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In a decentralized marketplace, buyers and sellers transact directly, without manipulation by intermediary platforms.

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Decentralized Blockchain-Based Electronic Marketplaces

E-COMMERCE MARKETPLACES—WHETHER business-to-consumer (B2C) or business-to-business (B2B)—are examples of a two-sided market.[6,19] Each side involves networks of participants. Network effects—the incremental value added by each new participant—play the dominating technological role in such markets. Over time, network effects inevitably yield a monopoly in which a single e-commerce firm manages the entire marketplace.[24]

In line with the "theory of the firm"—or a set of economic theories that explains and predicts the nature of the firm, company, or corporation, including its existence, behavior, and structure—most e-commerce firms today aim to maximize profit for shareholders

» key insights

- Decentralization alters the paradigms of firm-controlled marketplaces by providing security, trust, privacy, lower transaction costs, and transaction integrity.
- Blockchain-based marketplaces improve matching, transaction facilitation, and support for institutional infrastructure.
- Blockchain-based e-marketplaces open new frontiers in prediction markets, financial engineering, automated reasoning systems, and, smart-contracts-based systems.

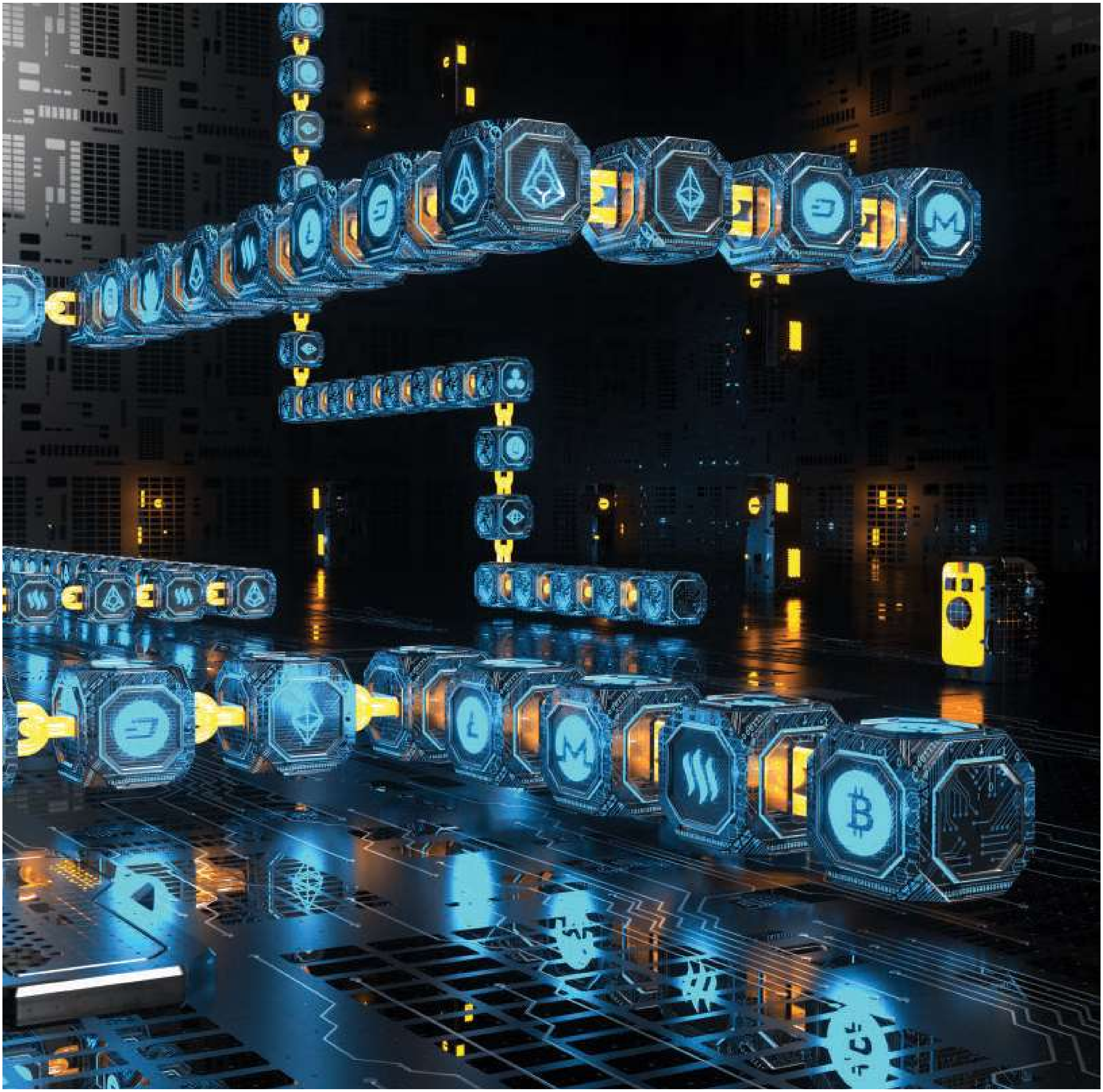


ILLUSTRATION BY SPOOKY POOKA AT DEBUT ART

by growing the corresponding network of participants using the platform, including sellers, buyers, developers, resellers, intermediary service providers (such as logistics providers), payment-gateway services, and institutional intermediaries, including legal advisors.

Strategies deployed by electronic marketplaces (e-marketplaces) to increase network effects include personalization of service offerings on the platform; recommendation systems for goods and services, trust mechanisms, and simplification of transactions. Here, I describe an alternative to the firm-controlled marketplace—a decentralized marketplace based on the blockchain.

The blockchain is a shared, distributed transaction ledger that records all transactions and operates through the Bitcoin protocol.[3,14] Each transaction is validated by a network of nodes, each hosting the blockchain and corresponding validation software. The validation algorithms confirm the transaction by preventing problems (such as "double spend," whereby a given amount of coins is spent more than once in the same transaction). Once the transaction is confirmed, its details are stored on a public ledger generated through an algorithmic process called "mining." A network of nodes, each with a local copy of the blockchain, provides an alternative to a centralized platform in which each node can maintain functions of the larger platform, partly or fully.

