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The Role of Electronic Money in the Payment System: Evidence from Middle-Income Economies

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ABSTRACT

Electronic money is one of the evolutionary stages of the payment system. In the low and middle-growth countries the role of both the centralized electronic and the decentralized cryptocurrency system is not significant. Moreover it is associated with risk. The purpose of this paper is to describe the electronic money genesis, which include the eight stages of its technological evolution; to reveal the final formation of the technical-and-technological concept; to prove the reinforcement of the financial content of electronic money in the legislation and delegating some functions in the payment systems to new technologies. The authors formulate the proposals on the improvement of the electronic money system using the block-chain technology. The researchers also characterize the requirements to cryptocurrencies as the types of electronic money and forecast the number, as well as the amount of transactions processed with electronic money in the middle and low growth countries. The authors use different mathematic methods such as Panel data, Gompertz and Pearl-Reed functions and others.

Key words: electronic money; payment system; cryptocurrencies; panel data

1. INTRODUCTION

The introduction of certain technological advances in the financial sphere led to the development of new payment and settlement means: a new payment and settlement instrument, i.e. electronic money, which is capable of existing both in centralized and decentralized systems appeared as the result of the advanced computer and information technology.

The specific characteristics of electronic money and its large-scale development and expansion on daily basis have attracted special attention from both potential users and regulating authorities. The current strong interest to the improvement of the procedures of its circulation can be explained by the successful functioning of private electronic money and cryptocurrency systems, the impact of the global economic crisis and the presence of cyberthreats in the financial environment. Nowadays, both economic entities and countries need the legitimate use of the decentralized approach to organize their electronic payment systems on the basis of the block-chain technology, as they lack the main shortcomings of centralized systems in terms of their secure processing. Thus, the problems of the development and spreading of the electronic money use, as well as the adaptation of the cryprocurrencies in the payment system are of primary importance.

The goal of the paper is, therefore, to investigate the technological profile of the electronic money and its role in the payment system, to define the concept of cryptocurrency in the legislation and to forecast the dynamics of electronic transactions in the legitimate payment system in the future. The economists have systematized the basic characteristics of the electronic payment and settlement systems and characterized the cryptocurrencies as the types of electronic money. However, their trend in the post-socialism countries has been unexplored. The benefits of new tools and technologies are the acceleration of payments and, respectively, the minimization of time and cost expenditure on the way to economic growth. The main results might be used by central banks to determine the direction of national payment systems' development. The empirical results can find certain applications in the improvement of the operating electronic payment systems, in the introduction of a block chain technology to the sphere of payments, and in developing and changing the legislative base regulating electronic money systems.

2. LITERATURE REVIEW

Cryptocurrencies, the block-chain technology as well as the organization and functioning of decentralized cryptosystems have been investigated by Athey [1], Ayganym [2], Mersch [3], Lipton [4], Geva [5] and other scientists.

There are three conceptual approaches to the definition of electronic money: a payment definition (Singh [6], Freedman [7], International Monetary Fund [8]), the definition of money as a non-monetary financial product (Bank for International Settlements [9]), the European Parliament [10], the European Central Bank [11, 12]) and a monetary definition (Goodhart [13], Athey [1]). According to the International Monetary Fund [8], electronic money is a payment instrument whereby monetary value is electronically stored on a physical device or remotely at a server. Electronic money can usually be used for payments to third-parties and is, therefore, a close substitute for transferable deposits. To qualify as electronic money, the payment instrument must represent general purchasing power (i.e., it may be used for making payments to a variety of other entities). Internet-based currency is not electronic money because it does not meet the definition of currency, as it is not issued or authorized by a central bank or government, and additionally is not widely accepted as a medium of exchange. Electronic money is classified as deposits rather than currency.

However, there is not any complex evaluation of the financial nature of electronic money in the present-day; the crucial factors of its evolution have not been covered and the perspectives of the block-chain technology (cryptocurrency) introduction in the existing payment systems have not been shaped. Lagarde, Obstfeld, Gian, Ferretti, Rice [14] believe that from the sort of block chain technology in general we see possible advantages in terms of the efficiency of payment systems and inclusion. It's an interesting development. We also see that crypto currencies could offer risks, and it is going to be important for regulators to be watching very carefully to make sure that the risks don't materialize.

Geva [5] writes that electronic money has neither physical existence nor official status; virtual currencies are neither ‘currency’ nor ‘legal tender’. It can affect the stability of prices, impact the financial system and generate payment system risks. According to Adrian, Leckow, Bredenkamp [15], given their pseudo-anonymous nature where the identities of participants in a transaction are not known, cryptocurrencies do give rise to significant money-laundering and terrorist-financing risks.

