

Wine NFT cryptoassets: EU regulatory issues and market challenges

Ibáñez Jiménez Javier¹

¹Full Professor of Commercial Law, Faculty of Law, Universidad Pontificia Comillas, 28015 Madrid, España

Abstract. The present paper examines the concept, legal nature and key legal issues faced by non-fungible tokens (NFTs) representing wine bottles to be marketed in decentralized secondary platforms qualified as organized marketplaces in accordance with the provisions of the ongoing provisions of the EU Market in Cryptoasset Regulation (hereinafter MiCA). The analysis is extended to essential market challenges posed by the aforementioned rules within the context of the functioning of wine token platforms in DLT (blockchain) public-permissioned networks (PPDLs). Specific MiCA compliance for NFT wine trading and the relationship between the property of the underlying deliverable wine and the credit rights of the token holder are also discussed under the perspective of MiCA stablecoin regulation and particular consumer law rules and principles, in order to efficiently organize markets to protect NFT holders, wine buyers and related rights of producers, distributors and intermediaries along the wine chain of value.

1 Introduction

Distributed-Ledger Technology (DLT), particularly in its blockchain technology variant, is part of the IT revolution for a distributed and decentralized economy that, in the case of wine, enables the opening of new cryptoasset (token) markets with the advantages of full traceability of the wine origin from vineyard to winery and distribution path, and verifiable cryptographic authentication of all related processes and transactions, including indelible records of wine trades in specific exchanges. In the case of NFTs, DLT transactions can incorporate data referring to the original characteristics of unique bottles or lots with full guarantee of legality of trading in secondary wine-market decentralised platforms, whenever proper DLT regulatory principles are set and fulfilled by the contracting parties, including the issuer of tokens and NFT buyers or investors.

Legal certainty and effective and valid exercise of rights of token holders entail, among other prerequisites:

a) Public-law compliant and technologically sound market platforms wherein NFTs can be traded, namely public-permissioned ledgers where market authorities can trace and control the regularity and legality of transactions, Smart-contract execution of token payments, and the regular existence and

delivery of the underlying wine to the ultimate NFT proprietor.

- b) Full compliance of Anti Money Laundering (AML) and related EU provisions, General Data Protection Regulation -within the EU context as well-, and a bunch of other public-law mandatory applicable regimes in accordance with existing rules and regulations in force within European member state jurisdictions, including wine consumer and wine and vine chain value protection rules.
- c) Legally binding trading and registration of wine token issuers in accordance with mandatory sector rules applicable in the home countries wherefrom wine is produced, bottled, labelled and distributed.
- d) Technological suitability and capacity of publicly accessible networks wherein NFT transactions take place within a Public-Permissioned Distributed Ledger, that is to say, a blockchain where previous authority and/or permission must be granted by the blockchain node community to nodes validating and recording the transactions that compose each block and the blocks themselves in order to be incorporated and replicated in the ledger. Such recording and replication implies the collective node acceptance and the adequate performance of automated

computational proofs to form the onchain blocks (like Proof of Authority -PoA-, based on primitive Ethereum Istanbul Byzantine Fault Tolerance -IBFT-consensus protocol) in the pertinent layer within the DLT network architecture.

1.1 PPDL architecture: Relevant issues

The architecture of a PPDL as a public ledger contains a series of layers, encompassing:

- a) the DLT basic HW and SW infrastructure layer that includes the blockchain network protocol service to enable the creation of successive blocks recorded in a distributed ledger,
- b) a specific service layer wherein Smart Contracts (hereinafter SC) are deployed and automatically executed -in the case of wine to register wine NFT delivery and payment transactions-, and
- c) an upper layer on top of the network in which decentralized applications are connected with the rest of the layers by means of application programming (API) automated interfaces.

ITU-T standards [1] mention a series of conditions to be fulfilled by PPDL architecture in order to optimally satisfy the needs of optimal market tokenisation, token issuers and holders of token rights, like indelible time-stamping, node security and operation governance, hash irrevocability, transaction pseudonymity and traceability, personal data privacy and ledger and DApp-layer auditability by public authority, amongst other [2]:350.

1.2 The market platform in the decentralized-application (DApp) layer

Onto the aforementioned DApp layer, market organisers and promoters can set wine market platforms to enable cryptographic blockchain transactions on previously tokenised wine, that is to say, on wine tokens.

