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THE INTERSECTION OF BLOCKCHAIN'S TWO NEW FRONTIERS: HOW NFTs AND DEFI CONSTITUTE VALUE TOGETHER

Master's Thesis

Technology Governance and Digital Transformation

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ABSTRACT

The present study aims to analyze the interoperability and value creation of two emerging frontiers within the blockchain ecosystem: Non-fungible tokens (NFTs) and decentralized finance. The case study of JPEGd, a protocol that integrates NFT technology into decentralized finance applications, is analyzed through interactions with several smart contracts and the collection of primary and secondary data. The analysis indicates that NFTs and DeFi are highly compatible and their interoperability unlocks innovative functionalities, such as the establishment of the novel NFT lending market. NFT lending, as the initial representation of the interaction of these technologies, arguably offers a digitalized alternative to an analogue practice: art lending. The NFT lending concept demonstrates the potential for entrepreneurs to integrate NFTs and DeFi in order to create new markets, products, and functionalities. Overall, the thesis aims to make contributions to blockchain research through realizing the value propositions of emerging phenomena within the blockchain ecosystem.

Keywords: Non-fungible tokens, decentralized finance, value, online markets, innovation

INTRODUCTION

The financial crisis of 2008 led to a loss in trust in financial institutions both in the EU and the United States with spillover effects to the rest of the world (Roth, 2009, Uslaner, 2010). Electronic financial transactions traditionally relied on the basis that users must trust third party financial institutions for securing transactions (Martins & Yang Yang, 2011). In response to the both ongoing financial crisis, overall loss of trust to the financial system and being reliant on third parties for the approval of financial transactions, Nakamoto (2008) introduced a peer-to-peer transaction system called Bitcoin that facilitates transactions with cryptographic proofs rather than being reliant on third party financial institutions. In its essence, the Bitcoin network is built on the technological infrastructure that became available through the innovations around the ICT revolution and it was introduced as an experiment to offer an alternative to the existing financial transactional methods.

Transactions on the Bitcoin network are verified through a technology called blockchain, which is essentially an array of connected blocks that store and process information cryptographically. As a novel and developing technology, blockchain's value proposition evolved throughout the years. Initially, a public blockchain was introduced with Bitcoin (Nakamoto, 2008) and its value proposition was cryptographically solving the double-spending problem, enabling peer to peer transactions through a decentralized, uncensorable way and providing a low cost alternative to existing money transfer systems (Van Alystine, 2014). Following Bitcoin, Ethereum was introduced (Buterin, 2014) to extend use cases of the blockchain by introducing smart contracts that made it possible to run applications on top of decentralized consensus mechanisms. Unlike Bitcoin's limited scripting language, Ethereum was designed to be a programmable blockchain with a goal to empower multiple applications through verifying transactions in a decentralized manner (Antonopoulos & Wood, 2018, 2) .

While Bitcoin network stayed resilient and processed transactions as envisioned, the number of weekly average transaction counts on Ethereum network had a higher growth rate and surpassed Bitcoin transaction number in 2017 (The Block Research, table transaction count). Transaction fees gathered through user activity have also remained higher on the Ethereum network compared to Bitcoin's since the beginning of 2021 (The Block Research, table transaction fees). Further analysis reveals that dapp activity is the main source of transactions within the Ethereum ecosystem (Etherscan, table Ethereum gas tracker). When Blockchain activity is checked, Opensea and Uniswap come up as two dapps with the most active users with the highest transaction volume (Dune Analytics, table top Ethereum…). Uniswap and Opensea are also the most used dapps for two new frontiers of the blockchain ecosystem: Decentralized finance (DeFi) and non-fungible tokens (NFTs).

DeFi represents an array of financial applications built on the Ethereum network. These applications enable peer-to-peer transactions without a central point of failure with an aim to create an alternative financial system that is decentralized, open, interoperable, and transparent (Chen & Bellavitis, 2020). DeFi applications present traditional financial services like trading, lending/borrowing, options and futures in a permissionless manner where smart contracts take the place of the middleman to execute transactions.

NFTs are another phenomena gaining traction together with DeFi within the dapp ecosystem. NFTs represent digital ownership of unique assets on the blockchain. The NFT standard EIP 721 was first introduced on the Ethereum Github, and physical property ownership and digital collectibles that can be authenticated and stored through decentralized consensus were described as the potential use cases for NFTs on the Ethereum blockchain (Entriken et al., 2018). Together with DeFi, NFTs have expanded the blockchain user base and have become a vibrant part of the blockchain ecosystem. While the NFT ecosystem is speculative in its nature and financial gains are an obvious motivation for some, if not all, of the participants; the underlying technology unlocks novel use cases for both creators and collectors. For artists, they represent a chance for their digital art to be authenticated and secured via a decentralized network; for owners, NFTs represent a chance to custody digital collectibles without any intermediaries.

Numerous studies pointed out the potential of NFTs to boost economic activities on online networks and make profound impact on the current decentralized markets (Wang et al., 2021; Kugler, 2021; Usman, 2021), yet the technology is still in its infancy and the research on academic level is limited (Nadini et al., 2021). Furthermore intersection of NFTs and DeFi remains unexplored as these two concepts were not highly interoperable until the introduction of NFT lending markets. Schumpeter (1939) explains entrepreneurs innovate and drive economic growth through carrying out novel combinations of resources to create new products and establish novel markets. In this regard, NFT lending emerges as a compelling case worth discovering as the concept integrates novel technologies to serve a specific purpose.

Following these perspectives, this thesis focuses on answering the main research question: How is value created through combining NFTs and DeFi? Are these experimental technologies offering any economic value creation proposition beyond their speculative hype? The motivation behind the main research question is to address the gap between previous studies on value creation with blockchain and the status quo. Blockchain's value proposition has changed throughout the years as new technologies emerged; and with their unique mechanisms, NFTs and DeFi require in-depth analysis to understand their own value propositions.

To explore the main research question, the theoretical part of the thesis will focus on literature research on the phenomena of value creation in the domain of virtual markets. Value, as an abstract concept, attributed multiple meanings among various theoretical backgrounds. The thesis will use the value creation in online networks conceptual framework (Amit & Zott, 2001, 2010) to shed light on the impact of NFTs and DeFi on value creation. Conceptual frameworks connect various concepts to provide a broad understanding of a complex phenomena (Jabareen, 2009). In that perspective the chosen framework benefits from multiple theoretical viewpoints in entrepreneurship and strategic management research to understand value creation in the context of online networks. Accordingly, this part of the thesis will focus on answering the sub-thesis question: How value is created on virtual markets?

The analysis part of the thesis will focus on a novel NFT lending protocol: JPEGd. Amit & Zott's (2001) framework focuses on answering how participants, including the firm, facilitate transactions and how this configuration of transactions enables value creation. In line with this

perspective, JPEGd protocol arguably presents an interesting case for analysis as the protocol has a unique transaction mechanism that enables NFT owners to lend their digital collectibles and borrow platform's cryptocurrency pETH (JPEGd 2022a). Amit & Zott (2010, 216) highlight that participants of a transaction system try to generate value through collaboration with their partners and each participant tries to appropriate their share of overall created value. JPEGd protocol is a complex transaction system encompassing NFT creators, NFT collectors, JPEGd team and external DeFi protocols that are collaborating with JPEGd protocol. Accordingly, the analysis part of this thesis tries to answer the sub-thesis question: How does the JPEGd protocol integrate the NFT standard into decentralized finance smart contracts to constitute value?

To analyze main and sub thesis questions the thesis will benefit from both primary and secondary data. Primary data will be collected through acquiring an NFT and directly interacting with JPEGd's smart contracts to reach certain information such as transaction time, transaction cost and token standards involved in the transaction. This data will be permanently recorded on the Ethereum blockchain and remain publicly available as a reference for future studies. In addition to primary data, secondary data will be collected from JPEGd's communication channels such as Medium page, Github page, Snapshot page and governance forum. Furthermore, real time blockchain tracking tools Dune Analytics, Etherscan and Defi Llama will be used to reach certain metrics that will be used to support the analysis. Overall, the thesis aims to interpret concrete findings that shed light on the research questions and make contributions to the NFT and DeFi research literature and point directions for further studies.

1. THEORETICAL BACKGROUND ON VALUE CREATION IN ONLINE MARKETS

Value as an abstract phenomena have distinct interpretations on different disciplines. The focus of this thesis, however, is the perception of value in the entrepreneurial and strategic management context. More specifically, this thesis is focused on two levels of the value concept: creation of value through technology, skills, resources and creativity and the capture of the value that is generated with a purpose of economic gains (Lepak et al., 2007, Bowman & Ambrossini, 2000, Amit & Zott, 2010). Accordingly, the theory section of this thesis tries to analyze these questions: (1) What are the sources of value creation? (2) How value is created in online markets?

To analyze these questions, the theory section will first briefly explain the evolution of the term value in classical economics thought. The section then will continue with the interpretation of value in various entrepreneurial and strategic management theories such as Schumpeterian innovation, value chain, resource-based view, transaction cost economics and strategic networks. Finally, the last chapter will explain the theoretical framework synthesized through analyzing these five theories. The synthesized framework is mainly derived from Amit & Zott's business model framework (2001, 2010) with minor contributions from the author's own contribution which will be further explained in sub-chapter 1.3.

1.1. Value in Classical Economics

It is clear that throughout centuries, human skills and labor have played a major role in value creation. This effort eventually leads to products and services that people pay for using. Many economists tried to explain the fundamentals of this exchange to shed light on the motivations behind trade/barter actions and to further understand what constitutes value.

One of the possible motivations behind barter actions is perhaps the need or desire to acquire the service/good. Smith in Wealth of Nations (1776) arguably provided the first complete theory in modern economics by emphasizing the difference between the "use value" and the "exchange value" (Pazaitis et al., 2017). Smith remarks that in civilized societies, people are in constant need for each other's assistance and bartering serves to satisfy this basic human need. According to Smith, the exchange value or the price of goods essentially corresponds to the toil and trouble of acquiring what men want and money is a medium of exchange for labor (Smith 1776, 31). He further states that this exchange value is not necessarily correlated to the use value. Smith gives the comparison of water and diamond and states that while the former provides great value in use and the latter provides scarce value in use, the latter has greater purchasing power (Ibid., 30).

Another influential economist, Ricardo, also touched on this differentiation between value in use and value in exchange. In his well known book Principles (1821), Ricardo emphasized that utility, or value in use, is absolutely essential to possess exchange value; yet, the exchange value, which is the main concern for economic analysis, is determined by scarcity and quantity of labor required to acquire goods/commodities. According to Ricardo, value in use is important as products need to contribute to our gratification; however, analyzing value in use is insufficient and pointless for understanding the economic implications (Hollander, 1904, 458). Ricardo further expanded on the impact of scarcity on exchange value by mentioning that scarcity is the only determinant for some commodities like rare statues and coins where labor effort can not increase the supply (1821, 8-9). However, he says, such commodities only form a small fraction of market volume and the goods that dictate greater size of the market are directly and solely produced by labor. Hence, except for these rare commodities, labor hour is the only determinant of exchange value and is the main focus of economic analysis. Accordingly, Ricardo's theory (Ibid.) implies that commodities/goods are correspondences of labor hours they possess and this exchange of labor hours is the main underlying mechanism of trading.

