Influencing NFT Pricing on Secondary Markets: A case study of Vpunks

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Abstract
Non-fungible tokens (NFTs) allow for users to transfer the digital rights of a good, for example, art, via a blockchain. This enables users to track the art's proof of origin and authenticity. We investigate potential influence auction house features, project roadmaps, and community growth have on NFT sales prices. Using OLS techniques and data from 7,272 secondary sales of the NFT project Vpunks we find auction house features, like being able to sort via price or rarity, decrease the sales price. We also find increased community engagement and the existence of a roadmap to increase sales prices.

Introduction
Non-fungible tokens (NFTs) represent unique digital assets stored on a blockchain. They provide unique, verifiable via a blockchain, proof of origin, and can therefore be used as proof of ownership by whoever holds the NFT (Bsteh and Vermeylen, 2021). One can use NFTs to show personal ownership of artwork, music, videogame assets, etc. (Fairfield, 2021). The first recorded NFT used for digital art can be attributed to Anil Dash and Kevin McCoy at *Seven on Seven* in May of 2014 (Dash, 2021). Since that time the NFT market has grown significantly. The most popular NFT trading platform, OpenSea, was valued at $1.5 billion in summer 2021 (Matney, 2021) and handled over $3.4 billion worth of NFT auctions and trades in August 2021 alone (Yue, 2021).

The immutable and permanent proof of origin nature of NFTs help digital artists solve a prevalent issue that has been a problem in the digital art world; who owns the original art? NFTs allow both artists and collectors the ability to digitally prove ownership, the transfer of the asset, and its potential trade history through meta data stored on a blockchain. Furthermore, artists are able to sell directly to people through platforms like OpenSea, Rarible, or create their own sales website, potentially increasing the number of prospective buyers (Paul, 2021).

One such project that created their own website to mint, sell, and hold auctions for their NFTs was Vpunks. The Vpunks project is a collection of 10,000 unique, 24x24 pixel algorithmically generated images, similar to the CryptoPunks created by Larva Labs in 2017 (@Vpunksofficial, 2021a). Vpunks' NFTs are stored on the VeChainThor blockchain. The initial minting stage began on July 25, 2021, and required the VeChainThor token, VET. The price to mint a Vpunk increased with every 1,000 Vpunks minted, starting at 390 VET for Vpunks numbered 0-999 and ending at 3,900 VET for Vpunks 9,000-9,999. The 10,000th , and final, Vpunk was minted on August 5, 2021 (@Vpunksofficial, 2021b). The Vpunk community launched a Telegram chatroom on July 30, 2021. The chatroom has been used by the community to make announcements and as a place for potential buyers/sellers to discuss the project. As of September 6, 2021 the Telegram group had grown to 1,616 members.

When the 10,000th Vpunk was minted, the project's secondary market platform allowing for direct sales and auctions between Vpunk holders was limited in its useability. There was no way for users to sort the active sales or auctions, nor was there a fully published roadmap for how the project was to evolve. However, over time Vpunks has integrated new sorting features

into their secondary markets platform. Prospective buyers can now sort active auctions and sales by price, rarity, and other attributes. Vpunks have also published a roadmap to provide collectors with more information regarding the future of the project.

Vpunks' evolving marketplace allows for a unique perspective into how prices on secondary NFT markets are impacted by evolving market environments. There does not exist any research into the ability to sort NFT sales and auctions impacts the sales price. This research is designed to investigate the possibility that the sales price of NFTs change when users can sort by price and/or characteristics, the size of a project's community, and the potential impact of a published roadmap. These are key considerations for future NFT projects.

Given the more recent development of NFT marketplaces there have been only a few studies analyzing the price of NFTs. Dowling (2021a) analyzed the price efficiencies/inefficiencies of LAND, an NFT representing digital land necessary to join the virtual world Decentraland (Ordano et al., 2017). His findings indicate the pricing of LAND is inefficient but increases rapidly. He questions, however, the generality of their findings for other NFTs, such as CryptoPunks, as LAND is similar to physical land found in traditional markets and thus may have an intrinsic value different than that of more novel NFTs, like Vpunks.

Other research has looked into if the price of NFTs are impacted by cryptocurrency pricing. Dowling (2021b) analyzes the potential relationship the cryptocurrencies Bitcoin and Ether have on the NFT market places of LAND, CryptoPunks, and Axie Infinity through volatility shocks and volatility transmission. The findings indicate two significant findings. First, NFT pricing is distinct from cryptocurrency pricing in terms of volatility transmission. And second, there is little volatility spillover between NFT marketplaces. Further research has identified a potential positive relationship between Bitcoin price shocks and the number of NFT sales, as well as Ether price shocks potentially reducing the number of active NFT wallets (Ante, 2021).

