

**Louvain School of Management**

# **To what extent do NFTs contribute to the diversification of a portfolio?**

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## Abstract:

This research explores the impact of Non-Fungible Tokens (NFTs) on portfolio diversification. The study provides an in-depth analysis of NFTs as an investment asset and compares them to other investments such as real estate, stocks, bonds, gold, oil and interbank rates. The research aims to contribute to the existing literature on NFTs and investment by providing empirical evidence of their potential to improve portfolio performance.

The study uses a quantitative approach, analyzing data from various sources, including NFT marketplace and financial databases. The results show that NFTs can be used to diversify a portfolio and improve its performance. The study also highlights the unique potential of NFTs as an investment asset.

The implications of these findings are significant for investors and portfolio managers, offering an opportunity to improve portfolio performance while managing risk. Future research should focus on examining the impact of NFTs in different economic conditions and over a longer period.

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I would like to begin this preface by expressing my deepest gratitude to my promoter, James Thewissen, whose passion, and support have been a guiding light throughout my academic career.

It is with personal interest that I have closely followed the evolution of Non-Fungible Tokens (NFTs) for many years. The potential transformations they could bring to the world piqued my curiosity. I also wanted to understand more about the value and impact of NFTs on investment strategies. This research is not limited to an academic exercise, it is also a personal exploration that I hope will allow me to develop more effective investment strategies and better understand the NFT market.

Finally, I would like to express my gratitude to all those who have supported me throughout my academic career. To my family, friends, girlfriend and co-workers for their incredible support and constant encouragement.

In summary, this work is the product of passion, support and curiosity. I humbly offer it as a contribution to the existing literature on NFTs and hope that it will be of interest and usefulness to others in this fascinating and ever-evolving field.



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## 1. Introduction

This thesis addresses a very recent and unexplored topic, namely “To what extent do NFTs contribute to the diversification of a portfolio?” There is an urgency to answer this question because today, the regulator is lost. The rise of NFTs has altered the global financial landscape and turned traditional perceptions of investment assets on their head. NFTs have become a revolution in the world of art, finance, and technology, overturning our perception of ownership and digital value.

More and more investors are turning to these asset classes to balance their portfolios against traditional investments such as mutual funds, bonds, and equities. Non-fungible tokens (NFTs) have particularly attracted investor interest since 2021, standing out within this alternative asset space. Using blockchain technology, NFTs offer ownership rights to unique assets without the investor necessarily owning a physical object (DappRadar, 2022).

In the world today, NFTs are used as certificates of ownership for a whole range of objects, photos, videos, virtual domains, art, music, games and more. The huge sale of Beeple's artwork "Everydays: The First 5000 Days" (see Appendix 1) for \$69 million in March 2021 significantly increased public interest in NFTs (Kastrenakes, 2021). Subsequently, major companies such as Warner Music Group, Marvel Entertainment and Louis Vuitton also entered the field, testifying to the evolution of NFTs into everyday business (Warner Music Group, 2021).

Research in this area is focused on understanding the risk and return characteristics of NFTs. Indeed, Kong and Lin (2021), find that NFTs have higher returns than traditional financial assets. However, investing in NFTs comes along with high volatility. But, although the weight of NFT sales worldwide during 2022 amounts to \$25 billion (see Appendix 2), academic exploration of this new cryptographic asset class remains scarce (Denn, 2023). In the current context where NFTs stand out as an innovative asset class, their potential as a source of portfolio diversification is an equally unexplored topic. While many articles, such as Coryanne Hicks' article in Forbes, demonstrate the place of cryptocurrencies in an investment portfolio, very few addresses the place of NFTs in it. This is partly because NFTs are a relatively new phenomenon, and their market is still in its early stages of development. Moreover, the volatility and illiquidity of NFTs make it difficult to predict their potential impact on portfolio performance (Alam, Chowdhury, Abdullah & Masih, 2023).

According to the trend in scientific publications, there seems to be a growing interest in understanding NFTs, but comprehensive and rigorous studies that highlight the performance of diversified portfolios containing NFTs over the past few years are still lacking. Additionally, most academic studies published to date have focused primarily on the technical aspects of blockchain and cryptocurrencies.

The vast potential of NFTs remains unexploited and exceeds expectations. Indeed, compared to other disruptive technologies, such as the electric car, whose market doubled in 2021, NFTs are growing at a more exponential rate. The sector saw its sales volume increase by 21350% in 2021 (NonFungible.com). In its report (2021), NonFungible.com states that of the 71 million active Ethereum wallets, over 2.5 million transacted NFTs in 2021, compared with 89,000 in 2020. This represents an impressive increase in active wallets of 1822%.

In order to demonstrate the place of NFTs in a diversified portfolio, 80 collections were selected based on their age, so as not to shorten the analysis period too much. Indeed, as NFTs are a very recent subject, a balance had to be struck between sample size and length of analysis period. The initial objective was to have a representative sample of all the different types of NFTs. This made it possible to obtain an NFT performance index. The analysis also provided several statistics. In addition, it highlights correlations, positive or negative, with traditional and alternative assets such as equities, bonds, real estate, gold, oil, and Libor and Euribor interbank rates. This has enabled us to determine whether NFTs can reduce total portfolio risk while enhancing performance.

However, we did not expect the top 80 NFTs to perform so poorly. The research will attempt to explain them by the global economic situation during the analysis period and 2 events: the war in Ukraine and the launch of the NFT "Pixelmon" collection. This is why we further look at the top 15 NFTs, which overall represent the best quality and most relevant NFTs. In this case, the NFTs outperformed the other investments.

This research makes several significant contributions to previous research. Firstly, it will attempt to demonstrate that NFTs have a place in a diversified portfolio and that such an investment can improve portfolio performance. Specifically, this paper will attempt to demonstrate that the inclusion of NFTs in a diversified portfolio can increase the Sharpe ratio, reduce risk, and exhibit low correlation with traditional assets. Secondly, this study aims to enlighten investors, banks and regulators on the potential recognition and use of these assets.

Thirdly, by providing an in-depth analysis of NFTs as investment assets, this study could help investors make more informed decisions about including NFTs in their portfolios, and help regulators develop appropriate regulations for this emerging market. Given the recent emergence of this asset class, there are still many areas to explore, making this research even more fascinating and necessary.

NFTs also have far-reaching management implications. For example, in risk management the addition of NFTs to the portfolio introduces new types of risk, such as cybersecurity or market volatility, which need to be taken into account. In corporate finance, NFTs offer new ways of raising funds or monetizing assets. This trend therefore implies adapting and updating the skills needed to understand, evaluate, and integrate these new assets into a portfolio management strategy. For example, in corporate strategy, NFTs open up new avenues for creating value by monetizing digital content in unique ways, or by creating exclusive experiences for customers. Overall, the study of NFTs and their impact on portfolio diversification is a timely issue that can enrich management education and prepare future leaders to navigate an increasingly digital and complex financial landscape.

The dissertation is structured as follows: first, the introduction, followed by a review of the existing literature on NFTs and their role in investment. This is followed by the research methodology, before examining in detail the various contributions and the research question. The next section provides an in-depth analysis of the results obtained. The analysis continues with the limitations of the work. Finally, the dissertation ends with a conclusion that summarizes our main findings and suggests directions for future research.

## 2. Literature review

NFTs, or non-fungible tokens, are a type of digital asset that represents ownership of a unique object or content, such as a work of art, video game, song, tweet, or even virtual real estate. Unlike cryptocurrencies such as Bitcoin or Ethereum, which are interchangeable or "fungible", NFTs are unique and non-interchangeable (Future Fest, 2023). NFTs are created on a blockchain, typically the Ethereum blockchain, which enables the ownership and provenance of the asset to be tracked and verified (Abramovitch & Cook, 2021).

NFTs are tokens that can be used to represent ownership of unique items (ethereum.org) They allow us to tokenize things like art, collectibles, real estate, and many other things. As said before, the ownership of an asset is secured by the blockchain, which means that no one can change the ownership record of an NFT (Bao & Roubaud, 2021). The value of NFTs depends on various factors, including their rarity, the demand for the artwork or sometimes even the artist, and the prices of the underlying cryptocurrency used. Many online marketplaces that sell NFTs are powered by a blockchain. Currently, the Ethereum blockchain powers the most popular ones. This means that the price of an NFT is often expressed in Ethereum (ETH). So, if an NFT is worth 1 ETH on the market, let's assume it's worth 1 ETH over time. What can vary is the value of the ETH itself. At its peak value in 2021, 1 ETH was worth \$4,784. Today, it's worth just \$1,830 (Investing.com). So, even if the ETH price of NFT remains the same, the actual dollar cost of NFT may vary according to the current ETH price (see Appendix 3).

