Blockchain technology and market transparency

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"[Blockchain can be understood] *as a revolution (or evolution) in institutions, organization and governance*"

(Davidson, De Filippi and Potts 2016)

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… but we are not there yet …

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What is Blockchain?

"*The blockchain is an incorruptible* ***digital ledger of economic transactions*** *that can be programmed to record* ***not just financial transactions but virtually everything of value***." (Don & Alex Tapscott, authors Blockchain Revolution 2016)

"*Blockchain, defined broadly, is a* ***mechanism for reaching consensus regarding the state of a shared database between multiple parties who don't trust each other****."* (Kravchenko 2016)

"*[Blockchain is a] distributed* ***database composed of a network of interconnected computers*** *that are used* ***to keep a distributed ledger of information****." (Marc Kenigsberg)*

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What is Blockchain? (cont.)

- Originally ***created by Satoshi Nakamoto in 2008*** to verify and register financial transactions for the ***Bitcoin*** digital currency (crytocurrency)

- Since then ***many digital currencies emerged***: Ethereum, Litecoin, Dash, Zcash, EOS, etc. – more than 1000 digital currencies exit today ➔ Current market value of digital currencies ≈ 350 billion

- Blockchain is a ***promising technology for many areas***.
  - Examples where blockchain can be applied: money transfers, managing healthcare records, recording land titles, electricity market, insurance market, supply chains, smart contracts, etc.

What is Blockchain? (cont.)

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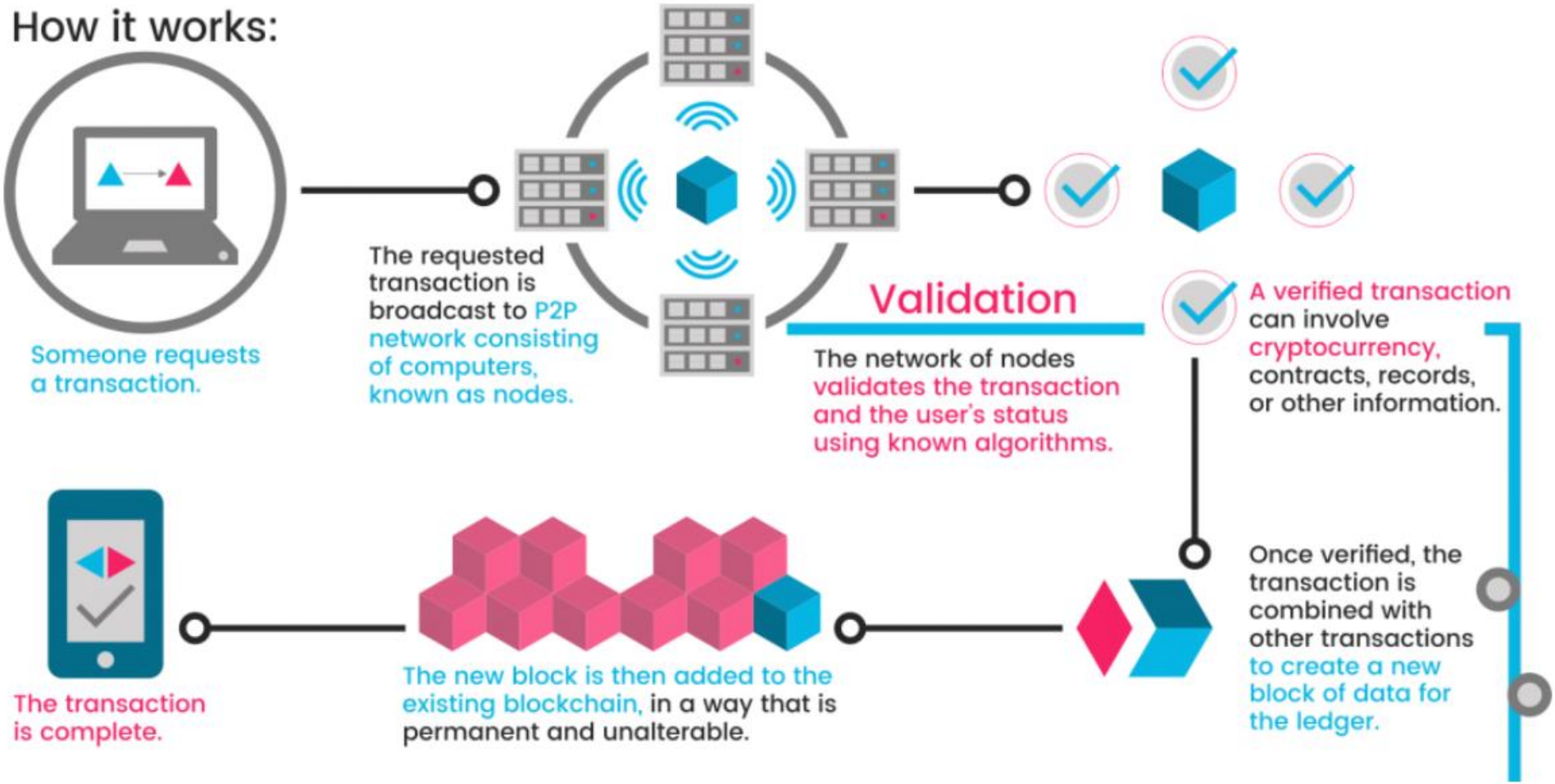