The blockchain supports several key functions:

Distributed storage and listings. A network of nodes lists items offered through the marketplace by individual businesses, eliminating single-point-of-failure scenarios and preventing a single controller firm from manipulating the shared central database;

Transactional validity. Fraudulent and duplicate transactions are prevented through timestamp-based validation;

Transactional persistence. All transactions concerning an asset or service traded in the marketplace are stored on a publicly accessible and verifiable ledger;

Transactional anonymity. The true identity of marketplace participants is hidden from other participants and the network by allowing users to create multiple wallets to be used on the network for transactions;[18]

Transactional privacy. Transaction details are hidden from the network (though the ledger is public) by the blockchain automatically encrypting transactions;

Transactional traceability. Each transaction can be traced back to the sender's and the receiver's true identities through a combination of techniques (such as IP tracing and blockchain graph analysis).[18] Traceability is used by government regulators (or analysts) to detect theft, money laundering, and other illegal activity on the network, and can be both computationally and economically expensive, depending on blockchain implementation; and

Transactional immediacy. A mechanism built into the network consummates each transaction in the shortest possible time, with many implementations of the blockchain achieving instant validation through "proof of service,"[4] "consensus,"[21] and "proof of stake."[2]

Most important, the blockchain eliminates the central authority needed to validate transactions, thus realizing many computational efficiencies; for example, transaction costs due to contract enforcement (such as following a sale) can be eliminated when the network validates the transaction. Likewise, the payment (good) transfer between buyer (seller) and seller (buyer) is recorded in a common, secure ledger.[7] To illustrate such efficiency, consider a conventional e-commerce store. When a buyer clicks the checkout button, multiple systems (such as payment and credit-card networks) each charge a fee. Despite such payment, fraudulent transactions are not necessarily always eliminated. In a decentralized e-marketplace, traders transact with each other securely and directly, and the network of nodes validates and records each transaction.[3]

Decentralized marketplaces using the blockchain as a foundational block are a viable alternative to firm-controlled marketplaces, yielding advantages from how decentralization supports marketplace functions, matching transaction support and institutional infrastructure.[1]

