# Market Forces in Play: Analyzing Pricing Dynamics of NBA NFT Collectibles

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**Abstract.** This manuscript delves into the influence of supply and demand on pricing mechanisms within nascent digital markets, with a particular focus on the sphere of digital collectibles associated with the National Basketball Association (NBA). Employing regression analysis on transaction data sourced from nbatop-shot.com, the investigation meticulously explores pricing trends and discerns patterns pertinent to the NBA's digital collectibles. The findings corroborate the fundamental economic tenets of demand, highlighting that escalating demand and the novelty of the market are pivotal in propelling NFT prices. In contrast, a high concentration of ownership detrimentally impacts NFT valuations, likely due to the enhanced risk of market manipulation and diminished asset liquidity. The principle of scarcity emerges as a crucial determinant, with NFTs of limited issuance or distinct attributes commanding premium prices, reflecting the market's predilection for rarity. Furthermore, the analysis accentuates the significance of player-centric factors within the NBA NFT market, where performance metrics markedly influence pricing structures. Despite its distinctive characteristics, the NFT marketplace broadly adheres to classical economic theories. This research furnishes a comprehensive quantitative insight into the dynamics of the NFT market, offering valuable guidance for stakeholders to formulate nuanced trading and investment strategies.

**Keywords:** NFT market, pricing mechanism, digital collectibles

## 1    INTRODUCTION

NFT, an emerging block-chain application, has rapidly taken center stage in the digital art and collectibles market. These one-of-a-kind digital assets, which provide tamper-proof proof of ownership and scarcity through block-chain technology, have triggered the birth of a whole new economic ecosystem [1]. Since the NFT market has witnessed explosive growth over the past few years [2], the number of market participants and transaction volumes have reached unprecedented heights [3], thus triggering the need for an in-depth exploration of its value system and pricing mechanism.

According to a forecast published by research firm MarketsandMarkets, the NFT market size will grow to $13.6 billion by the end of 2027[4], with an estimated compound annual growth rate (CAGR) of 35%. Regionally, North America is the largest

market with a share of about 34%, followed by Asia-Pacific and Europe with shares of about 31% and 23%. Based on type, art and collectibles are huge segments with more than 70% share. NFT has created a digital revolution by allowing everyone to create, share, and access a wide range of digital currencies, including visual arts, games, and music[5]. In terms of applications, the more extensive application is the primary market, followed by the secondary market.

The NFT market is a diverse field that includes a variety of players, such as artists, developers, investors, and collectors [6]. In the supply and demand economics theory, prices are determined by the supply and demand for a good or service. However, this classical theory faces new explanatory challenges in the NFT market. [7] The non-homogeneous and digital nature of NFT means that each token is unique, and there are no production costs or supply chain constraints as in the case of traditional goods.

The motivation for this study stems, first and foremost, from the quest for a deep understanding of the interplay between supply and demand and product pricing within the NFT market[8]. Economic principles have matured for the analysis of traditional markets, but the uniqueness of the NFT market requires us to revisit the applicability of these principles in a new context[9].

Second, understanding the dynamics of supply and demand in the NFT market is crucial for market participants. Understanding price fluctuations helps collectors and investors make more informed buying and selling decisions while guiding artists and creators on pricing strategies. As the NFT market continues to mature, the study of these dynamics helps enhance market transparency and liquidity[3].

Finally, with the rapid expansion of the NFT market, understanding its pricing mechanisms is becoming critical to building a sustainable and healthy ecosystem[10]. This is a testing ground for economic theories and a challenge for regulatory practices in emerging markets. This study aims to delve into the role of supply and demand in the NFT market to provide insights into this ever-changing market and lay the foundation for future research.

## 2    DATA

This section outlines the sources, reliability and specific data content of the data used in the article. By examining the data, this section draws some preliminary conclusions and sets the stage for a deeper investigation.

### 2.1    Data Source

The NFT transaction data used in this project are extracted from nbatopshot.com. Due. Due to extraction limitations, the data are extracted in Excel and transferred to a CSV file. Then, the data becomes native and can be imported into Python indefinitely. The data obtained from nbatopshot.com is considered the official trading data and is very reliable. After importing into Python, the data for this project totaled 447,660 entries.