NFTs, whose ownership has been authenticated and stored on a database called blockchain, can be bought, sold, and traded on various online platforms such as OpenSea, Rarible, etc. and it is usually necessary to have a digital wallet containing cryptocurrencies to pay the related fees (Encyclopedia Britannica, 2023). Their value is determined by the market demand for that particular item. "The purchase of an NFT gives the buyer exclusive ownership of an instance of the asset in digital form, although the creator may retain that asset in its tangible form, such as a physical painting that has been digitized" (Cuban, 2023). In addition, NFT sales generally confer rights over the digital asset, such as the right to exhibit it, although the artist may receive royalties. In some cases, creators include a restrictive clause in the NFT that grants them a portion of the proceeds from any subsequent resale, which is easily tracked by the blockchain.

"The blockchain may be among the buzziest technologies to disrupt the world of finance" (Montevirgen, 2022). Blockchain is a decentralized digital ledger technology that records

transactions securely and transparently. It creates a permanent, unforgeable record of transactions that can be shared by a network of computers (Encyclopedia Britannica, 2023). The link between blockchain, NFTs and finance is that blockchain technology provides a secure and transparent way to create, exchange and track NFTs (Treleaven, Gendal & Yang, 2017). Blockchain can also help reduce fraud and increase the transparency of financial transactions.

Tokens are part of FinTech (Finance Technology). In their article entitled "Recent Development in Fintech: Non-Fungible Token", Bao and Roubaud (2021) refer to the Fintech era as "the period marked by the rapid development and adoption of financial technology solutions" (Bao & Roubaud, 2021). This translates into new and innovative ways of conducting financial transactions, managing money, and investing (Kong and Lin, 2021). The Fintech era has brought significant changes to the financial industry, including increased accessibility, efficiency, and convenience for consumers (Alt et al. 2018; Das 2019; Horvat and Bobek 2020).

NFTs have gained popularity in recent years as a way for artists and creators to monetize their digital creations and establish ownership and provenance for their work (Abramovitch & Cook, 2021). However, the concept of NFTs is still relatively new, and debate continues over their value and potential uses beyond the art world (Future Fest, 2023). Indeed, according to Behl et al (2023) in "Knowledge development in non-fungible tokens (NFT): a scoping review", NFTs have emerged as an important asset class due to their potential to provide investment opportunities beyond traditional markets. The authors highlighted the significant evolution of NFTs, citing their applicability in a variety of fields, including digital art, real estate, intellectual property, and virtual goods. Token-related issues are fast-growing areas of interest among practitioners and theorists alike (Ahlstrom et al. 2018; Masiak et al. 2020). Indeed, the number of theoretical papers is increasing rapidly, but the structure of this research area and the main directions are not yet fully established.

Having defined and understood how NFTs work, it's essential to look at their potential for portfolio diversification. "Don't put all your eggs in one basket" it's the best way to sum up one of the core concepts of investing: portfolio diversification. Diversification means spreading your investments across different asset classes, such as stocks, bonds, and other investments, like foreign currencies, commodities and even cryptocurrencies (Encyclopedia Britannica, 2023). Diversification also means holding many types of stocks and bonds in different sectors and industries, and in many regions of the world.

Investment portfolio diversification helps mitigate risk, particularly the risk of losing too much money on a single investment (Dodds, 2023). Indeed, "if the determinants of the performance of different assets are not correlated with each other, the behavior of said assets will be different (low covariances), and the variance of the portfolio will be lower than the weighted average of their variances" (Vaissié, 2019). In other words, it is theoretically possible to invest in (more) risky assets, and thus increase the portfolio's earning potential, without entailing a proportional increase in risk. Investors therefore began to diversify their portfolios across different asset classes, geographical zones, styles, factors, strategies, etc. (Vaissié, 2019). Empirical studies have also shown that international diversification reduces portfolio risk more than purely domestic diversification. Indeed, El Hedi Arouri (2005) discusses the fact that as long as financial markets are affected by specific risk factors, correlations between these markets are relatively low and the expected gains from international diversification strategies are significant.

When constructing a portfolio, there is always a part of the risk that cannot be diversified: this is systemic risk. Systemic risk can be defined as "the risk that a particular event will have a "snowball effect" on other financial institutions, thereby threatening the stability of the global financial system. Systemic risk is both unpredictable and unavoidable. But while it cannot be mitigated by diversification, it can be eliminated by hedging or by using an appropriate asset allocation strategy" (El Harake, 2022). For example, Solnik (1974) found that while purely domestic diversification reduces the risk of a portfolio to 27% on average (100% is the average risk of holding an individual US stock), international diversification reduces this risk to 11.7%.

In his study "Alternative Investments in the Fintech Era: The Risk and Return of Non-fungible Token (NFT)", Kong makes a strong case for the potential of NFTs in investment portfolios. Incorporating NFTs into an investment portfolio could help mitigate risk through diversification, as NFTs do not always follow traditional market trends. This can offer a certain level of protection against market downturns. Kong (2023) also argues that the uniqueness and indivisibility of NFTs contribute to their appeal as an alternative investment. He also noted that the value of NFTs, driven by market demand and the uniqueness of the token, could provide high returns. Entrepreneur Chris Dixon points out that including NFTs in an investment portfolio can offer unique advantages, such as access to niche markets, investment opportunities in cultural assets and exposure to emerging industries. NFTs can also enable artists and creators to participate in innovative business models, such as income from royalties on secondary sales of digital artworks.

However, diversification has its limits. As expert Mathieu Vaissié (2019) puts it, "when the system comes under pressure, the market loses its ability to discriminate between risks, the correlation between assets tends to converge towards 1, and the benefits of what was thought to be the only "free lunch" on the markets, vanish". Unexpectedly, in extreme conditions, diversified portfolios prove just as vulnerable as more concentrated ones (Leibowitz and Bova, 2009). By diversifying their portfolios, investors reduce their average sensitivity to the main systematic risk factors, and therefore their average volatility. But they also expose themselves to another potential risk that manifests itself less frequently. If everyone diversifies their portfolios to the extreme, everyone ends up holding the same assets, and therefore being exposed to each other's panic movements (Vaissié, 2019). In a way, the drop in volatility achieved by diversifying portfolios (sometimes too much) does not reflect a reduction in risk, but rather a transfer from average risks to extreme risks.

NFTs are therefore an investment alternative to core assets. The study by Kampakis (2022) focuses on evaluating investment performance, assessing price-driving variables, calculating portfolio diversification potential and comparing investment performance with other financial assets including NFTs. The results indicate that the "CryptoPunks" collection would have been the best investment from 2019 to 2022, with an average monthly return of 34.19% and a standard deviation of 61.76%. Moreover, the Sharpe ratio indicates a good risk/return trade-off. Another important finding is that attribute rarity and CryptoPunk type have a positive effect on prices. In addition, NFTs CryptoPunks have portfolio diversification potential due to their low correlation with other asset classes. The study concludes that NFTs can be a viable investment, with good returns and a diversified risk profile that is uncorrelated with other benchmark assets, such as art, treasuries, and major cryptocurrencies. However, this study is only based on a flagship collection of the NFT market. To date, there has been no comprehensive analysis of all NFT collections of different types.

Speaking of correlation with other assets, some researchers such as Ko, Son, Y.Lee, Jang and J. Lee (2022) have studied the correlation between NFTs and other traditional financial assets, such as stocks or bonds. Their results suggest little or no correlation between NFTs and traditional assets. Indeed, with values ranging from -0.2 to 0.21, this low correlation suggests little co-movement between NFTs and traditional financial assets, which could be interesting for diversifying an investment portfolio.

While NFTs can promise high returns and offer opportunities for portfolio diversification, they also carry significant risks. In the same study, Kong (2023) highlighted these risks, including high price volatility and a relatively illiquid market. Wang, in the article "Volatility spillovers across NFTs news attention and financial markets", analyzed the relationship between news about NFTs and volatility in financial markets. Wang (2023) found that news about NFTs significantly influenced their price volatility, impacting overall financial market stability. This confirms the potential risks associated with NFTs as an investment. Lin, in collaboration with Kong, conducted an empirical study to provide an overview of current trends in the NFT market. According to their findings, the NFT market has experienced substantial growth, with a notable increase in investor interest. However, they also highlighted the speculative nature of the market, warning investors of possible risks (Kong & Lin, 2023).

It is important for investors to be aware of the various risks involved in investing in NFT-type financial assets. These investments involve risks such as fraud, uncertain regulation, environmental impact, and the possibility of losing access keys to NFTs. The NFT market is relatively new, and there is little clear regulation. The NFTs do not function as traditional securities and do not fit clearly under the existing regulatory framework (SEC, 2020). This can lead to fraudulent practices, scams, or market manipulation, resulting in financial losses for investors.

In addition, there are concerns about intellectual property, counterfeiting and the ease with which NFTs can be copied or pirated. In his article on Plasseraud, Millet (2022) explains that it is increasingly common for "tokenized" works to pose difficulties with regard to Intellectual and Industrial Property law, as everyone can easily create them without owning the rights to the original work, as demonstrated by the multiple lawsuits initiated in the USA since the end of 2021 in connection with accusations of counterfeiting involving collections of NFTs (cryptonews, 2022). In addition, the nature of NFTs, their modes of use and the inherent operation of blockchains create an unprecedented situation undeniably complicating the enforcement of intellectual and industrial property rights.

