EIS 11/2017

Submitted 04/2017

Accepted for publication 08/2017

Opportunities and Barriers for Application of Distributed Ledgers in the Context of EU Digital Single Market Strategy

Natalija Kostrikova, Baiba Rivza

Latvia University of Agriculture, 2 Liela Street, Jelgava, LV-3001, Latvia, kostrikova.natalia@gmail.com

http://dx.doi.org/10.5755/j01.eis.0.11.18134

Abstract

Decentralization, on one hand, brings more transparency and trust to the parties involved in transactions, but on the other hand, it narrows possibilities for central control. Distributed Ledger Technology (DLT) is a recent decentralized innovation in the field of information and communication technology (ICT) that acts as self-sustainable ledger for documenting transactions self-protected against counterfeiting and hacker attacks. The **aim** of the current research paper is to reveal opportunities and barriers for utilization of distributed ledgers in the context of EU digital single market strategy. The main **tasks** are (1) to analyze functionality dynamics of existing distributed ledgers, (2) to analyze utilization areas of distributed ledgers, (3) to analyze digital trends related to utilization of distributed ledgers within the EU. The current research paper utilizes **methods** of content analysis, grounded theory, descriptive statistics, correlation analysis and regression analysis. The research has revealed that half of EU Digital Single Market priorities can be facilitated through distributed ledgers.

KEYWORDS: distributed ledger, digital single market, European Union, decentralization, ICT, blockchain.

Introduction

Decentralization processes are currently taking place all over the world creating new economic models and supported by modern ICT tools. Since the end of 1990s a trend toward decentralization has been noted all around the world (Dethier, 1999), however since its creation, European integration has been a process of gradual centralization with the Single Market being arguably the most spectacular success of European integration (Wyplosz, 2015).

Digital Single Market is among political priorities of the European Commission for the years 2015-2019 (European Commission, 2017). The idea of a Digital Single Market stems from the rapid development of an ICT sector intertwined with four founding principles of the European Union – the free movement of people, services, capital and goods. EU single market provides for economy of scale and a wider choice of products and services at lower prices, however regulatory and non-regulatory barriers are existent, for instance, not standardized business processes in Europe (Delina, 2016)

Modern ICT solutions are required to implement the Digital Single Market Strategy. One of such solutions can be a Distributed Ledger Technology (DLT), a recent ICT innovation that acts as a self-sustainable ledger for documenting transactions self-protected against counterfeiting and hacker attacks. Current knowledge about DLT is fragmented, lacks theoretical background and common technological implementation. The novelty of the current research paper lies in

European Integration Studies
No. 11 / 2017
pp. 160-172
DOI 10.5755/j01.eis.0.11.18134

interdisciplinary approach to policy analysis, involving combination of technical knowledge and economic analysis tools. In this paper, authors pay substantial attention to structuring existing knowledge about DLT under comprehensive framework in order to reach indicated research aim.

The **aim** of the current research paper is to reveal opportunities and barriers for utilization of distributed ledgers in the context of EU digital single market strategy. The main **tasks** are

1. to analyze functionality dynamics of existing distributed ledgers,
2. to analyze utilization areas of existing distributed ledgers,
3. to analyze digital trends related to utilization of distributed ledgers within the EU.

Methodology

Qualitative research in ICT can apply various methods, e.g. case study, ethnography, action research, grounded theory and content analysis (Thinagaran, 2014). The current research paper utilizes **content analysis method** to identify existing DLT applications and analyze their functionality. For the purpose of current research content analysis is defined as a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the context of their use (Krippendorff, 2004). Since there are only a few DLTs apart from crypto-currencies that are currently implemented in public space, **no sampling method** is applied and all available DLT applications are selected for detailed functionality analysis.

The main sources of information are white papers and web sites of existing DLT applications, expert interviews and official documents of public authorities and think-tanks. The "context of use" of analyzed information is exploration of interconnections between DLT functionalities and priorities of the EU Digital Single Market Strategy. Since DLT is a recent ICT innovation, a proper scientific research has not yet been implemented and a theoretical framework is non-existent. Grounded theory is very useful when current theories about a phenomenon are either inadequate or non-existent (Creswell, 2014). Thus, the current research will also utilize a **grounded theory method** to identify and analyze areas for DLT application.