Our research into NFT pricing is distinctly different than that of previously published works. We look to answer three main questions:

1. Does the ability to sort active sales/auctions by price and/or attributes impact the NFT's final sale price?
2. Does the existence of a roadmap impact the sales price(s) of NFTs?
3. Does the size of a community impact NFT sales prices?

We hypothesize that both the ability to sort active sales/auctions, and the existence of a roadmap, have positive impacts on the sales price of an NFT. The reason being is people will be able to identify the NFTs they wish to purchase more easily through auction sorting features, and people may be more inclined to participate in NFT projects that have robust roadmaps which may indicate the developers are dedicated to seeing the success of the project. Both may increase the demand for the NFT, thus increasing the final sales price. We also hypothesize the larger the community the higher the sales price as the more people interested in a project the more demand may increase, increasing the secondary market sales price.

Data and Methodology

Our dataset comprises 7,272 observations (July 29, 2021 to September 6, 2021) of Vpunk secondary sales. Since minting prices were fixed we do not take into account minting sales. Our dataset contains information on the following: sales price in VET, the log sales price, the date and time of sale, the rarity score of each Vpunk sold, number of Vpunk Telegram members at the time of sale, the number of attributes of each Vpunk, the humanoid form (male, female, zombie,

ape, or alien) of each Vpunk, when such auction house features like sorting by price and/or rarity were implemented, and when the Vpunk project roadmap was published. Using publicly available information contained on the VeChainThor Blockchain we were able to obtain the sales price, date and time of sale, and attribute characteristics. We used the Vpunks official Twitter account to identify when the sorting features were implemented in the auction house and when the roadmap was published. No personal, nor identifiable, information was mined nor used for this study. Table 1 below contains summary statistics of our dataset.

To investigate the potential relationships between sorting features, roadmaps, and community size on NFT sales prices we use OLS regressions. However, given the nature of the project and the rising sales price floor of Vpunks, we use the log value of the final sales price (in VET). By doing this we can determine via percentages how our independent variables may impact the sales price of an NFT. We use two base models, one using *rarity score* and the other using both *number of attributes* and *humanoid forms*, to account for the potential impact the individual attributes each Vpunk has on its sales price. These must be separated as the *rarity score* is highly correlated with both the *number of attributes* and *humanoid forms*. Both base models also include the variable *number of Telegram users* which measures the number of members in the Vpunk official Telegram chatroom at the time of sale. Using the two base models three variants of each are run, for a total of six models, to identify the potential relationship auction house sorting tools and the publication of a project roadmap has on the final sales price.

$$\log(Sales\ Price - VET)_i = \begin{bmatrix} sortable\ by\ price_1 \\ sort\ by\ rarity_3 \\ published\ roadmap_5 \end{bmatrix} + rarity\ score_i + number\ of\ Telegram\ users_i \quad (1), (3), \& (5)$$

$$\log(Sales\ Price - VET)_i = \begin{matrix} sortable\ by\ price_2 \\ sort\ by\ rarity_4 \\ published\ roadmap_6 \end{matrix} + number\ of\ attributes_i + humanoid\ form \begin{bmatrix} male \\ female \\ zombie \\ ape \end{bmatrix}_i + number\ of\ Telegram\ users_i \quad (2), (4), (6)$$

For all six models we use ordinary least squares (OLS) because the dependent variable is a continuous variable in log form. The independent variables *rarity score, number of Telegram users,* and *number of attributes* are continuous variables as well. *Humanoid Form* is a vector of four binary variables indicating the humanoid type of the Vpunk. Due to scarcity the form "alien" was excluded from the models, so coefficients of this variable should be measured against that of an "alien" Vpunk. Finally, the variables *sortable by price, sortable by rarity,* and *published roadmap* are binary indicating if the auction house sorting option had been implemented at time of sale or if the roadmap had been published at the time of sale.

Table 1: Summary Statistics

Variable	Count	Mean	Std. Dev.	Min	Max
Sales Price - VET	7,272	9328.879	19720.480	56.999	780000
Log sales price	7,272	8.518	1.007	4.043	13.567
Rarity Score	7,272	111.844	86.119	44.5	2309.31
Telegram Members	7,272	895.072	427.168	0	1616
Number of Attributes	7,272	2.715	0.755	1	6
Sort by Price				0	1
Before	2,185	30.04%			
After	5,087	69.95%			
Sort by Rarity				0	1
Before	2,748	37.78%			
After	4,524	62.21%			
Published Roadmap				0	1
Before	4,216	57.97%			
After	3,056	42.02%			
Male	4,410	60.64%		0	1
Female	2,791	38.38%		0	1
Zombie	52	0.71%		0	1
Ape	14	0.19%		0	1
Alien	5	0.06%		0	1

Results

Table 2 reports the findings of equations (1)-(6). All six of the models are statistically significant at a 1% level (Prob > F = 0.000) and are shown to predict at minimum 69% of the variance of the log value of the sales price of Vpunks (lowest $R^2 = 0.697$).