In the first volume of Capital (1867), Marx opposed Smith's and Ricardo's view that converges the meaning of value only to the exchange value. Marx explained that commodities, as the main object of trading, are mainly distinguished through two dimensions: quality and quantity (Ibid., 27). Marx stated that while the quantities and proportions of commodities work as a medium for

trade, converging all the value to the exchange value creates an abstraction that ignores the very material existence and essence of items (Ibid., 28). He stated that the material existence of commodities like iron, corn or diamond are independent from the amount of labor required for creating them. According to Marx, useful qualities of commodities are independent from the abstract exchange value and “use values become a reality only by use or consumption: they also constitute the substance of all wealth” (Ibid., 27). Hence, in contrast to Ricardo and Smith, Marx does not regard use value as an economic irrelevance but highlights it as a key concept for economic analysis (Keen, 1993, 110).

Even though they had different understandings on what constitutes value, both Smith, Ricardo and Marx acknowledged use value and exchange value. In addition to use value and exchange value, another phenomena that is perhaps still valid on modern economic analysis is the theory of "subjective value” that was introduced by Austrian economists. As one of the influential figures of Austrian economics thought, Menger provided a powerful insight that both sides gain from a trade as people exchange items they regard more valuable for items they consider less valuable (Henderson). Menger argued that human desire for *Güterqualitat*, or quality of being good, is the ultimate basis of exchange and if people were to lose interest, for example, their taste for tobacco; then cigars, cigarettes, tobacco stocks and factories would become obsolete (Stiegler, 1937). Menger stated that “differences in the magnitude of importance of different satisfactions” is the determinant of utility and the basis of subjective value (Menger, 1871, 122). Accordingly, value is a function of subjective judgment rather than the labor embodied in the good (Reinecke, 2010, 7-8). Wieser (1891, 118) also provided an arguably clear distinction between use value and exchange value by emphasizing that the former is particular and subjective whereas the latter is in general objective.

1.2. Value in Entrepreneurial and Strategic Management Context

It is clear that the teachings of classical economists made a profound impact on the analysis of value and such analysis showed that value is essentially a key component of society that is embedded into the daily life of anyone participating in basic trade/barter actions. Furthermore, phenomena such as use value, exchange value or subjective value are still incorporated into

multiple researchers' agenda to understand the interpretation of value in the modern economy (Reinecke, 2010, Lepak et al., 2007). However, the analysis of value did not become limited to these terms and further evolved and developed to reflect on the current economic and technological conditions.

The interpretation of value diverged to distinct explanations on different disciplines and there is no consensus on the definitive explanation of value. The focus of this thesis is to understand a complex activity system involving multiple actors, technologies and disciplines. The case study of the thesis embodies multiple phenomena such as online networks, entrepreneurship, strategic management, finance, creative industries and distributed ledger technology. The experiment in the analysis part will involve online transactions, hence; the value drivers in online markets is closely relevant to the focus of the thesis. Accordingly, the analysis of the thesis requires a holistic framework combining various perspectives from multiple academics on the interpretation of value. As will be further explained in sub-chapter 1.3., Amit & Zott's (2001, 2010) conceptual framework analyzes the interpretation of value in different literatures and arguably provides a comprehensive framework suitable for the focus of this thesis. Conceptual frameworks connect various concepts to provide a broad understanding of a complex phenomena (Jabareen, 2009). Similarly, the framework that will be used for the analysis connects teachings from multiple backgrounds to shed light on the main thesis question.

Consequently, the next sub-chapters will analyze five different theoretical backgrounds to analyze common themes on what constitutes value. These sub-chapters will explore respective literatures to shed light on the sources of value creation highlighted by each theory. Furthermore the analysis of each literature will be reflected on the domain of online networks. Eventually, the common themes that are identified as sources of value creation in online markets will form the conceptual framework.

1.2.1. Value Chain Analysis

Porter (1985) pointed out that competitive advantage is key to success for a firm and such phenomenon could only be understood by analyzing individual activities that form the value chain of the firm. Value chain framework regards activities as the sources of value creation and

further emphasizes that each activity has its own economics separately making an impact to the competitive advantage of the firm (Ibid., 38).

The value chain analysis is a useful framework for understanding the full product cycle from conceptualizing to recycling, and such analysis is considered as an efficient tool to realize which activities are critical for competitive advantage and which activities are the driver of sustained economic value creation and capture, especially in complex production systems (Kaplinsky & Morris, 2000, 5-9). In this regard, value chain theory can arguably be explained as a valid method for understanding the value creation process in the domain of physical products. However, Porter's (1985) value creation logic remains vague on the domain of service industries and virtual markets. Stabell & Fjeldstad (1998, 414) pointed the inefficacy of the value chain theory on service industries by focusing on the insurance companies and asking "What is received, what is produced, and what is shipped" as the value chain theory would imply uninsured people are raw materials and insured people are the end products.

Following the same logic, the interpretation of value chain theory to virtual markets remains abstract and arguably limited in its impact as internet based businesses operate with different dynamics. While it is easier to conceive the value chain around a physical product, analyzing the value chain around a digital item requires a different approach. Rayport & Sviokla (1996) tried to reflect on this problem by stating that the value chain framework regards information as a supporting item whereas in the online networks information itself is the main driver of value. Based on this interpretation, Rayport & Sviokla (1996) introduced the concept of virtual value chain where digital assets, which are essentially encoded information pieces, are the focus of value creation and these assets have three main different characteristics than physical ones: Firstly they are not used up upon consumption hence can easily be reused, secondly they can be produced in greater amounts therefore they are highly scalable and finally these assets are transported on a digital environment thus transaction costs are lower. Building on this hypothesis and overall market shift to Internet based businesses, value chain further developed into a value network where focus is intangible assets and value is co-created through collaboration with network participants (Ricciotti, 2019).

1.2.2. Schumpeterian Innovation

Schumpeter's theory of economic development emphasizes that entrepreneurs are the source of value creation and they are the drivers of economic growth through carrying out novel combinations (Schumpeter, 1934). According to Schumpeter, the concept of carrying out new combinations can be explained in several ways . Firstly, it could represent an introduction of a new good that is either unprecedented or it has different qualities than existing goods. Secondly, carrying out novel combinations can be performed through establishing a new production method that either did not exist before or has a unique mechanism for commercializing the product. Finally, another possible way of carrying out new combinations is by introducing a new market that is unknown for participants (Ibid., 66).

Schumpeter calls this act of carrying out new combinations as innovations and strongly emphasizes the distinction between innovation and invention (Schumpeter, 1939, 80-83). While invention is directly associated with scientific novelty, innovation is not bound by the domain of science but it is mainly concerned with turning these scientific discoveries into profitable enterprises (Schumpeter, 1934, in Perez, 2010). Furthermore, while innovation is the source of economic development, invention itself is economically irrelevant unless scientific discoveries are successfully commercialized (Schumpeter, 1934, in Scherer, 1986). In Schumpeterian view, innovation is the engine for economic growth and entrepreneurs are the main drivers of economic value creation through turning existing production functions to new use cases.

Innovations do not evolve in isolation and interconnectedness of technologies enable innovations to interact with other innovations and such phenomena eventually leads to a collaborative evolution for innovations (Schumpeter, 1939, in Perez, 2010). This dynamic environment of interconnected innovations leads to technology systems which are usually initiated by radical innovation and further developed by multiple incremental innovations around the radical innovation (Freeman & Perez, 1988,; Perez, 2010).

Similar to innovations interacting with each other to form technology systems, technology systems interconnect with other technology systems and these connected technology systems

lead to techno-economic paradigms. Techno-economic paradigms involve clusters of radical and incremental innovation combinations and both interconnected and interdependent technology systems, and such paradigm changes profoundly impact every aspect of economy and transform multiple industries and eventually the society (Freeman & Perez, 1988; Perez 2010, 189).

Following Perezian view, online markets can be recognized as a part of the ICT revolution and such markets are arguably technology systems as they are dynamic networks evolving through the impact of many agents such as suppliers, distributors, IT networks, individual entrepreneurs and even customers. Schumpeter emphasizes that entrepreneurs are not necessarily the owners of the enterprise but also the agents with freedom and power to perform entrepreneurial duty and carry out new combinations (Schumpeter, 1934, 74-75). Hence, in virtual markets, this synergy of the co-creation from multiple agents drives innovation. Through connecting Schumpeterian view with the current state of virtual markets, it could be argued that novelty and co-creation are commonly observed themes as sources of value creation in virtual markets.

1.2.3. Resource-Based View

The resource-based view of the firm (RBV) is developed around the hypothesis that resources and products of the firm are the reflections of each other and value creation potential of products, hence of the firm, can be analyzed by evaluating the quality of the firm's resources (Wernerfelt, 1984). According to resource based view, firm resources such as brand name, patents, skilled employees, special trade agreements, equipment and capital (Ibid., 172) are the drivers of firm's sustained competitive advantage and the firm should acquire, control and maintain such resources and capabilities for strengthening its position among competitors (Barney, 1991, in Kraaijenbrink et al., 2010) Overall, RBV is built around the assumption that the firm's resources and capabilities is the source of value creation (Barney et al., 2021).

Barney (1991, 105-112) highlighted a couple of key concepts that separates firms from their competitors such as resource heterogeneity and resource immobility. Following this perspective, sustained competitive advantage, hence value creation, relies on having resources that constitute one of the following four characteristics: (1) Valuable for exploiting opportunities, (2) rare in firm's competition environment, (3) hard to imitate or (4) irreplaceable by another resource.

RBV regards a firm's resources are valuable if they match either of these two clauses: (a) They increase the revenue of the firm when compared to their absence, (b) they reduce firm's costs (Barney, 1997, in Amit & Zott, 2001).

While it is easy to grasp the value proposition of RBV, as in the resources of firms are obvious catalysts for both value creation and capture of the value created, many researchers argued that initial representations of RBV is not sufficient for comprehensively understanding value creation. Teece et al. (1997) explained that regardless of the quality of the resources of a firm, competitors were able to create novel competitive advantages through staying responsive to the demand changes and adopting innovation based production strategy. Furthermore, while firms make an effort to sustain competitive advantage through focusing on resources that are rare and immobile, this competitive advantage will sooner or later vanish as other firms will imitate these resources to some degree (Teece, 2018). Information and communication technology created markets and networks that are open, accessible and without clear boundaries, and software companies have managed to provide similar services with different resources (Lockett et al., 2009, 23). Under the light of these perspectives and reflecting on the implications of RBV in virtual markets; it could be argued that the nature of virtual markets is a challenge for RBV as virtual markets are processing digital resources that are highly mobile and easier to imitate (Amit & Zott, 2001).