Descriptive statistics is used to analyze digital trends related to DLT utilization within the EU. **Correlation and regression analysis** is used to analyze interconnections between EUR-Bitcoin exchange transactions and components of a digital economy and society index (DESI), a composite index that summarises relevant indicators on Europe's digital performance and tracks the progress of EU Member States in digital competitiveness (European Commission, 2017). DESI components:

- Connectivity - Fixed Broadband, Mobile Broadband, Broadband speed and Affordability
- Human Capital - Basic Skills and Usage, Advanced skills and Development
- Use of Internet - Content, Communication and Online Transactions
- Integration of Digital Technology - Business digitisation and eCommerce
- Digital Public Services - eGovernment.

Literature, market and policy review

European Central Bank defines DLT as a record of information, or database, that is shared across the network (European Central Bank, 2016).Federal Reserve defines DLT as a combination of components, including peer-to-peer networking, distributed data storage and cryptography that, among other things can potentially change the way in which the storage, recordkeeping and transfer of a digital asset is done (Badev et al, 2016).

DLT is not the first technological attempt to implement transactions through ICT. The core underlying concepts of such applications include establishment of trust, maintaining confidentiality and ensuring secure data exchange and storage. Previous technologies include such concepts as blind signatures (Chaum, 1982), b-money (Dai, 1998), hash-cash puzzles (Back, 2002), reus-

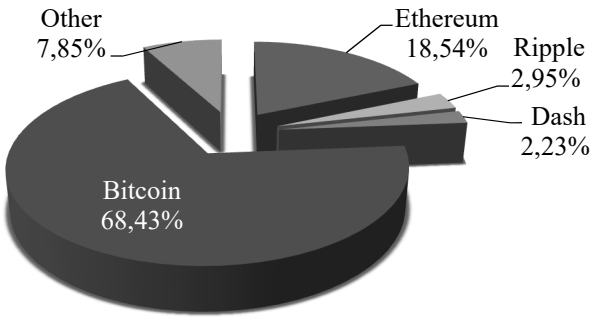
able proofs of work (Finney, 2004), all of them using encryption and consensus protocols, but none of them providing distributed data storage opportunity. In this sense, a distributed nature of DLT is truly a revolutionary concept to ensure transparency, security and immutability.

Researchers (Swan, 2015, Nguyen, 2016, Underwood, 2016), public institutions (Federal Reserve, 2016, European Parliament 2016, European Central Bank, 2016) and think-tanks (European Union Agency for Network and Information Security, 2016, Oliver Wyman, 2016, Deloitte, 2016) conclude that DLT can bring numerous benefits, however certain criticism exists majorly outlining a security concern about a possibility of a 51% attack (Chuen, 2014), slowness of the data adding process to the ledger (Deloitte, 2016), size problem if scaled to mainstream use (Swan, 2015) and wasted energy resources on mining (Swan, 2015).

The first practical application of a distributed ledger technology has been implemented by Satoshi Nakamoto launching a Bitcoin crypto-currency in 2009. In his Whitepaper Sakamoto described a peer-to-peer online payment system that functioned without a financial intermediary. All transactions with Bitcoins are digitally signed and stored in a peer-to-peer network that utilizes a proof-of-work concept (Nakamoto, 2008).

The total market capitalization of all crypto-currencies globally is estimated at approx. EUR 23,14 billion, whilst Bitcoin takes the 1st place and enjoys a 68,43% market share (fig. 1).

Figure 1
Market shares of crypto-currencies (Authors' based on data from Bitcoinity, 2017)



Current distributed ledger projects are promoted by business and heavily involve fintech. It is no wonder because intermediation being a core issue addressed by DLT is also at a core of financial transactions. Financial markets have developed significantly in the past decades, driven by deregulation, technology and globalization (Genberg, 2008). The evolution of financial intermediation is going to be one of the most important and consequential stories in the coming years for law, finance, and society (Lin, 2015).

Since Bitcoin a few other DLT platforms and initiatives have already been launched:

- 2nd layer Bitcoin projects that run on top of Bitcoin infrastructure and can store any type of transaction in the Bitcoin network For example, **Counterparty** allows users to create digital tokens that can be traded or exchanged through smart contracts (Counterparty, 2017), **Factom** offers ready solutions for auditing, compliance, quality control and due diligence (Factom, 2017), etc.
- 2012: **Ripple** is built around Interledger Protocol that allows transactions among different ledgers ensuring real-time settlement of cross-border payments and maintaining privacy of in-

volved financial institutions (Ripple, 2017).A protocol for Interledger payments enables anyone with accounts on two ledgers to create connections between them (Thomas S., Schwartz E., 2017).