Limitations of Firm-Controlled E-Marketplaces

Firms controlling e-commerce platforms support multiple networks, including customers, resellers, application developers, advertising partners, and financial intermediaries. Here, I address limitations with respect to firm-controlled marketplaces and the main marketplace functions.[1]

Matching sellers and buyers. E-marketplaces thrive due to the network effects they facilitate when buyers, sellers, and third parties (such as resellers) trade with one another. Either a seller-driven (or marketplace-driven) promotion or customer-initiated search will facilitate matching. Buyers benefit because the marketplace reduces search costs. Sellers benefit because the marketplace offers product listings at no marginal cost and because of shared inventory and logistics costs. E-marketplaces facilitate reach (buyers can be located anywhere) and transaction immediacy (buyers/sellers can trade at any time).[22]

E-marketplaces reduce search costs for buyers by efficiently listing and retrieving goods and services in databases. In addition to reducing such costs, marketplaces increase revenue by encouraging consumption by altering users' purchase preferences through product recommendations, bundling, and other product (or service) machinations. Likewise, B2B/B2C marketplaces facilitate customer credit to increase consumption. By providing APIs, marketplace platforms facilitate ease of integration with third-party resellers or franchisees to further increase a platform's reach.

Matching characteristics of markets is not performed efficiently in today's B2B/B2C marketplaces; for example, price changes facilitated by algorithms can make certain goods pricier online compared to similar offerings sold through conventional brick-and-mortar stores. Likewise, price matching offered by brick-and-mortar retailers negate the price-based advantages of e-marketplaces. The behaviors of sellers and buyers affect an individual firm's decisions with respect to the marketplace and vice versa; for example, if firms controlling a marketplace decide to stop accepting certain payment methods, market participants would have to either alter their payment behaviors policies or stop transacting on the platform. If firms controlling the platform decide to provide differential pricing for similar products across customer segments based on profit-maximization algorithms, traders would gain (or lose) the ability to buy (sell) from (in) markets where price is low (high). Consider how the taxi-ride-hailing service Uber uses proprietary algorithms to determine ridesharing prices that may not account for an individual driver's actual profit margin. This has led to protests in cities with traditional taxi services drivers have found to not be profitable.[5] When network effects are disruptive to the market, a monopolistic firm that aims to maximize its own profit can try to alter participant behavior, without necessarily improving the efficiencies that might otherwise be realized in an e-marketplace. With Uber, though the rider (customer) benefits due to lower prices compared to a conventional taxi service, the drivers (service providers) would be worse off due to discounted pricing as determined by the platform.

Facilitating transactions. Facilitating transactions is what a marketplace does to enable the exchange of value between buyers and sellers. The buyer pays the seller and the seller transfers the physical good (or service) to the buyer on the platform. A variable transaction cost is associated with each transaction due to banks, credit institutions, logistics providers, and other intermediaries. In most transactions, a legal entity ensures transaction validation by enforcing a legal contract.[7]

Trust plays a major role in any kind of transaction between a buyer and a seller on any marketplace platform.[9] Seller reputation displayed on the platform influences the buyer and vice versa. Either third-party services (such as Yelp.com and the Better Business Bureau) or marketplace-controlled "ratings and reviews" systems inform users about the reputation(s) of sellers. However, no reputation system is foolproof, possibly being influenced by spam, tampered ratings and reviews, and paid reviews. Reputation systems themselves can thus be a major source of concern undermining trust.

Modern e-marketplaces are serious about privacy. Enforcing "privacy with security," a feature all users want, is difficult on a centrally controlled platform. The seller's and the buyer's full identities, in addition to the transaction details, are disclosed to each other and possibly to others on the platform. Such disclosure has multiple uses, enabling, say, personalization algorithms to infer a user's purchase behavior or a seller's online behavior and target future promotions. Because such information can be misused, use of transaction information and personal information has been subject to much debate in Internet policy and law. Moreover, other marketplace participants (such as credit-validation services) use it to validate payment mechanisms or credit limits accessed by customers.

In a conventional marketplace, transactions are validated and confirmed through third-party agencies like credit-card companies using open-loop or closed-loop networks.[12] Personal information, including addresses, Social Security information, and credit-card details, has proven to be the most vulnerable source for security attacks. A single cyberattack on the database hosting personal information leads to disproportionate losses, including of trust by customers in the platform.[17] Every marketplace (such as Amazon, eBay, Sony, and Target) in recent years has been targeted by at least one attack involving loss of information.