Blockgeeks

Image Source

What is Blockchain? (cont.)

- ***BlockChain is shared public ledger*** on which all transactions are registered and serves as a proof of all the transactions on the network

- ***Blockchain has complete information about transactions*** (and ownership) from the genesis block to the most recently completed block (all history is recorded on the blockchain)

- Blockchain is ***not controlled by a central authority***, person, company,or government, but by ***a software algorithm*** sustained by ***network participants*** (***nodes, miners***)
  - ***Eliminates the need of intermediary*** (e.g. bank, agent)

- ***Each computer connected to the network has a copy*** of the blockchain – this ensures the **transparency of transactions**

What is Blockchain? (cont.)

- ***Decentralized peer-to-peer network*** - ***nodes provide their computing power*** and verify and record transactions into BlockChain

- ***Participation of nodes is voluntarily but incentive based*** ➔ in return for the service they receive compensation (e.g. in Bitcoin compensation = fees + newly minted coins).

- ***Transactions are validated by nodes based on pre-defined algorithm*** (e.g. by performing large computations to show "work") ***before being allowed to add a new block to the chain*** ➔ this discourages cheating.

- ***Transactions are verified by a consensus of a majority of nodes*** ➔ enabler of "trust in a trust-less system" – actors do not need to know/trust each other to participate in exchanges.

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Advantages of Blockchain

- ***Transactions history is immutable*** - they cannot be deleted or changed once recorded on blockchain
- ***Transparency and traceability*** of all transactions – all history can be traced on the blockchain
- ***Lowers transaction costs*** – decreases costs of exchanges in a "trustless" environment (e.g. no "trusted" intermediary is needed)
- ***Blockchain can be permissioned***: permissioned networks can restrict who is allowed to participate and in what capacity (e.g. to avoid fraud or access to confidential data)

Blockchain types:

	Public	Hybrid	Private
Overview	Fully decentralized – anybody can join and leave the blockchain at any time	Quasi-centralized by consortium of entities – entry/exit controlled	Centralized by one entity (central authority)
Permission	Permissionless - anyone can participate and read and write	Permissioned - selected entities can make changes	Permissioned - central authority can make changes
Transaction verification	Records are verified by majority of nodes (“miners”)	Transactions are verified by the consortium	Central authority verifies transactions
Transparency	Fully transparent - transparency necessity for public verifiability	Mixed - consortium decides on transparency rules	Non-transparent
Privacy	Conflict between transparency and privacy	Privacy relatively easy to control	Full privacy
Security of transactions	High, immutability secured by costly mining ("work").	Depends on wheatear verification is costless or not (risk of collusion)	Low - change of records costless to central authority

Sources: Deloitte (2017); Kadiyala, A. (2018); Smith + Crown (2016); Catalini and Gans (2016)

Blockchain and transparency of Food Chain

Traceability:

- Can ***track products through the multi-staged supply chain***
- Can ***tracks specific products*** in all stages of the chain
- ***Can track any number of characteristics/ attributes about food products*** (including prices)
  - Prices in all stages of the chain
  - Where/when/how was it produced and processed?
- ***Allows full traceability*** of all sources of all inputs used in all stages in the chain

Blockchain and transparency of Food Chain (cont.)