To our view, the payment and monetary definitions of the essence of electronic money cannot be considered satisfactory, while its definition as a non-monetary financial product is believed to be the most appropriate. According to this view, electronic money is characterized by a number of specific features and characteristics, such as the immediate transfer and disclosure on electronic accounts (digital wallets); fast authentication; the convenience of transactions; the absence of territorial and / or time limitations on its movement; low fees; high divisibility.

At the current stage of the IT development, electronic money is a full-fledged means of non-cash payment, a prepaid financial product, not linked to any personalized bank account, allowing its owner to demand the fulfilment of certain monetary obligations from the electronic money system operator through the refund of the prepaid money (used as a coverage), which records are maintained without personal bank accounts. To disclose any information on the availability of money in the system that provides the possibility to transfer it across its users, it is necessary to have an electronic account. We consider the concept of ‘a means of non-cash payment’ to be more justified than the concept of ‘a type of non-cash payment’, as the former functions as an account document, while the latter defines the order of flow of documents and the algorithm of the money transfer from a sender to a receiver.

The nature of the electronic money is based on the absence of its payment function, while bearing the settlement function. We believe that to answer the question on whether electronic money is able to function as a means of payment, it should be divided into the settlement function and the discharge of liabilities function. The official recognition of electronic money as a legitimate means of payment neutralizes its prepaid nature as, after being officially recognized, it will be non-cash money, the storage and the transfer of which will be possible both through the existing and the new information technologies. An electronic account will be similar to a bank account, which will enable the organizations to transfer electronic money in the fixed form among them, as well as it will define its commonly-accepted form on the whole territory of the country.

The study of the electronic money evolution within the period between 1850 and 2016 revealed 74 phases of the implementation of technical and technological knowhow cases, which can be combined into 8 stages: cable money transfers (since 1850); cards issued by non-banking organizations and used as a client identification which entitles him to receive services (since 1914); cards issued by banks (since 1951); conversion of financial information into the electronic form (since 1951); magnetic strip cards (since 1968); smart-cards with built-in chips (since 1974); distance-banking services (since 1984); electronic money (since 1990).

The appearance and the development of electronic money were facilitated by a number of factors, such as the computerization of the population; the wide-spread introduction and use of the Internet; the automation of the payment and settlement system; faster, more available and more reliable settlements; the distribution and popularization of the existing forms of non-cash settlements and the appearance of the new ones; the development of the Internet economy; the governmental policy on the reduction of cash settlements; the implementation of the payment system.

The genesis of the electronic money has a technological profile, which implies that its appearance and development in the currently existing form was induced, on the one hand, by the rapidly growing need for faster and larger payments and settlements, and on the other hand, by certain technological advances. Hence, we can state that the further improvement and development of the electronic money technology will be enhanced by the innovations in the sphere of the information technologies and telecommunications, while its financial content will be defined by the legal aspects delegating the functions in payments and settlements to new technologies.

It should be emphasized that the problem of keeping the record of the coverage of electronic money as it is not covered in full, increase money supply not covered by the corresponding amount of goods, which may lead to higher inflation. However, electronic money in its current status is not included in the definition of money supply.

To our view, the money which is covered by the legitimate money and is able to be used in settlements and payments should be included in the definition of money supply (such as M1) regardless of its form. The following, however, should be taken into consideration:

- if electronic money coverage is reserved only partially, the spread between the amount of electronic money and the account balance of the deposited money used as the coverage of electronic money should be included in money supply;

- if electronic money coverage is fully reserved, the account balance of the deposited money used as a coverage should not be included in money supply.

Considering the risks as an integral part of centralized and decentralized systems of electronic money, we should mention that decentralized cryptosystems function officially and are recognized by law, while their functioning is effectively controlled. Therefore, they are less risky compared with the centralized systems; in fact, the only risk assumed in such systems is client errors. Nevertheless, functional and technological characteristics of the decentralized systems are worse than those of the centralized: the absence of any likelihood to block accounts or recover credentials, the absence of any control over the clients' transactions and the presence of flexible terms of services, render a low velocity of transactions.

Low riskiness, high degree of reliability and security of transactions in decentralized cryptocurrency systems are provided by the block-chain technology they are based on. However, due to the peculiarities of their functioning, the currently existing cryptocurrencies cannot be used to design a legitimate decentralized cryptocurrency system. Thus, to use the block-chain technology in the payments system, it is necessary to eliminate the drawbacks of the decentralized approach to the system organization, to arrange the cryptosystem management, the regulations of its functioning, as well as to introduce the requirements of the obligatory coverage of such a cryptocurrency.