- 2013: **Ethereum** is a decentralized platform that runs smart contracts and uses different digital tokens, i.e. crypto-currency, representation of an asset, virtual share, proof of membership, vote, or anything at all. Ethereum is used as a platform for decentralized applications, decentralized autonomous organizations and smart contracts (Ethereum, 2017).
- 2015: **Hyperledger** is an open source collaborative effort created to advance cross-industry blockchain technologies that incubates and promotes a range of business blockchain technologies, including distributed ledger frameworks, smart contract engines, client libraries, graphical interfaces, utility libraries and sample applications (Hyperledger, 2017)
- 2016: **Corda** is an open-source distributed ledger platform designed to record, manage and automate legal agreements between businesses; its development is led by R3, a fintech company that heads a consortium of over 70 of the world's largest financial institutions in the establishment of an open, enterprise-grade, shared platform to record financial events and execute smart contract logic (Corda, 2017).

With the DLT all systems of involved actors can stay in step with each other without requiring armies of people to reconcile and resolve the issues, thus, increasing the speed of matching transactions, eliminating human error factor and reducing costs. Each file in a ledger consists of blocks that include cryptographic signatures of previous blocks, called hashes that are created by a particular algorithm (fig. 2).

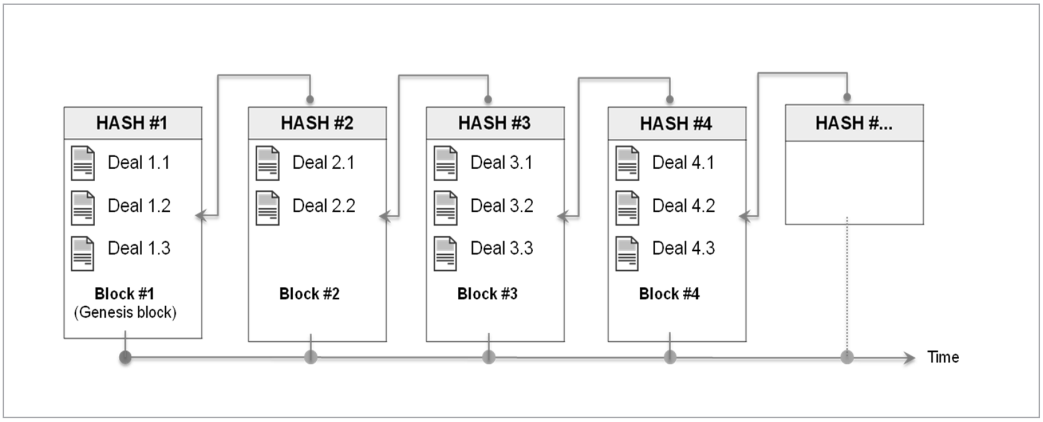
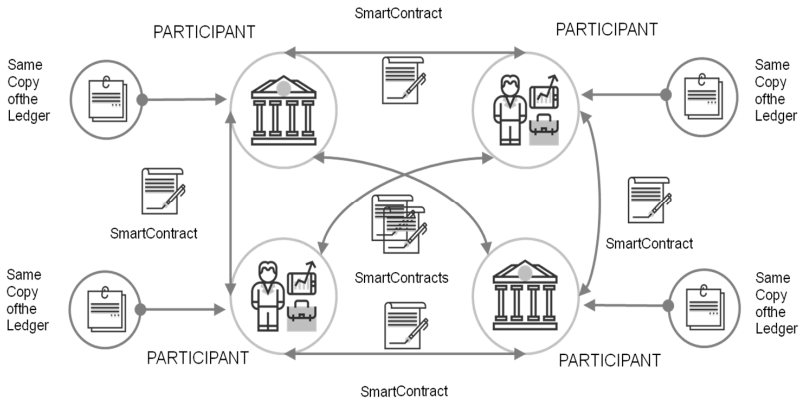


Figure 2
Data structure of a distributed ledger (Authors')

A ledger with files is stored in identical copies on devices of network's participants that are synchronized and automatically updated when a new file is added to a ledger. In comparison to traditional transaction networks, distributed ledgers do not require trusted intermediaries for ownership certification and transaction clearing (fig. 3).

Many global companies are currently exploring possibilities of DLT within their business processes, i.e. major global banks, Nasdaq, SWIFT, US Depository Trust & Clearing Corporation, etc. because DLT can bring confidence by providing a system with no central control. This means that the system cannot be shut down or changed by any single party. It enables the users of the network to know that they can safely use the network without the rules changing. This DLT func-

Figure 3
Distributed ledger network (Author's)



tionality is particularly important for ensuring secure cross-border data exchange between EU Member States providing unprecedented opportunities for deeper European integration.

