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CONFERENCE PAPER

# Overseas Transaction Fees: Sending Money via Bitcoin vs. Banks

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***Abstract:*** An important feature of every financial system throughout history is its capability to facilitate transfer of money in a secure and cost efficient manner. Cryptocurrencies as sources of innovative solutions – especially Bitcoin as their most prominent representative – have offered a completely new transmission system for a piece of information that can contain and carry value. There are many approaches to evaluate (un)successfulness of Bitcoin as money, and arguably one of the most important is to assess the fulfilment of its inventor's original proposition: can it be used to send money directly and securely abroad, to international destinations, without fear of double-spending? Moreover, by removing institutions and their fees from the system hierarchy, can it be done for a lower price? The objective of creating Bitcoin network (among others) was to promote democratization of finance by enabling monetary transactions over the internet without unnecessary intermediaries inserting and charging multiple layers of fees. In decentralized, distributed blockchains such as Bitcoin and Ethereum subjects are incentivized to collectively maintain the public ledger (blockchain) by collecting block rewards ("coinbase") and transaction fees. Blockchain maintenance is known as mining, and miners are compensated for their effort in the form of fees (and coinbase rewards) for verifying transactions. The objective of this paper is to examine and compare fees for transferring money internationally by means of Bitcoin network, in contrast to using traditional pathways, mostly banks, and in this manner to scrutinize the proof of concept and one of the cryptocurrency solutions to the issue of money transfer. By doing so we are attempting to provide answers to the questions of functionality and cost-effectiveness of an alternative financial system based on the blockchain technology. Transaction fees for international payments made by Bitcoin are compared by analysing a novel dataset obtained from World Bank and Croatian National Bank (CNB). CNB's data is not publicly available, and was attained for this paper specifically. It contains 1.400 types of fees charged by the 23 banks operating in Croatia for the period of October 2018 to February 2022. Bank fees for international transactions were matched with Bitcoin fees in the same period, with the data taken from Blockchain.com online service. On average, to send 1,000 USD abroad by using Bitcoin network required approx. three times less in fees than by using banks in Croatia. The calculation structure of bank

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fees, also presented in the paper, required higher costs for sending lower amounts (in terms of percentage); when transferring 200 USD banks worldwide charged on average approx. 30 times more in fees than Bitcoin miners. Additionally, transaction fees for international remittances were analysed with quarterly data from World Bank. Comparative analysis of these and Bitcoin fees was made, and it is clear that (on average) sending money abroad via Bitcoin network bears significantly lower costs for the end user, especially when transferring lower amounts. Due to the non-normality of the distributions of the underlying variables, non-parametric tests were applied and the null hypothesis that transaction costs have identical medians was rejected. In conclusion, when needing to transfer money internationally users can obtain significantly lower costs by using decentralized technologies such as Bitcoin's blockchain. This finding validates one of the key propositions of the distributed ledgers. Rather than focusing on wild daily Bitcoin price swings and its volatility, Bitcoin network functions as a cost-effective international payment system and proves itself as an alternative to traditional money transfer schemes.

***Keywords:*** blockchain; bitcoin; cryptocurrencies; transaction; fees

***JEL Classification:*** E42, G15, G21

## Introduction

An important feature of every financial system throughout history is its capability to facilitate transfer of money in a timely, orderly, secure, and cost efficient way. Cryptocurrencies – especially Bitcoin as their most prominent representative – have offered a completely new transmission system for a piece of information that can contain and carry value. If accepted by the receiver as such, this value can be regarded as money, and can have some (if not all) of money's functions. Even when not acknowledged on the receiving end as money per se, it can easily be converted into fiat currency quickly, practically everywhere.

The motivation to build an alternative financial system such as Bitcoin came from dissatisfaction of its inventor(s) with the traditional societal structures lulled in self-complacency by centuries of intermediation intertwined with rent extraction, with its elements deemed as too important and big to be faced with consequences of their often irresponsible behaviour. This is obvious from the *genesis block* of Bitcoin (the first block in its blockchain) which contains a message from the Bitcoin's originator, stating: "*The Times 03/Jan/2009 Chancellor on brink of second bailout for banks*" (Antonopoulos, 2017, p. 199), as a reference to the cover story of The Times newspaper from London (Elliott & Duncan, 2009) at the date. Discontent and frustration with institutions led to the development of an unconventional, innovative, decentralized system without institutions whatsoever, a system that attempts to serve as a secure channel for the transfer of value – value which can be perceived as money (or exchanged for it).