Under current economic and political conditions, the popularity of electronic money increases every year. According to the statistics provided by the European Central Bank [16], an increase in the number of transactions with electronic money and their share in the total amount of non-cash settlements were registered on the territory of the European Union. In the country-members of the Eurasian Economic Community, the level of the development and the use of electronic money has been relatively low despite the existence of the relevant legislation, while they are not recognized as an independent settlement instrument.

Taking into account the undertaken analysis of the structured information, we can identify the general advantages and disadvantages of centralized and decentralized electronic payment and settlement systems (Table 1).

Table 1: The main parameters of decentralized cryptocurrency systems

Parameter	Bitcoin	Ethereum	Litecoin	MaidSafe Coin	Dash	Factom	Syscoin	Xaurum
Ticker symbol of the unit	BTC	ETH	LTC	MAID	DASH	FCT	SYS	XAU
Starting date of functioning	2009	2015	2011	2014	2014	2015	2014	2015
Encryption algorithm	SHA-256	Dagger-Hashimoto	Scrypt	Transaction cumulation	X11	Transaction cumulation	Scrypt	Transaction cumulation
Max number of tabulation	21	~ 90	84	4300	22	∞	2000	10

Parameter	Bitcoin	Ethereum	Litecoin	MaidSafe Coin	Dash	Factom	Syscoin	Xaurum
units, mln								
Market capitalization, mln USD (06.01.2018)	295,556.76	101,205.94	16,253.71	466.05	9,864.38	557.98	442.92	18.14
The quantity of full units paid for one mined block	*[1]	-	-	*[2]	*[3]	-	128	-
Types of network security used[4]	PoW[5]	PoW	PoW	PoR[6]	PoW	PoE[7]/ PoP[8]/ PoA[9]	PoW	PoS[10]
Possibility of the anonymous transactions	No	No	No	No	Yes	No	No	No
Creator (country)	Satoshi Nakamoto (-)	Vitalok Buterin (Canada)	Charles Lee (-)	David Irvine (Scotland)	Evan Duffield (-)	Paul Snow, Peter Kirby and David Johnston (USA)	Dan Wasyluk (USA)	Slovenia

Notes:

[1] The reward for a block at the beginning of mining (2009) is 50 coins and it is reduced by 50% every 210,000 blocks.

[2] The reward depends on the CPU speed, bandwidth availability, storage space and online time.

[3]The quantity of full units paid for one block mined is calculated by the following formula: 2,222,222/(((difficulty+2,600)/9)^2), where difficulty is the current complexity of calculating a new block in the network.

[4] The decentralized system protection from the users not entitled to receive the units of a cryptocurrency system.

[5] Proof of Work (PoW) is a security mechanism based on the verification of the work done.

[6] Proof of Resources (PoR) is a security mechanism based on the provision of computational resources.

[7] Proof of Existence (PoE) is a security mechanism based on the verification of the data existence in a certain form at a certain moment.

[8] Proof of Process (PoP) is a security mechanism based on the verification of the data update.

[9] Proof of Audit (PoA) is a security mechanism verifying the audit, i.e. the check of the modifications in the updated data .

[10] Proof of Stake (PoS) – the proof is guaranteed by the amount of coins in the wallet multiplied by their “age” or the period they have been held.

The main advantages of the existing centralized systems are: 1) personal data security; 2) electronic money coverage by the legitimate money or precious metals; 3) rigorous exchange rate of electronic and traditional money; 4) official representative responsible for the system functioning and regulation; 5) the existence of a centralized authority responsible for dispute resolutions and the consideration of claims; 6) available account blocking and the rejection to make suspicious transfers.

The typical disadvantages of centralized electronic money systems are: 1) the centralized system management and data storage; 2) low transparency of the system performance (no access to statistics, the complexity of the data check); 3) no public access to the statistics on electronic money (on each electronic money system, in particular); 4) impossible real-time monitoring and audit of the electronic money operators' activities by the Central Bank; 5) possible uncovered emission of electronic money.

The advantages of the decentralized cryptosystems are: 1) their independence of the attacks or certain server failures due to the territorial distribution of the network; 2) the transparency of all financial operations; 3) the availability of the source code of the software, which enables the user to modify the system; 4) high levels of cryptoresistability enough for the safe storage of personal data and financial information; 5) the immediate disclosure of the amount of the transfer in the sender's and receiver's digital wallets; however, the confirmation of the transaction takes some time before the receiver will be able to use the money.