## 2.2    List of Variables

This study collected transaction data from nbatopshot.com, including factors such as NFT selling price, sales, player data, and scarcity of works. All variables are also put into python and representative variables are selected after regression analysis.

The first category of variables are non-continuous variables, including Transaction_date, Set, Highlight, etc., in which split the transaction date into Month, Weekday and Time period.

The second category is continuous variables, including the main indicators of NFT market, including *Serial_number, Series, Ask_Price, For_Sale, Lowest_Ask, Total_Owned, Unique_owners* and other special variables. This study profiles the variables used in this paper and the corresponding actual interpretations from Table 1.

**Table 1.** The list of variables and classification.

| Variable | Classification |
|---|---|
| Highlight | Dunk, Layup, Jump Shot, etc. |
| Set | A set is a curated collection of all of your NBA Top Shot Moment™ NFTs. Here you can check your progress as you buy packs or trade with others on the marketplace. |
| Days_since_release | Release date |
| Total_circulation_number | Same as edition size. two types of Edition Sizes in Top Shot: Circulating Count (CC) designates a moment that still has an open mint, meaning more of these moments might be made in the near future. For example, if a moment's marked as 35,000 CC, it means the edition size could continue to grow to 40,000 or even 50,000. Limited Edition (LE) designates a moment that is "retired." That means no more of this moment will be minted – ever. A moment is marked as 10,000 LE will never have more editions minted. All moments in our data are LE. |
| FOR_SALE | Number of listings |
| Lowest_Ask | Lowest listing price |
| Player_stats_height_inches | Player height |
| Player_stats_weight_numeric | Player weight |
| Player_stats_age | Player_age |
| Draft_Year/Draft_Round/Draft_Pick | Draft picks |
| Unique_owners | Number of unique owners of the moment with different serial numbers. |
| Total_Owned | Number of moments owned by collectors |
| Price | Transaction price |
| serial_number | Serial Number of the moment |
| time/month/weekday | Transaction time |
| Ask_price | Price asked by seller |
| Season Average | Season Average data |

# 3     DATA ANALYSIS

This article shows three basic sets of data comparisons. In figure 1, the first comparison of the average price of products grouped by 'Highlight' shows that the average price of 'Block' is significantly higher than the other grouped categories, with a gradual increase in price from 'Steal' to 'Dunk' with a gradual increase in price.
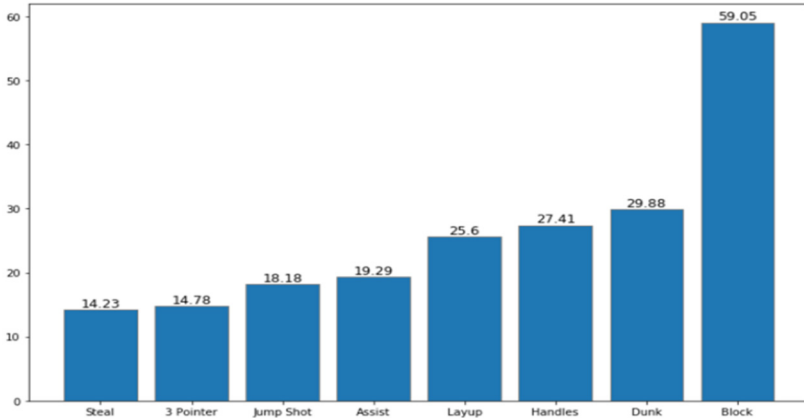