Experts such as Cathy Hackl<sup>1</sup> suggest various risk management strategies, including diversifying NFT holdings, conducting in-depth due diligence on exchange platforms and

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<sup>1</sup> Cathy Hackl is a globally recognized metaverse expert, tech futurist, and top business executive with deep experience working in metaverse-related fields with companies like HTC VIVE, Magic Leap, and Amazon Web Services.

projects, and using secure digital portfolios and robust security practices. For example, to manage the risk of the platforms used or the choice of NFT collections, investors can rely on market experts such as NonFungible.com, who provide information on current trends in the NFT market, such as the exploding popularity of NFTs in the digital art sector, partnerships with renowned brands and opportunities for the tokenization of real assets.

To better understand current trends in NFTs, it's useful to look at case studies and real-world examples from the market. The NFTs market has been growing exponentially since it first appeared in 2014, with a market capitalization approaching \$12 billion as of June 9, 2021, and a sales volume exceeding \$12 billion (Deloitte, 2022). What's more, major global brands such as Campbell's, McDonald's, Taco Bell, Gucci, Nike, and Louis Vuitton are using NFTs to increase demand for their services and products and build loyalty among their users. NFTs have become a new marketing tool for major corporations, and this trend is set to continue in 2023 and beyond (Musienko, 2023). According to Coin Market Cap and Crypto Go's "2023 NFT Market Analysis: An Insider Look", the Blur platform has surpassed OpenSea (previously number 1) in terms of transaction volume since its launch in December 2022. Despite this, OpenSea still has around three times as many independent traders as Blur. The Blur platform has also overtaken OpenSea in terms of royalty market share. Over 50% of NFT projects have a market capitalization of between 100 and 1000 ETH, and the top 50 projects represent less than 1% of the total number of projects on the market, but their market capitalization represents around 52% of the total. When a project reaches a trading volume of 1000 ETH, it is likely to be ahead of other projects in terms of robustness and to occupy a certain market share. Liquidity in the NFT market is closely linked to market activity. The market experienced its best overall liquidity from January to April 2022, then began to decline significantly in May, and finally reached its lowest level in September. It was not until the first half of 2023 that liquidity began to recover. As for the future of NFTs, they are seen as an evolving technology that is changing people's perception of digital assets and blockchain. "The future of NFTs is seen as a world of colorful ideas, and the technology is constantly improving" (Musienko, 2023). Experts expect to see NFTs used in many fields.

### 3. Methodology

This section presents the methodology adopted to answer the research question: " To what extent do NFTs contribute to the diversification of a portfolio?" The methodology includes a quantitative approach and is based on the collection and analysis of historical data. The following steps were taken to achieve this objective:

The first step is to understand and identify the research question. The main objective is to assess how NFTs contribute to portfolio diversification. This question will be addressed by examining the performance of NFTs relative to other forms of investment such as real estate, gold, oil, equities, bonds, and interbank rates. The quantitative method was chosen for its ability to quantify and analyze data objectively. It offers the possibility of performing statistical calculations and measuring correlations between different asset returns. Weekly historical data on the average price of 80 collections of NFTs on Opensea were collected for the period from January 1, 2022 to May 2023. This analysis period was chosen by default in order to find a balance between the size of the sample and the length of the analysis period. Indeed, NFTs being a very recent subject, few collections were available at the beginning of 2022. So, if we wanted to have a sufficient analysis period, we had to reduce the sample size. The selection of these 80 collections was based on specific criteria such as their presence before 2021, a high transaction volume, and their belonging to a certain type of NFT.

To collect the historical data required for this study, several tools and techniques were used. The main data sources included online platforms, financial databases, and institutional sources, specialized databases, scientific articles, academic works, encyclopedia, official reports, and financial archives. Weekly historical data on the average price of 80 collections of NFTs were collected from the Opensea platform. These data were recorded and noted by hand in an excel file for each week of the study period. In addition, weekly historical data for other investment types such as real estate, gold, oil, equities, bonds, and interbank rates were obtained from reputable financial and institutional sources such as the IMF and investing.com. The aim of gathering the same information for various assets in different categories is to compare the performance and statistics of these different investment assets.

Once the data had been collected, they were processed to enable comparative analysis of the performance of the different types of investment. The data processing steps were carried out using Microsoft Excel. Firstly, the weekly average prices of NFTs were recorded for each

collection. In parallel, the average price of Ethereum was calculated over the same period. By multiplying this average NFT price by the average Ethereum price and multiplying the sum by the total number of NFTs in each collection, the capitalization per NFT collection was obtained. This approach created a customized NFT index for each type of NFT, as well as a total index.

Second, to collect historical data for the other asset types, 1-month LIBOR and EURIBOR were drawn weekly. Note that we cannot directly invest in EURIBOR and LIBOR, but they are included in our portfolio because they are key elements of the global financial market. They influence the performance of a wide range of investments and provide insight into the general health of the economy. Moreover, they are often used as performance benchmarks for other investments. For example, an investment fund could aim to outperform LIBOR or EURIBOR by X percentage points. Therefore, they deserve to be included in any in-depth financial or investment analysis. For real estate, the S&P 500 Real Estate price was chosen. The same applied to gold and oil. For equities, the most relevant indices were selected: S&P 500, FTSE 100, DAX, CAC 40, NIKKEI 225, and SHANGHAI COMPOSITE. For bonds, the focus was on 10-year bonds from the same countries as those chosen for equities, to maintain consistency in the analysis.

Using this data, weekly returns for each investment type were calculated to compare the performance of investing 100 euros in each. Various statistical measures, such as mean, maximum, minimum, standard deviation, volatility, skewness, kurtosis, and Sharpe ratio, were also calculated. In addition, the different correlations between the returns of different assets were highlighted. Finally, to reduce the bias caused by the poor performance of less robust and less relevant collections, an analysis was also carried out using only the 15 best NFT collections over a 2-year period this time (from August 2021 to May 2023).

A specific analysis was also carried out to assess the impact of two major events on NFTs and the economy in general: the war in Ukraine and the launch of the NFT Pixelmon collection. The analysis examined the performance of NFTs before and after these events. The weekly historical data has been divided into pre-event and post-event periods, in order to compare the returns and price fluctuations of NFTs over these distinct periods. Finally, we analyzed the minimum variance portfolio and analyzed the interest of including NFTs in it in terms of statistics.

To guarantee the validity and reliability of the results, measures were taken throughout the study. Several aspects were taken into account, including the representativeness of the sample. The selection of the 80 NFT collections on Opensea was based on specific criteria, enabling us to represent a wide range of NFTs available on the platform. The precision of the measuring instruments and the historical data were collected from reputable and reliable sources, guaranteeing the accuracy of the information used in the analysis. Secondly, the rigor of the analysis. Statistical calculations and analyses were carried out rigorously and using appropriate methods. The various performance measures and correlations were calculated consistently to ensure the consistency of the results. Finally, data accuracy. Verification procedures were put in place to ensure the accuracy of the data collected. Checks were carried out to identify and correct any errors or inconsistencies in the records. It should be noted that this research has its limitations, which will be discussed at the end of the report.

#### **4. Research question and hypothesis development**

Over the past decade, investment in non-traditional asset classes has experienced unprecedented growth, attracting interest from institutional and individual investors worldwide. Among these new asset classes, NFTs stand out for their unique and intrinsically digital nature. NFTs, which use blockchain technology to prove the ownership and authenticity of a digital object, have aroused great curiosity among investors, both for their potential profitability and their ability to diversify an investment portfolio. However, despite their growing popularity, little research has been conducted to empirically examine how NFTs can contribute to portfolio diversification. We hope that this research will make several significant contributions to the existing literature on NFTs and investment.

*4.1. Research question: " To what extent do NFTs contribute to the diversification of a portfolio?"*

##### *4.1.1. Main contribution*

The first contribution will attempt to prove that NFTs have their place in a portfolio, as this type of investment enhances portfolio performance.

#### *4.1.2. Secondary contributions*

The study will demonstrate that investment in NFTs can enhance portfolio performance by increasing the Sharpe ratio and reducing risk. It will also seek to prove that NFTs have a low correlation with traditional assets, meaning that they can be used as a means of diversification. Finally, this research will help to establish NFTs as a legitimate asset class for banks, investors and regulators.

By providing a better understanding of NFTs, the study could enable investors to make more informed decisions, and regulators to develop appropriate policies for managing this emerging asset class. In sum, this research will strive to fill the gap in the existing literature on NFTs and their role in diversifying an investment portfolio, thus contributing to a better understanding of this fascinating new asset class.