The weaknesses of decentralized cryptosystems are: 1) the absence of the centralized authority responsible for controlling the system functioning; 2) impossible resolutions of claims due to the absence of an official representative of the cryptosystem; 3) the absence of the guaranteed coverage of a unit; high volatility of the cryptosystem units which depends on its demand; 4) possible implementation of the «51 %» (Note 1) and «dust» (Note 2) attacks; 5) impossible account blocking and the rejection of suspicious transfers, i.e. management of the account status and the transfer process; 6) the impossible recovery of the private key of the digital wallet and the cancellation of transfer; 7) low speed of transaction confirmation (about 1 hour); 8) impossible changes of the private key of the digital wallet (the storage of the cryptocurrency in the compromised digital wallet becomes insecure).

3. METHODOLOGY

The empirical analysis is carried out through the panel GMM approach. The authors use Gompertz and Pearl-Reed functions and others. The models are based on spatial structuring of information (cross-sectional data), computer-aided tools and time-series data analysis. The data base includes the information from Russia, Belorussia, Armenia. Kazakhstan, Kirgizstan [8, 17-25]. We formulate the proposals on the improvement of the electronic money system using the block-chain technology. We also characterize the requirements to cryptocurrencies as the types of electronic money and forecast the number, as well as the amount of transactions processed with electronic money in the middle growth countries.

The improvements of the payment system are focused on the development of methodological tools of assessment and modeling of its elements as well as on the implementation of electronic transactions contributing to higher quality of customer care. The modeling allowed the authors to reveal the impact of factors on the number and the amount of transactions with electronic money and assess the probability of their increase in the future.

We used series of steps:

- investigated the dynamics of money supply based on the criteria such as population, bank interest rates, quantities of service points, and others;
- defined the indexes by key terms in Google, Bing, Rambler, Yahoo, Lycos, Yandex, Aol, Metabot;
- collected the data base from web-sites of International Monetary Fund, Bank for international settlements, the Federal Reserve System, European Central Bank, Central Bank of the Russian Federation (Bank of Russia), Bank of the Kyrgyz Republic, Central Bank of Republic of Armenia, National Bank of the Republic of Belarus, National Bank of the Republic of Kazakhstan;
- examined the summary statistics: the unit root properties in the data through advanced panel unit root Pesaran CD test, Dickey-Fuller regressions;
- determined the degree of integration in the respective variables using the Smith tests;
- confirmed that the null hypothesis of a unit root is not rejected;
- checked the validity of instruments by Hansen J-test;
- forecasted the dynamics of the number of users in the legitimate cryptocurrency system based on the Gompertz and Pearl-Reed functions growth curves.

4. DATA AND EMPIRICAL ANALYSIS

Researchers have explored the dynamics of money supply based on certain drivers such as population, bank interest rates, quantities of service points, and others. Moreover, they have investigated the information on the adjustment of money supply in the conditions of changing digital technologies. Chiu and Wong [26] measure the instability of the e-money usage (or the systemic risk) in both centralized and decentralized systems. They describe the private issuance of e-money and found that network externality, social welfare and pricing scheme impacted the amount of e-money. Fung et al. [27] document that e-money varies across demographic groups based on regional, age, income and educational characteristics. Gans and Halaburda [28] and Fung [29] investigate the role of the Facebook and other social networks within the monetary mechanism. They illustrate that the popularity of cryptocurrencies on social networks influenced on growth of their volumes. Alvarez-Ramirez et al. [30] and Nadarajah and Chu [31] investigate the commission rate on settlement and payment transactions, for input-output of legal money from an electronic payment system, commission rate for the transactions by electronic money by means of five different tests on Bitcoin returns. They find that the market for Bitcoin presents correlations with respect to increasing and decreasing price trending. Meaning et al. [32] explore the role of interest rates and their impact on the monetary transmission mechanism, as well as the demand for e-cash. Tompkins and Galociova [33] examine e-payment segments associated with payments in POS (point-of-sale, or point-of-service) environments. Schuh [34] and Worner [35] explore the role of the digital money market in transactions, fees, market capitalization, volume index transaction costs, the monthly average of transaction fees paid, payments for service and so on. According to his opinion, transaction costs, transaction fees paid for input-output of legal money from an e-money system, the number of electronic money operators and exchange points influence on the amount of e-transactions.

As electronic money appeared at the end of the previous century, but the process of introduction in the everyday life has been extended since 2010, we have chosen a spanning research period from 2011 to 2018, while all data are on a quarterly basis. Following the main target, we investigated the dynamics of payment systems in the cases of Russia, Belorussia, Kazakhstan, Kirgizstan, Armenia.