Information access

- ***Near real time access to information*** on the blockchain

- ***Reduces costs of verification of attributes of products*** (e.g. product quality, prices) ***through eliminating intermediary*** (Catalini and Gans 2016)
  - Improves market efficiency
  - Reduces uncertainty in exchanges

- Cheaper access to information can ***improve communication and information flow*** (accuracy and speed) ***between players*** in the chain

Blockchain and transparency of Food Chain (cont.)

Information access (cont.)

- ***Cheaper and easier identification / verification when a problem emerges*** and in which stage of the chain it occurs (e.g. delayed payments, fraud, contract breach, product damage, food safety breaches)
  - Reduces the need of an audit of a third party for problem verification
  - Real time tracking of the cause of the problem (e.g. a player, a segment of the chain)

- ***Reduces asymmetric access to information*** - all blockchain participants have access to the same information
  - E.g., offers possibility to better monitor and have access to information about product quality or provenance which should facilitate exchanges
  - ***Reduces asymmetry in bargaining power*** caused by asymmetric information

Blockchain and transparency of Food Chain (cont.)

Privacy:

- ***Privacy control can be incorporated in the blockchain*** to protect sensitive information (Catalini and Gans 2016)
  - Easier in permissioned blockchains
  - Private blockchains are by default private

- Blockchain may ***need to be combined with other technologies*** to address the privacy issue
  - E.g. immutably linking sensitive private data (private blockchain or database) to the public blockchain through cryptography
  - This may enable users to retain control of private data and allow others to use them as desired

Blockchain and transparency of Food Chain (cont.)

Contracts:

- Blockchain can embed instructions (e.g. if-statements) which can be used for ***smart contracts*** (e.g. for payments, penalty fees)
  - This ***enhances blockchain information value*** and incentive to participate

- ***Pricing models can become more flexible***
  - Better link to product quality; link to timing of delivery; automating triggering of payments, fees; price linked to consumer satisfaction, etc.

Overall:

➔ Blockchain can provide **transparency beyond prices**

- Can record and track price, date, location, quality, inputs, certification scheme, storage, provenance, temperature condition of the product, etc.

Challenges for application in Food Chain

- ***How to link between physical food products and (unique) digital signature equivalent*** on the blockchain
  - This requires development of other technologies (e.g. smart sensors, biosensors, Internet of Things)
  - Need to deal with physical transformation (e.g. possessing) of food as it moves along the chain
  - Minimise human error in linking physical and digital

- ***The capacity problem of blockchain:*** how much information can be stored in a blockchain and how fast can they be processed by the network
  - Current blockchains have relatively low capacity. E.g. Bitcoin and Ethereum process around 10 transactions per second, while Visa on average processes around 5000-8000 transactions per second
  - The capacity needs to be improved to have a wide application of blockchain

Challenges for application in Food Chain (cont.)

- ***Cybersecurity*** needs to be addressed to avoid breach of private information, loss of assets, etc.
  - Cybersecurity relevant to gain users' trust in blockchain
  - Experience from cryptocurrencies shows that cyber-attacks can cause big losses to users

Challenges for application in Food Chain (cont.)

- ***Network effect important*** - requires adoption/collaboration of all players
  - All stages of the supply chain must participate in blockchain in order to achieve transparency along the whole chain (Barnard 2017)
  - Could be problematic in global food chains, e.g. low adoption or difficult access to technology (interface) in some regions

- ***Potential implications for the governance structure and/or market structure***: blockchain may change exiting business processes/ relationships/ practices and result in different benefits and costs for players in the chain.
  - Higher transparency, lower information asymmetry, free entry/exit, lower transaction costs ➔ higher competition and change in power structure among players
  - Certain players might become redundant, e.g. intermediaries

Challenges for application in Food Chain (cont.)

- ***Regulations might need to be adapted to facilitate adoption:***
  - Confidentiality and property of data on blockchain
  - Legalization of smart contracts
  - Global chains: harmonization of rules might be needed between countries to allow blockchain application across countries

Implications for competition

- ***Blockchain reduces transaction costs and eliminates information asymmetry ➔ greater competition*** (Cong and He 2018; Catalini and Gans 2016)
  - Decentralized blockchain can better track goods between firms and along the chain giving all parties equal access to transaction information
  - Facilities cheaper verification of transactions
  - The use of smart contracts improves contractibility and enforceability of transactions contingent on real outcomes

Implications for competition (cont.)