### **5. Analysis**

In today's dynamic and unpredictable financial markets, the need for effective portfolio diversification has never been more relevant. Non-fungible tokens (NFTs), a technological revolution stemming from blockchain, have generated increased interest as potential assets for diversifying an investment portfolio. However, their recent emergence and inherently volatile nature raise the question of their actual effectiveness in this regard. This analytical work aims to explore and understand " To what extent do NFTs contribute to the diversification of a portfolio?"

We have already reviewed the existing literature, defined our methodology and formulated contributions about the potential impacts of NFTs on portfolio diversification. Now it's time to delve into our analysis. We will start with a presentation and analysis of the data we have collected, before comparing the performance of NFTs with that of other assets. Descriptive statistics will enable us to examine in detail the Sharpe ratio and volatility of NFTs, and to test their correlation with traditional assets. In the following section, we will focus on some relevant events.

We will justify the slow economic growth by the war in Ukraine, and we will analyze the impact of the launch of the "Pixelmon" collection on the NFTs market. We will then take the analysis in a new direction, revising our sample to focus on the top NFT collections.

We will then explore the place of NFTs in an equal-weight portfolio, while examining the level of risk investors are willing to tolerate due to the volatility of NFTs. Finally, we will provide some key statistics to a diversified portfolio.

The aim of this analysis is to provide a balanced and in-depth perspective on the potential impact of NFTs in diversifying an investment portfolio. Looking beyond current trends and speculation, we will seek to understand the true value that these unique digital assets can bring to a diversification-minded investor.

### *5.1. Presentation and Analysis of collected data*

The first stage of this analysis focuses on presenting and examining in detail the data collected for this brief. The main objective is to understand trends and variations in the field of NFTs (Non-Fungible Tokens) as well as other types of investments. This understanding will subsequently enable us to analyze the extent to which NFTs contribute to the diversification of a portfolio.

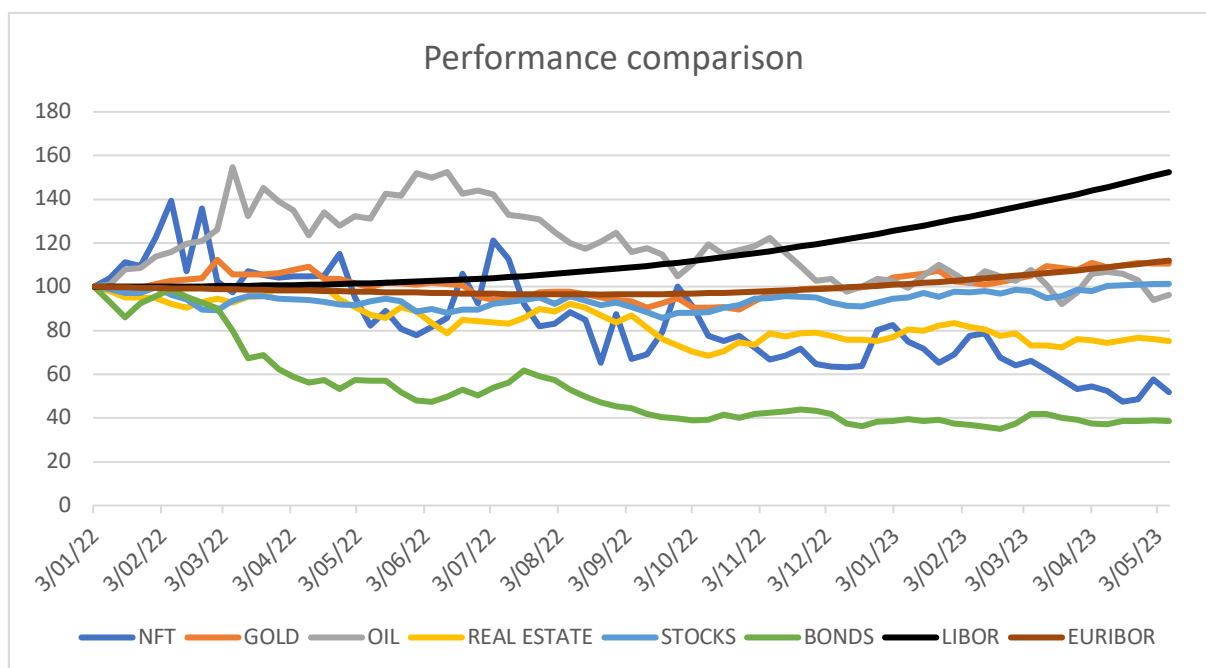
For the period from January 1, 2022 to May 2023, we collected weekly historical data on the average price of 80 NFT collections sorted by category on Opensea (see Appendix 4), a widely recognized NFT exchange platform. The selection of these 80 collections was strategically made on the basis of their existence prior to the year 2022, to ensure sufficient data depth for consistent analysis. Given the recent and constantly evolving nature of NFTs, this selection helped to mitigate possible biases linked to the novelty effect or too short a timeframe.

At the same time, weekly historical data were also collected for other types of investment, including real estate, gold, oil, equities, bonds, and interbank rates. These data provide a context and a point of comparison for understanding the performance of NFTs versus other types of conventional investments.

The data collected will be analyzed using various statistical tools and data visualization techniques to understand trends and variations. These tools include creating trend charts, analyzing volatility, assessing correlation between different asset classes, and applying appropriate statistical tests to verify the results. This analysis will provide a clear picture of the performance of NFTs in comparison with other assets, which will be crucial in answering the main question of this dissertation.

## 5.2. NFT Performance: A comparative analysis with other assets

Analyzing data can sometimes be complex, but let's see what these figures tell us. The data provided represents the performance of the various asset classes from January 3, 2022 to May 8, September 2023. We have considered an initial investment of \$100 in all the different assets, and we are going to analyze the evolution.



At first glance, we can see that the performance of NFTs (non-fungible tokens) is quite volatile compared to other asset classes. NFTs have experienced significant growth, rising from \$100 to \$139.34 on February 7, 2022, followed by a steady decline to \$51.92 today. This fluctuating trend has continued throughout the period studied, suggesting a higher level of risk for this asset class.

Oil, meanwhile, showed an upward trend, rising from \$100 to \$152.54 on June 13, 2022, although it also experienced significant fluctuations.

Real estate and equities also fluctuated, though less markedly than NFT and OIL. However, equities have remained generally more stable than real estate, which fell from \$92.31 on August 8, 2022 to \$75.23 today, while equities have rallied from that same date to \$101.36 today.

Gold, LIBOR (London Inter-bank Offered Rate) and EURIBOR (Euro Inter-bank Offered Rate) were relatively stable, with a slight upward trend. Interbank interest rates showed very little

volatility. Gold was a little more volatile, but generally followed the same upward trend. However, the trend for LIBOR is much more exponential than for EURIBOR.

Bonds fell across the board during the period under review, from \$100 to \$38.58 on May 8, 2023. This could indicate that bonds were less attractive to investors during this period. When interest rates rise, the value of existing bonds falls. This is because newly issued bonds offer higher interest rates, making older bonds with lower rates less attractive on the market. (AMF, 2017)

Overall, this analysis suggests that NFTs can offer high yields but also negative yields, but with increased volatility and potentially higher risk. This NFT volatility could be useful for portfolio diversification, provided the investor is willing to accept the associated level of risk. It should also be noted that this analysis is based on a specific period and that past performance is not necessarily indicative of future results.

### *5.3. Delving into descriptive statistics*

Descriptive statistics provide us with valuable information associated with each asset type (see Appendix 5).

First, we will analyze the average return obtained on each type of asset during the study period. We can see that LIBOR had the best positive average return (0.60%), followed by Gold (0.17%), EURIBOR (0.16%) and Oil (0.11%), while real estate (-0.35%) and NFTs (-0.16%) presented negative average returns. Bonds were the worst performers (-1.21%).

The maximum and minimum return indicators determine the best and worst performance recorded for each asset over the study period. NFTs showed the highest maximum return (33.78%), suggesting the possibility of high returns, but they also showed the lowest minimum return (-24.58%), indicating higher risk.

The standard deviation represents the dispersion of returns in relation to their mean. A higher standard deviation means that returns are more dispersed, indicating higher risk. NFTs show the highest standard deviation (12.67220707%), suggesting higher risk. We note that oil and bonds follow with a standard deviation of around 5 for both. Interbank rates have the lowest dispersion, very close to 0.

Volatility measures the variation in an asset's return. Higher volatility implies higher risk. Once again, NFTs have the highest volatility (106.023291%), indicating a higher level of risk.

Skewness measures the asymmetry of the distribution of returns. Positive skewness means that the distribution has a longer right-hand tail, which means a higher chance of extremely positive returns. NFTs have the highest skewness (0.564334562), which may indicate a chance of extremely high returns.

