Exploring the Price Influences of PFP Artworks in NFT Based on Regression Analysis

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Abstract

Based on the unprecedented boom in the NFT market in the last two years, more and more researchers paid attention to the factors of price influence. However, few papers studied the PFP (Profile Picture). This paper will study the price influencing factors for PFP, a representative product in the NFT market. This paper summarizes the characteristics that may affect the price of PFP products in a more comprehensive manner, in analogy to the price influencing factors of traditional paintings, and uses regression analysis to analyze these characteristics. The results found that the characteristics that have a greater impact on the price of traditional paintings do not apply to PFP products and that different characteristics have different impacts on high-priced PFP products and low-priced PFP products.

Keywords- *PFP, price influencing factors, regression analysis*

1. Introduction

With the rapid development of the Internet and the rise of blockchain technology, NFT products have reached the peak of development in the past two years. The global NFT market cap has remained low until 2021, with a global NFT market cap of USD 317 million at the end of 2020. As of the first half of 2021, the global NFT market capitalization reached $12.725 billion. NFT refers to the non-homogeneous digital assets based on blockchain technology, which are inseparable, irreplaceable, uninterchangeable, unique, verifiable, and tradable [6]. In recent years, as the world's largest Internet power, China has begun to invest in the NFT in its domestic Internet field (Tencent, Alibaba, etc.) According to statistics on the nftgo.io website, under the market value of $12.725 billion NFT market, collection (Art, PFP, and Collectibles) accounts for more than half of the total NFT [9]. Among them, the popular series of collectibles continue to break the news of sky-high sales.

As a branch of NFT, PFP NFTs are digital artworks on the blockchain, which are at the intersection of collectibles and generative art and are used as social media profile images, serving as an important part of the Meta universe. PFPs are collectible since they are usually large numbers (around 10,000) and have varying rarity degrees, similar to trading cards. At the same time, the PFPs are also generative. They are created by a simple plug-and-play method through which the user loads various features such as body size, head shape, and background color into an application and then randomly combines them into a large number of NFTs.

Starting from 2020, from Elon Musk to Yao Ming, from Coca-Cola to Disney and Marvel, to LV, GUCCI, eBay, and Facebook, both celebrities and famous brands have started to engage in NFT. As NFT steps into the public eye, NFT brings a series of issues, such as price spikes and volatility, collision with traditional FT, and impact on the FT market.

NFT products can be divided into various segments such as collectibles, PFP, games, and other aspects. Among these, PFP NFT products are usually a series of images that can be used as profiles on social media, and this category is said to be representative of NFT products in terms of sales, the number of products, and popularity [1]. However, although a PFP product is a digital artwork, it is still essentially a painting, and therefore its price influencing factors must be similar to those of a traditional painting. As a result, many scholars have

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combined PFP studies with traditional painting studies to find the factors influencing the price of PFP.

Some scholars applied the Hedonic model and regression analysis to analyze traditional artworks and CryptoPunk (one of the pioneers for the improvement of NFTs) respectively. Zhigang Lu turned up that the style of the painting and the painter's background all had an impact on the price of the artwork [12]. One of the conclusions of the research is the exchange rates that have a major impact on prices in the painting market are discovered by Xin Xie [11]. Shuangnan noticed that the price of artworks can be affected by auction houses and trade strategies [7]. Meanwhile, Ning Xiang (2015) and Xuan Zhufei (2020) optimized the research model in the course of their study. Ning Xiang's study found that the double-log mixed model was the optimal parametric model for the study of painting artwork price models [4]. Xuanzhu Fei found that the correlation between painting size and transaction time and price was high; the correlation between painting creation time and price was low [10].

In addition, many scholars have investigated some features unique to NFT products based on their characteristics. Kong mentioned that the pricing of NFTs largely depends on the scarcity of tokens [2]. Rachel A.J. Pownall (2016) investigated the effect of color on the price of NFT painted products by quantifying color as Intensity Lightness, L* a * b color space. Empirical results find significant evidence of darker colors carrying a significant and robust premium than equivalent artworks which are less intense in color, which is shown in Fig. 1. [5]. Meanwhile, the relationship between the price and rarity of different PFP series has been studied separately, and it was found that the price of only one series was correlated with rarity, while the price of the rest of the series was not significantly affected by rarity, which is shown in Fig. 2.