1.2.4. Strategic Networks

Strategic network theory adopts a different perspective than other conventional theories like value chain theory or RBV as it highlights that participants of a network form a synergetic relationship, and the focus of value creation is the network itself rather than the firm. In this regard, strategic network theory embraces a relational approach that strategic networks are formed by interconnected firms, and such complex and cooperative networks are strategically important for both creating value (Gulati et al., 2000), and sharing risks (Katz & Shapiro, 1985, in Amit & Zott, 2001).

Strategic network theory tries to understand value creation by breaking down industries to activities that constitute economic value and this theory highlights that each firm contributes to

the overall value proposition of the network through tackling problems with their own resources and capabilities (Jarillo, 1993, 21-30) Furthermore, innovation of a single firm is beneficial for all network participants. In other words, strategic network theory does not consider commercial interactions as zero sum games and further advocates that network participants' individual contributions can be beneficial for other participants.This perspective is perhaps in align with Menger's theory of subjective value (1871, 122) that both parties to an exchange acquire value through pursuing things that matter more to them.

While the implications of strategic network theory is clearly relevant for the virtual markets, and participants of these online networks collaborate and interact for creating economic value; these Internet based networks also gave rise to new concepts such as co-creation of value. As strategic network theory shifted the focus of value creation from firms to network of firms, Internet based businesses further shifted this focus to network of firms and consumers (Prahalad & Ramaswamy, 2000, 79-81). This change is mainly due to the fact that consumers are becoming more informed, connected and empowered thanks to easier access to both information and alternative products (Prahalad & Ramaswamy, 2004).

1.2.5. Transaction Cost Economics

Transaction cost economics (TCE) describes firms as governance structures and argues that value creation can be understood by analyzing complex economic activities through the lens of law, economics and organization theories (Williamson, 2008, 41). In contrast to neoclassical economics, TCE is not primarily concerned with price and value appropriation but rather focuses on understanding how economic activities are arranged across the organization.

TCE attempts to find out why firms incorporate economic activities within the organization instead of performing these transactions in the market (Coase, 1937, in Amit & Zott, 2001). In this regard, TCE emphasizes that transactions encompass multiple dimensions such as potential risks, relationship and agreement between parties and the overall cost of the exchange (Shelanski & Klein, 1995). Furthermore, transactions are complex in their nature and "contractual arrangements are closer to a constitution for a local government than to the simple paradigm

of a two-person market transaction" (Klein et. al., 1978, 325). Accordingly the governance structure of an organization needs to be arranged depending on the uncertainty, complexity and the frequency of the transactions with a goal of minimizing the risks and optimizing the economic value potential.

Transactions over the Internet are clearly within the context of TCE, however with different dynamics compared to analogue practices. Both business to business, business to consumer and peer to peer transactions occur through an open network with an instant manner. Exchanging information and digital goods takes less time and resources, hence the Internet provides an infrastructure for more efficient transactions. Another important phenomenon related to TCE is the information asymmetry. Tadelis & Williamson (2010) highlight that information asymmetry leads to transaction inefficiencies. In this regard virtual markets arguably increase transaction efficiency thanks to up to date information about products, comparison tools and user reviews. Information asymmetry is an interesting topic within the context of this thesis as well since blockchain based applications provide real time data through block explorers that is transparent and accessible for everyone.

Next chapters will explain the building blocks of the "value creation in online businesses" framework of Amit & Zott (2001) which is created by combining the key components of five conventional theories explained in the previous sub-chapters.

1.3. Proposed Framework: Value Creation in Online Markets

By considering the present-day economic realities and motivations, researchers expanded on the analysis of value through focusing on three main levels: (1) Sources of value creation, (2) design and organization of the system to empower sustained value creation and (3) the value capture that turns efforts into economic realities (Amit & Zott, 2001, 2011, Bowman & Ambrossini, 2000). This expression is perhaps in alignment with the classical economists distinction of use-value and exchange value. First two levels, sources of value creation and the design of the system, are concerned with utility and the intrinsic value of a network/business whereas value

capture is rather concerned with revenue stream and exchange value that is empowered by the sources of value within a system.

Amit & Zott's (2001) value creation in e-business framework has two main components that are interconnected: Sources of value creation and the business model. Sources of value creation are key components that give businesses an edge for value creation in online networks and the business model is the architecture of the system to empower sustainable value creation. Both components of the framework, sources of value creation and the business model, are created through understanding the contributions and limitations of five conventional theories explained in previous sub-chapters.

1.3.1. Sources of Value Creation

Amit & Zott (2001 & 2010) highlighted four drivers of value creation in online markets: Efficiency, novelty, lock-in and complementaries. In addition to these four drivers, the analysis through sub-chapter 1.2. showed that co-creation is a common theme as a value driver in multiple theoretical views. Accordingly the thesis adopts five sources of value creation to analyze the main research question.

Amit & Zott (2000, 503-504) emphasize transaction "efficiency" as one of the primary drivers of value in the domain of virtual markets. Efficiency aspect is in alignment with the TCE theory that transaction efficiency increases with decreased cost per transaction. Online businesses can create value through lowering costs for participants and increasing transaction efficiency. Furthermore, value chain researchers highlighted that processing of digital content is the main focus for analyzing value creation in online networks (Rayport & Sviokla, 1996, Ricciotti, 2019). Accordingly, any improvements enhancing efficiency of the distribution of the digital goods can provide value to the participants of the system.

One possible way of increasing efficiency is to diminish information asymmetry between transaction parties by providing up-to-date and detailed information. Providing accurate information decreases consumers' search and bargaining cost (Lucking-Reiley & Spulber, 2001,

in Amit & Zott, 2010). Other parameters related to efficiency enhancements are search costs, product selection range, speed of transactions, demand and supply aggregation and scalability.

Second important theme as a source of value creation is “novelty”. As analyzed through chapter 1.2., novelty is clearly a source of value for online markets. Schumpeter explains that carrying out novel combinations is the engine for economic growth and such new combinations enable the establishment of new or redesigned goods, markets and production functions (Schumpeter, 1939). Following that, Internet infrastructure provides entrepreneurs many alternatives for creating novel business structures that can transform existing industries.

Entrepreneurs can create value through integrating new transaction structures, new transactional content and embedding new participants into their business design. Consider, for instance, digital content distribution. Whether it is digital art, news, video or audio; establishing a business model that can distribute copies in a fast and secure manner can be the source of value creation since digital content is scalable and easily accessible through the globe. It is important to note that the potential for value creation through novelty does not guarantee the value appropriation as many online businesses fail due to lack of entrepreneurial experience, inefficient transaction choices, unfriendly website design and over expectation of user demand (Razi et al., 2004). Furthermore, Schumpeter (1939) describes that entrepreneurs turn inventions into innovations through sustaining economic gains. In this regard, the novelty aspect of this framework is concerned with both establishing new production methods and also the profitability of these methods.

Third theme as a source of value creation is “lock-in”. Online businesses can sustain created value through incentivizing customers for repeating transactions and further maintaining strategic collaborations with business partners (Amit & Zott 2001, 505). Such business practices are also known as lock-in, a phrase that reflects promoting and focusing long term relationships with network participants with the motive of preventing the migration of transaction partners to competitors. Lock-in is clearly manifested in the RBV theory as parameters like the brand name or firm’s resources and capabilities can be important for sustaining repeated transactions. Furthermore, TCE explains lock-in as switching costs (Williamson, 1975, in Amit & Zott 2001) as switching to different service providers requires the establishment of new contracts and relationships that can cost both time and money.

Lock-in concept is also manifested in the strategic network theory as network externalities. Katz & Shapiro (1985) explained that utility of some products is directly related to the number of other consumers using the same product. Consider for instance the telephone network or online video games. Clearly, the success of these products depends on the number of users connected to that specific network as the product design is mainly focused on peer-to-peer interactions.

Fourth theme as a source of value creation in online markets is "complementarities". Amit & Zott (2010, 221) explain complementarities are present whenever bundling activities within a system provides more value than running activities separately". Amit & Zott's (2001) analysis of e-businesses suggests that companies operating on virtual markets can create value through offering vertical and horizontal complementary activities where former refers to services like after sale or maintenance; and the latter refers to services like one-stop shopping. In addition, firms can offer complementary products for adding value that are not directly related to firms' core activities.

The fifth and the final source of value creation this thesis adopts is "co-creation". The analysis through 1.2. showed that adoption of co-creation within a system can enhance value creation. The decentralized nature of the Internet facilitates complex systems where power hierarchies are blurred and synergy through collaboration is increased. As Schumpeter states (1934), entrepreneurs are not only the enterprise owners but people with capabilities to carry out novel combinations. Hence, the decentralized structure of the Internet automatically integrates co-creation as a source of value creation for online businesses through empowering multiple agents to have an impact on system activities.

1.3.2. Unit of Analysis: Business Model Design

Value creation in e-business framework proposes "business model" as the unit of analysis, and business model refers to the design of content, structure and governance of transactions, or business activities, with a purpose to both create value within an ecosystem and also appreciate part of the value generated (Amit & Zott, 2010). Business model is conceptualized as a system of interconnected activities that transcends the firm's boundaries (Amit & Zott, 2010, 216).

Nonetheless, a business model can be designed around a firm in a way that the firm creates value with its partners and tries to appropriate its share of overall generated value. There are three main elements of the business model namely content, structure, and governance.

Transaction "content" focuses on what kind of information or goods are being subject to exchange (Amit & Zott, 2001, 514). While the context of the goods or information being exchanged is important, the resources and capabilities that are required for performing such activity is equally important for value creation.

Sources of value creation in virtual markets can be realized through the design of the business model content (Amit & Zott 2001, 512). For instance, introduction of a new product can constitute novelty on the transaction content. Furthermore, supporting the transaction process with real time data feed can increase transparency and reduce information asymmetry; hence, efficiency can be attained through business model content. Lock-in can also be relevant to business model content if the digital goods being exchanged are not accessible or exchangeable in other networks.

Second important theme regarding business model is the "structure" of the activity system. Structure of the business model is mainly concerned with how the parties involved in a transaction are linked together and how transactions between network participants are performed (Amit & Zott, 2010). Essentially, business model structure focuses on the infrastructure that is facilitating transactions and connecting network participants. Some important dimensions for transaction structure are exchange mechanisms and speed (efficiency), potential of new transaction methods to introduce new participants to the network (novelty), transaction reliability and the network effects (lock-in), and after sale services such as insurance (complementaries) (Amit & Zott, 2001, 512).

Third and final important theme of the business model is "governance". Governance in the business model construct is concerned with defining the responsibilities of parties involved in an activity or in a transaction. It refers to identifying or designing who controls the information flow, resources and services (Amit & Zott 2001). Furthermore, business model governance is

relevant for understanding the legal form of organizations and the primary focus is to understand the incentives and risks for parties involved in a transaction.

Williamson (1979) highlighted that transactions are complex phenomena with various levels of uncertainty and exchange frequencies. He further emphasized that defining contractual liabilities and choosing organizational structure through governance design is important for achieving efficient economic activity. Building upon this context and further reflecting on the dynamics of virtual markets, Amit & Zott (2001, 514) emphasized that design of business model governance is important, especially for aligning trust and incentives between parties in an optimized way to achieve sustained value creation.

Table 1: Sources of value creation (displayed as rows) and the business model elements (displayed as columns).