Based on the above discussion, the model employed in the empirical analysis is described as follows:

$$ETRit = bi + a1\ AGEPOPit + a2\ COMMit + a3\ COMM1it + a4\ COMM2it + + a5\ OPERit + a6\ EXCHit + a7\ ORGit + a8\ INDEXPOPit + \varepsilon \quad (1)$$

where, *ETR* is the number of electronic transactions. *AGEPOP* is number of working-age population. There is the direct link between the number of working age population and the number of the settlement and payment operations: if the first increases, the second also increases. *COMM* shows banks' commission rate on settlement and payment transactions. In practice the average minimum commission in the banks' settlement and payment system is much higher than in electronic payment systems. Thus, the level of the minimum commission is higher the operations for money transfers are less attractive. Therefore the appeal of wire transfers increases. *COMM1* - banks' commission rate for input-output of legal money from an electronic payment system. The commission for input-output of legal money from an electronic payment system is way to collect the payment for application of the electronic account (e-wallet). If these expenses exceed the received benefit from electronic payment, the number of electronic transfers decreases. *COMM2* shows banks' commission rate for the transactions by electronic money. Electronic money will be demanded as the innovative tool in case the transactions commission is insignificant. *OPER* is number of the registered electronic money operators. Increase in number of officially registered operators of electronic money promoters, increase in trust to a new product from users can stimulate the development of electronic money. At the same time both the number of clients and number of the operations grow. *EXCH* denotes number of collection and exchange points of electronic money (shops, schools, universities, drugstores, gas stations, housing and public utilities). Obviously, the more of collection and exchange points in the market, the probability of use of cheaper, convenient and fast electronic payments is higher. *ORG* is number of the organizations providing discounts for payment in electronic money (on each 1000 companies). The maximum benefit of the sender of money is defined not only by the sum of the commission for the transaction but also the additional discounts for use of electronic money. *INDEXPOP* is the index of popularity in Yandex, Google and others. The index of popularity in Internet information systems indirectly influences opinion of the users obtaining necessary information: the index is higher, the more users are interested in electronic money. The defined objects, the phenomena, technologies and events are important for society if they are mentioned in Internet information systems. To define the index of popularity we have counted number of a mention of key terms (electronic money, e-money, electronic found, electronic currency) in Google, Bing, Rambler, Yahoo, Lycos, Yandex, Aol, Metabot. ε denotes the error term, while b_i captures country fixed effects.

Table 2: Summary statistics

Variables	Mean	Standard Deviation	Min	Max
Number of electronic transactions, thous.	145,960	361,662	1.9	1,348,240
Number of working-age population, thous.	25,057	38,734.1	2,000.9	103,996
Banks' commission rate on settlement and payment transactions, US dollar	0.3	0.1	0.19	0.41
Banks' commission rate for input-output of legal money from an electronic payment system, per cent	2.1	0.4	1.4	3.1
Banks' commission rate for the transactions by electronic money, per cent	0.5	0.2	0.2	0.8
Number of the registered electronic money operators	14.6	32.3	0.01	104
Number of collection and exchange points of electronic money, mln.	180.1	375.8	0.4	1,300
Number of the organizations providing discounts for payment in electronic money (on each 1000 organizations)	2.7	3.7	0	15
The index of popularity in Yandex, Google and others	22,765	93,024	1.1	587,637

In the first step of the empirical analysis, we examine the unit root properties in the data through advanced panel unit root tests. Before selecting the appropriate panel unit root test is crucial to provide some evidence on the degree of residual cross-section dependence. The CD test statistic by Pesaran [36] is based on a simple average of all pair-wise correlation coefficients of the OLS residuals obtained from the standard augmented Dickey-Fuller regressions for each variable in the panel. Under the null hypothesis of cross-sectional independence, the CD test statistic follows asymptotically a two-tailed standard normal distribution. The results, reported in Table 3, uniformly reject the null hypothesis of cross-section independence.

Table 3: Cross-section dependence (CD) tests

Variables	CD
CEC	8.714***
	[0.00]
CO_2	7.373***
	[0.00]
GDPPC	8.569***
	[0.00]
R&D	9.615***
	[0.00]
FDI	7.364***
	[0.00]
SMC	9.452***
	[0.00]
PD	7.916***
	[0.00]

Notes: Under the null hypothesis of cross-sectional independence the CD statistic is distributed as a two-tailed standard normal. Figures in parentheses denote p-values. Significance level: *** (1%).

Next, two second-generation panel unit root tests are employed to determine the degree of integration in the respective variables. The Pesaran [37] panel unit root test does not require the estimation of factor loading to eliminate cross-sectional dependence. The null hypothesis favours the presence of a unit root. The bootstrap panel unit root tests by Smith et al. [38] utilize a sieve sampling scheme to account for both the time series and cross-sectional dependence in the data through bootstrap blocks. All four tests by Smith et al. [38] are constructed with a unit root under the null hypothesis. The results are reported in Table 4. They document that the null hypothesis of a unit root is not rejected across all variables considered in levels.