Collusion possible in situation where incumbent firms control (e.g. permissioned) blockchain (Cong and He 2018):

1) Collusion using Smart Contract:

- Firms can form a collation and sign smart contract on the division of the market (e.g. on pricing) including the punishment in the case of deviation from the collusive behaviour
  - This type of collusion is easy to detect

2) Tacit collusion - playing a certain strategy without explicitly documenting it

- More tacit collusion equilibria possible than in the traditional economy
  - Traditional economy: actions of other firms is imperfectly observed
  - Blockchain economy: easier detection of deviations and punishment can be more accurate ➔ collusive equilibria easier to sustain

Policy implications

- The transparency of blockchain ***allows regulators to better monitor market performance*** on a regular basis and at lower costs

How to address collusion?

1. ***A permissionless blockchain could be mandated if there is high risk of market monopolization or collusion*** (Catalini and Gans 2016)
2. ***Adding a regulatory node in the (permissioned) blockchain*** to monitor the behaviour of market participants and to reduce the risk of collusion (Cong and He 2018)
3. ***Separation of usage and consensus generation*** to enforce same access to information for nodes *vs*. users (Cong and He 2018)
4. ***Public-private partnerships*** to support market oversight
   - E.g., participation of a dedicated regulatory agency in the blockchain design

Examples of Blockchain application in Food Chain

- ***Relatively many applications (test / trials) exist today in food chains***
  - Specific applications of blockchain addressing specific issue (e.g. traceability) or sector
  - Lack of common technology that can connect different blockchains

Blockchain use cases in Food Chain

- ***bext360*** in partnership with ***Moyee Coffee*** - a FairChain coffee brand - are developing ***blockchain (crypto-tokens) to trace coffee from Ethiopia to Europe*** (Allison 2017)
  - Main purpose: traceability, transparency of the value added
  - At entry (collection) point in the chain, cryptotokens are created which represent the value of the beans (including quality)
  - New tokens are automatically created in every stage of the chain and they are exchanged with the older ones in order to represent the commodity in its new form
  - Tokens increase in value as the beans move through the supply chain – ***this makes transparent sharing of value added across all stages of the chain***


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Blockchain traceable coffee: bext360 partners in Africa, Europe and North America

bext360 launches full-scale program using crypto-tokens to trace coffee from Ethiopia to Amsterdam.

By Ian Allison
October 31, 2017 17:03 GMT

Coffee farmers in Uganda

Coffee farmers in Uganda (World Bank Group)

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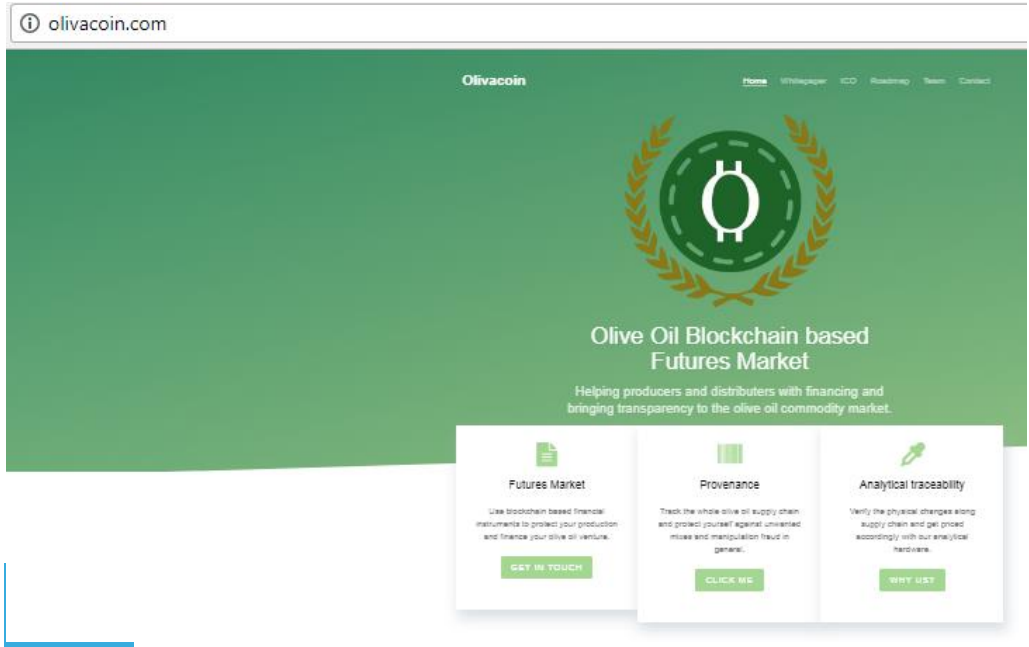
Blockchain use cases in Food Chain (cont.)