	Content	Structure	Governance
Efficiency	- Transparency and reduced information asymmetry	- Exchange mechanism - Transaction speed	- Time required for reaching to consensus on protocol level
Novelty	- New combinations of goods, services - New markets - Introduction of scalable and easily transferable digital goods	- Introducing new participants to network - Discovering novel mechanisms to link participants	- New incentives and risks for participants
Lock-in	- Customized interface	- Transaction reliability, - High number of participants	- Trust - Transparency
Complementarities	- Insurance - Bundles of products and services	- Access to services offered by the partners of the firm	- Alliance capabilities
Co-creation	- Multiple agents driving content creation	- Users are empowered to impact activity system	- Increased dialogue with ecosystem

Source: Amit & Zott (2001, 2010); Author's illustration.

2. METHODOLOGY

The main motivation of this thesis was to evaluate the value proposition of an under researched concept that is the intersection of two novel technologies; non-fungible tokens (NFT) and decentralized finance. As discussed in the theory chapter, value is an abstract and rather subjective phenomenon that gains different interpretations depending on the focus of the study. Gall et al (1996) explain qualitative research helps discover novel concepts upon collecting and analyzing data. In this regard, the thesis adopted a qualitative research method to analyze the main research question.

NFTs and decentralized finance are complex technologies involving multiple agents and industries such as cryptography, finance and art. Therefore, this thesis conducted an exploratory case study approach to shed light on these complex phenomena with a goal to inductively generate insights through analyzing the findings (Ogawa & Malen, 1991). JPEGd protocol is chosen as the case study since it is arguably a suitable case that helps analyze the main research question as it is one of the earliest protocols to integrate NFT standard into decentralized finance smart contracts to create a novel lending functionality for NFTs.

This thesis benefited from both primary and secondary data to discover the phenomena in focus. Primary data was collected through acquiring an NFT, and directly interacting with JPEGd's smart contracts to essentially secure a loan against an NFT. In this regard, primary data was collected through a peer-to-protocol manner. All interactions with smart contracts are permanently recorded on the Ethereum blockchain and each interaction is explored through blockchain explorer Etherscan. Certain information about transactions such as transaction hash, smart contract addresses, transaction cost, processing time and metadata of the NFT are documented through the sub-chapter 3.2. and detailed information about transactions are displayed through the appendices. The motivation behind collecting primary data was to explore and monitor the process to understand the advantages, risks and barriers of NFT lending and to

discover its differences in comparison to traditional art lending. Additionally, the data provided in the thesis can be used as a reference for future studies as these transactions can be easily accessed through any Ethereum block explorer.

In addition to the primary data, secondary data is collected through JPEGd's communication channels such as JPEGd's website, Github page, governance forum, Snapshot page, and Medium account. While the collected primary data through peer-to-protocol interaction is sufficient to analyze the types of token standards, smart contracts and transaction metrics involved in the NFT lending process; secondary data was used to understand the design choices on the protocol level. Some concepts that were analyzed through secondary data are protocol's governance mechanism and JPEGd's collaboration with other decentralized finance protocols. Along with JPEGd's communication channels, blockchain analytics tools like Dune Analytics and Defi Llama were used for accessing historical usage metrics about JPEGd protocol and decentralized applications that are mentioned in this thesis.

Finally, the data obtained from both primary and secondary sources are discussed in the light of the conceptual framework in the Discussion chapter to provide insights from the case study.

3. CASE STUDY

The focus of this thesis is to analyze how NFTs and DeFi constitute value together. To analyze the main research question, it is perhaps necessary to conceive how NFTs and DeFi create value separately. To understand how they create value separately, one must first explore if and how they offer any generally meaningful solutions beyond the speculation.

In alignment with the goal of the thesis, the next sub-chapters will analyze three different concepts that are relevant to the phenomenon of NFT lending: NFTs, art lending and decentralized finance. These sub-chapters will provide context before we move into sub-chapter 3.2. where we will experience the NFT lending process through interacting with JPEGd protocol's smart contracts and collect primary data.

3.1. Conceptual Background For The Case Study

3.1.1. Non Fungible Tokens

Before analyzing what NFTs are, it is perhaps useful to understand the meaning of the term "fungible" and "non-fungible" and examine the representation of these asset classes in the physical world. Fungible assets have the same nature and financial value, they can be substituted with each others for performing obligations and they are inseparable from their kind (Durham 1965; Muntean 2012). Non fungible assets, however, are easily distinguishable and they represent unique characteristics (Muntean 2012).

Non-fungible items/assets are essentially vital components of many industries ranging from online markets to construction; but perhaps they are most relevant to the realm of creative industries. Creative industries are emerging as a stimulating component of economic development and they involve industries "which have their origin in individual creativity, skill

and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property" (DCMS, 2001, 5). In creative industries, "creativity is an input and content or intellectual property is the output" (Potts & Cunningham, 2008). In other words, creativity is the source of the value creation and market appraisal of creative products represents the exchange value.

The boundaries of creative industries are not clearly defined but design, visual arts, copyright management, music, publishing, video games and photography are commonly accepted as part of creative industries (Jones et al., 2015). Building on the definition and the context of creative industries, it could be observed that productions of creative industries can mostly be categorized as non-fungible assets as each object is a unique creation. Each photograph, a website design, domain names, paintings, sculptures, computer generated visuals, articles, songs and videos are essentially production of human creativity and each product has distinct characteristics. Clearly, these products and creative industries are an important part of the modern economy as they empower economic growth through innovation and further enable the creation of new types of jobs, industries and services (Pots & Cunningham, 2008). In alignment with this perspective, we can shift our focus to understand what non-fungible token technology (NFT) means for the creative industries ecosystem.

Beyond the speculative pricing of NFTs, the technology provides authentication of non-fungible assets in the digital realm. Considering the importance of non-fungible assets for both creators and creative industries in general, NFT technology enables creators to record their non-fungible products on blockchains through an immutable and traceable manner. Furthermore, the technology arguably represents a solution for copyright issues of digital assets by publicly recording and representing the data and further creates a market for creators to financially appropriate the value generated through their craftsmanship.

Before diving further into the explanation of NFTs, it is perhaps necessary to focus on the underlying technology: blockchain. Blockchain is essentially an array of connected blocks that store and process information cryptographically and the security of this distributed ledger is assured by a decentralized network of computers. Similar to how the decentralization of communication systems initiated the creation of the Internet, blockchain technology can play an

important role in decentralizing the storage of data and processing of information (Wright & De Filippi 2015).

Building on this perspective and connecting the dots between creative industries, non fungible assets and the blockchain technology; non-fungible token technology is essentially a gateway for creators to authenticate, store and financialize their non fungible assets in the digital realm. The role of each technological improvement in society is to make life less problematic and each improvement comes with an implicit suggestion that life would be more convenient with it (van den Hoven 2007, 70). Similarly NFT technology brings convenience to the creative industries participants through multiple ways.

To analyze how NFTs secure the authentication of assets, it is essential to understand the two most commonly used token standards in the Ethereum ecosystem: ERC20 and ERC721. ERC20 standard enables the creation of fungible tokens that are created and run through interacting with smart contracts. As explained earlier, fungible assets are identical with one another and they can be both divided and summed up. Similarly, ERC20 token standard features functions like the total supply, balance, symbol and decimal of the token (Vogelsteller & Buterin, 2015). While ERC20 standard enables the representation of fungible assets in the cryptocurrency ecosystem, ERC721 standard was created to enable the authentication of non-fungible assets in the same ecosystem. It differed from ERC20 standard through introducing a unique token identifier called “uint256” and paved the way for standardizing the identification of non-fungible assets on the Ethereum blockchain (Entriken et al. 2018). Each NFT is designed to have a globally unique pair of contract address and uint256. While a contract represents a collection of NFTs, each NFT belonging to the collection can be identified through the specific token ID (uint256) attached to it.

Another important dimension needs emphasizing is the metadata that is attached to ERC721 tokens. While ERC721 standard enables the identification of the token, it is metadata that reveals what is encoded or assigned to that specific token (Guadamuz 2021). Metadata essentially enriches the NFT with additional information such as name, description and a link. This metadata is shown via Uniform Resource Identifier (URI), that points out the corresponding asset like the cached or hosted version of the image. While on-chain storage comes with an

implicit suggestion that the image will remain immutable as long as Ethereum blockchain stays resilient, this option is not optimal for high resolution images as the process bears significant costs (Balduf et al. 2022). Accordingly, creators prefer alternative hosting services centralized storages (cloud) or decentralized storage systems like Inter Planetary File System (IPFS) to host the corresponding image/asset.

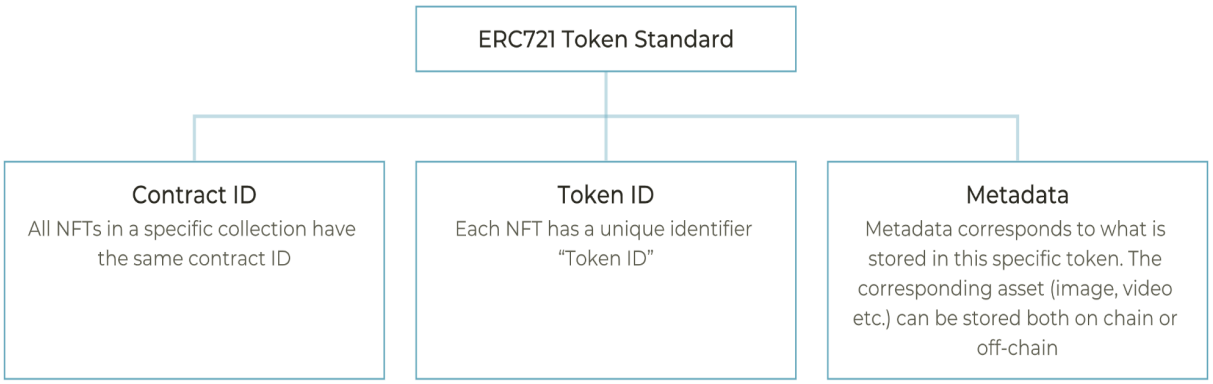

Figure 1: Conceptualized illustration of ERC721 Token Standard (Source Entriken et al. 2018; Author's own illustration)

Jones et al. (2015, 6-7) highlight two key dimensions for value creation through creative products: semiotic codes and material base. Semiotic codes pertain to the symbolic nature of a creative product and how the artist uses it to convey meaning and influence the interpretation of the audience. The material base, on the other hand, refers to the systems and technologies used in the production and consumption of creative products. Jones et al. (2015) explain that the change in the material base from analogue to digital disrupted multiple industries such as music, publishing, and video streaming. Following this perspective, NFT technology arguably presents a novel material base for creative industries to expand their presence in the digital realm. Furthermore, NFT collections can inherit various semiotic codes that represent the conveyance of the artist. For instance, CryptoPunks, one of the earliest NFT collections, represent dystopian grit of cyberpunk and the importance of self-custody (Christie's 2021a). In this regard, NFT technology and the art pieces represented via this technology drive value through both the symbiotic meanings and the novelty on the material base.