Kurtosis (kurtosis) measures the "weight" of the tails in the distribution of returns. A higher kurtosis indicates a distribution with more frequent extreme returns (both positive and negative). Commodities have the highest kurtosis, which may indicate a risk of extreme price events. LIBOR and EURIBOR logically have a negative kurtosis.

The Sharpe ratio measures the excess return (or risk-adjusted return) per unit of risk. A negative Sharpe ratio, as is the case for all the assets in your study, is not ideal, as it indicates that the return is lower than the risk-free rate. Therefore, in this case, all assets have underperformed the risk-free rate.

Overall, NFTs offer an attractive risk/return profile, with the potential for high returns but also a higher level of risk. This may prove attractive to investors willing to accept a higher level of risk in exchange for the possibility of a higher return. Furthermore, it is important to note that the integration of NFTs into an investment portfolio will largely depend on the investor's risk tolerance and specific investment objectives.

However, the negative Sharpe ratio indicates that returns on NFTs are lower than would be expected given their level of risk, compared with a risk-free investment. This means that, although NFTs could potentially offer diversification due to their unique return characteristics, they do not necessarily compensate for the level of risk they present during this period.

#### *5.4. Correlation: An analysis of other investment correlation*

In this section of our analysis, we will examine the correlations between the returns on different types of assets: NFTs, gold, oil, real estate, equities, bonds, the Libor interbank rate and the Euribor interbank rate (see Appendix 6).

It's important to remember that the correlation coefficient, which fluctuates between -100 and 100, measures the degree of linear relationship between two variables. A positive correlation coefficient indicates that when the value of one variable increases, that of the other variable also tends to increase. Conversely, a negative correlation coefficient indicates that when the value of one variable increases, that of the other variable tends to decrease.

An analysis of the data reveals the following trends:

NFTs have a negative correlation with gold (-4.24%), oil (-15.29%), real estate (-12.14%), LIBOR (-5.81%) and EURIBOR (-5.04%). This suggests that when yields on these assets rise, yields on NFTs tend to fall, and vice versa. Thus, NFTs could serve as a diversification tool in a portfolio that includes these assets.

NFTs have a positive correlation with equities (12.06%) and bonds (3.14%). This means that when returns on these assets rise, returns on NFTs also tend to rise, and vice versa. In a portfolio comprising these assets, the inclusion of NFTs could therefore increase overall risk. It is therefore less attractive to include NFTs in a portfolio containing this type of asset. We can note a disagreement with the study of Kong (2023) and Ko, Son, Y. Lee, Jang and J. Lee (2022) developed in the review literature when they explain that NFTs do not always follow traditional market trends and that there is little or no correlation. In our case, they are correlated.

As far as correlations between other asset types are concerned, EURIBOR and LIBOR show the highest correlation (95.30%), which is not surprising given that they are both interbank rates and are therefore affected by similar economic factors.

The strongest negative correlations are between oil and LIBOR (-16.12%) and between gold and oil (-18.64%). These relationships suggest that these assets could offer good diversification opportunities.

In conclusion, we can confirm our second contribution that NFTs show signs of potential for portfolio diversification, especially when combined with gold, oil, real estate, Libor and Euribor. However, they seem to add risk when combined with equities and bonds. It is therefore essential for investors to consider these correlations when designing their portfolio strategy, always taking into account their risk aversion and investment objectives.

## *5.5. Significant events*

Analysis of the impact of two major events in February 2022 - the war in Ukraine and the launch of the NFT Pixelmon collection - on various types of investments shows that both had significant effects, but in different ways and on different assets.

### *5.5.1. War in Ukraine*

The war in Ukraine has had a considerable impact on the global economy and on different types of investment. European markets have been particularly hard hit because of their dependence on Russian natural gas, which has had an impact on equities and other investments in the region. The European Central Bank estimates that 20% of the variance in the equity market from one country to another could be explained by the proximity of the conflict. In addition, GDP growth in the Eurozone is expected to fall to 0.3% in 2023, from 3.2% in 2022, which could lead to a recession. Here is a preliminary analysis of the war's impact on gold, oil, real estate, equities, bonds, Libor and Euribor interbank rates, and the NFT market.

The war worsened global inflation, which led to an influx of inflation protection and therefore pushed the market value of gold higher. Sanctions against Russia, a major gold producer, are expected to halt the mining process for some time, which has helped keep prices high.

In terms of oil, before the invasion, Russia was a major energy supplier to Europe, with 60% of its oil exports and 74% of its dry natural gas going to Europe. However, the war put an end to this dependence. Although the transition was difficult, Europe reduced its natural gas consumption by more than 20% due to rising prices caused by supply shortages.

In terms of equities, the war brought volatility to the stock markets and probably influenced share performance.

The war was surely one of the triggers of this economic slowdown. Banks to counter the effects of inflation had to raise interest rates. This indirectly increased LIBOR and EURIBOR. In the same logic, people in general buy less real estate during this period due to the fact that the mortgage rate is quite high.

As for NFTs, studies show that they are still quite sensitive to outside news, and a war can only create panic and a consequent outflow of investment from risky assets. Many sells in anticipation of the fall, creating a snowball effect.

### *5.5.2. Launch of the NFT collection “Pixelmon”*

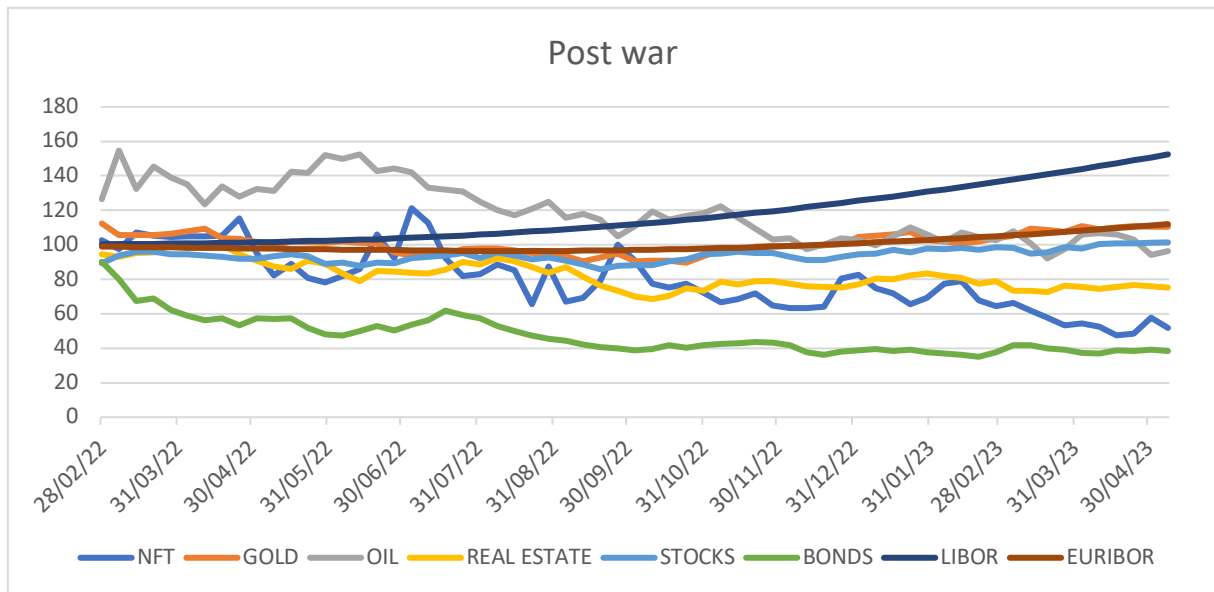
The NFT Pixelmon collection was launched at a sale on February 7, 2022. Due to the hype surrounding the project, the entire collection sold out in a matter of hours, adding an astonishing \$70 million to the project's treasury, making it one of the biggest NFT project launches to date.

Early buyers paid up to 3 ETH (around \$8,000 at the time) per NFT Pixelmon. Some 7,500 people spent between \$8,000 and \$16,000 at the time. Even though the game's launch was still a long way off, buyers were generally satisfied with the incentives they were promised.

However, optimism surrounding the project was quickly toppled following the reveal of the NFT Pixelmon artwork. Buyers discovered that the NFT Pixelmon artwork was very different from the in-game pictures that the development team had posted on social networks. Not only were the designs mediocre, but they were also so poorly conceived that the project became an internet laughingstock. This led to a significant drop in the base price of the collection, which fell to 0.3 ETH, barely 10% of the original mint price. Pixelmon's impact on the NFT market has been significant. After the revelation of the 10,000 NFTs in the collection, the NFT community reacted widely, with some going so far as to call Pixelmon the worst project ever. This was a huge cash outflow from the NFT markets. Volume was very low in the weeks that followed.

Overall, the Pixelmon launch had a major impact on the NFT market, highlighting both the power of hype and the potential challenges associated with managing high expectations. The launch also raised important questions about transparency and ethics in the NFT world, issues that are likely to continue to influence the market in the future.