European Parliament notes that DLT's potential to accelerate, decentralise, automate and standardise data driven processes at lower cost has the potential to alter fundamentally the way in which assets are transferred and records are kept, with implications for both the private and the public sector (European Parliament Committee on Economic and Monetary Affairs, 2016). Thus, the core EU strategy aimed at strengthening EU Digital Economy and Society is further analyzed in this paper to highlight opportunities and barriers for application of distributed ledgers in the process of creating and sustaining a digital single market within the EU.

EU Digital Single Market Strategy is built on three pillars (European Commission, 2015):

1. Better access for consumers and businesses to online goods and services across Europe.
2. Creating the right conditions for digital networks and services to flourish.
3. Maximising the growth potential of European Digital Economy.

The first pillar involves harmonization of online and offline environments to enhance cross-border online activities. The second pillar includes ensuring proper regulatory framework for fair competition, investments and innovation with high-speed secure access to trustworthy content services and infrastructures. The third pillar refers to investments in ICT infrastructures and new technologies (i.e. Cloud, Big Data), supporting research and innovation activities, providing better public services, developing ICT skills and ensuring digital inclusiveness.

12 priorities of the Digital Single Market Strategy (European Commission, 2015) can be summarized as follows:

1. E-commerce:
   - Cross-border e-commerce rules
   - Consumer and contract law harmonisation
   - More rapid, agile and consistent enforcement of consumer rules
   - Alert mechanisms to detect infringements faster
   - EU-wide online dispute resolution platform

2. Parcel delivery:
   - Affordable, high-quality cross-border delivery services
   - Price transparency for European deliveries
   - Enhanced regulatory oversight of the cross-border parcel markets

3. Geo-blocking:

- Preventing unjustified geo-blocking
- Unjustified practices should be expressly prohibited

4. Copyright:

- Modern and harmonized European copyright framework
- Wider use of copyright-protected material, including across borders
- Effective and balanced civil enforcement system against infringements
- Clear rules for online intermediaries concerning copyright protected works
- Safeguarding fair remuneration of creators
- Enhanced cross-border access to broadcasters' services in Europe

5. VAT:

- Minimizing VAT related obstacles in cross-border sales
- Ensuring that VAT revenues are attributed to consumer's Member State
- Clarifying tax treatment of e-services
- Taxation of profits where the value is generated

6. Telecoms

- Telecoms Single Market package with clear and harmonized rules for net neutrality
- Final elimination of roaming surcharges
- More harmonised framework for the radio spectrum
- Release of the 700 MHz band
- Encouraging deployment of very high capacity networks while maintaining effective competition
- High-capacity connectivity for schools and universities/ research hubs
- Review of the telecoms rules

7. Media

- Minimum rules for traditional television broadcasts and on-demand audiovisual media services
- Regulatory framework for keeping up with market and technological developments
- Promoting catalogues of European works on Video on Demand platforms

8. Online Platforms

- Regulatory environment for platforms and intermediaries of sharing economy
- Measures for tackling illegal content on the Internet with due concern about the right to freedom of expression
- Increasing transparency with regards to how online platforms use acquired information

9. Security & Personal Data

- Protecting critical infrastructure
- Effective response to cyber-threats
- Adoption of cybersecurity strategies and regulation on national and EU levels
- Take-up of more secure solutions by enterprises, public authorities, and citizens
- Effective response to criminal activity on the Internet
- Personal data protection

10. Data Economy

- Cloud services, big data and the Internet of Things
- Removing technical and legislative barriers related to the rights for data usage and interoperability of systems and services
- Adopting data protection reform package
- Removing unnecessary requirements for data location within the EU
- European Cloud initiative certifying cloud services

11. ICT Standards

- More efficient cross-border interoperability across borders, especially between public services and authorities
- ICT Standardisation for 5G, digitisation of processes in manufacturing and construction, cloud services, data driven services, cybersecurity, e-transport, e-health, mobile payments and energy (smart metering)
- Promoting ICT standards through public procurement

12. Skills and E-government

- Raising levels of digital skills
- 'Once-Only' principle for businesses and citizens
- EU wide solution for secure online document repository
- Transition to full e-procurement
- Integration of European portals, services, networks and systems
- Promoting the use of electronic documents
- Interconnection of business registers

Research results and discussion

Ethereum and 2nd layer Bitcoin projects facilitate transactions between all possible actors involved in financial and value exchange transactions – businesses (including non-profits), governments and customers (physical persons) (table 1).