Even though there is no "official" vision and mission publicly declared, it is accepted as a truism that the objective of creating Bitcoin network was not building a new investment vehicle to enrich few fast, but – among others – to promote democratization of finance by enabling monetary transactions over the internet without unnecessary intermediaries inserting and charging layers upon layers of fees. Accordingly, there are many ways to evaluate (un)successfulness of Bitcoin as money, and arguably one of the most important, is to assess the (un)fulfilment of Nakamoto's (2008) original proposition: does it accomplish what it promises to do? Can it be used to send money directly and securely abroad, overseas – wherever – without fear of double spending? Furthermore, can a transaction party employ it in a cost efficient way?

Albeit cryptocurrencies and blockchain as their underlying technology have by now established their way into mainstream, they are still controversial and finding many opponents, as well as promotors who are nonetheless not blind to all the shortcomings and under-delivery of a viable, radically different financial system. Cryptocurrencies are accepted as money only anecdotally, and most merchants still prefer to do business only with government-backed (paper) money. Their value is extremely volatile, which makes them unpractical as a universal unit of account. They are not present for a long enough period to be considered as a good store of value, albeit they have realized very high returns from the time they came to fruition (in the range of 150 to 200 times the original investment for the period of 2015 – 2022). Hence, by being disruptive by design it does not come as a surprise that in practice they still are yet to deliver basic functions of money. However, from its inception and throughout of all its (still not too long) history, 99,98% of the time Bitcoin has functioned as a transaction system, it had only two out-of-order events, and its blockchain has never been hacked nor was anything ever stolen from it, even though its code is open-source and its operation maximally transparent.

Having this in mind, from a perspective of an end user, the objective of this paper is to examine and compare fees for transferring money abroad by means of Bitcoin network, as opposed to using traditional, "classic" money transfer systems, and in this manner to inspect one of the functions of this proposed innovative solution to sending and receiving money.

International transactions between citizens are frequently performed in the form of remittances, which are cross-border person-to-person payments of relatively low value, or (in other words) financial transfers from a migrant to a beneficiary in the migrant's country of origin (EU Commission, 2022). They represent the largest source of foreign income for many developing countries (Ratha, 2022). As such, analysis of remittance fees could be a valuable and effective test of realisation of cryptocurrencies' selling proposition, and database from the World Bank, expanded with the novel data obtained from Croatian central bank, was used to examine and compare transfer costs. The main hypothesis of the paper is that Bitcoin fees are much lower than those of banks, and that transferring money internationally via cryptocurrencies presently

has lowest (direct) costs to the transacting parties. To the best of our knowledge there are no previous studies dealing with these questions, which supports scientific contributions of this paper.

This paper is organized as follows. After this introduction, the second chapter delivers an overview of transaction fees in Bitcoin network and in (bank) remittances, and a brief outline of previous literature in this field. Third section explains what data was used, lists data sources, states the frequency of the data and the sample periods, discusses modifications to the raw data and explains the methodology used. Fourth chapter provides descriptive statistics and delivers and discusses the results of the comparative analysis. Finally, the fifth chapter concludes with implication of findings and its limitations.

## Transaction fees in Bitcoin network and for bank remittances

By now there is an abundant literature that explains and discusses the procedures, operation and details of Bitcoin's hashes, nodes, *mempool* and its other peculiarities (Narayanan et al., 2016; Antonopoulos, 2017; Judmayer et al., 2017; etc.), so here the focus is not to introduce the Bitcoin as a "novelty" to newcomers, but to outline some of the points that are of importance to the end users regarding the transaction mechanism in the context of this paper's objectives. Therefore, the idiosyncrasies and minutiae of original cryptocurrency mechanics will not be discussed here.

One of the important selling propositions of Bitcoin as a first widely accepted blockchain is that it enables low-priced payments regardless of the geographical location of the transaction parties, and as such it directly competes with traditional payment systems (Moeser & Boehme, 2015, p. 19). In decentralized blockchains such as Bitcoin and Ethereum subjects are incentivized to collectively maintain the public ledger by collecting block rewards and transaction fees. Blockchain maintenance is known as *mining* (Dujak & Sajter, 2019, p. 28), and miners are compensated for their work in the form of incentives for verifying transactions (a *coinbase* transaction with the miner as the beneficiary), and transaction fees. The fee is attached to a Bitcoin transaction by participant as a sort of a "tip" for the miner, thereby wanting to ensure that the miner includes the "tipped" transaction in the blockchain.