In addition to this perspective, NFT technology enable creators to appropriate the value they created through their creative work. When we analyze well known art auction houses like Christie's and Sotheby's it can be observed that many NFT auctions include images or videos created through computer programs like Anadol's real-time data generated art piece "Living Architecture: Casa Batlló" or Beeple's dynamically changing hybrid artwork Human One (Christie's 2021b). Accordingly, it can be argued that NFTs are an important tool for modern creative talents to both authenticate their art and financially appreciate their creations.

3.1.2. Art Lending

The notion of lending is considered to be as old as civilization, and the first records of lending transactions dates back to the third millennium B.C. in ancient Mesopotamia (Garfinkle, 2004). Garfinkle categorizes the function of ancient lending practices into two as productive and consumptive loans. Productive loans were made mainly through silver with a goal to improve material conditions of the household whereas consumptive loans were mostly on the barley basis with a goal to provide immediate subsistence to the household. Similar to ancient times, lending practices play an important role in the modern economy as the loaned amount can help to solve liquidity problems and unlocked capital can stimulate economic activity. Secured loans are often referred to as "the oil of the economy and the engine of economic growth" (McCormack, 2004, 15). Furthermore, while financial capital and credit creation leads to bubbles that inevitably collapse, it also facilitates the development of novel concepts through supporting emerging industries with funding (Perez, 2004).

As explained in the earlier sub-sections, products of creative and cultural industries such as art pieces and antiques are fundamentally non-fungible assets, and lending practices regarding such assets dates back to centuries ago. For instance, one of the wealthiest and most respected banks of the Renaissance period, Medici Bank, was offering credits secured by crown jewelry (De Roover, 1999). Furthermore, studies about the origins of Leonardo Da Vinci's paintings revealed that it was possible to secure a loan against paintings during the 16th century (Greenstein, 2004, 21). While the practice of loans secured by art was observed throughout history, this market stayed rather niche as banks and financial institutions often avoided accepting art as collateral due to insufficient liquidity and inefficient pricing mechanisms (Giardini, 2021). However, due

to increasing demand for financing from the art collectors, Citibank and Rosenthal & Rosenthal started establishing common practices and standards for art-secured lending in the 70s (Charlin & Cifuentes, 2019).

The concept of art-secured lending essentially involves two parties; lender of money and borrower of money, art piece and an agreement stating the conditions of the transaction. These transaction contracts generally involve several conditions such as loan to value (LTV) ratio representing the amount that can be borrowed with respect to the financial value of the art piece, interest rate, whether the borrower can keep the art piece or not during the loan period, and the due time for repayment (Deloitte, 2021, Neuhaus, 2015). In essence, art lending process can be conceptualized in four steps:

1. Art lender and the counterparty sign an agreement stating the financial value of the art piece, amount that can be borrowed (LTV), interest rate and due time.
2. Upon the signature, the art lender receives the money (collateral either stays with the owner or secured by the money lender depending on the jurisdiction).
3. Art lender returns the payment and additional interest.
4. Art lender receives the collateral.

It is important to note that if an art lender fails to perform step (3) and can not repay the required amount, the art piece that has been collateralized is liquidated and the ownership of the asset moves to the money lender.

Deloitte's "Art & Finance Report" (2021) estimates the art secured loan market to be over 20 billion US dollar with an average 10.7% growth rate. The report highlights that in addition to aesthetic and intellectual reasons, collectors are motivated for financial aspects as well and they are considering art pieces as part of their overall balance sheet and a source of capital. The report emphasizes several reasons underlying the need for art secured lending such as accessing liquidity for business operations, unlocking capital without the need to sell the underlying art piece and using the loaned amount for interest arbitrage (Deloitte, 2021, 206). Typical loan ranges from 500.000 US dollars to 5 million US dollars (Charlin & Cifuentes, 2019). Art collectors can secure loans mainly through private banks and auction houses.

Private banks are dominant as far as the art-secured lending market share is concerned. Private banks mostly regard art-secured lending as a complementary product to their existing clients, and offer loans based on overall creditworthiness of the borrower (Neuhaus, 2015). In other words, if the borrower fails to repay the loaned amount and the additional interest, private banks can have a claim on the other assets of the borrower (Giardini, 2021). Private banks offering such loans are mainly siloed in the United States and institutions like Citibank and Bank of America are leading the space (Deloitte 2021).

Differing from private banks, auction houses like Sotheby's are not concerned with financial information of the client and the art piece securing the loan is the only collateral. As private banks offer art-secured loans mostly to their existing clients, Sotheby's offers an alternative for art collectors without ties to these private banks. However, since Sotheby's only takes the art piece as collateral, the pricing of the pledged artwork becomes more important. In this regard Sotheby's carries out an extensive evaluation phase for the pledged art work and either rejects the application or provides funding within 30 days (Sotheby's 2022).

While art-secured lending is recognized as a growing financial area, this niche market is facing several problems. Legal issues regarding art lending are highlighted as a major concern in several studies. Charlin & Cifuentes (2019) emphasized that the sector lacks internationally recognized authority establishing the sole owner of the art pieces. In addition to this opaque ownership authentication, each jurisdiction applies their own rules for art lending. For instance, the United States applies Uniform Commercial Code laws enabling art lenders to keep the art piece through the loan period whereas in Europe laws require money lenders to possess the art piece until the repayment (Deloitte, 2021). This lack of common standards further leads to confusion. Giardini (2021, 116-117) provides the Dutch case as an example to this confusion where the State of the Netherlands acquires a 17th century work "View of the Golden Bend in the Herengracht" from Dutch art collector Louis Reijtenbagh in 2008. The problem was that the art piece was already used as a collateral to obtain a $50 million loan from JP Morgan Chase in 2006, and the State of the Netherlands was unaware of such loan. When the art collector, Mr. Reijtenbagh defaulted, J.P. Morgan Chase tried to take possession of the art piece as agreed upon

their contract; however, Dutch law prohibited the transfer of the art piece and J.P. Morgan eventually settled out of court by accepting the losses.

Overall, the art-secured lending industry is regarded as a niche and developing industry with increasing demand from both art collectors and managers; however, the industry has problems regarding authentication, fraud and lack of globally accepted legal practices.

3.1.3. Decentralized Finance

The case study that will be performed in the next sub-chapter will illustrate how decentralized finance (DeFi) works. However, it is perhaps necessary to explain some fundamental concepts about DeFi before exploring the case. DeFi is essentially an array of financial applications that operate on a permissionless manner, empowered by the blockchain technology (Chen & Bellavitis, 2020)

There are three main themes that help conceptualize DeFi: No middleman, smart contracts and decentralized applications. No middleman is essentially inspired from Bitcoin as Bitcoin was the first public blockchain to remove the need for third party approval to facilitate electronic financial transactions. It is important to note that the Bitcoin network has a specific purpose which is to facilitate BTC (network's cryptocurrency) transactions in a permissionless manner. Similarly, DeFi benefits from the Ethereum network's consensus mechanism to serve multiple financial purposes through the help of smart contracts.

Smart contracts are predefined code structures that are deployed on the Ethereum network with an ability to execute transactions without a middleman. They are essentially contracts in a sense that they represent an agreement and terms between two parties to a transaction, and they are smart because they execute themselves without the involvement of a third party like a lawyer or notary (Szabo 1994, Metcalfe 2020). Once these smart contracts are deployed on the blockchain, they are run as immutable code structures and ecosystem participants can interact with through a permissionless way.

Decentralized applications (dapps) are a bundle of smart contracts (in the backend) and an open front end that users can interact with. Developers initially design the mechanism of dapps, further implement it via smart contracts, and finally deploy these smart contracts on the Ethereum blockchain. Upon deployment, these contracts are run automatically and any user interaction with these contracts are verified and authorized by Ethereum block validators. In its essence, DeFi is a term vaguely used to cover dapps that are mainly focused on the financial applications such as decentralized lending and decentralized exchanges. In this regard, DeFi is not an officially recognized standard like NFTs or smart contracts but rather a term that helps categorize within the dapp ecosystem (Ethereum.org, 2022).

3.2. The Case of JPEGd Protocol

Previous chapters provided technical and fundamental background for multiple concepts such as creative cultures, smart contracts, NFTs, decentralized finance and art lending. These phenomena are essentially either directly or indirectly inherited in the concept of NFT lending, which is the focus of this thesis. NFT lending is fundamentally similar to art lending as it involves counterparties (lender and borrower), a non fungible asset (NFT or art piece), fungible asset (national currency or cryptocurrency) and a contract defining the terms of the loan. While these concepts are fundamentally similar, technical and legal infrastructures are clearly distinguishable.

As discussed in the previous chapters, smart contracts enable parties to a contract to come to an agreement on the terms and also perform transactions based on agreed terms. In essence, NFT lending is a system of transactions transferring NFTs based on agreed terms benefiting from smart contracts to execute these terms. First decentralized applications enabling loans secured by NFT collateral emerged in 2021 (Dune Analytics, table monthly NFTfi…) and the total value collateralized by NFTs reached over 80$ million in 2022 (Defi Llama, table NFT lending…).

JPEGd is chosen as the case as it is one of the most used NFT lending protocols and arguably a suitable representation for analyzing the interaction of NFTs with DeFi. JPEGd's transaction network involves multiple dapps and NFT collections. The protocol enables NFT holders to

borrow platforms cryptocurrency pETH, which is essentially a synthetic cryptocurrency that is pegged to Ethereum network's native cryptocurrency ETH (JPEGd, 2022a). As of December 2022, there are over 250 NFTs collateralized on the JPEGd platform with a total valuation of 16 million US dollars (Defi Llama, table JPEGd). The valuation of NFTs on the protocol happens through a third party data provider: Chainlink. In this regard, JPEGd provides lending services to collections that are included in Chainlink's decentralized price feed (JPEGd, 2022b).

Once new collections are added to the Chainlink price feed, JPEGd's governance votes whether to enable these new collections as collateral on the platform. Overall, the governance procedure starts with initial discussion on adding new collections on the governance forum and then continue with the product improvement proposal (PIP) through the Snapshot page (JPEGd, 2022c). It is important to note that anyone can create discussion on the forum and start the voting procedure on Snapshot. Once the poll is created on Snapshot, JPEGd's governance token holders can vote to initiate the change or not. Each poll needs to reach a certain quorum for the team to implement (JPEGd, 2022d).

The protocol initially started with only accepting Crypto Punks as collateral (JPEGD 2022a) and expanded to eight collections following PIPs and collaborating with Chainlink (JPEGd 2022b). Once these collections are enabled as collateral, protocol automatically creates a debt ceiling for each collection by analyzing the Chainlink floor price data. Floor price is a term that corresponds to the lowest price of the NFT for sale of a specific collection. Floor prices of the approved collections range between 3 ETH (Pudgy Penguins) to 65 ETH (Crypto Punks) on the JPEGd platform (JPEGd 2022e).

The collection with the lowest floor price, Pudgy Penguins, is selected for interacting with the protocol to collect primary data. Next sub-chapters will explain three concepts that are relevant to the study: NFT lending, monitoring process and the repayment of the debt to receive collateralized NFT back.