**Fig. 1.** Comparison of average price of products by 'Highlight' grouping.

Figure 2 shows the comparison of the number of products according to the '*Highlight*' grouping., and the results show that the number of *'Dunk'* is much higher than the other products, and the *'Block'* lowest quantity and the greatest scarcity.' *3 pointer*' and '*Assist*', which are in the middle to lower price range on average, have maintained a certain number of sales.
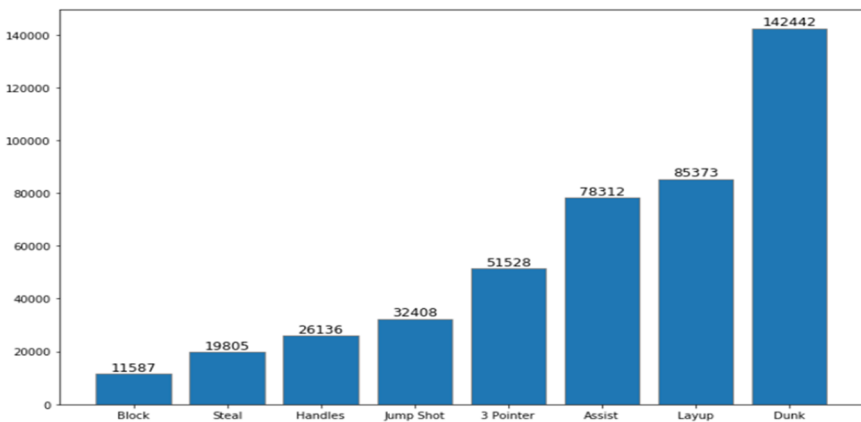


**Fig. 2.** Comparison of the number of products by '*Highlight*' grouping.

Finally, by looking at the average price of the products(shown in Figure 3) in the product category 'series', scarcity affects the price of the products to a great extent, and the price of the 'Rare' products is much higher than the price of the 'Common' products. The average price is close to a 49-fold difference.
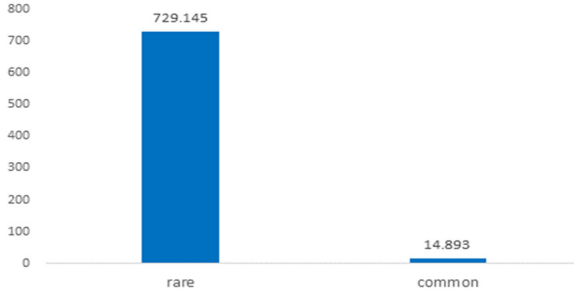


**Fig. 3.** Comparison of average price of products by product series category.

The study further divided the variable combinations into three groups, which are Key NFT Market Indicators, Draft and Player Data and Categorical Variables (Set and Highlight). The correlation coefficients of the main indicators are shown next to confirm that no duplicated or similar variables are selected, followed by an interpretation of the results of the analysis (see Figure 4). Due to the fact that the 'total owner', 'Unique_owner', and 'total circulation_number' correlation coefficients are too high, one of them was chosen to be retained as a variable to continue to be brought into the regression before regression.

Figure 1 is a heat map of correlation coefficients between the nine leading NFT market indicators representing the primary metrics of this study.
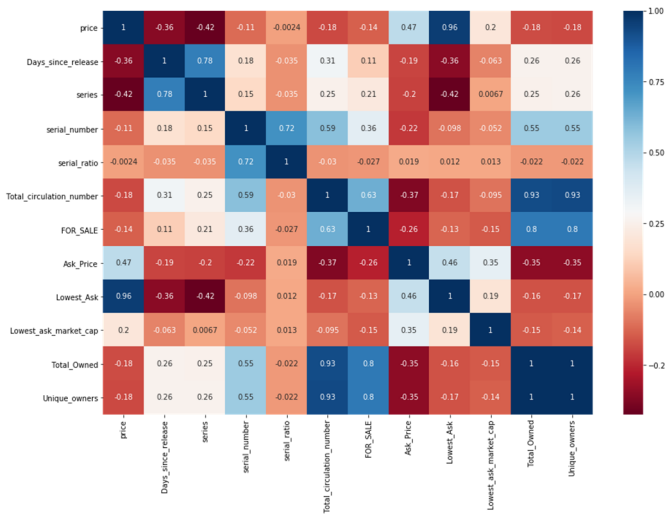


**Fig. 4.** Correlation between key NFT market indicators.

# 4    REGRESSION ANALYSIS

Regression analysis is a powerful statistical method used to examine the relationship between a dependent variable and one or more independent variables. The primary objective of regression analysis in this study is to identify and quantify the factors that affect the pricing and valuation of NFTs.