### 5.5.3. Post war analysis



Given the many explanations of the Pixelmon collection in section 5.5.2, we can see that the price of NFTs has only fallen since February 2022.

In general, we can also see that OIL, real estate, bonds and NFTs have been in constant decline since February 2022, the date of the 2 events.

Gold and equities also decline initially, before recovering slightly towards the end of 2022.

Interest rates, meanwhile, have been rising exponentially since February. The rise in interbank rates can be due to several factors, but is often linked to higher inflation expectations, changes in central bank monetary policy or increased loan demand.

Secondly, geopolitical, and economic shocks such as the war in Ukraine can lead to an increase in state borrowing rates, as the risk for investors becomes higher. This, in turn, could lead to an increase in other interest rates like those of mortgages and potentially interbank rates. It results in a decrease of real estate.

### 5.6. A Critical Setback: Analyzing performance of top collections

In the first part of the analysis, we can quickly see that the very poor performance of NFTs is not due solely to the economic slowdown, but to reasons specific to NFTs. Indeed, collections with less credibility perform the worst, which justifies a revision of our analysis approach.

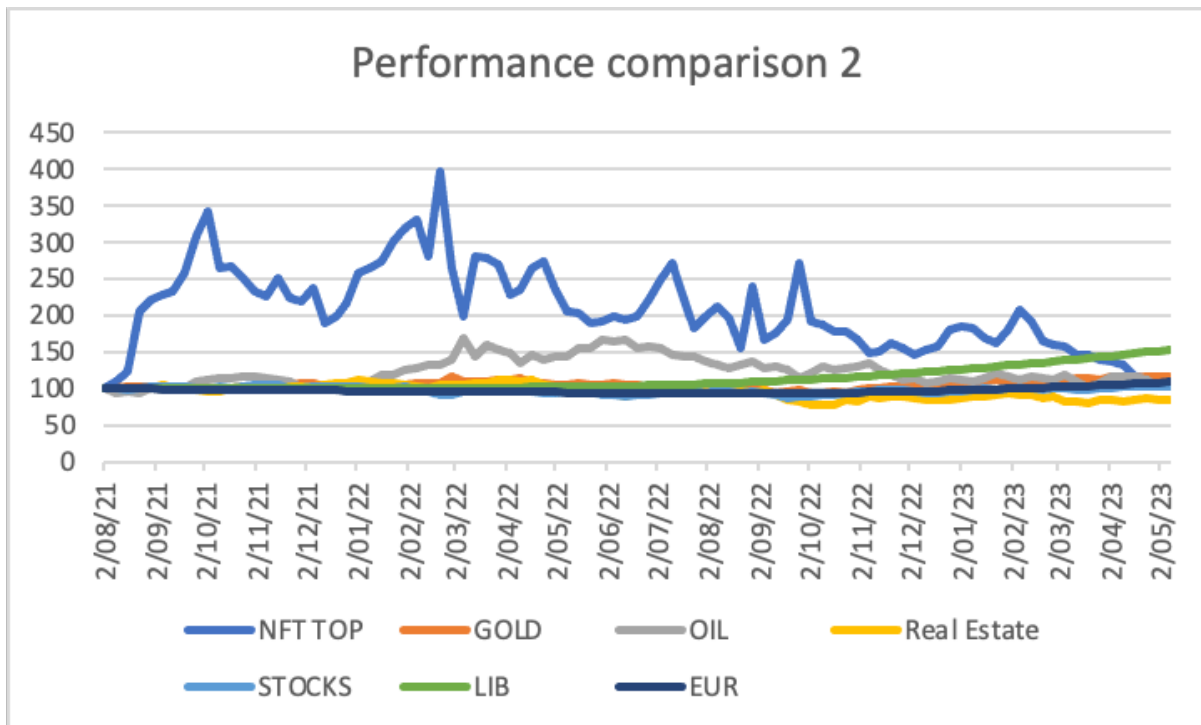
The first criticism concerns the selection of the NFT sample. In the initial analysis, a sample of 80 NFT collections was used. However, this raises questions about the representativeness of the sample. NFTs can be created by anyone, which means there is incredible variety in terms of quality, relevance, and potential for value appreciation. A large proportion of this sample could be made up of low-quality NFTs, which are unlikely to make a significant contribution to portfolio diversification.

Furthermore, NFTs are by nature a highly volatile and unregulated asset. This means that their performance can vary considerably, with peaks and troughs sometimes drastic. By using such a large sample, we risk masking these variations and losing valuable information about the real potential of NFTs.

In addition, with NFTs really coming into their own at the end of 2021, very few collections were available before then. So, by having a smaller sample, we can take a longer analysis period and therefore get a better idea of the impact of NFTs on a portfolio.

To solve these problems, it makes sense to reduce the sample to 15 collections of high-quality NFTs, selected on the basis of a multitude of factors such as project transparency, credibility, their creation dates, their value appreciation potential, and generally higher quality. This approach would reduce the noise created by lower-quality NFTs and focus on the real potential of NFTs as a source of portfolio diversification. The performance of these collections could then be analyzed over a longer period, from August 2021 to May 2023.

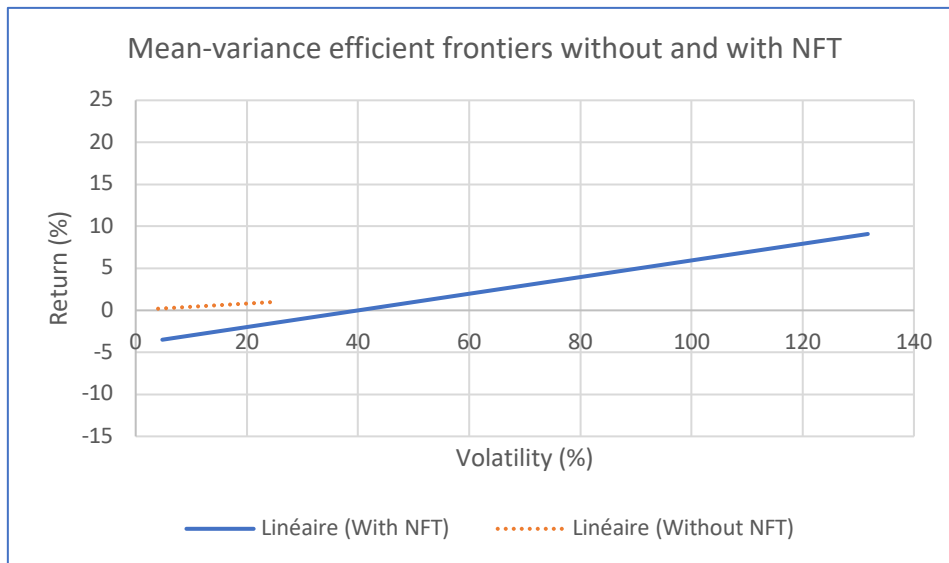
This would not only allow us to revisit the previous analysis, but also to deepen our understanding of the specific mechanisms by which NFTs can contribute to the diversification of an investment portfolio. In addition, this approach could provide valuable insights into the factors that contribute to the performance of NFTs, a question that remains largely unresolved in the existing literature.



The first observation is the outperformance of NFTs compared to the rest of the investments. The other investment types generally behave the same as in section 5.2. of the analysis. It should be noted that due to the significant divergence and the extreme results generated by the inclusion of bonds in our study, it appeared necessary to remove them from this part of the analysis. These outliers over the August 2021-January 2022 period compromised the ability of the analysis to produce meaningful and relevant information, making it difficult to make a balanced and fair comparison with the other asset classes studied. Therefore, to ensure the integrity of our analysis and provide a more accurate picture of portfolio diversification, we have chosen to exclude bonds from this section of the study. This decision allows for a better comparison between the remaining assets, thus providing more useful and applicable insights for the purpose of our research.

We can therefore see that over a longer period and on better chosen NFTs collections that NFTs have more of a place in a portfolio because they increase its performance. In this case, the NFTs compensate better for the level of risk they present in opposition to the first analysis in point 5.2.

### 5.7. Comparison of a portfolio with and without NFT in terms of return and volatility



In this graph, we compare the volatility and returns of two different portfolios: one with NFTs (equally weighted portfolio) and one without NFTs. This analysis falls within the framework of Harry Markowitz's modern portfolio theory, which states that investors seek to maximize return for a given level of risk (Sharpe, 1964).

The graph shows that when the portfolio with on average 14% of NFTs has a negative return of -4%, it has a volatility of 5%, indicating that if there is a low risk, there is a potential low loss associated with it. However, the trend line shows an increase in performance up to 9% as volatility increases to 130%. This progression suggests that, despite the significant increase in risk, portfolio performance is gradually improving. This can be interpreted as an indication that NFTs can offer higher returns if there is a greater uncertainty. According to Markowitz's theory, this portfolio would be attractive to investors with a higher risk tolerance.