Variables	(1) ln price	(2) ln price	(3) ln price	(4) ln price
Red	−0.00291*			−0.00142
	(0.00148)			(0.00235)
Green		−0.00354**		−0.000378
		(0.00164)		(0.00382)
Blue			−0.00364**	−0.00229
			(0.00176)	(0.00322)
Log edition	−0.0909*	−0.0971*	−0.0947*	−0.0964*
	(0.0519)	(0.0520)	(0.0514)	(0.0523)
Log size	0.552***	0.558***	0.588***	0.556***
	(0.184)	(0.174)	(0.167)	(0.173)
Log age	1.274***	1.303***	1.300***	1.306***
	(0.419)	(0.414)	(0.412)	(0.417)
London	0.335	0.379*	0.348	0.348
	(0.216)	(0.215)	(0.215)	(0.219)
New York	0.0900	0.109	0.118	0.108
	(0.217)	(0.219)	(0.218)	(0.217)
Christie's	0.120	0.107	0.116	0.121
	(0.179)	(0.182)	(0.181)	(0.182)
Sotheby's	0.171	0.145	0.185	0.177
	(0.187)	(0.186)	(0.185)	(0.194)
Constant	1.407	1.307	1.020	1.365
	(2.453)	(2.384)	(2.354)	(2.369)
Observations	178	178	178	178
R-squared	0.218	0.221	0.221	0.225

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Figure 1. Log art prices and RGB pixels

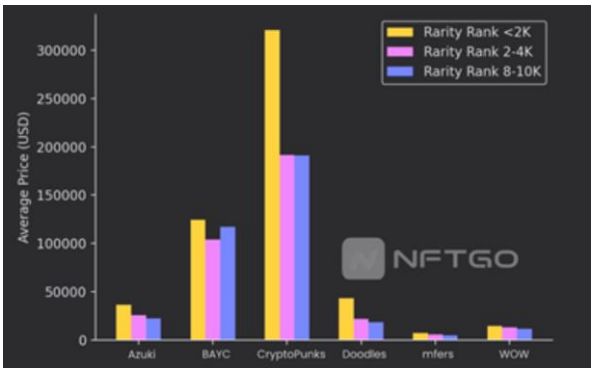

Figure 2. The average sale price of NFTs (In USD) based on rarity rank (from NFTGO)

It can be found that a large number of scholars have analyzed the price influencing factors of traditional artworks based on hedonic models, but the articles on NFT products do not comprehensively consider the influence of all characteristic factors (such as color, size, etc.) on price. Therefore, this study will collate the factors influencing the price of traditional paintings and use regression analysis to explore the relationship between the characteristics of PFP products and their prices, taking into account the characteristics of PFP products and putting forward targeted suggestions to make prospects for the NFT product market.

The Method section of this paper will present detailed data on the characteristics of PFP products and quantitative explanations of the relevant factors and will use regression analysis to analyze the factors influencing the price of PFP products. In the Results section, the results of this study will be described in detail, and recommendations for the PFP product market will be presented. A possible innovation of this paper is to analyze the factors influencing the price of PFP products as comprehensively as possible, based on the actual consumption of PFP products.

2. Methods

2.1. Data

Our dataset consists of two parts. One part is the data about the NFT Collections, and the other part is the data about the characteristics of the collections.

NFT Top Collection data is secondary data about NFT Top Collection prices, their series, IDs, and transaction records originated from https://nftgo.io until April 20, 2022. We choose this website to get the data because it is the most authoritative and largest real-time updated website and has very detailed raw data; The individual characteristics data are based on the characteristics of the NFT collection itself. We study them and classify them into different categories according to their characteristics, and then we datamined

these characteristics to finally obtain the individual characteristics data. The data descriptive statistics are shown in Tab. 1.