Table 1
Distributed ledgers versus transaction types

		Fintech	B2B	B2C	B2G	C2B	C2C	C2G	G2B	G2C	G2G
1	Bitcoin	X	X	X		X	X				
2	2nd layer Bitcoin projects		X	X	X	X	X	X	X	X	X
3	Ethereum	X	X	X	X	X	X	X	X	X	X
4	Ripple	X	X								
5	Corda	X	X	X	X						
6	Hyperledger		X	X	X						

Source: Authors'.

Having analyzed DLT functionalities and opinions of different stakeholders, it is possible to group DLT transaction types under two major categories – Fintech and E-Government, whilst transactions involving government can be also categorized according to Litvack's (2000) identified types of government decentralization (fig. 4).

Although technically it is possible for governments to base their DLT projects on Ethereum and 2nd layer Bitcoin projects, there are however ethical barriers and security concerns impeding public institutions from using those platforms for transactions involving government. European Central Bank notes that the technology is not yet mature, the clarification of critical legal, operational and governance issues will take time and there is a risk of abuse of certain applications for criminal conduct, including money laundering and terrorist financing (Pinna, Ruttenberg, 2016).

On the other hand, Committee on Economic and Monetary Affairs of the European Parliament acknowledges that DLT provides reductions in transaction costs and the ease of use while providing for resilience and varying levels of privacy and foresees emergence of DLT applications in the areas of smart contracts, intellectual property transfers, supply chain management and government services (European Parliament Committee on Economic and Monetary Affairs, 2016). Thus, public institutions at all levels will have an important role in adoption and promotion of

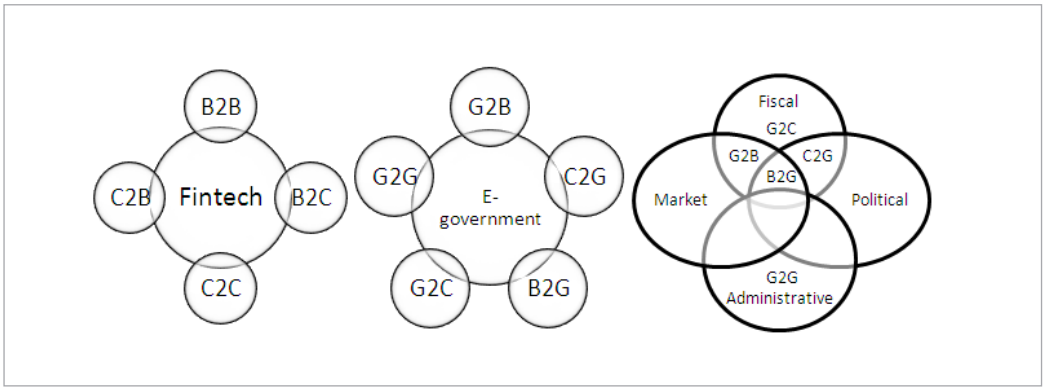


Figure 4
Groups of transactions facilitated through DLT (Authors')

distributed ledger projects involving implementation of transactions with government such as registering civic statuses, filing applications, collecting taxes, transferring property, ensuring regulatory oversight, etc.

Bitcoin-EUR exchange transactions and components of EU Digital Economy and Society Index have grown since 2013 whilst Bitcoin-EUR exchange transactions more than doubled in 2016 in comparison to 2015 (fig. 5).

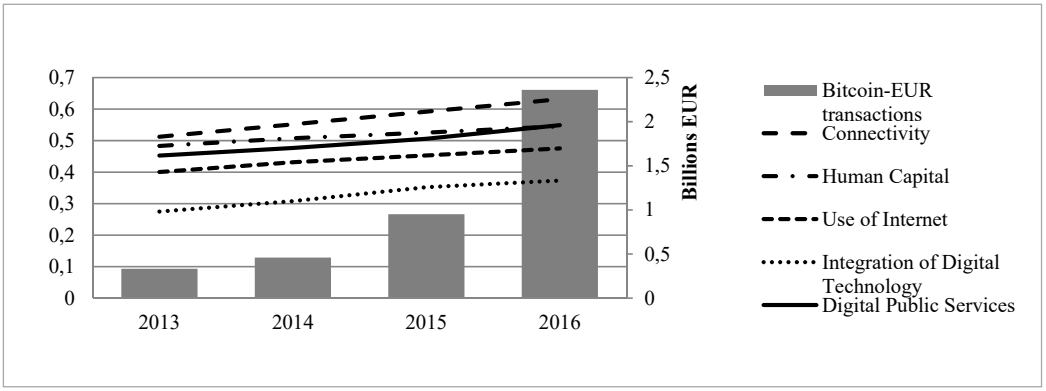


Figure 5
Bitcoin-EUR exchange transactions, EUR, and EU28 DESI components, indices, 2013-2016 (Authors' based on data from Bitcoinity, 2017, EC DG CONNECT, 2017)