Models (1), (3), and (5) are used to measure the potential impacts a Vpunk's *rarity score*, the *number of Telegram members at time of sale*, the ability to *sort by price* (1), the ability to *sort by rarity* (3), and the existence of a *published roadmap* (5) have on the sales price. In all three of these models the variables *rarity score* and the *number of Telegram members at time of sale* are shown to have a positive impact on the sales price. For each 1 incremental increase in the *rarity score* the sales price increases by 0.5%, and for each new Telegram member the sales price increases by 0.2%. Both variables indicating the ability to sort active sales/auctions in the auction house are shown to have a statistically significant negative impact on sales price. The ability to sort by price lowers the sales price by 46% and the ability to sort by rarity score decreased the sales price by 51%. Finally, the existence of a *published roadmap* is shown to increase the sales price by 33%.

Equations (2), (4), and (6) replace the rarity score with the number of attributes and the type of humanoid form the Vpunk is. The number of telegram members is measured as well, as are the variables *sort by price* (2), the ability to *sort by rarity* (4), and the existence of a *published roadmap* (6). The findings indicate the higher number of attributes a Vpunk has the

higher the sales price. It is also indicated that the most valuable sales are aliens, followed by apes, zombie, females, and males in that order. This is expected due to the rarity of each. The number of Telegram members at time of sale is shown to have a positive impact on the sales price (0.2% increase per member), just like in equations (1), (3), and (5). Finally, the results for equations (2), (4), and (6) are consistent with (1), (3) and (5) regarding the abilities to *sort by price* and *sort by rarity* having negative impacts on sales price while the existence of a *published roadmap* has a positive impact on sales price. All of the tested variables are statistically significant at a 1% level.

Table 2: Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Log sales price		Log sales price		Log sales price	
Sort by Price	-0.618***	-0.582***				
	(0.021)	(0.022)				
Sort by Rarity			-0.732***	-0.710***		
			(0.022)	(0.024)		
Published Roadmap					0.291***	0.290***
					(0.025)	(0.027)
Rarity Score	0.005***		0.005***		0.005***	
	(0.000)		(0.000)		(0.000)	
Telegram Members	0.002***	0.002***	0.002***	0.002***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of Attributes		0.171***		0.172***		0.171***
		(0.009)		(0.009)		(0.009)
Male		-4.554***		-4.493***		-4.452***
		(0.251)		(0.248)		(0.261)
Female		-4.434***		-4.371***		-4.338***
		(0.251)		(0.248)		(0.261)
Zombie		-1.479***		-1.358***		-1.372***
		(0.263)		(0.260)		(0.273)
Ape		-0.991***		-0.852***		-0.913***
		(0.292)		(0.289)		(0.303)
Constant	6.359***	10.906***	6.216***	10.706***	6.529***	10.968***
	(0.016)	(0.252)	(0.017)	(0.249)	(0.021)	(0.261)
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.740	0.690	0.746	0.697	0.712	0.667
Observations	7272	7272	7272	7272	7272	7272

*Statistical significance is indicated by * 10%, ** 5%, and *** 1%*

Conclusion and Discussion

NFTs like Vpunks are a rapidly growing market. They allow for artists to potentially grow their footprint and client base through platforms like OpenSea, or through their own minting, sales, and/or auction websites. Our research investigates potential factors of NFT secondary market pricing.

The results indicate NFTs that are deemed to be rarer, either through certain attributes or a lower supply, tend to sell for higher values on the secondary market. This is to be expected as lower supplies should result in higher prices. More importantly, our research indicates how important community growth and communication is for NFT projects. Higher community growth, through platforms like Telegram, and the existence of a project roadmap are both shown to increase the sales price of NFTs on the secondary market. If artists want to maximize secondary market sales prices, they should consider building a robust social community and publish a project specific roadmap.

Two surprise findings were the ability to sort by price and the abilities to sort by rarity in the Vpunk auction house significantly decreased the sales price. This is contrary to our initial hypotheses. One theory as to why this is the case is the sorting ability made it easier for casual buyers to simply buy the cheapest Vpunks on the market at any time. Previously, buyers would need to comb through multiple pages to find the lowest priced punk, which could take significant amounts of time.

More research should be conducted in this area to investigate economic behaviors of NFT buyers and market participants. Certain types of collectors and market participants may react differently to auction house features, like the ability to sort ongoing auctions/sales, than others. Our research does not look at the behavioral characteristics of NFT market participants. Furthermore, our research is limited to the secondary market of one NFT project, Vpunks, over a span of only 40 days. Using data from more NFT projects and over longer time horizons may reveal more information on how NFT secondary markets are priced.

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