3.2.1. NFT Lending on JPEGd Protocol

NFTs are stored through self-custody wallets such as Metamask which is essentially a gateway between the user device (such as computer or mobile phone) and decentralized applications. Metamask enables users to create an account on the Ethereum network, and access to that account is secured via private key. These private keys, also known as secret recovery phrases, mostly involve 12 or 24 word seed phrases each corresponding to a series of numbers and the right configuration of these seed phrases is needed for unlocking an account (Metamask, 2022).

Metamask is an online browser and can basically be downloaded via the Chrome web store. Upon downloading the extension, Metamask shows two options to proceed: Either to connect via a secret recovery phrase or through creating a new wallet. Upon choosing the new wallet option, Metamask provides the secret recovery phrase including 12 words. In the next step, Metamask automatically creates a unique Ethereum address that can be managed through the Metamask application. This account address can be conceptualized as our identity in the Ethereum network, and each transaction and asset transfers to this address will be recorded on the blockchain.

Table 2: Ethereum account information

Blockchain	Ethereum
Account Address	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Self-custody tool	Metamask

Source: Author's illustration

Ethereum transactions require computational resources for the execution and each execution requires a gas fee. Gas fee is essentially the amount required for performing the transaction and it is denominated in ETH. In our case, before we buy the NFT and lend it, we first need to fund our wallet with an amount covering potential gas fees and the sale price of the NFT. Metamask offers various alternatives for funding the wallet such as direct ETH purchase with Visa or Mastercard. Another alternative is to send ETH from another wallet, and in our case we fund the wallet from a centralized cryptocurrency exchange Coinbase. Centralized exchanges are custodial, and user deposits are managed by these exchanges. Conceptually, they work similar to

banks as users need to trust both banks and centralized exchanges to store and process their funds. Centralized exchanges like Coinbase act as an intermediary between traditional finance and decentralized finance and they enable withdrawal and deposits of both fiat money to banks and cryptocurrencies to self custodial wallets.

We continue with funding our with 5.05 ETH by withdrawing that amount to fund Ethereum account address and the details about the transaction #1 is displayed on Table 3. (see Appendix 1). The funded account address can now be used to perform initial interaction with smart contracts. There are multiple dapps that we can interact with for purchasing NFTs, and in our case we will continue with the marketplace called Blur to purchase an NFT from the Pudgy Penguins collection. The details about the initial interaction with smart contracts is displayed on Table 4 (see Appendix 2), and these details reveal two main interpretations: (1) acquiring art (or any kind of non-fungible asset) in the NFT form does not require direct human interactions as smart contracts handle the transfer logic, (2) transfer of art pieces through NFT technology takes few seconds to complete. In this regard, NFT technology arguably provides an efficient solution for the authentication and transfer of digital non-fungible assets.

Table 4 also presents information about the Pudgy Penguin collection's contract address and unique token ID that is transferred to the Ethereum account. Further analysis (Etherscan, table Contract) reveals that this specific NFT stores a link to metadata that is stored in decentralized storage infrastructure IPFS. The analysis on metadata points out that Figure 2 is the corresponding asset that is authenticated via this specific NFT.

Figure 2: Image that is authenticated via the NFT (Source: IPFS 2022)

After purchasing the NFT, the Ethereum account is ready to interact with the JPEGd's smart contracts to lend the NFT and receive a loan. Upon visiting JPEGd's website, the protocol displays a disclaimer explaining that JPEGd is a novel protocol and the protocol might involve risks related to smart contracts. By entering the protocol users accept that the JPEGd team can not be held responsible for any loss of funds. Upon agreeing on the terms, we connect to the dapp with our Metamask wallet. Then we proceed to the dashboard section, and the interface automatically shows if we have any eligible NFT for borrowing money.

Next to our NFT, we can see the automatic valuation as 3.07 pETH, credit limit as 1.07 pETH and status as ready for borrowing. As briefly mentioned earlier, JPEGd protocol benefits from third party data provider Chainlink's data feed for estimating the valuation of the NFT (JPEGd 2022b). Chainlink essentially benefits from a decentralized network of independent oracle nodes to aggregate data (Chainlink 2022). This data, such as NFT prices, is then represented as an API that smart contracts can connect to. Accordingly, the automatic valuation of 3.07 pETH is defined by the NFT with the lowest price, or the floor price, from the selected collection.

Overall, JPEGd protocol estimates all NFTs from Pudgy Penguins collection at the same price and provides a credit limit based on this floor price.

Upon selecting the NFT, JPEGd protocol provides a user interface to select the amount to be borrowed. The maximum borrow amount, or the credit limit, is shown as 1.07 pETH. The credit limit changes dynamically through Chainlink price feed and 1.07 represents the 35% of the floor price (3.07 ETH). Following this logic, if the floor price drops to 3 pETH the credit limit would decrease 1.05 pETH and if the floor price increases to 5 pETH then the credit limit would increase to 1.75 pETH. Understanding the logic behind this dynamic valuation is essential for managing risks as decreases in the valuation of the protocol can liquidate the underlying NFT.

As we perform the transaction #3 and interact with JPEGd's smart contract, it can be observed that smart contract automatically transfers the NFT to the smart contract's address, and the borrowed amount 0.1 pETH to our Etherem account address. The details of the NFT lending transaction is displayed on Table 5 (See Appendices 3). The transaction context provides several insights such as that NFT lending happens without any human interaction through a peer-to-protocol manner. In addition, while the process for taking a loan takes a month in traditional art lending (Sotheby's 2022), the same process occurs in 15 seconds on the JPEGd protocol. Furthermore, this transaction structure exhibits a novel mechanism introducing ERC721 token standard to smart contracts that are used to facilitate decentralized finance applications.

Figure 3. represents the information provided on the JPEGd's website upon receiving the loan. The protocol supports the NFT lending process by providing real-time data that can be verified through blockchain.

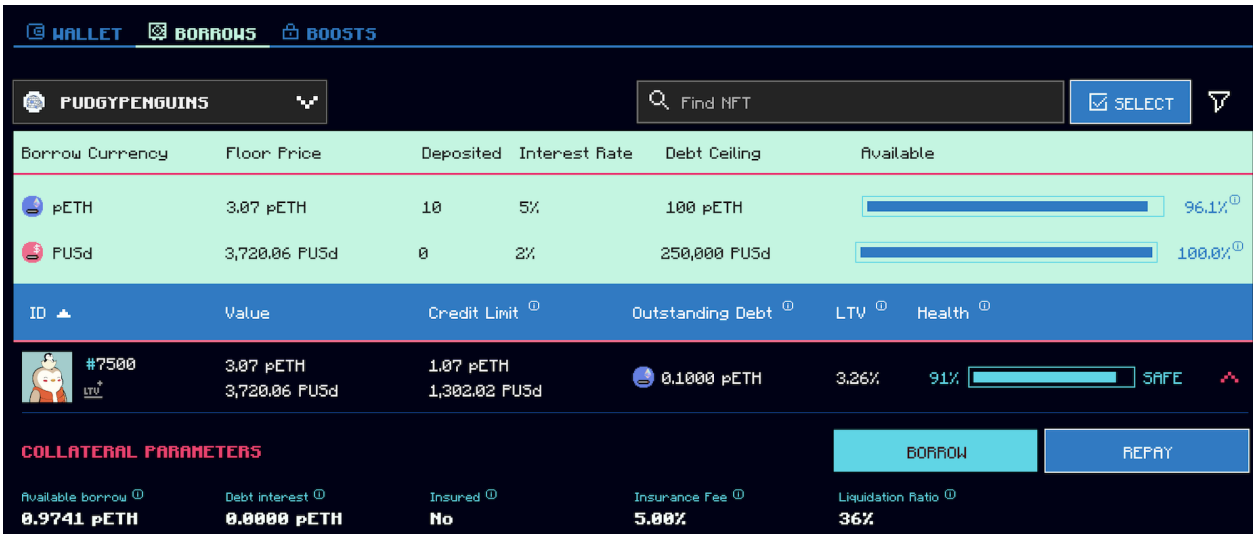

Figure 3. Initial NFT loan position (Source: JPEGd 2022e)

3.2.2. Monitoring NFT Lending Process

Upon visiting JPEGd's interface, the protocol displays information regarding several metrics such as interests accrued, outstanding debt, dynamic NFT valuation, credit limit and the health of the position. Figure 4. displays the relevant data about the position three weeks after lending the NFT. As can be seen on the Figure 4., the position accrued 0.38 US dollar interest to be paid to the protocol. In addition dynamic valuation of the NFT is represented under the "Value" column. As the valuation of the NFT increased during the loan period, credit limit also increased and the position became less risky. This dynamic valuation of the NFTs during the loan period differentiates NFT lending from traditional art lending as the valuation remains same for the latter during the loan period.

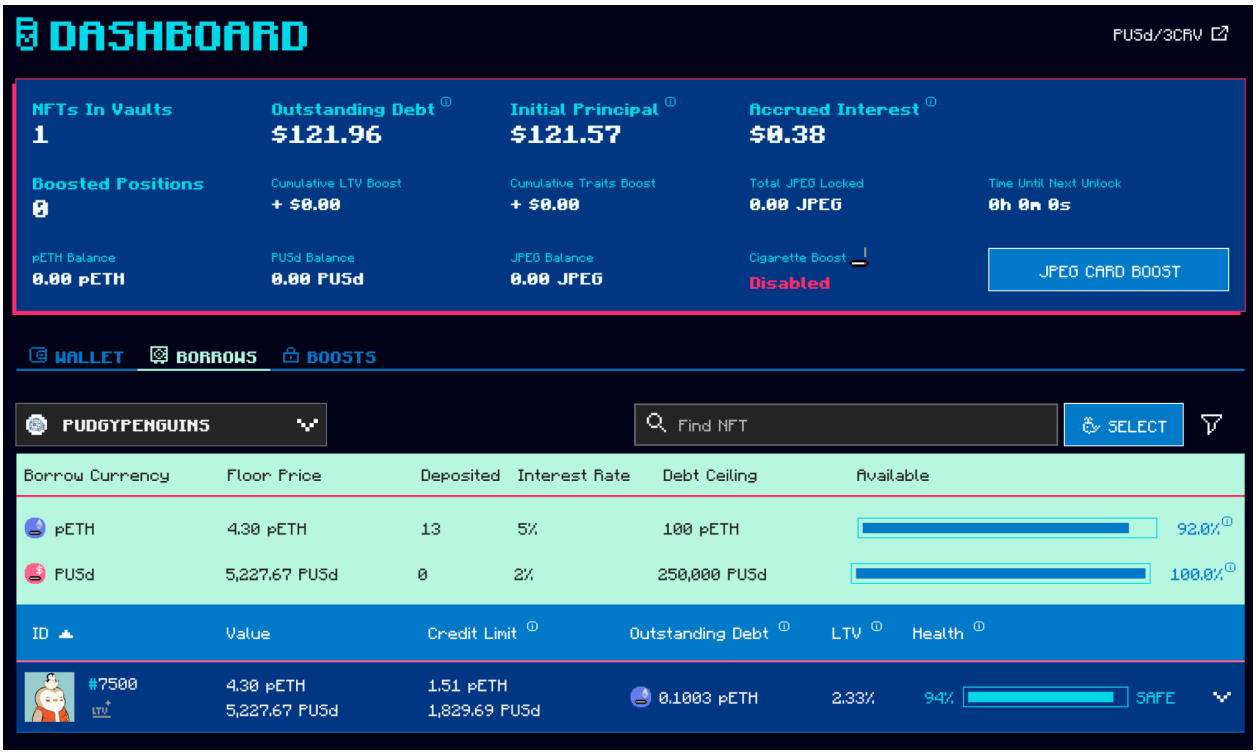

Figure 4. NFT loan position three weeks after the smart contract interaction (Source: JPEGd 2022e)

Both Figure 3. and Figure 4. displays a "Deposited" column that corresponds to the total number of Pudgy Penguin NFTs collateralized on the JPEGd protocol. The change from 10 to 13 explains that three more Pudgy Penguin NFTs are collateralized during the three weeks period. The open nature of DeFi enables tracking of each interaction with smart contracts. In this regard, our interactions with smart contracts are visible to everyone, and similarly; other users' interactions with the JPEGd protocol are visible to us. In the traditional lending process, the financial institution has access to information about every users' position but each user only has access to their own position. This transparency and equal access to track every position is perhaps one of the most important differentiators of DeFi lending from traditional finance lending and NFT lending from traditional art lending.