Major blockchains currently use "pay your bid" or "first-price" type of auction, where the miners' main strategy is to take the highest bids (Chung & Shi, 2022, p. 1; Roughgarden, 2021, p. 2). Such a design of the system could impede Bitcoin usage, because users bid between themselves to get transactions embedded in the blockchain, and in the process fees sometimes rise to such levels that deter from Bitcoin. Hence, higher transactions costs could obstruct its expansion as a transaction service (Easley et al., 2019, p. 5). Miners search for highest fees, but users aim to pay the lowest possible price for the inclusion in the block, and must strategically determine

the lowest bid they can submit such that it will be included in the blockchain, which is known as "bid shading" (Lavi et al., 2019, p. 2951). Wallets use various estimation techniques to find optimum fee amount. Size of the block is here crucial, since increasing block size implies smaller transaction fees, and the block size therefore considerably influences miners' income (Lavi et al., 2019, p. 2950).

The Bitcoin system limits the number of transactions that a block can contain, so that miners prioritize transactions with larger fee. Consequently, the confirmation time of transactions with a low fee are likely to be longer than those of transactions with a large fee (Kasahara & Kawahara, 2019, p. 366). In case of micro-payments the fees are also likely to be "micro", which hinders the development of the network for the processing of smaller amounts since the confirmation time of transactions with micro fees will be too long for users to even make micro payments. Easley et al. (2019, pp. 38–39) argue that increasing transaction fees would increase the number of miners, but this would produce escalation in the difficulty level to control the creation of new blocks, and in that way raise the miners' costs, which in turn would not result in an overall increase in miners' compensation.

The protocol does not explicitly specify amount of fees, and it is up to the transaction participant to decide on its amount. This also indicates that if the transaction is not "tipped" it will most likely not get validated and included in the blockchain. If there were no fees at all, in the long run blockchain would not be maintained, since a decreasing coinbase reward which dissipates (halving every four years) was designed, and will eventually fade away completely. Moeser and Boehme (Moeser & Boehme, 2015) performed longitudinal analysis of 55.5 million transaction records, and found several regime shifts in agents' behaviour related to the payment of transaction fees. They conclude that the level of transaction fees is primarily driven by social norms and conventions rather than set by the protocol's market mechanism.

Even though the fees are not yet the largest component of miners' total revenues, the development of transactions fees reflects an important step in the evolution of the bitcoin blockchain from being a mining-based set of rules, toward a market-based system capable to adapt to changing economic conditions (Easley et al., 2019, p. 3).

Albeit it cannot be considered as a novelty, Bitcoin is still "fresh", and only approx. 10% of the world population either owned or used cryptocurrencies in 2020 (calculation by author, sources: Statista, 2022; Worldometer, 2022). Share of the population without access to bank services or similar organizations worldwide in 2021 ("the unbanked" population) is approx. 25% (calculation by author, sources: Merchant Machine, 2022; Worldometer, 2022). This means that there are 7.5 times more people throughout the world with access to banks than those who use, or have used cryptocurrency. When comparing Bitcoin adoption internationally Parino et al. (2018) found that it is highly correlated with the population, the GDP per capita, the freedom of trade and the Internet penetration, and that its adoption in developing

countries increased slowly. As such, low acceptance prevents cryptocurrencies from being more widely used as a transaction medium in the context of remittances.

One of the major sources of foreign exchange earnings for low-and middle-income countries are remittances, and for many countries these income flows surpass incomes from tourism, foreign direct investment and official development aid. Official statistics are most likely underestimated since a large proportion of transfers is made through informal channels (Ahmed et al., 2021, p. 2).

Lowering the costs of transferring remittances is one of the targets of the United Nations' 2030 Sustainable Development Goals, and by reducing average costs to 3% globally, remittance families would save an additional 20 billion USD annually (United Nations, 2022). There is a trade-off between more frequent remittances and increased transaction costs (Zhu, 2016, p. 28).

Ahmed et al. (2021) found that transaction costs are a significant predictor of the volume of remittances, and that a 1% decrease in the cost of remitting USD 200 leads to about a 1.6% increase in remittances. Reducing the costs of sending money from the current level of 7% to the 3% target of United Nations' 2030 Sustainable Development Goals would almost double the volume of formal remittances (Ahmed et al., 2021, p. 17).