Other disadvantages can include scenarios in which transaction costs are greater than the actual sale price, limitations to payment modes, and network infrastructure challenges (such as sites unable to handle large volumes of transactions). Although e-marketplaces are geared for trade across geographies or national borders, B2B trade is limited due to friction related to currency-transfer laws and complex logistics. For example, if a buyer in the Middle East wants to buy music from the iTunes store and the payment gateway does not support international credit cards, the sale would be suspended, even though technology willingly supports the trade.

In a decentralized e-marketplace, traders transact with each other securely and directly, and the network of nodes validates and records each transaction.

Facilitating institutional infrastructure. E-marketplaces traditionally enable contracts that are honored by participants through such mechanisms as click-wrap, shrink-wrap, and web-wrap enforcement. E-marketplaces validate transactions and enable automatic enforcement of contracts through exchange of payment and goods (or services). Likewise, e-marketplaces protect participants' intellectual property by ensuring copyright laws are followed and counterfeit goods are prohibited, thus protecting brand value of the goods being traded.

Contracts in e-marketplaces for outsourced labor often involve significant transaction costs because contracts between vendors and customers are based on time and money or labor requirements. Renegotiating contracts increases transaction costs, precluding contractual support for agile project management (such as software development and architectural design) needed in the marketplace.

Blockchain-Based Decentralized Marketplaces

I now explore examples of such marketplaces, along with their architectures and potential business advantages. The Bitcoin cryptocurrency is the most widely used application of decentralization and can be viewed as a bearer bond in which each transaction accounts for value transfer between the two parties. Network participants, or "miners," validate transactions through a process known as "mining." Likewise, other participants host nodes that run the blockchain and "validate" transactions.

Ethereum is another blockchain-based protocol, enabling programmable contracts through distributed validation on the blockchain.[25] Once transaction rules are agreed upon by a participating buyer and seller, those rules can be programmed into a contract to then reside on the blockchain. Nodes on the network are incentivized by "ether" rewards for validating and securing transactions on the blockchain. Such incentives have spawned e-marketplaces for contract-specific transactions (such as prediction markets and initial coin offers like the "decentralized autonomous organization").

The Lazooz distributed ride-sharing network is another example of a decentralized marketplace in which customers sharing rides use a mobile application to order the ride. On the Lazooz network, individual participants produce a "Zooz" token used to compensate drivers. Each transaction, or ride, is recorded on the blockchain's network of nodes.[16]

OpenBazaar is a decentralized marketplace in which software is installed on each seller's node where listings are created. The marketplace accepts Bitcoin as its mode of payment and helps users trade with one another by reducing transaction costs compared to a conventional marketplace. The main advantage is that it offers participants pseudo-anonymity of transactions, direct payment for goods and services via Bitcoin, and search that is unaltered by the marketplace. The marketplace's quality of service is assured by independent third-party brokerage services. Likewise, reputation brokers maintain user reputations throughout the network.[13]

Figure 1. Multilayered architecture of a decentralized e-marketplace.

Layer 5	Quality of Service
Layer 4	Decentralized Applications
Layer 3	Blockchain
Layer 2	Mining Software
Layer 1	Network Infrastructure