**Table 2.** Results of regression analysis.

|  | (1) | (2) | (3) |
|---|---|---|---|
| const | 90.4253*** | 69.6337*** | 1773.3901*** |
| Days_since_release | -0.0256*** | -0.0233*** | -0.0336*** |
| series | -31.0642*** | -33.056*** | -26.8978*** |
| serial_number | 0.0007*** | 0.0007*** | 0.0008*** |
| serial_ratio | -30.544*** | -32.0115*** | -33.4512*** |
| FOR_SALE | 0.0027*** | 0.0033*** | 0.0019*** |
| Ask_Price | 0.0018*** | 0.0016*** | 0.0016*** |
| Lowest_Ask | 0.0086*** | 0.0086*** | 0.0086*** |
| Lowest_ask_market_cap | 0.0682*** | 0.1962*** | 0.1664*** |
| Total_Owned | -0.0007*** | -0.0008*** | -0.0008*** |
| Draft_Year | | | -1.1145*** |
| Draft_Round | | | -1.8423*** |
| Draft_Pick | | | 0.0055 |
| Player_stats_age | | | -1.0861*** |
| Player_stats_weight_numeric | | | 0.0085 |
| Player_stats_height_inches | | | -0.1778*** |
| Season_Average | | | 0.0158 |
| Hours | | | |
| 6:00-12:00 | | 0.4200** | 0.4253** |
| 12:00-18:00 | | 1.3436*** | 1.3267*** |
| 18:00-24:00 | | 1.319*** | 1.3518*** |
| weekday | | | |
| 1 | | 10.6385*** | 73.1066*** |
| 2 | | 9.8978*** | 72.3978*** |
| 3 | | 9.9548*** | 72.5139*** |
| 4 | | 9.8865*** | 72.5011*** |
| 5 | | 9.7879*** | 72.3902*** |
| 6 | | 9.4685*** | 72.0278*** |
| No. Observations | 447591 | 447591 | 447591 |
| R_square | 0.562 | 0.690 | 0.732 |

*Note: The data in the table are the regression coefficients of each variable, \*\*\*, \*\*, \* indicate that they are significant at 1%, 5%, 10% level of significance, respectively.*

The model's goodness-of-fit was evaluated using the R-squared statistic. The F-statistic was significant, suggesting that the model was a good fit for the data. As shown in Table 2, The regression analysis results from the NFT market data reveal several

insights into the factors influencing NFT prices. A negative coefficient for 'Days_since_release' suggests that the value of NFTs depreciates over time, while the positive coefficient for 'Ask_Price' indicates a direct relationship between asking prices and final sale prices. The negative coefficient for 'Total_owned' could imply that scarcity drives value, aligning with basic economic principles of supply and demand. A surprisingly negative coefficient for 'Total_owned' may suggest that NFTs held by fewer unique owners are valued more, potentially due to perceived exclusivity.

The results for draft and player data provide insights into the variables that impact the valuation of players in terms of their marketability or potential career success. The negative coefficient for 'Draft_Year' suggests that more recent players are valued less, potentially due to a lack of established performance history. 'Player_stats_age' also has a negative coefficient, indicating that younger players may be valued more highly, perhaps due to their longer potential career span and room for development.

The analysis of categorical variables shows a clear distinction in the NFT valuation based on specific characteristics. Sets like 'Metallic Gold LE' and 'Rookie Debut' have significantly high positive coefficients, indicating that these particular sets are highly valued in the market.

The findings from the regression analyses offer a multifaceted view of the NFT market. They underscore the importance of rarity, perceived value, and the collective narrative that the market assigns to particular NFTs. In addition to these market-based factors, player-related data is also crucial, including their draft history and physical attributes like age, weight, and height. The results indicate that the NFT market is not only swayed by traditional supply and demand factors but also by the unique characteristics of blockchain-based assets and the stories behind them. The negative coefficient for 'Total_owned' may indicate that NFTs that change hands less frequently are more valued, perhaps due to a stronger narrative or attachment that comes from longer ownership. The regression analysis provides valuable insights into the factors that influence the pricing of NFTs and player valuations. It highlights the complex interplay between various elements such as scarcity, ownership distribution, and player characteristics. While certain trends are observed, the market for NFTs remains highly speculative and influenced by a multitude of factors beyond the scope of traditional economic analysis.