The onset of cryptocurrencies coincided but also advanced promotion of financial technology (*fintech*), which is a broader term that encompasses blockchain and all other technologies used to enhance and improve financial services and processes. Bersch et al. (2021) analysed the potential of fintech to facilitate cheaper and more efficient remittances, and to improve financial inclusion in Central America. They concluded that fintech facilitates cross-border payments, and that greater competition could further decrease fees. They did not, however, include cryptocurrencies in their analysis, even though they observed that traditional key players in the industry, such as Western Union and MoneyGram, have enabled their clients to transfer funds directly to mobile wallets using blockchain, and partnered with the global settlement and currency exchange network Ripple to provide real-time messaging, clearing and settlement of remittances (Bersch et al., 2021, p. 10). Fintech companies can be viable alternatives to traditional remittance service providers (Hahm et al., 2019, p. 24).

## Data and methodology

Three data sources were used and compared to analyse transaction fees for sending money internationally:

1) The World Bank (WB),
2) Croatian National Bank (CNB) and
3) Blockchain.com.

The WB data on remittances (World Bank, 2022) consists of total costs of the transaction in percentage when transferring 200 USD and 500 USD across borders.

It encompasses 214 countries and territories in the period dating from 1st quarter of 2011 to 3rd quarter of 2021, with 151.255 data entries. Observations are arranged and published quarterly.

The data on international transaction fees regarding banks operating in Croatia was attained from the CNB. Only a segment of this data is directly accessible and freely downloadable (Croatian National Bank, 2022b); full database was obtained for this paper from the CNB upon query. It contains 312 Fee Information Documents (FIDs) with 1.400 types of fees from 23 banks, which the banks were obliged to deliver to the Central bank.

Since the fees provided by the World Bank are denominated in US dollars, all of the data from CNB which is denominated in kunas (HRK) were converted to US dollars with middle exchange rate at the date of delivery of FID to the CNB. Historical exchange rates of HRK to USD were also taken from CNB (Croatian National Bank, 2022a). The FID's were delivered in the period from October 29th 2018 to January 31st 2022, with irregular frequencies. Observations were grouped quarterly and averaged to obtain required comparability with WB data. This procedure condensed the database to 14 average quarterly international transaction fees across the entire Croatian banking system in the period dating from 4th quarter 2018 to 1st quarter 2022.

As explained, Bitcoin users have to pay fees to miners regardless of the amount paid. This is in contrast to the fee structure of traditional payment systems commonly used by banks (in Croatia and elsewhere) for remittances and other international transactions, which is usually formulated as:

*a* %; min. *b*; max. *c*; + *d*; where

*a* = international money transfer fee,

*b* = minimum amount of fee to be charged to the client,

*c* = maximum amount of fee to be charged to the client, and

*d* = additional costs of the transaction.

In Croatia medians for *a*, *b*, *c* and *d* in the observed period were 0,50%; min. 80 HRK; max. 500 HRK; 15 EUR. With these median amounts in order to send 200 USD abroad required the following calculation; the nominal fee is 0,50 % x 200 USD (≈ 1,300 HRK) = 6.50 HRK; since here the fee is lower than the minimum, the minimum of 80 HRK plus 112.50 HRK (≈ 15 EUR) = 192.50 HRK would be charged, which in total makes a fee of 14.8 % (= 192.50 / 1,300).

Total fees decline in terms of percentage with higher amounts to be transferred, and to transfer 1,000 USD takes also 192,50 HRK in fees, which is 2.96 % of the transfer amount. This is the reason why fees were expressed for sending different amounts (200/500/1000) in a transaction.

Bitcoin data was downloaded from internet (Blockchain.com, 2022), and it consists of daily average transaction fees in USD per transaction in the period of January 17th 2009 to April 9th 2022, with daily frequency. These observations were also grouped quarterly and averaged in order to make them comparable with other two

sources. Grouping and averaging was performed twice; separately for the WB and for the CNB. This is because raw data from WB and CNB came in different frequencies, and only dates for which data was available was used to calculate quarterly averages of Bitcoin (BTC) fees.

After arranging all of the data, the comparative analysis was performed. Beside descriptive breakdown, statistical analysis attempted to examine if the differences between fees are substantial and statistically significant. First step was testing for normality of the distributions by using the Kolmogorov-Smirnov test with Lilliefors probabilities and Shapiro-Wilk W test.

The Kolmogorov-Smirnov one-sample test for normality is based on the maximum difference (*d*) between the sample cumulative distribution and the hypothesized cumulative distribution. The hypothesis that the respective distribution is normal should be rejected if the *d* statistic is significant. When the mean and standard deviation of the hypothesized normal distribution are not known (they are estimated from the sample data) in a Kolmogorov-Smirnov test, then the probability values are not valid, and instead the Lilliefors probabilities should be used in determining whether the Kolmogorov-Smirnov *d* statistic is significant.