Tokens are digital representations of wine, and the previous existence of the wine property (e. g., a grand-vintage bottle in the case of NFT wine tokens) conditions the structure of the token with must be non-fungible although tradable to be sold on a decentralized DLT platform

Ethereum is the blockchain where PPDL networks on which secondary-market or exchange platforms usually run, designing specific DApps for tradable NFT wine tokens. Different transaction protocols may serve to compose token transactions: particularly, the so called Proof of Stake -PoS-, which proves a degree of participation or control in transactions and prevents mining monopoly; and Proof of Authority -PoA-, proving and granting validator-node recognition empowered by the resto of nodes. In Ethereum and alike blockchains, NFTs are usually built upon protocols like Ethereum Request for Comments like ERC721 or ERC1155 commonly utilized for the creation and representation of non-fungible cryptoassets. Under both ERC 721 or ERC 1165 token configurations, wine non-fungible,

irreplaceable, nonexchangeable or unique assets can be represented and traded. This means that the underlying wine (e.g. one or more bottles, boxes, pallets or containers) is attached to a specific token, facilitating the posterior acquisition of wine once the token holder has been identified as its legitimated and exclusive owner or proprietor of the underlying asset, which must be kept and reserved for the prompt and correct allocation of the deposited or reserved wine to the right and only owner of the token. Public registries may help preventing fraud or misconduct of depositories or manipulators of wine bottles or physical assets, ensuring the permanent correspondence between cryptos and represented wine. Specific efficient app programming interfaces (APIs) in accordance with ERC 721 ensure interaction between token and self-executable DLT smart contracts to facilitate token payment, track of precedent transactions and onchain immediate and correct transmission to buyers or purchasers. Wine delivery and payments by smart contracts increases the efficiency in credit collection from clients and in credit payment to wine suppliers, reducing working capital requirements. Where the terms are payable upon receipt, proof of delivery from a carrier automatically triggers digital invoicing and banking or fintech payment [3,10].

1.3 The double market legal compliance: Wine-sector regulation and cryptoasset market regulation

Law compliance is required in order to bring legal certainty to DLT decentralised-finance (DeFi) market agents. If a set of wine NFTs are issued to represent the rights of token owners on underlying wine (either in form of batches or in bulk, or in form bottles), such compliance encompasses both blockchain technology regulatory issues, and legal issues connected with the underlying commodity, wine and wine regulation, since the rights to be exerted by wine token holders must cope with legal requisites of wine as a marketable commodity or merchandise [6].

Wine NFTs represent unique, fine or high quality wine bottles, barrels or other kind of containing recipients, the tokens provide their owner with a prevailing proof of ownership or alternative rights to possess and handle the underlying wine. Tokens are easily transferred in a PPDL, but the underlying physical wine must remain deposited and available whenever the token owner decides to exert the incorporated rights in order to take possession of wine as previously agreed. Therefore, wine NFT issuance calls for trusted third parties to continuously verify the existence, availability, and technical-enological characteristics of the commodity, in accordance with the publicity and transparency documentation served by the issuer or public offeror of the tokens mainly within the context of the terms of a so-called initial public offering -ITO-whitepaper, which contains a promise of the issuer to sell the token incorporating the rights attached thereto.

Since NFTs are not regulated or tracked by central authorities until today [2-4], they pose huge legal

challenges contrarily to fungible tokens regulated by laws like EU MiCA Regulation or MiFID financial market regime. Within the next sections we discuss the optimal characteristics of DeFi markets wherein wine NFTs should be traded in order to comply with legal principles of legal certainty, investor protection, market integrity, operational resilience, intellectual-property and privacy rights protection, among other key legal issues posed by the new phenomenon of NFT tokenisation.

2 Key legal issues on tokenisation: Primary market challenges to protect wine buyers

DLT tokens can validly represent in rem rights in favor of the token holder. In the case of wine tokens, these rights deal with the possession, delivery to the holder and further consumption of the delivered wine. In the particular case of NFT wine tokens, the deliverable object is the specific bottle identified in the blockchain by means of a Digital Identifier (DID), which is globally unique, permanente and does not require a centralized registration authority, since it is generated and/or registered cryptographically, in accordance with W3C DID definition.

NFTs representing specific lots, batches or bottles of wine can be identified by means of a DID (similar to a kind of standardised uniform resource identifier -URI-), in a blockchain or out of a blockchain, but always in a decentralized ecosystem, removing the need for identity providers, certificate authorities or centralized registries. Wine token DIDs are tied to the wine bottle, batch or lot underlying the token, thus enabling the permanent and secured identification and verification of its origin, geographic, enological, vintage, winery, vineyard or other specific relevant attributes and verifiable credentials -cf. <https://www.w3.org/TR/did-core/>.

Whenever wine token issuers enter an organised market to publicly offer wine tokens (by means of a legally binding initial public offering (hereafter ITO) they must systematically ensure investor transparency by means of a prospectus (named “White paper” or whitepaper in DLT market and DeFi jargon) displaying all relevant information in order to ensure that potential token buyers know all essential characteristics of tokens and the issuer’s company and business, which in the case of wine is probably a winery, international wine distributor or exporter, big wine cooperative or relevant wine producer, or persons acting on behalf of the aforesaid actors. Considering this, three main legal challenges must be faced by wine-token market, as shown in the following subsections.

In the EU regulatory context it must be noted that if the cryptoassets are unique (and that is the case of NFTs) and therefore not fungible, concrete provisions related to investor protection will not be applicable when MiCA regime becomes enforceable. In particular, informative prospectus (white-paper) transparency, publication and administrative notification, and other public-law requisites forthcoming by 2024 when new Regulation

applies. Regulatory hardening and administrative control of NFTs will be sought by market competent authorities apart from such forthcoming regime, although NFT exclusion reduces significantly the possibilities of administrative control.