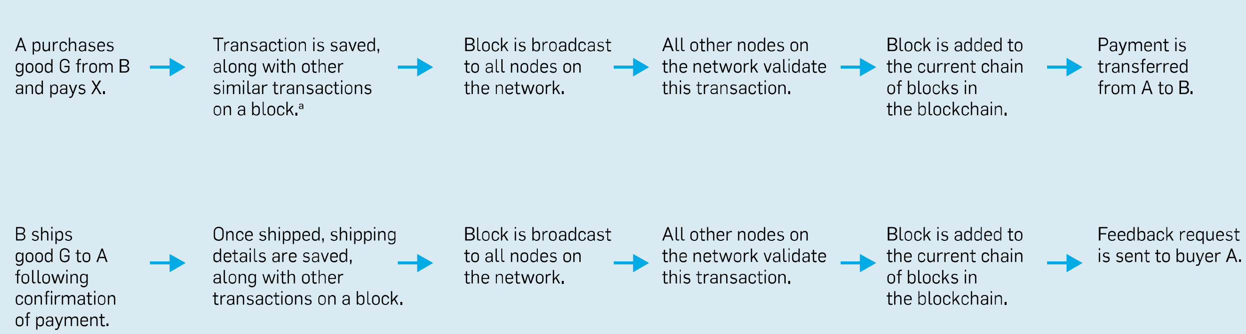
Multilayered platform. Figure 1 outlines the architecture of a decentralized e-marketplace architecture in which Layer 1 is the network infrastructure consisting of hardware nodes and client software. The client software provides listings of goods in which each node runs a local copy of the network's blockchain that also includes its own product listings. Layer 2 is the mining software used to create new blocks of data consisting of network transactions; newer tokens of value are issued into the network based on mining algorithms. Layer 3 is the software responsible for validating transactions on the network and for storing validated transaction records. In layer 4, distributed applications might include a peer-to-peer marketplace or a seller-logistics marketplace (such as the electronic data interchange interface and reputation models). And Layer 5, or the quality-of-services layer, is where a marketplace's customer relationship management functionality is implemented. Reputation models, designed to increase trust between buyers and sellers, are implemented through user feedback, ratings, and reviews. Likewise, dispute resolution is facilitated through third-party brokers. Search is also facilitated in this layer by third parties or directly by the platform. Figure 2 outlines transactions in a decentralized marketplace.

Advantages of a Decentralized Marketplace

In a decentralized marketplace, the firm responsible for ensuring the marketplace functions properly by matching buyers and sellers, facilitating transactions, and/or enabling institutional infrastructure is replaced by a network of nodes, each independently and concurrently accomplishing the same functionality as that of a centralized marketplace. As in Figure 1, blockchain-based programs validate each transaction transparently and securely.[14,25] Decentralized platforms ensure privacy and security for transactions while facilitating trust among platform participants.

Matching buyers and sellers. Decentralized marketplaces can provide unmodified "access" to information (such as listings) as desired by the seller, since each node is able to list prices, goods, and reviews pertaining to goods. The individual sellers are themselves responsible for creating the product listings that are then redundantly distributed throughout the network. Information transfers are completed much more reliably when search results pertaining to goods listed by the seller are unchanged. Likewise, listing errors are minimized by design, since price-altering and preference-altering algorithms can be disabled or managed by individual sellers. And matching functionality through search engines can exist independent of the marketplace; for

Figure 2. Transactions flows in a decentralized marketplace.



[a] The transaction here could piggyback on the Bitcoin network[14] or follow a different blockchain implementation (such as Ethereum).

example, market platforms Duo Search and Bazaar Bay provide search listings for OpenBazaar.

Transactions. Transaction costs are minimized because intermediaries (such as payment gateways) are excluded. Buyers pay sellers directly, and the current network or other cryptocurrency networks validate payment transactions. Transactions are more secure, owing to the fact they cannot be manipulated by anyone in the marketplace. Transactional anonymity and transactional privacy reduce incentives for cyberattacks on both individual accounts and transactions. Micro-transactions (such as tipping and micropayments) are also facilitated. Disputes involving transactions are handled by third-party conflict brokers. The reputations of both sellers and buyers are thus managed independent of the marketplace. And returning goods and payments is handled in accordance with the mediation facilitated by brokers through such mechanisms as multi-signature contracts, notarization, and arbitration.

Institutional infrastructure. Programmable contracts facilitated through the network of nodes ensure buyers and sellers adhere to the rules and norms of a contract. Fully automated enforcement, partial automation, and manual enforcement modes for contracts thus ensure all participants in a transaction adhere to the negotiated, agreed-upon terms. Table 1 compares various features of decentralized e-marketplaces with those of their counterparts in traditional e-marketplaces.

Conclusion

Decentralized marketplaces provide many advantages to all market participants, including security, trust, privacy, lower transaction costs, and transaction integrity. Decentralization alters the paradigms of today's conventional marketplaces in which a large intermediary firm that controls the platform is able to control every aspect of a trade, from product listings to price discovery, product search, logistics, and the customer experience.