TABLE 1. THE DATA DESCRIPTION STATISTICS

	The data description statistics		
	Overall	***High price category***	***Low price category***
Number	149	85	64
Minimum	.0010	42.096	.0010
Maximum	12446000.0000	12446000.0000	35.0000
Mean	83902.586205	147072.01829	5.684213
Std Dev	1019585.7400922	1349887.534178	8.7024971

a. Sample of a Table footnote. (Table footnote)

2.2. Establishing characteristics

Based on relevant research literature and previous research results, we summarized 12 characteristics related to the prices of collections in our research hypothesis. Then, we selected and characterized a total of 149 of the most expensive PFP collections and some low-priced PFP collections from the top collections for characteristic statistical analysis. The specific structure of the characteristics is shown in Tab. 2.

TABLE 2. STRUCTURE OF THE CHARACTERISTICS

Projects	**Structure of the characteristics**		
	Individual characteristic	***Explanatory variables description***	***Indicator Description***
Collections characteristics	Main color	Dark=1, Light=0	The main color describes the color shade of the main content
	Background color	Dark=1, Light=0	Background color describes the color shade of the PFP background
	Color Match	Similar color matching = 1, contrasting color matching = 0	Color Match describes the difference or similarity between the color of the PFP background and the main body.
	Main characteristics	People = 1, Animal = 2, Object=3	The main characteristics describe whether the form of the main body is human, animal, or an object
	Pattern style	2D=1 3D=0	Pattern style describes whether the PFP work is a graphic work or a 3-dimensional work
	Special Functions	Yes=1, No=0	Special Functions describes whether the PFP work only provides an appreciation function
	Rarity	Rarity Score	Rarity describes the extent to which the PFP work has the same parts in the series
Series Impact	Series Market Cap ($) (Million)	numerical value	Series Market Cap ($) (Million) describes the cap of the series in which the PFP work is located
	Series average price ($) (Million)	numerical value	Series average price ($) (Million)describes the average price of all works in the series in which the PFP work is located.
	Items Number	numerical value	Items Number describes the number of works owned in the series
	Series Owner number	numerical value	Series Owner number describes the number of works in the series that have been purchased
	Series Total NFT sales ($) (Million)	numerical value	Series Total NFT sales ($) (Million)Describes the total sales of the series

We divided the characteristics into two main categories: work itself and series factors.

According to the research of Rachel, the collection price influence factors are attributed to three factors: the work itself and artists [13]; We know that the price of traditional artworks is influenced by the fame of the writer [3], while NFT works are different from traditional artworks. NFT is a new form of artwork, the blockchain characteristics make the writer private and their data hid [8], its popularity is more reflected in the series popularity, so we changed the writer factor to the series factor.

In individual characteristics, through "Pricing color intensity and lightness in contemporary art auctions" [5],

dark colors have a significant and strong price premium, so we choose color visual influences. In addition to color, Main characteristics and Pattern style are also visual influencing factors. Furthermore, Series Impact is intuitively influential on price.

Among the many cryptocurrencies, eth and NFT products have a direct connection because the vast majority of NFT products are published and paid through a protocol registered in eth, so this makes eth the largest blockchain in NFT trading. Opensea acts as the largest trading marketplace and almost all PFP product trading is done on the Opensea platform. As we know from the above, the trading environment of PFP artworks is almost the same or the differences are very slight, which is different from traditional artworks.

2.3. Methods

Multiple linear regression belongs to the category of statistics and is often applied to the analysis of factors influencing the price of artworks. The price of an artwork is often influenced by several factors, such as the reputation of the artist, the style of the work, its size, and so on. Multiple linear regression is used to explore the linear relationship between the dependent variable (Y) and multiple independent variables, and therefore the results are more realistic and accurate when applied to PFP products, which are essentially works of art, so we use multiple linear regression to explore which characteristics of a collection are related to its price. We define the dependent variable Y as the price of the NFT artwork and the independent variable as the characteristics of the NFT. Also, due to a large number of Y's, there is a large quantitative difference between the independent variable and the other dependent variables, so logy is used as the dependent variable for the study.

3. RESULT

Based on STATA multiple regression analysis, we conducted an overall analysis of the entire randomly selected PFP works and obtained the following Tab. 3.