Olivacoin (olivacoin.com):

- Developed by the Seville University

- For executing olive oil futures contracts
- For placing olive oil orders between distributors and producers
- Traceability of Olive Oil (supply-manufacturing-distribution-consumption)
- To minimize the abuses and fraud in the sector
- Provide price information and transparency

- ICO: July 2018



Blockchain use cases in Food Chain (cont.)

- ***Cargill*** is testing a blockchain to track the ***provenance of turkey*** products (photos of turkey, where they were raised, comments from farmers) (Main purpose: traceability)

Blockchain use cases in Food Chain (cont.)

- China's ***ZhongAn*** plans to use ***facial recognition to monitor life journey of chickens in organic farming*** using blockchain
  - Main purpose: traceability, food safety concerns of urban consumers

- *"Each of our chickens wears an anklet since birth, which is an IoT [internet of things] device that connects wirelessly to our blockchain-based network and sends real-time data about the bird's whereabouts, and how much exercise it gets every day"* (Chen Wei, ZhongAn, *South China Morning Post*, Hong Kong)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Insurtech giant ZhongAn plans to use facial recognition, blockchain to monitor chickens

Tech unit of Hong Kong-listed ZhongAn Online Property & Casualty Insurance targets 23 million birds for project 'gogochicken' in three years

PUBLISHED : Sunday, 10 December, 2017, 8:32am
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Blockchain use cases in Food Chain (cont.)

- ***IBM collaborates with major global food companies*** (Dole, Driscoll's, Golden State Foods, Kroger, McCormick and Company, McLane Company, Nestlé, Tyson Foods, Unilever and Walmart) ***to identify new areas where the global supply chain can benefit from blockchain***

- ***IBM – Walmart collaboration on blockcahin*****:** trials with tracking pork in China and mangos in Mexico were performed. *Illustration of blockchain benefits:*
  - Walmart run a small experiment asking staff to find where a pack of mangoes came from: it took them 6 days, 18 hours and 14 minutes
  - The same mangoes were also tracked by blockchain as part of a pilot scheme: it took only 2.2 seconds to find their place of origin (Churchill 2018)

Blockchain use cases in Food Chain (cont.)

- ***Ambrosus (AMB)*** - combines high-tech sensors, blockchain technology, and smart contracts to track transactions in the food and medicine industry (ambrosus.com)
  - to track products across the supply chain and to guarantee their quality, safety and origin for consumers
  - Official partner in the United Nations 10YFP Sustainable Food Systems Programme – 10-year framework of programmes on sustainable consumption and production patterns (10YFP)
- ***FoodCoin*** - complements and expands services provided by the traditional financial, legal, insurance and logistical institutions (foodcoin.io)
  - to create a global marketplace of food and agricultural products
- ***WineCoin*** - linked to a real bottle of Purcari wine (winecoin.global)
  - physical asset investment, wineries' raise of capital, consumers' purchase of wine
- ***CaskCoin*** - whisky-based cryptocurrency (caskcoin.com)
  - physical asset investment in the maturing Scotch Whisky

Conclusions

- Blockchain has high potential to improve market transparency of food chains ➔ **full and near real time traceability beyond prices**

- Technology not yet fully mature
  - Main challenges: capacity, security, interface between physical and digital
  - Alternative technologies in development that may address some weaknesses of blockchain (e.g. capacity): Tangle (IOTA), Hashgraph

- Regulatory framework might need to be adapted
  - to promote its adoption
  - to address privacy of data
  - to avoid collusive behavior of participants

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Thank you for your attention

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