Bitcoin-EUR exchange transactions have strong correlations with all DESI components (table 2), however only Digital Public Services component has a statistically significant correlation (Sig.=0.04<0.05), meaning that development of E-government within the EU and Bitcoin-EUR exchange transactions are strongly and significantly interconnected.

		Connec-tivity	Human Capital	Use of Internet	Integration of Digital Technology	Digital Public Services
Trans actions	Pearson Correlation	.912	.898	.881	.868	.960*
	Sig. (2-tailed)	.088	.102	.119	.132	.040
	N	4	4	4	4	4

Source: Authors' calculations based on data from Bitcoinity, EC DG CONNECT.

Table 2
Correlations between Bitcoin-EUR exchange transactions and DESI components, 2013-2016

Also, stepwise regression analysis proves strong interconnection between Bitcoin-EUR exchange transactions and Digital Public Services (table 3, table 4).

Table 3
Regression model summary for Bitcoin-EUR exchange transactions, 2013-2016

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,960[a]	.922	.883	.31739	
2	1,000[b]	1.000	.999	.02476	
3	1,000[c]	1.000	.	.	2.401

a. Predictors: (Constant), Digital Public Services

b. Predictors: (Constant), Digital Public Services, Connectivity

c. Predictors: (Constant), Digital Public Services, Connectivity, Human Capital

Source: Authors' calculations based on data from Bitcoinity, EC DG CONNECT.

Table 4
Coefficient analysis for Bitcoin-EUR exchange transactions, 2013-2016

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9.644	2.198		-4.388	.048
	DPS	21.510	4.419	.960	4.868	.040
2	(Constant)	-10.913	.185		-58.905	.011
	DPS	65.868	2.475	2.941	26.612	.024
	CON	-36.253	2.003	-2.000	-18.098	.035
3	(Constant)	-8.709	.000		.	.
	DPS	64.595	.000	2.884	.	.
	CON	-30.166	.000	-1.664	.	.
	HC	-9.806	.000	-.280	.	.

Source: Authors' calculations based on data f rom Bitcoinity, EC DG CONNECT

The results of stepwise regression analysis:

- Digital Public Services (x1-independent variable) explain **92,2%** of variance of Bitcoin-EUR transactions (y-dependent variable); the linear one factor regression equation y **= -9,644 + 21,510*x1** and regression coefficients are statistically significant (Sig.=0,040; 0,048; 0,040 accordingly).
- Digital Public Services (x1-independent variable) and Connectivity (x2independent variable) explain **99,9%** of variance of Bitcoin-EUR transactions (y-dependent variable) ; the linear two factors regression equation **y = -10,913 + 65,868*x1 – 36,253*x2** and regression coefficients are statistically significant (Sig.=0,015; 0,011; 0,024; 0,035 accordingly).

6 out of 12 Digital Single Market priority areas can be technically facilitated through existing DLT initiatives (table 5).

Table 5

		2nd layer Bitcoin projects	Ethereum	Ripple	Corda	Hyperledger
1	E-commerce	X	X	X	X	X
2	Parcel delivery					
3	Geo-blocking					
4	Copyright	X	X	X		X
5	VAT	X	X	X	X	X
6	Telecoms					
7	Media					
8	Online Platforms					
9	Security & Personal Data					
10	Data Economy	X	X			X
11	ICT Standards	X	X			X
12	Skills & E-government	X	X	X	X	X

Source: Authors'.

Conclusions and recommendations

According to the 1st research task authors have analyzed functionality dynamics of existing distributed ledgers and made the following conclusions:

- Bitcoin was the first transaction network that implemented peer-to-peer distributed data storage functionality, however, not the first transaction network facilitated through ICT.
- Distributed ledgers bring numerous benefits in comparison to traditional systems for recording transactions such as reduced costs for data storage, faster transaction implementation process, immutability of recorded transactions, no central control and data ownership, no human error factor in the process of implementing and recording transactions, etc.
- Transaction network based on distributed ledger technology must consist of more than a half of honest participants in order to ensure credibility of transactions and exclude possibility of a hacker attack.