TABLE 3. REGRESSION ANALYSIS RESULTS

Projects	Categories
	Overall
Product Series Market Value	-.041 (.072)
Series sales in the last month	.011 (.028)
Number of series publications	0* (0)
Series Owner number	.001** (0)
Series Total NFT sales ($) (Million)	.028 (.045)
The average price of series（30）	-.039 (.051)
Main color	.068 (.326)
Background color	.293 (.364)
Pattern style	.662 (.749)
Main characteristics	-.214 (.639)
Color Match	.128 (.338)
The algorithm randomly generated regions	.205* (.12)
Special Functions	-1.789** (.778)
Rarity	-.62*** (.148)
_cons	.026 (1.949)
Observations	149
R-squared	.695

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

From the results in Table 3, the R-squared is larger than 0.4 in all cases, which confirms the establishment of a multivariate linear relationship. The R-squared of the Overall section is 0.695, which indicates that the model fits well. The R-squared of the High price category and Low-price category is larger than 0.4, which indicates that the fit is not good enough but still can explain the model. The values in brackets in the table represent standard errors, and the values above the brackets represent the fitting coefficients.

In the Overall section, based on the fitted coefficients, we know that rarity is closely related to the price of collectibles and shows a negative correlation. However, as this study uses smaller values to represent higher values of a rarity in the statistics, the rarity values show a positive correlation with the prices of collectibles, meaning that a higher rarity has a higher probability of causing a premium for PFP products. Also, Series Owner number and Special Functions have an impact on the price of PFP, with Special Functions showing a negative correlation with a coefficient of -1.789, while Series Owner number shows a positive correlation with the price of PFP products. The algorithm generated regions and Number of series publications are related to the price of the collection, but with a smaller coefficient of influence; this suggests that series features are a factor in the value of the product, just not a significant one. (The coefficient for the Number of series publications is zero, as it is too small to be negligible)

We also divided the PFP works into high price categories, low price categories, and overall and we get the following Tab. 4.

TABLE 4. REGRESSION ANALYSIS RESULTS

Projects	Categories	
	High price category	*Low price category*
Product Series Market Value	-.139 (.104)	-.028 (.091)
Series sales in the last month	-.074 (.045)	.01 (.018)
Number of series publications	0 (0)	0 (0)
Series Owner number	0 (0)	0 (0)
Series Total NFT sales ($) (Million)	.07 (.053)	.019 (.057)
The average price of series（30）	.23 (.181)	-.032 (.06)
Main color	.523 (.497)	-.046 (.242)
Background color	-.248 (.622)	.56** (.254)
Pattern style	-.156 (.889)	.654** (.266)
Main characteristics	.438 (.858)	
Color Match	.302 (.441)	-.233 (.386)
The algorithm randomly generated regions	.345* (.174)	.08 (.122)
Special Functions	-1.119 (.96)	
Rarity	-.891*** (.305)	-.449*** (.147)
_cons	-2.409 (3.044)	4.412*** (1.162)
Observations	70	79
R-squared	.47	.412

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

It is worth mentioning that in the high price category, a rarity still has a significant effect on the price of PFP products and is positively correlated. However, other influences that have an impact on price in the overall category are not significant in the high price category, e.g., special features, and several series owners. Other influencing factors in the high price category products, only Algorithm randomly generated regions have a positive correlation with the price of the collection of PFP.

In the Low-price category, rarity is still strongly correlated with the price of the collection. In addition, Background color and Pattern style had a significant effect on the price of PFP products in the low-price category, where dark background color and 2D pattern style are more likely to result in a premium for PFP products. The results of the study show that rarity has a significant impact on the price of PFP products, both in the overall section and in the classification into high and low-price categories, and both show a positive correlation as an important factor influencing the price of the product.

4. CONCLUSION

With the rapid development of the new Internet and the germination of blockchain technology, NFT products have reached a peak in recent years. In particular, the prices of certain NFT products such as PFPs rise so fast and some of them even ask for sky-high prices. In this study, the aim is to assess the factors affecting the price of PFPs. To conclude, regression analysis is conducted for the 150 data samples which are all selected from the largest trading platform in the world-Open Sea. These samples were divided into two categories according to the price: High prices and low prices and then the overall category was added to analyze the factors of PFPs prices separately.