On the other hand, when the portfolio is close to 0% return, it is also close to 0% volatility, indicating the absence of risk and returns. It then rises to 3% yield with 19% volatility. This demonstrates that the portfolio without NFT is less risky, with a relatively lower return. According to Markowitz's theory, this portfolio would be better for investors who are more risk averse.

In conclusion, this graph suggests that incorporating NFT into a portfolio can increase potential returns, which indicates a higher level of risk. This is in line with Markowitz's theory which supports the idea of diversification to achieve the best possible trade-off between risk and return. A portfolio without NFT, although less volatile, offers a lower potential return.

Therefore, investors should consider their risk tolerance and investment objectives before making the decision to include NFTs in their portfolio.

#### *5.8. Descriptive Statistics: A comparative study of portfolios with and without NFTs*

This part compares a portfolio with and without NFT with statistics developed below. On average, the return of a portfolio with 14% of NFTs (Non-Fungible Tokens) is 0.19%, compared to 0.13% for a portfolio without NFTs. This suggests that including NFTs in a portfolio could improve the average return (see Appendix 7). But we can notice that 14% of NFT in a portfolio is probably too much for investors, given the early stage of this asset.

The maximum return for a portfolio with NFT is 12.76%, while for a portfolio without NFT it is 4.1%. This difference marks a higher growth potential for portfolios that include NFTs. Nevertheless, there is also a higher risk associated with NFTs, as shown by the minimum return. A portfolio with NFT has a minimum return of -11.27%, much lower than a portfolio without NFT, which is -2.89%.

The standard deviation is also higher for a portfolio with NFT (3.90%) compared to a portfolio without NFT (1.19%). This indicates that the returns of portfolios with NFT are more dispersed and therefore riskier. This is also reflected by the volatility measure, which is significantly higher for a portfolio with NFT (37.45%) compared to a portfolio without NFT (11.39%).

In terms of skewness (asymmetry), a portfolio with NFT (0.26) is less asymmetric than a portfolio without NFT (0.39). This suggests that portfolio returns with NFT are more symmetrically distributed. The kurtosis is higher for a wallet with NFT (2.35) compared to a wallet without NFT (0.65). This indicates that portfolios with NFT have more frequent extreme returns.

Finally, the Sharpe ratio, which measures risk-adjusted return, is higher for a portfolio with NFT (-0.46) than for a portfolio without NFT (-1.58). This suggests that despite the increased risk, the additional return gained from adding NFTs to a portfolio could outweigh the additional risk.

## 6. Limitations

The analysis of the place of NFTs in a diversified portfolio has several limitations that must be taken into account to interpret the results obtained and thus provide a clear perspective.

### *6.1. Methodological limitations*

For this study, data collection was done mainly on a single site, OpenSea. It is also important to note that each NFT sales platform may have its own characteristics and offers a specific selection of digital artworks. They also record different volumes and average prices. Consequently, our sample cannot represent the entire NFT market, which could introduce a bias into our analysis.

### *6.2. Data available*

The NFT market is a relatively new topic, which limits the availability of historical data needed to predict long-term market behavior. Although we have collected data over a period of one and a half years, it is important to note that this period may be insufficient to capture longer-term trends. Investor and user behaviors may change significantly as the NFT market grows and consolidates.

### *6.3. Early adopters*

As with any technological innovation, early adopters play a key role in popularizing NFTs. However, due to the nature of this initial phase, it is possible that the hype surrounding NFTs has led to temporary price overvaluation and artificially high demand. As the NFT market stabilizes, it is likely that the behaviors of early adopters will not be representative of those of longer-term investors. Therefore, it is important to take this potential bias into account when interpreting the results.

### *6.4. Diversity of NFTs*

NFTs cover a wide variety of categories, ranging from digital art to video games to music and more. In addition, there are several NFT chains on which these tokens can be bought and traded, such as Ethereum, Binance Smart Chain, or Flow. This diversity complicates analysis, as each NFT category and each channel may have their own distinct characteristics and market

dynamics. Thus, the conclusions drawn from our study may not apply uniformly to the entire NFT market.

#### *6.5. Limitation related to the rarity of NFTs*

A key factor not taken into account in our study is the scarcity of NFTs. This characteristic, determined by various factors such as different traits, has a major bearing on the value of NFTs. Our analysis, excluding this dimension, may therefore present limits in terms of precision of the results.

#### *6.6. Lack of uniform regulation*

The lack of uniform regulation regarding NFTs is another important limitation to take into account. Regulations vary from country to country, creating an environment where rules and constraints can differ significantly. Intellectual property, tax and consumer protection laws can have a significant impact on the NFT market. Therefore, the behaviors of market players can be influenced by country-specific legal, economic, and cultural factors, which makes a consistent global analysis difficult.

#### *6.7. Rapid Market Evolution*

The NFT market is changing rapidly and dynamically. Our research focused on a 1.5-year analysis period, but it is important to note that market trends and dynamics can change quickly. Economic, technological, and cultural factors can all influence the evolution of prices and behaviors of NFT market players. Therefore, it is essential to remain vigilant when interpreting long-term results.

#### *6.8. Selection bias*

When building our sample, we did our best to include representative NFTs from different categories. However, it is important to note that there are hundreds of thousands of collections of NFTs, and our sample of 80 NFTs may not fully reflect the diversity of the market. It is possible that certain categories of NFTs or certain artists are not represented in our sample, which can introduce a bias into our analysis and limit the generalization of our results.

### *6.9. Price and currency variations*

Although we have analyzed the price variations of NFTs, it is important to recognize that these variations can be influenced by other factors, such as fluctuations in the value of Ether (ETH) and fiat currencies like the dollar. American. Changes in exchange rates can have a significant impact on the perceived value of NFTs, and this should be taken into account when interpreting the results.

### *6.10. Usefulness of NFTs*

In our thesis, we mainly discussed the financial aspect of NFTs, focusing on prices and transactions. However, it is important to note that NFTs have many other uses, such as private access to events, exclusive goodies, virtual jewelry, and even concert tickets. These uses not taken into account in our study can have an impact on the perceived value of NFTs and must be considered in a more complete analysis of the market.

## 7. Conclusion

In conclusion, this research explored the impact of NFTs on portfolio diversification. This study is important because it contributes to the existing literature on NFTs and investing by providing empirical evidence of their potential to add value in a diversified portfolio.

The main results of this research showed that NFTs can be used to diversify a portfolio and improve its performance. This can be justified by a higher Sharpe ratio for a portfolio with NFTs and a negative correlation between NFTs, oil and gold as well as real estate and interbank rates. NFTs have also been compared to other investments such as real estate, stocks, bonds, gold, oil, LIBOR and EURIBOR, showing their unique potential as an investment asset.

These results are relevant because they change the traditional understanding of portfolio diversification by introducing a new asset class. The practical implications for investors and portfolio managers are significant as they provide an opportunity to improve portfolio performance while managing risk.

From my opinion, I think that the market during the period of analysis was very complicated given the economic context. However, NFTs have been able to prove good returns over the period preceding our analysis period and to hold up during it. So, I think that today it is interesting to include NFTs in your portfolio in order to diversify it but in small quantities regardless of your risk aversion. It is still too early to invest too large part of a portfolio in these assets.

For future research, it is recommended to further study the impact of NFTs on different types of portfolios and under different economic conditions. The current economic situation is not optimal to perform this type of analysis. By doing further analysis later in time, we will be able to determine if NFTs were just a passing mode or if they represent a new asset class that will endure and influence the way investors diversify their portfolios. Finally, I think it may be interesting to redo an analysis, this time taking into account the fluctuations of the Ethereum, considered as fixed in this report, in order to see if it is not the cryptocurrencies which impacts the portfolio more than NFTs.