According to the 2nd research task authors have analyzed utilization areas of distributed ledgers and made the following conclusions:

- Distributed ledgers facilitate financial and value exchange transactions between all possible actors – businesses (including non-profits), governments and customers (physical persons).
- There are five main platforms for developing distributed ledger initiatives up to date, mainly focusing on business-to-business, business-to-customer and customer-to-costumer transactions and involving fintech.
- Transactions facilitated through distributed ledgers can be grouped under two major categories: Fintech and E-government.
- Second layer Bitcoin projects and Ethereum are the most multifunctional, cross-sectoral and customizable distributed ledgers up to date.

According to the 3rd research task authors have analyzed digital trends related to utilization of distributed ledgers within the EU and made the following conclusions:

- Residents of the European Union increasingly utilize Bitcoins for economic transactions between each other.
- The biggest contributing factors to the growth of Bitcoin-EUR exchange transactions are improving e-government and connectivity levels within the European Union.
- Digitization of economy and public services within the European Union is happening simultaneously and with high correlation.
- European Union institutions acknowledge the potential of distributed ledgers to transform different sectors of the economy, but so far, they do not formally participate in the development of distributed ledger initiatives and wait for the technology to mature.
- The main barriers for utilization of distributed ledgers in transactions involving government include the lack of clarity about legal, operational and governance issues.
- Half of EU Digital Single Market priorities can be technically facilitated through distributed ledgers.

Based on above listed conclusions authors have put forward the following recommendations:

- EU regulation and supervision authorities (e.g. European Central Bank, European Banking Authority) to create working groups with promoters of distributed ledger initiatives and other stakeholders in order to ensure adequate regulatory responses to technological developments in this field.
- EU research institutes and other research institutions to explore areas of potential introduction of distributed ledger technology in e-government on EU level with economic and social impact assessment.
- European Commission to encourage creation of consortiums of public authorities to develop distributed ledger prototypes in e-government area.
- European Commission to consider developing pan-EU e-government backbone based on distributed ledger technology for interoperability of e-government initiatives of Member States.
- Authors to analyze in future research exact benefits that can be brought by distributed ledgers to each of the identified priorities of EU Digital Single Market Strategy and to assess them in a view of European Integration theories.

Acknowledgments

The paper was financially supported by the Latvia National Research programme EKOSOC-LV.

References

Back, A. (2002) Hashcash—a Denial of Service Counter-measure. Retrieved 1 April 2017 from www.hashcash.org/papers/hash-cash.pdf

Badev A., Baird M., Brezinski T., Chen C., Ellithorpe M., Fahy L., Kargenian V.,Liao K., Malone B., Marquardt J., Mills D., Ng W., Ravi A., Wang K. (2016). Distributed ledgertechnology in payments, clearing, and settlement. Finance and Economics DiscussionSeries 2016-095 (p. 10). Washington: Board of Governors of the Federal Reserve System.

Bitcoinity (2017). Bitcoin Trading Volume. Retrieved 2 April 2017 fromhttp://data.bitcoinity.org/markets/volume/30d?c=e&t=b

ChaumD. (1982). Blind Signatures for Untraceable Payments (p. 200). Santa Barbara: University of California.

Chuen (2014). David Lee KuoChuen: Interview. London. United Kingdom.

Corda (2017). Retrieved 3 April 2017 from https://www.corda.net/

Creswell J. (2014). Qualitative inquiry and research

design: Choosing among five traditions. 4th edition. London: Sage.

Counterparty (2017). Retrieved 22 April 2017 from https://counterparty.io/platform/

Dai W. (1998). B-money. Retrieved 1 April 2017 fromhttp://www.weidai.com/bmoney.txt

Dethier, J.-J. (1999), Governance, Decentralization and Reform in China, Indiaand Russia (p. 25). Bonn: Center for Development Research (ZEF).

Delina R. (2016). Digital single market conceptual model for intelligent supply chains (p. 269). IDIMT Proceedings.