In any ledger, each NFT is owned in digital wallets, under private-law national rules applicable. Wine NFTs may be transferred individually to a singular purchaser, or traded by speculative investors, directly or through DeFi brokers specialized in operating with these wallets.

The referred or underlying wine can be non-fungible, and such non-fungibility justifies the issuance of the NFT. But since the token individuation is independent from the degree of fungibility of the physical underlying wine, each NFT can be issued on groups of fungible wine assets functioning unitarily or characterized by convention with unicity, or on identified parts of such fungible assets, parts, or fractions of them. Thus, a PPDL platform manager or DApp programmer (NFT issuer or not) can involve the trading of rights on any wine assets derived from the NFT, or on the NFT itself, or create guarantee contracts or other kind of guarantees or akin securities also recordable on or off the ledger. Thus, permissioned blockchains can stand trades of unlimited number of NFTs (under ERC721 or ERC1155) and ERC 20 fungible tokens as well. In the case of ERC 1155 NFTs, the broker or investor uses a secure interface and the SC allows to adapt a menu of unique wine, grape or vine parameters and conditions, also allowing to send even over one thousand tokens in a single block transaction, shortening the wait for block closures, thus agilizing safe and disintermediated DeFi “atomized” contracts. Thus, each NFT can represent fungible or non-fungible goods or rights, irrespective of its own full individuation as a stand-alone asset, preventing massive exchangeability and facilitating legal exemptions from issuance and whitepaper primary-market regimes applicable (e. e., EU MiFID, and other DeFi regimes; cf. art. 4 MiCA).

Irrespective of the level of legal control on NFTs, a previous authorisation mechanism for representing the rights of the parties contracting NFTs is to be envisaged in any DeFi Marketplace, under private-law boundaries. Smart contracts (SCs) required to execute NFT investments must also be preauthorised to run on the SC PPDL service layer, before the issuance of NFTs. The subdivision of the represented property is possible only under credit rights regimes in the case of NFT ITOs (see *infra*, 2), and not under the rules for in rem rights (property or possession rights on wine in this case). regimes. Such credit rights can be exercised against the issuer of the tokens, which may (or not) be their offeror. In case of initial token offering (ITO), the credit rights are usually “fungibilized,” which does not imply a conversion of NFTs into fungible assets, but rather a substitution or fractioning of the object of investment to allow massive DeFi trading. In the case of wine tokenization, ERC20 tokens can represent credit rights on wine standard properties or assets, providing an alternative to transfer of full or limited rights on them. The link between a wine NFT and the real wine grants

the holder a legal position similar to the one of an investor in securities or listed merchandises or commodities, as explained hereafter.

2.1 Whitepaper transparency

2.1.1 On tokens

In accordance with EU Market in Cryptoasset (MiCA) Proposal of Regulation (September of 2020, not yet approved as a definitive text), issuers of asset-referenced tokens must produce a crypto-asset (token) white paper and submit it for approval to the competent authority of their home Member State (art. 7). In the case of wine tokens, particularly when tokens represent fungible wine or fungible rights on specific wine (that could have been individually represented by an NFT, but actually is not), the technical and legal investment contract characteristics of the wine as “referred asset” (asset valid to create a public market-price reference) must be clearly explained to wine token investors. Such characteristics encompass those tied to the related PPDL wherein tokens are traded, the kind and protocols of the wine tokens, including the kind of ERC (ERC20 in particular, if Ethereum PPDL is used for fungible token transactions) and their characteristics as cryptoassets (like their degree of fungibility and technical identifiers as digital assets). Besides, all relevant terms and conditions of the wine represented and accessible or redeemable by the token holder should be publicly stated within the whitepaper. Ultimately, the aim of the MiCA regulation with respect to token transparency is to supply all relevant information on the referenced wine and the tokens themselves, in order to help potential wine token purchasers to adopt rational investment decisions. A preliminary summary of the whitepaper (equivalent to financial-instrument prospectus) will serve as a contractual basis for such purpose (cf. art. 17.2 MiCA), irrespective of the need to complete all token characteristics as required in MiCA Annexes.

2.1.2 On the business model of the issuer

The issuer of wine tokens, according with art. 17.1.a MiCA, must communicate detailed description of inner governance arrangements, even those involving third-party entities ex art. 30.5b. If wine was foreseen as reserve asset ex art. 32, the business model of the issuer must include wine custody arrangements and segregation provisions for wine (v. art. 33). If no direct claim or redemption rights were granted to token holders, the whitepaper will clarify the condition on which the underlying wine is available or redeemable in accordance with the issuer’s business model.