# 5    FEATURE IMPORTANCE ANALYSIS

To identify the key factors affecting the transaction price settled, this paper adopts feature selection method. Decision tree is a basic classification and regression method, and the regression part is described in this paper. The regression decision tree mainly refers to the classification and regression tree (CART) algorithm, and the internal node features take the values of "yes" and "no", which is a binary tree structure (see Figure 5). The regression tree is to divide the feature space into several units, and each partition unit has a specific output. Because each node is a "yes" and "no" decision, the boundaries are parallel to the axis. For the test data, we only need to classify it to a certain unit according to the characteristics, and then we can get the corresponding output value.
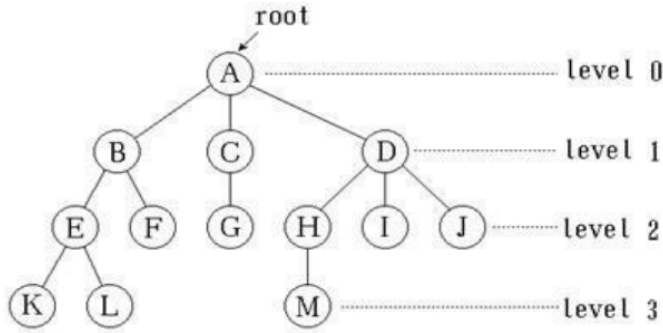
**Fig. 5.** The steps of the Decision Tree regression algorithm.

Table 3 presents the search parameters and simulation results for DT model, which is the best parameter would be set to make the settled price prediction. The summary of results is shown in the Table 4, and the R-square of the test set ups to 87%, and it can also be seen that we can build a prediction model with good interpretation of the test set. The feature selection method based on the Decision Tree model ranks variables in order of importance, as shown in Table 5.

**Table 3.** Tuned hyperparameters of the Decision Tree model.

| Parameters | Meaning | Raw_features |
|---|---|---|
| max_depth | The maximum depth of the tree. | 10 |
| min_samples_split | The minimum number of samples to split an internal node. | 2 |
| min_samples_leaf | The minimum number of samples at a leaf node. | 1 |
| max_features | The number of optional features per node | None |

**Table 4.** Summary of results.

|  | RMSE | MAE | R-square |
|---|---|---|---|
| Train set | 33.43 | 5.96 | 97% |
| Test set | 58.00 | 6.88 | 87% |

From Table 5, it is apparent that the "*ask price*" is the most crucial variable, exerting the greatest impact on the model's accuracy with a contribution rate of 45.6%. This indicates that the final transaction price is significantly influenced by the seller's asking price, suggesting that the NFT product trading market is largely a seller's market. In this market, products within the same series (whether 'common' or 'rare') exhibit considerable price disparities, yet the final transaction prices are generally very close to the seller's asking price. It is noteworthy that there have been numerous instances where the final transaction price of products from the same series and type varied by nearly 200 times solely due to different asking prices set by sellers. Following "*ask price*", the "*Number of listings*" and "*Player_stats_age*" are the next most significant variables. According to the regression results, a higher number of listings correlates with higher prices, whereas older player ages correlate with lower prices. Clearly, unlike classic

collectibles, younger counterparts are more favored in the market. Features such as "*Total_Owned*" and "*Lowest_ask_market_cap*" are less critical but still contribute to predictions.