First, we can conclude that the price influencing factors of PFP artworks are different from those of traditional paintings. In traditional artwork, the artist, the quality of the work, and the contextual factors combine to determine the price of the artwork. Through regression analysis, we can learn that PFP artworks are different from traditional artworks. The visual effect of dark colors in traditional artworks makes traditional artworks more expensive, but this feature is not present in high-priced PFP artworks and is reflected in low-priced PFP prices, indicating that the visual influence factor is no longer the main factor affecting the price of PFP.PFP is different from traditional artworks that rely on the fame of the artist to add value to the work, the value of PFP works is not affected by the series from regression analysis, subjectively, PFP works mainly rely on the series fame to enhance the popularity of the series and increase the volume of the series, thus making its high rarity more valuable. Traditional artworks rely on historical background or policy environment to add unique value to the work, but PFP artworks rely on trading platforms and blockchain platforms, today ETH is the largest NFT market trading platform for PFP, and Opensea is the largest trading market, and almost all PFP artworks are offered on it, so the platform and blockchain influence factors on the price of PFP need to be further effective analysis.

In PFP's analysis of price influencing factors, rarity is still the main price influencing factor in general, unlike NFTGO's annual data report, which concluded that rarity is not the only factor influencing price, but in general, rarity is still an important factor in measuring the price of a single item. Second, the number of series ownership represents the number of purchases of this series, which means that the hotter the series is, the more purchases there will be, and the more purchases will prompt the author to release more series. the influence of Series Owner number over the Number of series publications also proves this point, showing that both together influence the price of PFP works. The two influences may arise because the PFP market is now questioned by the bubble economy, so when investors enter the PFP

investment market, they choose the largest and most popular products to reduce their investment risk.

Meanwhile, a series of important indicators identified based on experience such as Main characteristics and Special Functions only have very limited influence on the model. This is because the influence of the model cannot be fully determined empirically and requires further effective analysis. Many low-priced PFP products do not have Special Functions. Based on the market situation, we know that some mid-range PFP series are making the series popular with some interesting special functions to expand the fame to reach the price influencing factor, which also needs further effective analysis. In Algorithm randomly generated regions, we can speculate that the increase in the number of algorithm regions makes the pieces have more changeable parts. Each part is involved in the calculation of rarity, so the more the number of Algorithm regions in a series, the more significant the difference in the rarity of individual pieces, and the price changes as a result. This is why the higher-priced categories have a relationship with Algorithm randomly generated regions while the lower-priced ones do not. More interestingly, the low-priced PFPs are more similar to traditional artworks in terms of visual influences, while the high-priced PFPs are related to rarity.

The factors affecting the price of PFP products are very complex and from the above conclusions, it can be concluded that rarity is important but by no means the only factor affecting price. In the current market environment, the price of PFP products is still very closely related to the range in which they are available, with prices often varying precipitously from range to range. While the prices of PFP products with high rarity are relatively high, there can be huge price differences between PFP products in different series, even if the rarity is similar. What determines the price difference between the different series is precisely the heat of the IP in the different series.

There is no denying that PFP-type projects have successfully created encrypted social networks, giving such NFT products a social identity and application scenario. However, as NFT is currently an emerging market, there may be some blind buying by purchasers and some of the prices may not be realistic. Therefore, to analyze the price changes of PFP products over time, it is important to focus not only on the rarity of the PFP product but also on the popularity of the IP of the series in which the PFP product is sold. A good IP is the only way to sustain the fan base and sustain a high valuation over time. At the same time, high rarity can only ensure that some of the products in a series maintain a high price, but not the entire series. Therefore, while it is true that products with high rarity have a relatively high probability of appreciation from a buyer's point of view, the extent to which a series of IPs is developed should also be considered. A series with a relatively complete range of peripherals and a relatively stable fan base, combined with rarity, has a higher potential for premiums for PFP products in that series.

The conclusions are as follows. Firstly, four main indicators proportionally affect the price of a PFP: the number of regions randomly generated by the algorithm, and the rarity of the PFP (legendary, rare, classic, and common). This means that the more regions a piece include, or the higher its rarity, the higher its value. Secondly, the PFP series not only affects the price of PFP items directly but also indirectly through increased IP visibility and increased rarity; thirdly, in the low-price category, where visual effects are similar to traditional artwork, color still has a price impact on low priced PFP items; and fourthly, factors that directly or indirectly affect rarity can increase the price of PFP items.

In a word, the contribution of this paper in the area of the NFT market will effectively help purchasers make better decisions in NFT trading to some extent.

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