2.2 Appropriate publicity

After the authorisation of the issuer by a national financial market authority to offer tokens referred to wine, whose value exceeds 5 M EUR, appropriate publicity conditions under existing DLT market regimes are to be

fulfilled. Such conditions, in the case of EU wine token ITOs ruled by MiCA regulation -cf. art. 24-, include the publication of the token whitepaper and, where existing, the presence of certain legal conditions in marketing communications addressed to potential investors -cf. art. 25 MiCA-, like clarity, identification as commercial publicity, website of the issuer, consistency with the data contained in the whitepaper, and the indication of the public disclosure of such paper; and, if no token redemption rights were granted, a statement indicating such circumstance.

2.3 Efficiency of the initial token offering process, including token distribution

The issuer must apply for authorisation of token trading as part as the initial token offering (ITO) process, ex art. 16 of MiCA Regulation. Such process will be efficient if the application is assessed with positive results by market authorities (cf. arts. 18 and 19 MiCA). The approval of the token whitepaper is an essential prerequisite for the ITO success, as far as its endorsement by public national and EU authorities brings confidence to investors. In an opposite direction, the withdrawal of a previously granted authorisation damages investors’ confidence, either in cases of wind-down plan of the issuer or in those of infringement of MiCA rules.

A second precondition of ITO efficiency is the stability of the business models of token issuers and underlying vine and wine enterprises (wineries, cellars, cooperatives and other producers, grape distributors), in particular when rights of wine physical asset are granted in the whitepaper. For such reason, a modification on the governance arrangements of the issuer, or a variation on the wine conditions as token reserve assets -as ruled in art. 21.1 MiCA-, could significantly harm market the confidence of investors in token contracting. Contrarily, whitepaper soundness, clarity and completeness of the whitepaper and its summary strengthen confidence, as far as such characteristics increase the transparency of the ITO and facilitate liability of token issuers in case of claimable damages ex art. 22 MiCA.

Other economic preconditions of efficiency have been incorporated as compulsory requisites to be fulfilled by the issuers of referenced-asset tokens, like:

- a) Prevention, management and disclosure of conflicts of interest (art. 28 MiCA) present in the relations between issuers and other stakeholders, very diverse in the case of the wine industry.
- b) Robust governance arrangements and organisation of the issuer in order to monitor and prevent market risks (art. 30 MiCA) beyond mandatory law ordinary compliance (e. g., GDPR, AML regulations).
- c) Specific measures to protect the reserve of the assets underlying the token (cf. arts. 32 and 33 MiCA), to protect the rights of investors related with the redemption or withdrawal of such assets from their depositaries or custodians (cf. 30.5 h and 35 MiCA); such measures are particularly relevant if wine tokens are to be issued in form asset-reference tokens in accordance with MiCA provisions.

3 The protection of NFT trading in the secondary platform under the MiCA perspective

If the wine tokens issued are NFTs, as we have explained (supra, 2) no specific rules on whitepaper transparency and administrative ITO control will apply under MiCA provisions (cf. art. 4.2). The same exclusion is applicable to all wine tokens even fungible ones, if the ITO offers them for free, or as a reward for a DLT ledger maintenance or for mining ledger blocks. And the exclusion is extended to ITOs directed to qualified investors, or to less than 150 investors per EU country.

The effects of the transparency whitepaper umbrella could be perverse, since commercial publicity or soft whitepapers aligned with private incentives could distort a sane perception of wine NFT investors with respect to the quality of the business model and the risks associated to token trading in DeFi secondary-market platforms.

We believe that such risks have been underestimated by MiCA legislator -namely by ESMA and ECB regulatory authorities-, more worried by financial stability than by private investor protection, as undoubtedly shown by the stablecoin token regime, including ART rules. If NFT tokens are not referred to a wine market, ART protective belt won't allegedly cover token owners, and alternative softer regimes will apply, probably out of the MiCA scope. Let us not forget that MiCA whitepaper compels all token issuers to expressly warn on the possibility of losing the whole invested value, and also on liquidity and transferability risks (cf. art. 5.5 MiCA).

3.1 The wine-token trading platforms

Under MiCA provisions, managers decentralised trading platforms must be permanently authorised and registered for proper supervision by national competent authorities (cf. arts. 53 to 58 MiCA), and they must act fairly and professionally in the best interest of investors, coping with severe prudential, organisational and informative requirements, (60 to 62 therein), safekeeping their tokens and funds (63) as the rest of professional cryptoasset service providers. The operation of a trading platform for wine tokens requires, in accordance with the specific demanding and exhaustive rules present in art. 68 MiCA, the fulfilment of strong security and organisational procedures and the provision of according risk preventive measures:

- a) A set of operating rules for the trading platform to predetermine the due diligence and approval processes applied before admitting tokens to the DeFi exchange automated DLT trading. These rules include, amongst other, the ones related to the following secondary-market matters:
 - Excluded types of tokens that shall not be admitted to trading on the platform (encompassing those issued without whitepaper disclosure requisites, unless exempt under legal exemption -cf. 4.2 MiCA). NFTs can be excluded in accordance with MiCA provisions, but they could be included

applying specific non-MiCA provisions. If tokens are to be reputed securities, MiFID regulations could be applicable whenever the DeFi platform qualifies as a regular exchange, in accordance with ESMA and national authority law-compliance criteria.