**Table 5.** Ranking of feature importance.

| Variant | Importance score | Importance ranking |
|---|---|---|
| Ask_Price | 0.45692 | 1 |
| FOR_SALE | 0.223858 | 2 |
| Player_stats_age | 0.083164 | 3 |
| Total_Owned | 0.07482 | 4 |
| Lowest_ask_market_cap | 0.052849 | 5 |
| Days_since_release | 0.046889 | 6 |
| serial_ratio | 0.017953 | 7 |
| serial_number | 0.012056 | 8 |
| Highlight | 0.010106 | 9 |
| weekday | 0.006394 | 10 |

This market dynamic presents speculative opportunities for investors, contingent upon their ability to foresee or influence shifts in market preferences towards specific NFTs. Successfully navigating this landscape to buy at lower prices and sell at higher valuations could yield considerable gains. Nonetheless, this approach is fraught with elevated trading risks, attributed to the market's volatility and propensity for irrational behavior, which may precipitate abrupt price swings and escalate the potential for financial losses.

From the perspective of purchasers, the allure of an NFT transcends mere financial gain. A significant segment of collectors and aficionados are motivated by a profound appreciation for certain artworks, cultural emblems, or communities, alongside a quest for unique experiences and avenues for personal articulation. This emotional investment and the quest for personal fulfillment underscore the distinctive charm of the NFT marketplace, serving as a pivotal catalyst for its sustained expansion.

# 6      CONCLUSION

This article endeavors to ascertain the determinants that significantly influence product pricing within the NFT market. Through an exhaustive regression analysis of NFT trading data, it elucidates several intriguing and insightful conclusions. Primarily, it delineates how demand growth exerts a direct and substantial impact on NFT prices, highlighting that an upsurge in searches and transactions for an NFT markedly escalates its price. This phenomenon suggests that the valuation of a particular NFT series appreciates in tandem with increased market engagement and collective holdings, indicative of a vibrant market characterized by widespread participation and robust liquidity. It underscores a direct correlation between market interest and participation in NFTs and their pricing, corroborating the demand law in conventional economics. Notably, NFTs

possessing unique cultural or artistic significance witness a pronounced price augmentation in response to heightened demand, accentuating the pivotal role of market sentiment in NFT valuation.

Furthermore, the study notes that a high concentration of NFT ownership might detrimentally affect prices. It observes a diminution in the average price of NFTs as the portfolio of works by a singular artist expands, potentially due to the amplified risk of market manipulation and diminished asset liquidity adversely influencing prices.

Moreover, the scarcity of an NFT significantly predicates its pricing. NFTs with limited circulation or distinctive attributes are typically valued higher, reflecting the market's predilection for rare and exceptional items, and translating this preference into a higher willingness to pay.

Additionally, within the unique context of the NBA's NFT market, which assesses asset value based on player performance, highlight moments, and a player's season-long performance significantly propel price appreciation. Investors show a propensity to procure NFTs of players who resonate with them, primarily those showcasing commendable performances, albeit individual performances may introduce some price volatility.

Finally, our research reveals that the current NFT market is significantly biased towards a seller's market, as evidenced by the lack of comprehensive and regulated pricing standards in the market. In such a market environment, personal preferences and subjective pricing have become important factors in determining the transaction price of NFT. Consequently, the evolution of the NFT market necessitates the exploration of novel avenues to preserve equilibrium between creators and collectors. This entails, on one hand, the imperative for more transparent and equitable trading mechanisms aimed at mitigating the risks associated with speculative activities and market manipulation. On the other hand, the sustenance of the NFT market's diversity and innovation, coupled with a respect for individual preferences and the liberty of expression, constitutes a cornerstone for fostering its robust development. By adhering to these principles, the NFT market can authentically emerge as a pioneering domain for artistic and cultural expression, concurrently delivering value and gratification to its stakeholders.

In summary, the findings from this analysis accentuate that supply and demand are paramount in influencing product pricing in the NFT market. Despite the unique attributes and dynamics of the NFT market, particularly the NBA's NFT segment, and the inevitable price fluctuations due to individual player performances, the market still adheres to fundamental economic principles. This study furnishes quantitative insights into NFT market dynamics and supports market participants in formulating pricing strategies. Future research could delve into additional factors contributing to NFT price volatility, including macroeconomic conditions, technological advancements, regulatory changes, and market sentiment, to attain a more holistic understanding of the market dynamics.

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