Table 4: Panel unit root tests

Variable	**Pesaran CIPS**	**Pesaran CIPS***	**Smith et al. t-test**	**Smith et al. LM-test**	**Smith et al. max-test**	**Smith et al. min-test**
ETR	-1.27	-1.34	-1.36	3.42	-1.34	1.35
ΔETR	-5.83***	-5.75***	-5.74***	21.68***	-6.82***	6.19***
AGEPOP	-1.32	-1.39	-1.43	3.52	-1.34	1.34
ΔAGEPOP	-5.64***	-5.82***	-6.39***	20.64***	-7.91***	7.59***
COMM	-1.29	-1.37	-1.35	2.58	-1.27	-1.32
ΔCOMM	-6.38***	-6.81***	-6.84***	20.69***	-6.88***	-7.48***
COMM1	-1.24	-1.34	-1.29	2.74	-1.23	-1.31
ΔCOMM1	-7.52***	-7.59***	-7.24***	23.89***	-7.58***	-7.96***
COMM2	-1.38	-1.43	-1.35	2.47	-1.30	-1.35
ΔCOMM2	-6.71***	-6.87***	-6.29***	20.56***	-6.82***	-6.79***

OPER	-1.42	-1.35	-1.32	2.82	-1.25	-1.38
ΔOPER	-6.85***	-6.92***	-6.85***	20.54***	-6.23***	-6.92***
EXCH	-1.39	-1.48	-1.31	2.53	-1.35	-1.32
ΔEXCH	-6.68***	-6.52***	-5.86***	19.49***	-5.68***	-6.85***
ORG	-1.42	-1.36	-1.28	2.28	-1.28	-1.36
ΔORG	-6.25***	-6.41***	-6.12***	21.18***	-6.04***	-6.71***
INDEXPOP	-1.37	-1.39	-1.34	2.41	-1.35	-1.30
ΔINDEXPOP	-6.16***	-6.53***	-6.36***	20.73***	-6.26***	-6.38***

Notes: Δ denotes first differences. A constant is included in the Pesaran [36] tests. Rejection of the null hypothesis indicates stationarity in at least one country. CIPS* = truncated CIPS test. Critical values for the Pesaran [36] test are -2.40 at 1%, -2.22 at 5%, and -2.14 at 10%, respectively. "***" denotes rejection of the null hypothesis at the 1% level. Both a constant and a time trend are included in the Smith et al. (2004) tests. Rejection of the null hypothesis indicates stationarity in at least one country. For both tests the results are reported at lag = 3. The null hypothesis is that of a unit root.

The empirical analysis is carried out through the panel GMM approach. The GMM methodology avoids potential endogeneity and is based on the approach recommended by Arrelano and Bover [39] and Blundell and Bond [40]. The Hansen test for over-identification can be used to check the validity of instruments, while a two-step system GMM provides more efficient estimators over one-step system GMM. Moreover, two-step GMM gives robust Hansen J-test for over-identification.

The empirical findings are reported in Table 4. The results document that increased working aged population, banks' commission rate on input-output of legal money from an electronic payment system, banks' commission rate on the transactions by electronic money, the number of the registered electronic money operators, the number of collection and exchange points of electronic money, and the index of popularity in Yandex-Google, are all related to higher electronic transactions, while banks' commission rate on settlement and payment transactions exert a negative impact on electronic transactions.

All the relevant diagnostics are reported at the bottom of Table 5. For the validity of the instruments, the results need to reject the test for second-order autocorrelation, AR(2), in the error variances. Moreover, they need to reject the null hypothesis of difference-in-Hansen tests of the exogeneity of instruments. It is evident that both the test for AR(2) of disturbances and the difference-in-Hansen tests fail to reject the respective nulls. Thus, these tests support the validity of the instruments used, while difference-in-Hansen tests imply the exogeneity of the instruments employed. The table also reports the Hansen test for over-identifying restrictions. In the estimation process, 32 instruments have been used. These instruments were generated as we used two lags for levels and three lags for difference in the regressors. As the number of instruments was by far lower than the number of observations, it did not create any identification problem, as reflected in the Hansen test. Reported Hansen test results also fail to detect any problem in the validity of the instruments used in the estimation approach.