- Policies, procedures and technical guidelines for market actors to operate in the platform, including token service providers and investors. Such rules will ensure fair and orderly market trading, as in traditional non-DeFi or centralised exchanges governed by market self-regulatory authorities organising the marketplace [4,7]. The level of fees, if any, that token issuers must spend to obtain the admission of trading to the DeFi platform must be previously disclosed.
 - Limitations of public participation in trading activities in accordance with objective and proportionate criteria. These ones shall promote fair and open access to the platform in accordance with equality of opportunities and non-discrimination principles. Cryptos must remain accessible for trading, according with efficient liquidity thresholds periodically disclosed. And exchange managers shall envisage exceptional social, political, financial-market or macroeconomic adverse conditions under which trading of crypto-assets is suspended or postponed.
- b) Clear and efficient procedures that ensure the effective fulfillment of principal secondary-market contracts (token buying and selling, derivative contracting), including clearing of cryptoassets, debt calculation and settlement of both token transactions and fiat currency transactions tied to liquidation. In the case of wine tokens, a set of liquidation rules, in wine markets and in the reserve-asset depositories, shall determine the conditions under which wine token holders can take possession of wine tied to contract liquidation and in kind payment in both spot and forward underlying contracts.

Exchange service providers authorised to operate in the trading platform must ensure that all wine tokens comply with the aforementioned operating secondary-market rules. They must also assess the quality of the tokens, considering the experience and reputation of the issuer and its development team, and intrinsic token quality according with its technical, economic and legal-compliance standards Irrespective of this, the trading platform must also assess the quality of the wine crypto-assets benefiting from the exemptions, in order to fully protect investors in prevention of legal sanctions from supervisory market authority. This is particularly relevant in the case of NFTs representing lots or batches of fine-wine, or specific bottles, since these tokens will normally not be ruled neither by MiFID stock-exchange regime nor by MiCA provisions, in accordance with exemptions in article 4.2. The stock-exchange common prohibition of self-dealing is applied by art. 68.3 MiCA to token traders operating on an authorised platform, even if they have permission to exchange tokens for fiat currency or other cryptos; this rule shows the magnitude of self-dealing risk of fraud or misconduct of the dealer, beyond the scope of

similar risks in conflictual positions in traditional stock markets.

3.2 Wine-token principal and auxiliary contracts within the MiCA regulatory context of investment token services

Principal or main secondary-market contracts do not differ much in the case of DeFi platforms from a private law viewpoint, with respect to traditional Exchange principal contracts, buying and selling of securities or derivative trading (futures, options and swaps). In the case of wine cryptos, including NFTs, all these kinds of spot and forward contracts on the crypto bring the same liquidity, market-price reliability and public confidence to the public, in a context of PPDL DLT-DeFi contracting submitted to public-law surveillance and administrative proper control. This is a huge challenge in all cryptoasset markets, since public intervention of DeFi seems to contradict the philosophy of decentralization, creating an apparently unsolvable paradox [4,5]. However, such contradiction declines considering the necessary public-law intervention of PPDLs (and DLT networks in general) by public order (legal and economic) justified reasons tied to the protection of constitutional individual rights and to the benefit of state macroeconomic objectives, including financial stability. In the enology context, such aims reach to the protection of wine markets and vine and wine economic ecosystems, mainly in world-leading wine producing countries and regions.

Auxiliary contracts in the secondary market must also protect the interest of investors and market integrity and stability in a suitable manner. To this respect, MiCA regulation has found effective ways to prevent misconduct and lack of risk self-control from token service providers. Risks that could bring lethal consequences to market confidence in token contracting, particularly in the case of token custody -which usually includes token private-key custody in the best interest of token holders-, token administration, and other related operations like the exchange of cryptos for fiat money or other crypto-assets for disinvestment, and other investment services. Note well that, in a DeFi context, broker activity is diluted, since brokerage is at least partially replaced by platform and node activity gathering supply and demand of tokens, whatever their underlying asset is. If a wine token platform operating in a DeFi market custodies or administers wine tokens, clients must be informed about this service under MiCA regime (art. 67). The platform manager must inform them on the nature of the custody or administration services provided, in accordance with preset custody policies and procedures ensuring the control of the tokens, and facilitating the exercise of the rights attached to the tokens. It is relevant to understand that such rights are related with tokens themselves, not with wine redemptions as is the case of ART tokens.

4 Other relevant legal issues within a PPDL context: Digital identity, privacy and public intervention of nodes

4.1 Digital identity of wine market actors to operate in PPDLs as wine token issuers, investors or intermediaries with self-sovereign identities (SSIs) or to exchange traceable documents

In order to legally and orderly trade in wine token markets, wine investors and consumers, and brokers or intermediaries acting on their behalf in secondary-market trades, must be locatable, reachable and accessible. Only PPDLs guarantee this, since traceable DLT token transactions let public authority know which nodes are operating, but the identification of nodes does not imply the identification of managers and persons on which behalf these managers are acting.