The Shapiro-Wilk W test is also used in testing for normality. If the W statistic is significant, the hypothesis that the respective distribution is normal should be rejected. The Shapiro-Wilk W test is the preferred test of normality because of properties as compared to alternative tests.

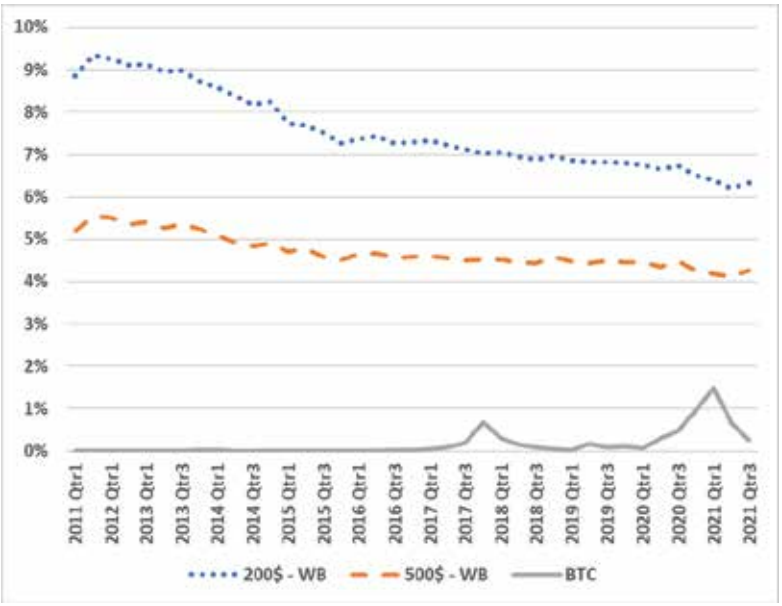
If the underlying distributions are not normal according to the above tests, analysis of variance (ANOVA) will be performed. The purpose of ANOVA is to test for significant differences between means by comparing variances. Friedman ANOVA is a nonparametric alternative to one-way repeated measures analysis of variance. The null hypothesis for the procedure is that the different variables contain samples drawn from the populations with identical medians. Additionally, Kendall concordance coefficients will be calculated which express the simultaneous association between rankings among variables. The range of coefficient is from 0 to +1; values close to zero represent lack of agreement in the rankings of the variables among cases, while values close to one represent perfect agreement in the rankings of the variables among cases.

## Results and discussion

International transaction fees of sending 200 and 500 USD via traditional financial system (mostly banks) worldwide are declining. In the last decade they decreased from approx. 9% to 6% when sending lower amount such as 200 USD. Conversely, if the amount to be transferred is higher (500 USD), the decline was not so substantial and noticeable – from cca 5.5% do 4.5% (Graph 1). In the same period BTC fees had

two spikes in the periods when there were large volumes of transactions (end of 2018 and beginning of 2021), but in the whole period remained considerably lower than the bank fees.

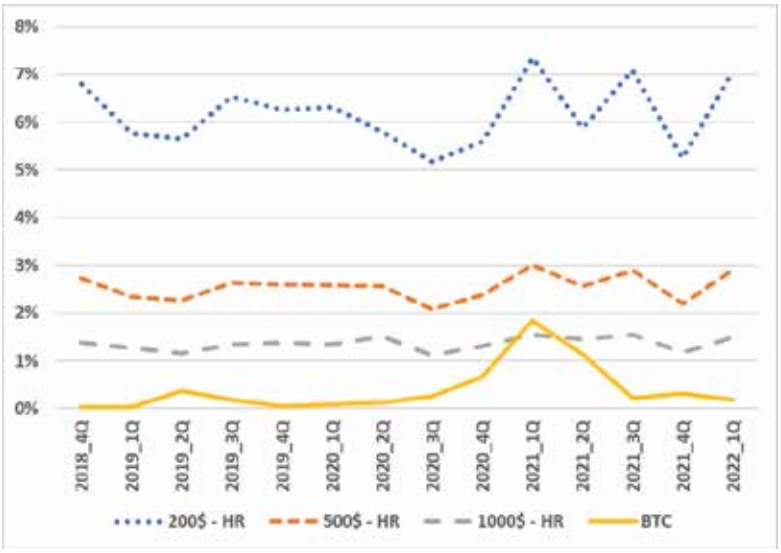
Graph 1: Average global quarterly international transaction fees of sending 200 and 500 USD via traditional financial system vs Bitcoin network




