig. 5”, “Fig. 6” show the process of generating royalty.

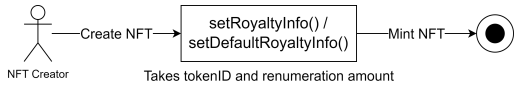

Fig. 4. Setting Royalty Amount During Minting

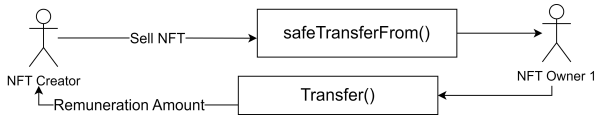

Fig. 5. First Token Transfer after setting Royalty

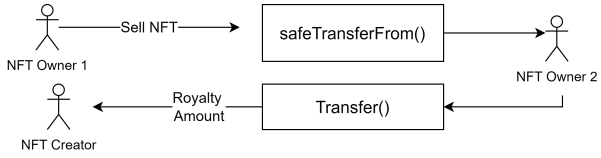

Fig. 6. Consecutive Token Transfers after setting Royalty

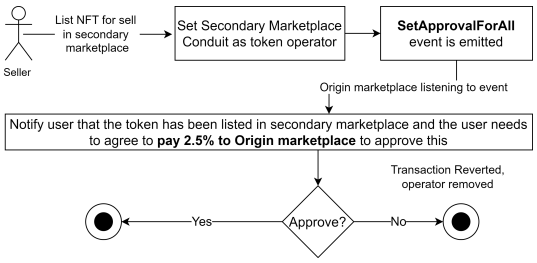

Fig. 7. Approving Royalty Fee Transfer During Selling

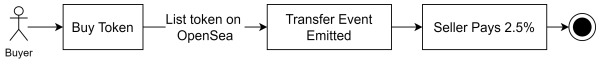

Fig. 8. Royalty Transfer During Selling Token at any marketplaces

Royalty Calculation: The default royalty rate is set to 10%. This percentage must remain constant regardless of the sale price. If the calculation results in a remainder, implementers have the flexibility to round up or down to the nearest integer.

Our proposed Royalty Distribution Mechanism: We propose another royalty standard that can be used instead of the ERC2981 royalty standard. It will give the origin marketplace more control over the tokens on that platform. In our case, the origin marketplace will listen to the **SetApprovalForAll** event. Its emission means that any third-party contract or address has been set as the token operator. So our platform will ask the owner to confirm that indeed the owner has listed the token on another platform & they need to pay 2.5% to the host platform as well. The 2.5% transfer occurs when the token transfer occurs. “Fig. 7” & “Fig. 8” narrates this procedure. The **ApprovalForAll** function should be overridden & our conduit should be set as Operator. Whenever **ApprovalForAll** is invoked, the **setApprovalForAll** event is emitted. We can then warn the user that the token has been listed in Secondary Marketplace. During the transfer, the origin marketplace will also get a 2.5% royalty from the transfer.

V. Future Work

While this study has provided a comprehensive analysis, further research into proposed royalty structures is warranted. The scope of this study is to provide an analysis of our proposed royalty standard & ERC 2981.

VI. Conclusion

This paper explores DeFi literacy & the microstructure of NFT markets in the DeFi landscape. It emphasizes understanding key concepts for industry practitioners & academic researchers. Overall, this paper serves as a valuable resource for understanding the complexities of DeFi & NFT marketplaces, offering insights & guidance for practitioners & researchers in the field. As the DeFi landscape continues to evolve, it is crucial to stay informed & adapt to emerging challenges.

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