Under self-sovereign identity systems wherein DLT transactions are orders by data issuers identified by predetermined self-selected verifiable credentials, the identity of operators behind pseudonymous trades is discoverable and transparent. Wine token service providers authorised for the operation of trading platforms and for trading on behalf of clients must ensure transparency on the fair and non-discriminatory use of self-sovereign identities, not incentivising disorderly trade conditions or the modification or cancellation of orders given by identified clients.

4.2 Platform resilience issues

Crypto-asset service providers authorised to operate on a token must implement effective systems, procedures and arrangements to ensure that their trading systems are resilient and ensure orderly trading under conditions of severestress.

Platform resilience is a crucial prerequisite for orderly wine token trading, since DeFi efficiency implies the utilization of markets platform able to absorb token demand in accordance with investor and consumer needs in physical wine markets. Demand for wine is a key factor in wine DeFi trading, therefore wine-token platforms must be able to automatically reject orders exceeding predetermined volumes and prices, and erroneous orders as well (cf. 68.4 a, b MiCA). From a technical viewpoint, platform resilience also means capacity to prevent token exchange failures, and that is why proper arrangements ensuring trading continuity are essential for stability in both wine-token and wine physical related marketplaces. DeFi platform resilience is linked to transparency, and for that reason it is important that token bid and ask prices and volumes remain timely and continuously public during trading sessions (v. 68.5 to 68.7). Wine-token traders and platform managers must serve details of all transactions online if possible, and

platform operators shall ensure on a “reasonable commercial basis” (ibid..) non-discriminatory free access to that information, which must remain available (at least two years under MiCA provisions).

In summary, wine-token marketplace resilience, including digital resources and backup facilities, is substantially similar to that required in non-DeFi classical exchanges, but it affects related wine underlying trades, thus increasing the liability of platform managers and crypto service providers authorised for the operation of the DeFi system, who must complete the final settlement of token transactions on the DLT on the same date as the transactions has been executed on the trading platform; and as arranged, on the posterior date on which the underlying wine delivery or payment will be executed at the physical wine market. All these processes must be reported to competent supervisor authorities in both financial and commodity markets.

4.3 Privacy issues

Digital signatures or wine token transactions are created using the private key component of a public-private key pair. A digital certificate contains the public key component of the identified transaction sender. A certificate Authority (CA) can issue a certificate, binding a subject identity to a key pair. Trust in identity of the sender comes from the verification of such certificate. However, identification ultimately depends on the subject who maintains possession of the private key; attackers gaining such possession can impersonate the token holder and to forge the signatura or operate without permission. That is why privacy challengers are easier to solve in PPDLs. wherein severe requirements for using public-key infrastructure (PKI) with associated certificates can be set, and public keys are used to verify the origin and validity of a signature created together with a private key. PKI signatures created with a private key and verified using the associated public key ensure data integrity and origin authenticity or non-repudiation, to comply with legal or regulatory requirements; in the EU, General Data Protection Regulation, GDPR, a Regulation requiring justification for processing personal data and providing subjects with rights like oblivion and erasure, difficult to make compatible with PPDLs, although they are not exercisable if the justification to store private data ceases. Anyway, a general ITU-T recommendation is never store personal data on a Blockchain, and this principle must apply to wine-token DLT transactions; storage should be made offchain with data possession in hands of competent supervisory authorities.

Organisations like wine-token platforms and wine market authorities could require specific privacy requirements and impose security policies of verification and use of certificates for wine-token transactions, compelling market operators to display CA validation of specific certificates and their paths, containing valid token or wine data, approved algorithms, non revocation of powers or valid transaction dates, among other [1]:15.

In the MiCA context, operating rules of the trading platform for crypto-assets shall prevent the admission to trading of tokens containing inbuilt anonymisation function, thus impeding effective supervision. But, in order to preserve adequate privacy, anonymisation of token transactions will be permitted if investor and their transaction history can be identified by intermediaries authorised for operating on DeFi approved exchanges or platforms, by competent authorities, ex art. 68.2 MiCA. Anyway, forthcoming post-quantum scenario will render useless current 128-bit algorithms, and 256-bit keys will be used as a minimum algorithmic floor to serve privacy for token markets wherein data should be kept for more than ten years.

4.4 Node intervention in PPDLs as a law compliant solution in case of breach of legal duties by node clients in a wine market context

Node intervention is an efficient remedy unavailable in permissionless ledgers. Bitcoin and similar public networks do not facilitate public administrative surveillance on irregular or unlawful node transactions (e.g. in cases of market abuse like insider trading or price manipulation), contrarily to PPDLs wherein permissioning validator nodes enable public authority intervention on transactions, in accordance with network governance protocols and self-regulatory provisions. PPDLs also facilitate timely suspension of platform operations in cases of cyberattacks, operational fraud from platform clients or irregular activity of crypto service providers. In cases of breach of legal duties by specific clients directly operating on their own behalf or through investment service providers, in accordance with investment token contract terms and conditions, enforcement can be envisaged onchain by automated alternative dispute resolution (ADR) devices implemented on smart-contract service layer of the PPDL architecture.