While this information can be manually tracked on the blockchain, JPEGd protocol displays each position on their website to ease access to this information. Figure 5. displays Pudgy Penguin NFTs that are collateralized on the protocol. This real-time information feed helps analyze the overall risk of the protocol by displaying credit limit and outstanding debt of each position.

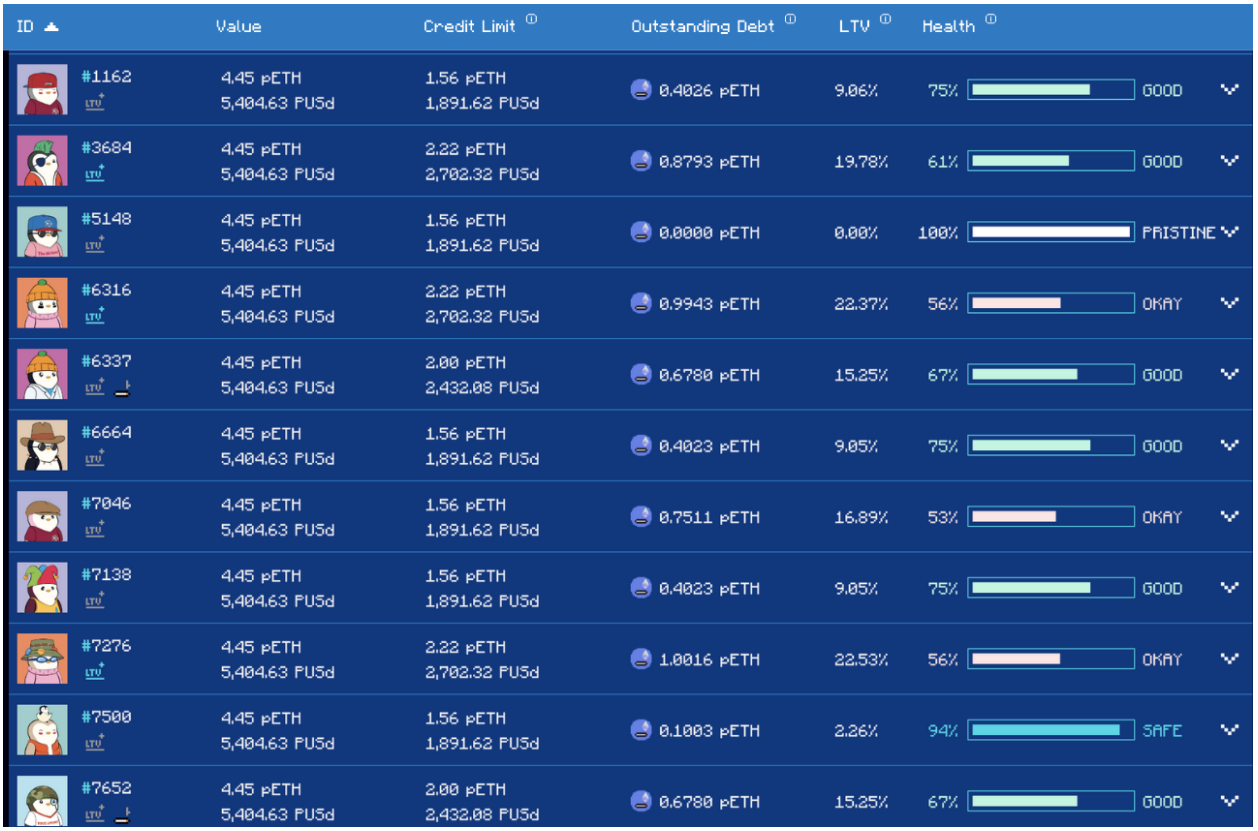

Figure 5. Pudgy Penguin NFTs collateralized on the JPEGd protocol (Source: JPEGd 2022e)

3.2.3. Repayment of The Loan and Receiving Collateral Back

In order to close the position and receive the collateralized NFT back, JPEGd requires the payment of the outstanding debt that equals to the sum of initial loan and the interests accrued. Upon visiting the JPEGd interface, the UI provides the outstanding debt to be repaid (Figure 2). Similar to our initial interaction with JPEGd's smart contracts, this exchange happens in one transaction through "Repay & Withdraw" option that transfers the NFT to our Ethereum account address and the outstanding debt to JPEGd's smart contract.

As can be seen on Table 6., transaction #4 involves the interaction with JPEGd's smart contract that automatically sends the ERC721 token (Pudgy Penguin #7500) to our wallet and ERC20 token (pETH) to Ethereum burn address (See Appendices 4). JPEGd smart contract mints pETH upon depositing NFT and burns the token when NFT is withdrawn from the protocol. The protocol collects interests accrued, which is the main revenue stream for the protocol, at a later

stage through recording the overall interest accrued and minting the total fees (JPEGd 2022f). Summary of the whole NFT loan process is displayed through Table 7.

Table 7: Summary of NFT loan transactions

Action	Transaction Duration (Seconds)	Transaction Fee (US dollar)
Acquiring NFT	4	2.79
Lending NFT and Receiving Loan	15	5.01
Repayment of Debt and Receiving NFT	10	4

Source: Etherscan (table Transactions); Author's illustration

3.2.4. Protocol Liquidity on Curve

Another concept that is unique to JPEGd's platform is JPEGd's synthetic cryptocurrency pETH. In traditional art lending, loans are made as national currencies like the US dollar which can be used for several purposes directly. JPEGd's pETH, however, is only functional within JPEGd's ecosystem and if users wish to spend the borrowed amount for real life transactions, then pETH needs to be transferred to a centralized exchange. It is noteworthy that pETH is not listed on any centralized exchanges. Therefore, users first have to interact with a decentralized exchange to trade pETH for other cryptocurrencies like ETH; and then finally transfer it to a centralized exchange to trade ETH for desired national currency.

Unlike centralized exchanges, decentralized exchanges enable the listing/trading of any ERC20 token in a trustless manner that everyone can interact with the smart contracts to create a trade pair or provide liquidity to existing trading pairs. In this case, JPEGd collaborates with the Curve decentralized exchange for liquidity provision (JPEGd, 2022a). Curve is an automated market maker (AMM) enabling the creation of distinct pools where the price of assets are determined via the convex relationship (Lehar & Parlour, 2022).

Table 8 (See Appendices 5) displays our Etheruem account address' interaction with Curve's smart contracts that provides pETH-ETH liquidity the decentralized exchange. Such liquidity provision from loan receivers is essential for pETH to sustain its functionality. Without any

liquidity pETH has only one purpose which is to repay the debt and receive the collateralized NFT back. In this regard, users' liquidity provision makes a direct contribution to the JPEGd protocol.

4. DISCUSSION

Previous sub-sections, conceptual background analysis and the case study points out several interpretations regarding the main research question which is “how NFTs and DeFi constitute value together”. This section will evaluate the main research question by analyzing the case through the proposed conceptual framework. As explained in the theory section, this thesis is mainly concerned with the value creation in two levels: (1) What are the sources of value creation? (2) How value is created through the business model?

With respect to “novelty”, JPEGd protocol provides a novel infrastructure through integrating ERC721 token standard to smart contracts. This mechanism connects NFTs (ERC721), fungible tokens (ERC20) and DeFi (smart contracts) to unlock novel use cases for NFTs. Schumpeter explains innovation drives value creation through introduction of new markets and bringing together combinations of resources (1934). Following this logic, the case study shows that NFTs and DeFi are interoperable phenomena and JPEGd integrates existing resources/standards to create a novel NFT lending market.

Regarding “efficiency”, JPEGd protocol depicts unique characteristics.. Firstly, the protocol provides dynamic valuation for NFTs and collectors can get the loan in 15 seconds (Table 7) whereas in traditional art lending practices, auction houses like Sotheby’s require 30 days to decide on the terms of the loan. Secondly, the protocol provides accurate up-to-date data that can be verified on blockchain, which eventually reduces information asymmetries. The data also provides information about the positions of other participants, and unlike traditional art lending practices, the loan terms are the same for every participant. Overall, JPEGd benefits from blockchain’s transparency to democratize access to information for all participants.

While “lock-in” is manifested in the NFT technology and the Ethereum network, it is difficult to mention lock-in as an important source of value on the JPEGd protocol level. NFT technology works as a medium for creators to capture value from their craftsmanship and enforce royalties for secondary sales. Ethereum can be considered as the most vibrant NFT ecosystem as it processes the highest amount of NFT volumes. These considerations attract both creators and collectors to prefer Ethereum network as it increases chances for creators to financialize their art work, and increases chances for collectors to find counterparty for trade. This dynamism in the network arguably creates a lock-in effect for participants. However, this lock-in effect is not manifested in the JPEGd protocol. Dapps like JPEGd do not require “know your customer” process or account creation for participation, and as shown in the case it takes seconds to interact with smart contracts. Furthermore, the open-sourced culture of Ethereum enables developers to replicate and copy the underlying smart contract mechanisms to create similar products. In this regard, switching cost or the lock-in effect is not remarkable on the protocol level.

“Co-creation” is a clear source of value creation for the JPEGd protocol as can be observed through several levels. To begin with, the JPEGd protocol gains more utility as the number of users providing liquidity to the Curve protocol increases. As explained through the experiment, users play an important role by increasing liquidity for pETH-ETH liquidity which unlocks new use cases for platform’s own synthetic cryptocurrency pETH. As more users participate and increase liquidity, the magnitude of impermanent loss effect decreases. Another layer of co-creation is the indirect contribution of creators/artists to the JPEGd protocol. Similar to musicians acting as sources of value creation to Spotify, art creators provide value to the JPEGd protocol. Finally the protocol’s governance mechanism enables anyone to create product improvement proposals through the Snapshot page (Jpegd, 2022c, 2022d) and if the voting reaches the quorum, the team implements the changes. This governance design essentially empowers every participant of the ecosystem to act as an entrepreneur to design, propose and implement changes with the help of the core team.