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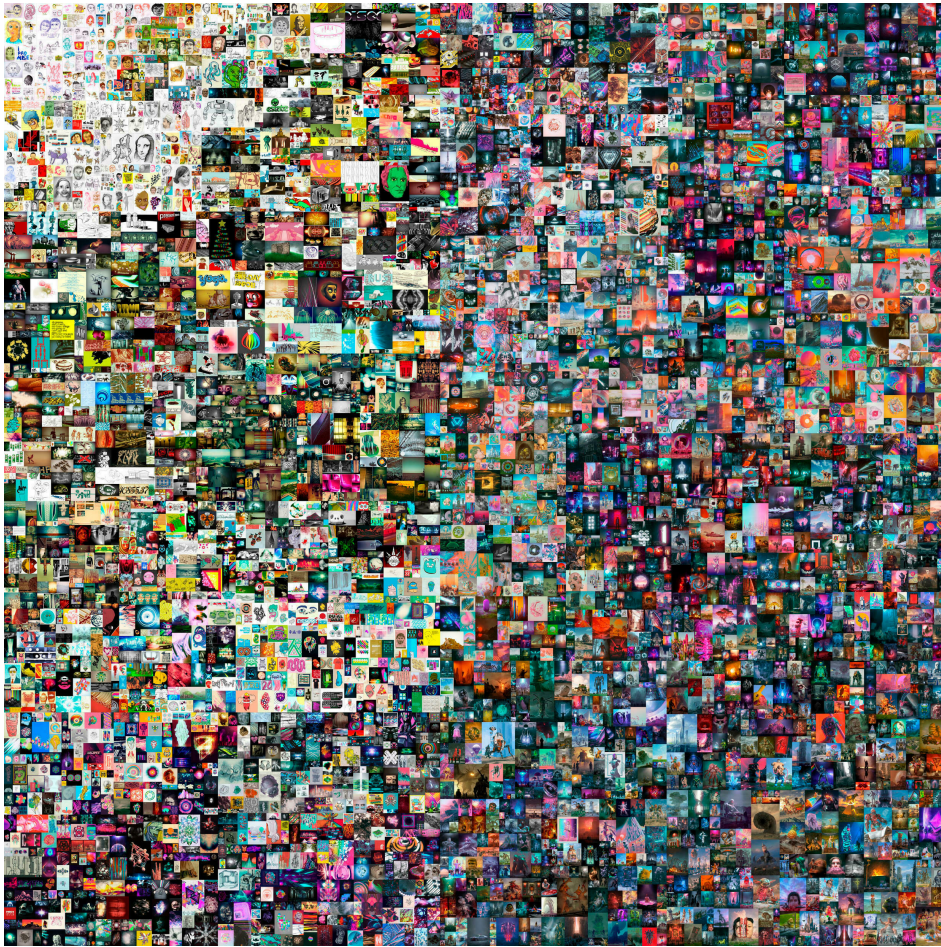
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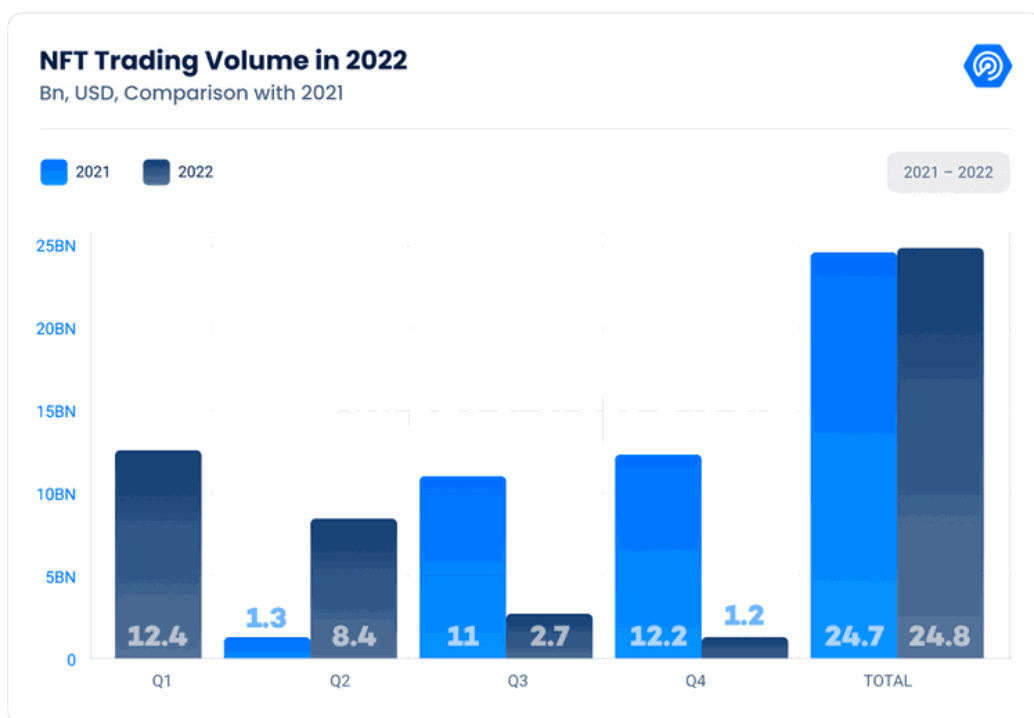
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## 9. Appendices

### Appendix 1: Everyday: The First 5000 Days"



### Appendix 2: Total volume of NFT trade in 2021 vs 2022



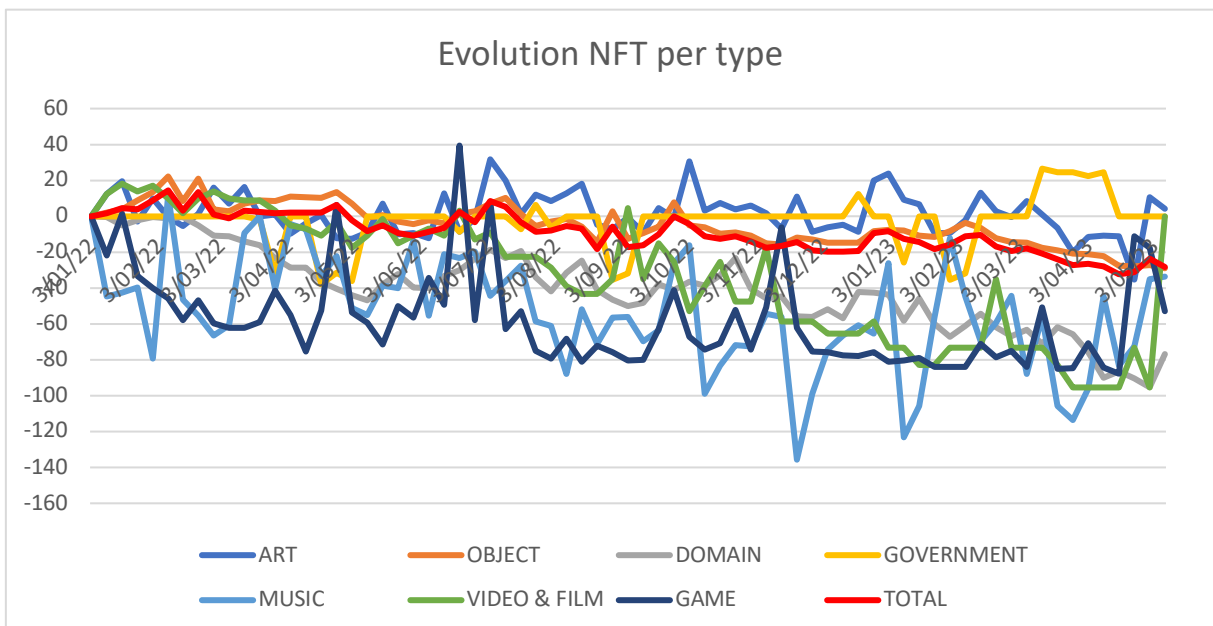
Source : Les Echos.Investir

Appendix 3: ETH's evolution (2021 until now)



Source: Investing.com

Appendix 4: The NFT's evolution taking into account the type of these NFTs



## Appendix 5: Descriptive statistics of different investment

	NFT	OR	OIL	IMMO	STOCKS	BONDS	LIB	EUR
MEAN	-0,16	0,17	0,11	-0,35	0,04	-1,21	0,60	0,16
MAX	33,78	8,18	22,53	7,71	4,80	11,47	1,17	0,71
MIN	-24,58	-5,96	-14,54	-7,00	-4,99	-15,66	0,02	-0,13
STD.DEV	12,67	2,28	5,78	3,35	2,02	5,26	0,40	0,30
VOLATILITY	106,02	19,11	48,32	28,06	16,89	44,04	3,36	2,50
SKEWNESS	0,56	0,05	0,62	0,30	-0,21	0,07	-0,08	0,49
KURTOSIS	0,52	2,32	2,24	-0,23	-0,08	0,09	-1,57	-1,32
SHARPE RATIO	-0,32	-1,30	-0,52	-1,04	-1,01	-0,63	-3,68	-6,43

All data are in % except Sharpe ratio.

## Appendix 6: Correlation of different investment

	NFT	OR	OIL	IMMO	STOCKS	Bonds	LIBOR	EURIBOR
NFT	/							
OR	-4,24 /							
OIL	-15,29	-18,64 /						
IMMO	-12,14	17,37	-0,15 /					
STOCKS	12,06	-9,92	4,86	24,65 /				
Bonds	3,14	20,52	5,08	1,41	17,05 /			
LIBOR	-5,81	10,89	-16,12	7,00	17,20	18,85 /		
EURIBOR	-5,04	14,23	-10,23	5,78	14,62	16,68	95,30 /	

All data are in %.

## Appendix 7: Descriptive statistics of a portfolio with and without NFT.

	With NFT	Without NFT
MEAN	0,19	0,13
MAX	12,76	4,10
MIN	-11,27	-2,89
STD.DEV	3,90	1,19
VOLATILITY	37,45	11,39
SKEWNESS	0,26	0,39
KURTOSIS	2,35	0,65
SHARPE RATIO	-0,46	-1,58

All data are in % except Sharpe ratio.