Alternative offchain enforcement can also complement such devices, or serve as one and sole kind of non-automated ex post remedies to compel the unfulfilling party to pay, deliver or cover damages derived from breach of contract. Even when offchain remedies are the only ones available, PPDL node intervention is essential to prove fraud, misconduct or unlawful procedures of clients or intermediaries acting on their behalf. DLT transaction traceability. combined with PPDL node intervention, composes an efficient operative framework for *restitutio in integrum* to compensate a fulfilling and damaged contracting party with respect to token-transaction related obligations. In the case of wine NFTs, it is also an optimal solution to provide connection with the underlying reserve-asset depository or underlying wine market wherein contractual ultimate obligations are to be satisfied in accordance with liquidation terms and conditions.

5 Brief market considerations

5.1 Custody of wine as a reserve asset when wine tokens are issued as ARTs: The wine market conditions and the legal obligations of custodians

Issuers of wine asset-reference tokens (ARTs) use to sign optimal arrangements with relevant market actors like wineries, vineyard owners, cellar proprietors or managers, winemaking cooperatives, wine cooperative decision-making associates, or major wine distributors, dealers and exporting companies.

When token issuers participate as wine-market actors or as agents within the vine and wine chains of value, conflicts of interest usually arise. Wine market and related wine token markets call for proper detection, prevention and eventual resolution of these conflicts. Market integrity is an essential precondition of efficiency in both spaces (MiCAs and agricultural marketplaces), thus requiring the elimination of adverse effects caused by conflictive positions of the aforementioned actors that could damage market confidence and distort token prices or wine prices, either intentionally or as a consequence of a breach of the duty of care in the prevention or resolution of conflicts (e. g., in the case of wine ARTs issued by a winery proprietor who deals with tokens and custodies wine as reserve asset, without segregating this wine and other lots or batches destined to exportation or foreign trades; or in the case of encumbrance or pledge of the wine underlying the token to cover obligations or commitments of the issuer, impeding a prompt access to that wine to meet redemption requests from token holders). Therefore, wine custodians should be other than issuers, in order to prevent conflicts or, once arisen, solve them promptly so as to protect the rights of wine token holders.

Wine custodians of wine as reserve assets of tokens must pay careful attention to wine market conditions, particularly if different kinds of wine have to be custodied as diversified reserve assets, in accordance with specific custody policies as set in contractual agreements and specific governance policies of categories of wine as reserve assets covering different issued tokens. This point is emphasized by MiCA proposal, which cares for investor and consumer protection in both reserve-asset and token markets. If the token offering (ITO) encompasses only one category of ARTs, the issuer will operate and maintain only one custody policy (cf. 33.1 MiCA, in fine), even in the case that several categories of wine are custodied as reserve assets. Thus, the unicity of tokens determines the unicity of the custody policy, irrespective of the possible differentiation of wine categories encompassed.

A major problema posed by the application of this custody MiCA regime is the obligation to appoint a credit institution as custodian entity of the reserve (cf. art. 33.2.b of the Proposal). Obviously this forthcoming rule has been envisaged thinking of financial reserve assets other than cryptoassets (cf. 32.2.a, 3.1.10 and 53 MiCA, compelling to appoint a crypto-asset service provider in the case of a custodian of cryptos). However, contractual

agreements between custodian institutions (wine depositories) and a credit institution appointed by the token issuer can be set as a legal vehicle to apply MiCA rules on custody and governance policies applicable to reserve assets. This reasoning leans among other arguments on the following:

- A particular mention made by art. 3.1.3 MiCA when defining “asset-referenced tokens” (ARTs) to “one or several commodities” as is the case of wine or any other underlying commodity conferring the tokens their economic value.
- The stability and potential of wide, profound and liquid international wine markets serving systematically trustable, verifiable, accesible and continuous wine price references (quotations) with sufficient worldwide diffusion and relevant macroeconomic impact on domestic economies [8], unambiguously indicating the long-term marketing and macroeconomy prefiguration of wine as a worldwide marketable commodity.
- The existence of arising wine tokens in DeFi markets tradable on DLT platforms (like Robiza Wine Token, Eno Token -<https://enotoken.io>-, WiVa Token -<https://wiv.io/>, Brunello wineXchange NFTs -<https://www.brunello.io/wine-tokens> and other) irrespective of applicable legal regimes in jurisdictions where national financial market or commodity exchange legal boundaries are to be set for the proper surveillance of investments and for investor and trader protection.

5.2 Rights on wine assets and wine market considerations

Investor in wine token markets must be specifically protected against investment risks present in DeFi and in international wine markets as well, since the rights of token holders should be exerted alternatively (namely in the case of redemption of the reserve wine assets in the case of configuration of tokens as ARTs), under public market supervision, in both of them. For this reason, a proper regulation on the rights of token investors, on token themselves and in the underlying wine assets as well, is crucial to bring confidence and law-compliance to decentralized markets, either in token platforms available in PPDL networks, or in other DLT networks even without permission for transactions, where public control of transactions is more expensive and legally uncertain.