The protocol offers both primary and secondary “complementarities”. Insurance is an arguably useful complementary service that NFT loaners can purchase for an additional fee that enables users to purchase NFT back in case of liquidation. Another complementary service is the “Auction House" where liquidated NFTs are auctioned to JPEGd’s own NFT holders or JPEG

token holders (2022e). While these complementaries are within the boundaries of the protocol, JPEGd's liquidity pool in Curve can also be stated as a complementary service enabling protocol users to collect additional trading fees with the loaned amount.

Amit & Zott (2001, 2010) explain a firm's business model benefits from a business opportunity through fulfilling customer needs. They further emphasize that the architecture of the business model that determines the content, structure and governance of the activity system is how a firm enables value creation.

As far as the transaction "content" is concerned, JPEGd's service corresponds to a certain demand by enabling NFT holders to receive loans through their collateral. In this regard, JPEGd's design choice and capability to integrate ERC721 token standard into smart contracts to facilitate NFT lending provides a novel service for collectors (Table 5, Table 6) . Additionally, choosing NFTs as the main activity content enables JPEGd to benefit from the value creation potential of both NFT technology and NFT creators. JPEGd enriches activity content through real-time and transparent data feed which makes it possible to conveniently monitor metrics throughout the lending process.

The "structure" of the JPEGd's activity system benefits from globally accessible DeFi infrastructure. Unlike the traditional art lending process, JPEGd's activity structure does not require any interactions with human counterparts and users interact directly with protocol's smart contracts to reach their goals. Design choices on the structure of the protocol decreases transaction times and costs for securing a loan and arguably democratizes access to participation as users around the world can interact with smart contracts regardless of their location or nationality. In this regard, NFT lending offers a globally accessible alternative to traditional art lending market that mainly is siloed in the US and mostly accessible to banks' existing customers.

"Governance" within the context of Amit & Zott's conceptual framework is mainly concerned with analyzing the trust, incentives and responsibilities of parties to a transaction. As far as trust is concerned, NFT lenders can track where NFT is stored in real time through analyzing blockchain. Users can also track other NFT lenders' positions to analyze the overall risk of the

system and arguably this reduced information asymmetry and transparent nature of DeFi enhances trust at this level. However, JPEGd is still an experimental product and the team behind the project is anonymous. Upon entering the protocol, users need to approve the risks of smart contract exploitations that can lead to loss of assets and further confirm the team will not be held responsible for any losses. While smart contracts of the protocol are audited several times (JPEGd 2022a), these audits also do not guarantee any legal assurance. Furthermore, the consequences are unclear in the case of the anonymous team's disappearance. It is clear that users can still interact with smart contracts as they are immutable and will be live on the Ethereum network; however, if there is not enough pETH liquidity on the Curve pool users may have troubles to acquire pETH and pay their debt to receive their NFT back.

5. SUMMARY AND CONCLUSIONS

The aim of the present study was to examine two emerging frontiers within the blockchain ecosystem to realize how interoperable they are and how they constitute value together. In order to support the main research question, the theoretical part of the thesis focused on analyzing how value is created in online markets through examining various strategic management and entrepreneurial theories. Theory chapter showed that while the main focus for value creation differed on examined literatures, five themes are commonly observed as sources of value creation in online markets: co-creation, novelty, efficiency, complementaries and lock-in.. In addition to these sources of value creation, design of the activity system is highlighted to answer the "how" question; as the content, structure and the governance of the system embeds value sources into the system and links activities together to empower value creation (Amit & Zott, 2001, 2010).

Analysis part initially provided three conceptual backgrounds that are relevant to the case study: NFT technology, art lending market and decentralized finance. These sub-chapters provided several interpretations:

- Beyond speculation, NFT technology emerges as a useful tool for creative industries as it enables authentication of non-fungible assets in the digital realm and offers an alternative for creators to financialize their craftsmanship.
- Art lending market is a growing market; however, this niche market has several problems such as authentication inefficiency and lack of globally recognized laws.
- The combination of Ethereum's decentralized consensus mechanism and smart contracts enable creation of an alternative financial structure that runs without intermediaries and is globally open.

To analyze the main research question, JPEGd is chosen as the case study since the protocol is one of the earliest examples to integrate NFT standard (ERC721) into smart contracts that run decentralized finance applications. The case study is analyzed through interacting with several smart contracts to eventually experience all the NFT loan process. While these interactions with smart contracts provided primary data, secondary data is also collected from blockchain analytics tools and JPEGd's communication channels. The analysis of the collected data provided several insights for the main research question:

1) NFTs and smart contracts that run DeFi applications are highly compatible as they benefit from the same transaction network (Ethereum) and both can be accessed from the same self-custodial wallet (Metamask).
2) This compatibility unlocks novel functionalities for non-fungible assets and NFT lending is an early representation of such interoperability. NFT lending is a novel market that gains attraction from NFT collectors and such demand shows that entrepreneurs can carry out novel combinations of NFTs and DeFi to establish new markets, products and functionalities. In this regard, JPEGd inherits the characteristics of Schumpeterian theory of innovation (1939) as the protocol combines existing token standards and smart contracts to establish a novel market and turn these resources into economic realities.
3) Traditional art lending is perhaps the most suitable comparison to NFT lending as they both focus on the credit creation for non-fungible assets. The case of JPEGd shows that the intersection of NFTs and DeFi provides several improvements to the concept of non-fungible asset lending. To begin with, the protocol democratizes access to participation as anyone can interact with the smart contracts regardless of their location or nationality. This democratization is also manifested for accessing information as metrics about the protocol, such as each participant's position, is open to everyone and can be tracked on the blockchain in real-time.
4) Interaction of NFTs and DeFi unlocks a novel application layer for blockchain technology and the case of JPEGd is an effort to understand the evolution of blockchain's value proposition.

To summarize, NFTs and DeFi are emerging as novel, cutting edge technologies as part of the ICT techno economic paradigm. The case of JPEGd is an initial representation of how

blockchain's novel frontier technologies can operate to serve certain demand. This early use case, NFT lending, arguably offers a digitalized alternative to a real life phenomenon, art lending. While JPEGd protocol adopts a peer-to-protocol structure, alternative NFT lending protocols adopt peer-to-peer and peer-to-pool business model structures. In this regard, future studies can discover these alternative designs to explore changes regarding risks, incentives and the value propositions of respective NFT lending design choices. Furthermore, the intersection of DeFi with NFTs is not limited to the concept of NFT lending; hence, further studies can analyze the intersection of DeFi with NFTs representing in-game assets or real life assets (like real estate) to explore how these interactions constitute value in different domains.

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APPENDICES

Appendix 1. Table 3. Account Address Funding Transaction

Transaction #	1
Transaction Hash	0x4c5212994e8c74c2ec6ce900423b0cbe3fc26a55c472c03eaddcc1b5e1163ba9
Block	16061688
Timestamp	Nov-27-2022 01:41:11 PM +UTC
Transaction Duration	9 seconds
From	0x71660c4005ba85c37ccec55d0c4493e66fe775d3
To	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Value (ETH)	5.04979
Fee (ETH	0.0002309944718
Transaction Link	https://etherscan.io/tx/0x4c5212994e8c74c2ec6ce900423b0cbe3fc26a55c472c03eaddcc1b5e1163ba9

Source: Etherscan (table Transactions); Author's illustration

Appendix 2. Table 4. NFT Purchase Transaction

Transaction #	2
Transaction Hash	0xed09b6fc0f989baac7c56f4102682f9528c6faba7f7a914dce0ae9a9a3f25995
Block	16061888
Timestamp	Nov-27-2022 02:21:47 PM +UTC
Transaction Duration	4 seconds
From	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Interacted With	0x000000000000ad05ccc4f10045630fb830b95127
To	0x788286cb76164e783CBC2F3882b629797F34e148
Value (ETH)	4.19
ERC721 Token Contract	0xBd3531dA5CF5857e7CfAA92426877b022e612cf8
ERC721 Token ID	7500
Fee (ETH	0.002339011214
Transaction Link	https://etherscan.io/tx/0xed09b6fc0f989baac7c56f4102682f9528c6faba7f7a914dce0ae9a9a3f25995

Source: Etherscan (table Transactions); Author's illustration

Appendix 3. Table 5. NFT Lending Transaction

Transaction #	3
Transaction Hash	0x623bab7c49b3e7b3837e424e0b5a2cda0faf2a47c1496c15fe4a9208019cd036
Block	16061936
Timestamp	Nov-27-2022 02:31:23 PM +UTC
Transaction Duration	15 seconds
From	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Interacted With	0x4b94b38bec611a2c93188949f017806c22097e9f
ERC-20 Transfer To	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Value (pETH)	0.1
ERC721 Transfer To	0x4b94b38bec611a2c93188949f017806c22097e9f
ERC721 Token ID	7500
Fee (ETH	0.004202891948
Transaction Link	https://etherscan.io/tx/0x623bab7c49b3e7b3837e424e0b5a2cda0faf2a47c1496c15fe4a9208019cd036

Source: Etherscan (table Transactions); Author's illustration

Appendix 4. Table 6. Repayment of The Debt

Transaction #	4
Transaction Hash	0xb0b30056bc43a77dc70ded42cc012c34a776aae89a154e49ccb9d6ace98767e5
Block	16227371
Timestamp	Dec-20-2022 05:22:23 PM +UTC
Transaction Duration	10 seconds
From	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Interacted With	0x4b94b38bec611a2c93188949f017806c22097e9f
ERC-20 Transfer To	0x0000000000000000000000000000000000000000
Value (pETH)	0.1003170535
ERC-721 Transfer To	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Token ID	7500
Fee (ETH	0.003282179935
Transaction Link	https://etherscan.io/tx/0xb0b30056bc43a77dc70ded42cc012c34a776aae89a154e49ccb9d6ace98767e5

Source: Etherscan (table Transactions); Author's illustration

Appendix 5. Table 8. Liquidity Provision on Curve Decentralized Exchange

Transaction #	5
Transaction Hash	0x81e90455969d5367853a63424e4889657f86b7b2574e5d1164e306a56abbe7e4
Block	16062046
Timestamp	Nov-27-2022 02:53:35 PM +UTC
Transaction Duration	11 seconds
From	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Interacted With	0x9848482da3ee3076165ce6497eda906e66bb85c5
ERC-20 Transfer To	0x9848482da3ee3076165ce6497eda906e66bb85c5
Value (pETH)	0.1
ERC-20 Transfer To	0x65c9874A0107c5553c92430a7AA3863a79D543fD
Value (pETH LP)	0.3511572136
Fee (ETH	0.001606091432
Transaction Link	https://etherscan.io/tx/0x81e90455969d5367853a63424e4889657f86b7b2574e5d1164e306a56abbe7e4

Source: Etherscan (table Transactions); Author's illustration

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