Deloitte (2016). Bitcoin, Blockchain& distributed ledgers:Caught between promise and reality, Retrieved 3 April 2017 from https://www2.deloitte.com/content/dam/Deloitte/au/Images/infographics/au-deloitte-technology-bitcoin-blockchain-distributed-ledgers-180416.pdf

Deloitte (2016).Blockchain applications in banking. Retrieved 3 April 2017 fromhttps://www2.deloitte.com/content/dam/Deloitte/ch/Documents/innovation/ch-en-innovation-deloitte-blockchain-app-in-banking.pdf

EC DG CONNECT (2017). European Union Open Data Portal. Retrieved 2 April 2017 from https://data.europa.eu/euodp/en/data/publisher/cnect

Ethereum (2017). Retrieved 3 April 2017 from https://www.ethereum.org/

European Central Bank (2016). In Focus. Issue 1. Distributed Ledger Technology.Retrieved 2 April 2017 from https://www.ecb.europa.eu/paym/pdf/infocus/20160422_infocus_dlt.pdf

European Commission (2015). A Digital Single Market Strategy for Europe. Retrieved 5 April 2017 from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52015DC0192

European Commission (2017). Commission and its priorities. Retrieved 30 March 2017 from https://ec.europa.eu/commission/priorities_en

European Commission (2017). The Digital Economy and Society Index. Retrieved 2 April 2017 from https://ec.europa.eu/digital-single-market/en/desi

European Parliament Committee on Economic and Monetary Affairs (2016). Report on virtual currencies. Retrieved 1 April 2017 from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A8-2016-0168+0+DOC+XML+V0//EN&language=nl

European Union Agency for Network and Information Security (2016). Distributed Ledger Technology & Cybersecurity.Improving information security in the financial sector (p. 9).

Factom (2017). Retrieved 22 April 2017 from https://www.factom.com/solutions

Finney (2004). Reusable Proof of Work. Retrieved 1 April 2017 from www.finney.org/~hal/rpow/

Genberg H. (2008).The Changing Nature of Financial Intermediation and Its Implications for Monetary Policy.Bank for International Settlements. Retrieved 10 April 2017 fromhttp://www.bis.org/publ/bppdf/bispap39.pdf

Krippendorff (2004). Reliability in Content Analysis. Some Common Misconceptions and Recommendations. Human Communications Research Vol. 30 Iss. 4, p. 18. https://doi.org/10.1111/j.1468-2958.2004.tb00738.x

Lin T. C. W. (2015). Infinite Financial Intermediation. Wake Forest Law Review, Vol. 50, No. 643. Temple University Legal Studies Research Paper No. 2016-06.

Litvack, (2000) Decentralization Briefing Notes. World Bank Institute. Retrieved 15 April 2017 from https://europa.eu/capacity4dev/file/8474/download?token=ViwoHuLP

Nakamoto S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved 31 March 2017 fromhttps://bitcoin.org/bitcoin.pdf

Nguyen K.Q. (2016).Blockchain - A Financial Technology for Future Sustainable Development. Conference on Green Technology and Sustainable Development. IEEEXplore Digital Library. https://doi.org/10.1109/GTSD.2016.22

Oliver Wyman (2016). Blockchain in Capital Markets The Prize and the Journey. Retrieved 3 April 2017 from http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/feb/BlockChain-In-Capital-Markets.pdf

Pinna A., Ruttenberg W. (2016). Distributed ledger technologies insecuritiespost-trading. ECB Occasional Paper 172. Retrieved 1 April 2017 from https://www.ecb.europa.eu/pub/pdf/scpops/ecbop172.en.pdf

Ripple (2017). Retrieved 3 April 2017 from https://ripple.com/technology/

Swan (2015). Blockchain: Blueprint for a New Economy (p. vii, 82-83). Sebastopol: O'Reilly Media

Thinagaran P. (2014). Research Methodology. Qualitative research methods (p. 107). Open University Malaysia.

Thomas S., Schwartz E. (2017). A Protocol for Interledger Payments. Retrieved 4 April 2017 from https://interledger.org/interledger.pdf

Underwood (2016). Blockchain Beyond Bitcoin. Communications of the ACM. Vol 59. No 11. https://doi.org/10.1145/2994581

Wyplosz C. (2015). The Centralization – Decentralization Issue, European Economy Discussion Paper (p. 25). Luxembourg: Publications Office of the European Union.

About the authors

RIVZA BAIBA

Dr. habil. oec

Latvia University of Agriculture

Fields of research interests

Regional economy, human capital

Address

Svetes 18, Jelgava, Latvia
Tel. +37163021041

KOSTRIKOVA NATALIJA

PhD student

Latvia University of Agriculture

Fields of research interests

Digital economy, e-government

Address

Svetes 18, Jelgava, Latvia
Tel. +37126873416