When wine-token DeFi platforms give investors the choice to select among different wines serving as a physical commodity backing the tokens representing them digitally, a bunch of ideal characteristic should be fulfilled by wine markets thereof: a) Liquidity and investment market potential of the wines selected as underlying commodity, in order to adequately back the issued tokens as collateral and as a property in case of Exchange of tokens for physical or redemption in accordance with whitepaper provisions. b) Suitability of tokens in accordance with the characteristics of the underlying wine. The tokens can function as a stable

currencies or cryptoasset only if the wine is accesible and its quality is coherent with the terms and conditions expressed in the whitepaper, one one hand, and on the other hand, with traceable wine characteristics and token trading history [9]: 150; [10]:54. c) Feasibility and prompt executability of auxiliary contracts linking DeFi and wine markets. Among such contracts we find collateralisation agreements, wine-token lending to collateral providers, exchange of token wine fractions for physical delivery.

d) DeFi and underling market agility to provide wine custodian and DeFi intermediaries (including all cryptoasset service providers in accordance with MiCA rules) capability to facilitate law-compliant investment services to token holders, according with ITO and whitepaper commitments.

It is to be noted that some wine-NFT issuers and investment service providers in DeFi exchanges operate as wine funds, depositories or custodians, depending on the provisions written in the whitepaper. In some of these exchanges, token holders deposit NFTs as collateral acting as wine borrowers or taking out a loan, expecting wine revaluation or appreciation.

In other brand new relevant wine token markets, ERC-20 fungible wine tokens have started regular circulation on promising PPDL decentralised platforms, performing transactions under Ethereum protocol, with highly enhanced liquidity, limited market volatility and worldwide immediate tradability. Such characteristics, together with the relative isolation of wine economy with respect to macroeconomic, political and financial crisis, have started to boost investor returns in comparison with common investment alternatives, as synthetically but accurately shown in the following graphics.

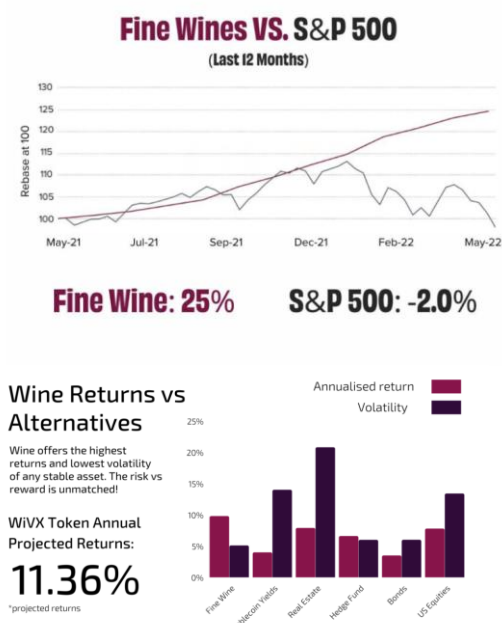


Figure 1. Fine-wine DeFi market one-year price comparison with S&P500 Index prices, and comparison of its annualized yield and volatility with financial and non-financial most common alternatives. Source: WiVX Token – WiV – Fine wine investment on blockchain.

It should be well noted that, irrespective of the regime applicable to the DeFi platform and decentralised applications tied thereto, public transparency of the wine market conditions is vital for trading stability and reliability. Other market preconditions essential to this aim include periodical and timely auditing of the underlying assets (as collateral guarantees or as redeemable commodity) and an updated reinforcement of the contractual position of token owners, allowing them to cheap and agile access to wine in the stipulated scenarios agreed for the use of the reserve, with no unnecessary delay, without prejudice to alternatives for redemption foreseen in the whitepaper (namely, in form of deliverable liquid cryptos).

6 Conclusion

Wine token marketplaces can be developed in Europe under the MiCA regime on ARTs, or under existing national civil law mandatory rules, without prejudice to DLT-PPDL and DLT consortium guidelines and self-regulatory provisions and policies, including node governance and liability and prevention of conflict of interest, both essential for DeFi market prevention of fraud or misconduct of token issuers and intermediaries.

As far as ITO conditions set forth in whitepapers preceding massive token public trading, primary market regulations should apply to protect investors in both wine token and physical wine markets, enhancing cryptotrading confidence and market integrity. Reinforced investment protection is emphasized by MiCA proposal, whose rules will not apply to wine tokens other than ARTs, since non-ART tokens (including wine NFTs) cannot be considered stablecoins, even under ERC 20 protocols and alike, envisaged for fungible tokens underlying bulk wine or other kinds of wine for which the form of NFT digital representation is not suitable.

NFT representation impedes the application of MiCA regime, thus multiplying legal risks and related agency costs -including supervision surveillance-, causing investor uncertainty. However, NFT representation is necessary for the DeFi development of fine-wine token markets or for expanding distributed-ledger traffic of specific categories of rare-vintage or outstanding quality vine grapes.

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