Table 5: GMM estimates

Variables	Coefficients
ΔETR(-1)	0.574***
	[0.00]
ΔAGEPOP	0.061***
	[0.00]
ΔAGEPOP(-1)	0.059***
	[0.00]
ΔCOMM	-0.030***
	[0.00]
ΔCOMM(-1)	-0.059***
	[0.00]
ΔCOMM1	-0.052***
	[0.00]
ΔCOMM1(-1)	0.048***
	[0.00]
ΔCOMM1(-2)	0.021**
	[0.05]
ΔCOMM2	-0.040***

	[0.01]
ΔCOMM2(-1)	-0.028***
	[0.00]
ΔOPER	0.086***
	[0.00]
ΔOPER(-1)	0.047***
	[0.00]
ΔEXCH	0.029***
	[0.01]
ΔEXCH(-1)	0.022**
	[0.03]
ΔORG	0.038***
	[0.00]
ΔORG(-1)	0.033**
	[0.04]
ΔINDEXPOP	0.046**
	[0.03]
ΔINDEXPOP(-1)	0.031**
	[0.05]
ΔINDEXPOP(-2)	0.018*
	[0.07]
Diagnostics	
R^2	0.67
AR(1)	[0.00]
AR(2)	[0.49]
Hansen test	[0.54]
Difference Hansen test	[0.80]

Notes: AR(1) is the first-order test for residual autocorrelation. AR(2) is the test for autocorrelation of order 2. Hansen is the test for the over-identification check for the validity of instruments. The difference-in-Hansen test checks the exogeneity of the instruments. Figures in parentheses denote p-values. *:p≤0.10; **: p≤0.05; ***: p≤0.01. All estimations were performed with time dummies and coefficients are not reported.

The future development of electronic money and higher efficiency of the payment systems will be the legitimation of the financial settlement instruments based on the block-chain technology. The sufficient benefits of the use of the cryptocurrency recognized by law allow us to assume the substantial users' demand for settlement transactions, which may lead to the growing profitability of the system exploitation. This assumption is justified by the forecast of the dynamics of the number of users in the legitimate cryptocurrency system based on the Gompertz and Pearl-Reed functions growth curves (Fig. 1).

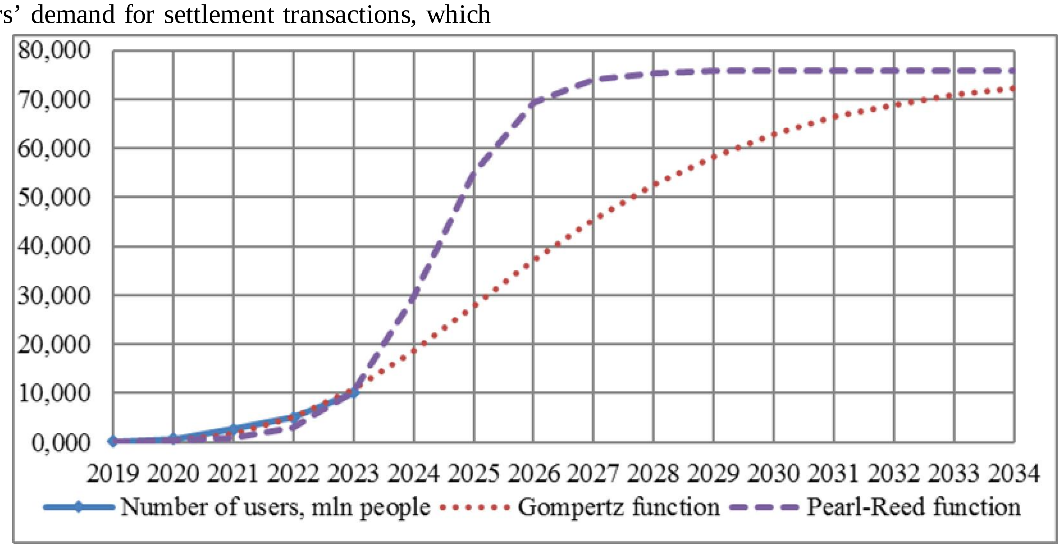

Figure 1: The forecast of the dynamics of the number of users in the modeled cryptocurrency system based on the Gompertz and Pearl-Reed functions and actual data of the Bitcoin system, mln people [40]

Despite the annual reduction in the number of operators of money transfers (from 958 in 2011 to 735 in 2015), there is a growth of the number of the operators of electronic money transfers (from 38 in 2012 to 104 in 2015), which is evident for the increase in the electronic money supply, the amount of its circulation and the number of the non-cash settlements with its use. According to this forecast, in the future the number of the transactions and the amount of operations with electronic money will be growing every year (Fig. 2).