While I have proposed an alternative to the existing firm-controlled marketplace, it is likely only certain functions within existing centralized marketplaces would be better off decentralized. For example, transaction facilitation on many centralized platforms (such as Amazon and Overstock) accept cryptocurrencies as an payment option. However, in certain marketplaces (such as crowdfunding and venture-finance IPOs), initial coin offers can replace existing mechanisms to provide a viable alternative with more functionality.[20] Smart contracts could be used to set up complex financial instruments with preset rules for paying dividends to investors. Table 2 outlines caveats concerning decentralization for a variety of e-marketplaces.

Decentralization is used to create a social network (such as Steem)

Table 1. Decentralized e-marketplaces vs. traditional marketplaces.

Marketplace Feature	Blockchain-Based Decentralized Marketplace	Traditional E-Marketplace
Trust through contract enforcement	Distributed validation, including proof-of-work mechanisms or proof-of-stake mechanisms. The network enforces the contract between seller and buyer. The network validates reputation ratings, including reviews and feedback mechanisms.	Third parties (such as a bank, certifying authority, promissory note, transfer systems, or other forms of contractual mechanisms). Usually controlled by the firm. Potential for significant alteration.
Transaction time	Can be instantaneous due to fast network validation. Delays can be mitigated using proof-of-stake/proof-by-consensus algorithms.[3,19]	Promissory note, letter of credit, or acceptance of credits that can take a long time.
Value	The network can reward participants with tokens or by accepting third-party tokens.	Banking systems (such as national exchanges, currency, and underwriters).
Privacy and security	Identity is not disclosed on the network. Tracking transactions can be facilitated, though with difficulty. Transaction details can be hidden behind layers of encryption. Cost of tampering with the network's validation mechanism is high.[a]	Identity fully disclosed in the marketplace. As secure as the network's components.

[a] To break the network's validation, an attacker would have to be able to control >50% of the network's hash power, involving a huge economic cost in case of proof-of-work validation mechanisms.
For proof-of-stake or proof-by-consensus mechanisms, tampering with the network's validation represents an economic disincentive.

Table 2. Decentralization in different e-marketplaces.

E-Marketplace	Decentralization Possibility	Reasons	Cryptocurrency Support
Physical products	Partly decentralized	Many components to decntralize, including B2B support, accounting, payment gateway, and reputation	Bitcoin, Dash, Ethereum, Monero
Digital products (such as e-books, music, video, and domains)	Very likely	Fully online payment and delivery of goods	Bitcoin, Dash, Ethereum
User-generated content marketplace	Very likely	Online content, including blogs, reviews, and online reputation	Bitcoin, Ethereum, Steem
Prediction markets	Very likely	Blockchain-based validation to enforce contracts	Augur, Bitcoin, Ethereum, Truthcoin
Crowdfunding, sharing marketplaces	Very likely	Simpler validation; functionality supported by blockchain	Bitcoind, Dash, Ethereum, Zooz
Currency exchanges, remittances, complex financial contracts	Very likely	Easy-to-create complex contracts and low transaction costs	Bitcoin, Dash, Ethereum, Ripple

in which content creators are identified, recognized, and rewarded.[11] Blockchain-based prediction markets include applications in basic sciences, where, say, drug discovery or patient outcomes might be predicted accurately through the wisdom of the crowd.[15] Likewise, blockchain-based software is being deployed in the financial industry for implementing automated reasoning for executing the complex rules in financial contracts.[10] Given the blockchain's special characteristics, successful execution and validation of rules by a network of nodes extends its blockhain-based applications to artificial intelligence applications in complex rule-based systems.[23] In financial markets, for example, the blockchain enables international remittance opportunities with instantaneous currency transfers and "de-risks" international currency exchange; for example, BITT is a Bitcoin-based platform for interbank money transfer among 16 Caribbean nations, some running the risk of currency de-recognition. Similarly, the blockchain plays an important role mitigating problems in business environments where market friction due to weak legal institutions is a challenge, as in the real estate market where property records on the blockchain are being sought as a solution.[8]

Decentralization is used to create a social network (such as Steem) in which content creators are identified, recognized, and rewarded.

Conclusion

By facilitating key marketplace functions, decentralization will, if successful, complement and rival traditional conventional e-marketplaces.

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