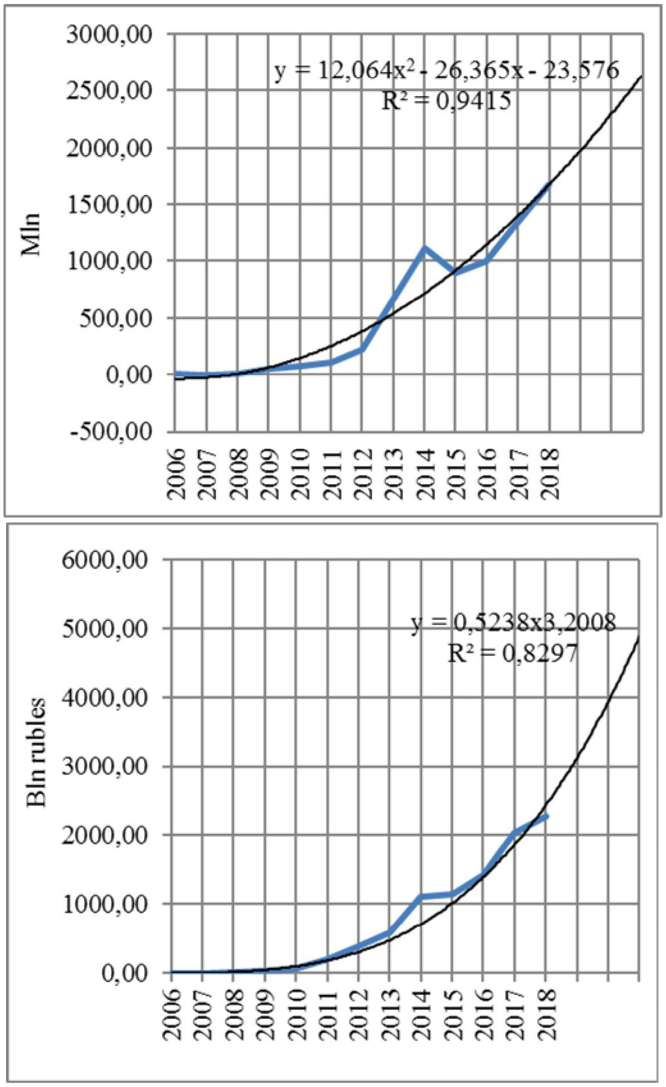

Figure 2: The forecast of the number (mln) and the amount (bln US dollar) of transactions with the electronic money [41]

5. CONCLUSIONS

This paper investigated the dynamic link between the number of electronic transactions, the number of working-age population, banks' commission rate on settlement and payment transactions, the number of the registered electronic money operators, the collection and exchange points of electronic money, the organizations providing discounts for payment in electronic money and the index of popularity in Internet for a panel of five post-socialism countries, spanning the period 2010-2017. The empirical analysis was based on the methodology in relevance to panel data, including second-generation panel unit root tests, panel GMM estimates, the test for second-order autocorrelation, and panel causality tests. More specifically, the goal of this study was to: i) examine the impact of control variables on the number of electronic transactions, ii) to investigate the short- and long-run association among the variables under study, and iii) to forecast the dynamics of the number of users in the legitimate cryptocurrency system.

The empirical findings documented that the variables under consideration are all related to higher electronic transactions except the banks' commission rate on settlement and payment transactions. According to these results, in the future the number of electronic transactions and volume of the operations is expected to increase. The comparison of the approaches in relevance to the organization of centralized and decentralized electronic payment systems, based on the block chain and cryptographic security technology, has allowed us to reveal a small risk, high reliability and the safety of the operations in the decentralized cryptocurrency systems. However, the features of the modern operating cryptocurrencies do not allow us to apply them to the generation of legitimate decentralized cryptocurrency systems. Therefore, to start off the official use of the block chain technology in national payment systems it is necessary to eliminate any defects of the decentralized approach, to provide the possibility of cryptosystem management, and to monitor the associated procedures and regulations.

The recommendations raised by the empirical findings are associated with: i) the implementation of cryptocurrencis is an integral part of the development of an Internet economy and the direction of economic development; ii) in addition to the economic effects of a cryptocurrency in national payment systems, the positive social result consists of an increase in the level of transparency and safety of carrying out settlement and payment operations. The results would be a good opportunity for further research venues to explore any potential mechanisms of the development of electronic payment systems.

NOTE

Note 1. «51 %» attack is the capture of the biggest part of the computing power of the decentralized network, with leads to the possible modification in the blockchain order for the attacker's benefit.

Note 2. The "Dust" attack is a great number of microtransactions sized up to 0.0001 BTC sent to the decentralized electronic payment and settlement system within a short period of time, which hinders its performance increasing the period of the transaction confirmation.

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