Source: author, data from World Bank (2022) and Blockchain.com (2022)

When observing the average quarterly international transaction fees of sending money via banks in Croatia in comparison to Bitcoin network fees, first it should be noted that the examined period is shorter than at WB vs BTC breakdown. In this window of analysis there is no clearly observable trend (Graph 2), and bank fees oscillate from approx. 5 to 7% for a 200 USD transaction. Apart from the amounts of 200 and 500 USD, another series of 1000 USD was added to expand the study, and to demonstrate that the proportion of fees (in terms of percentage) declines with the rise of the transacted amount. There was only one occurrence when BTC fees were higher than those from banks, and this was in the first quarter of 2021 when transferring 1000 USD abroad was more expensive over Bitcoin network than over banks in Croatia.

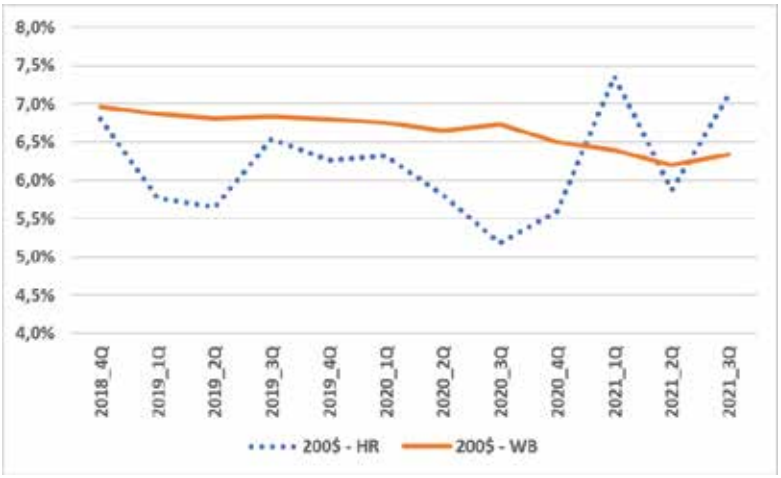
Graph 2: Average quarterly international transaction fees of sending 200, 500 and 1000 USD via banks in Croatia vs Bitcoin network




Source: author, data from CNB (2022b) and Blockchain.com (2022)

It is useful and convenient to observe competitiveness of Croatian banks in comparison to international transaction fees worldwide when transacting 200 USD (Graph 3). For the period where the WB and CNB data coincide it is apparent that most of the time, until recently, fees in Croatian banks were lower than the global average. Since the WB data series here consists of more than 200 countries and territories its volatility is lower, as oscillations within different countries tend to cancel each other out.

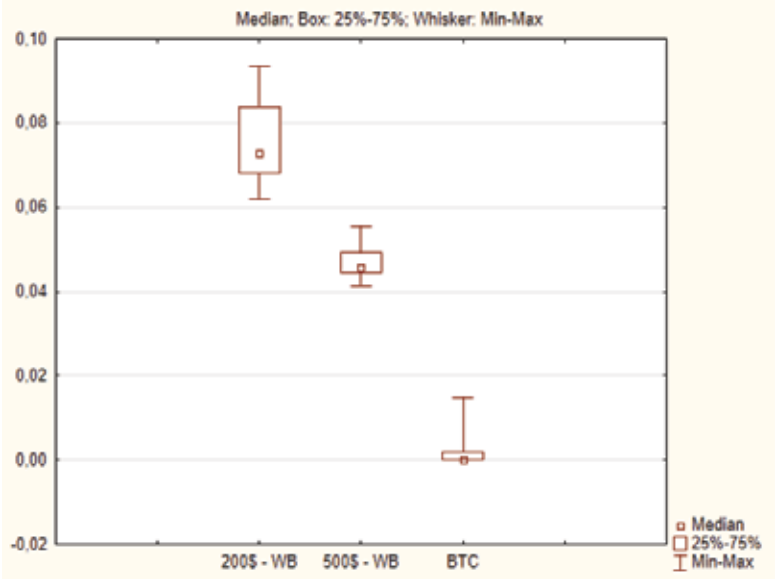
Graph 3: Average quarterly international transaction fees of sending 200 USD via banks in Croatia vs banks worldwide




Source: author, data from World Bank (2022) and CNB (2022b)

The considerably lower fees of Bitcoin network in contrast to traditional financial system in the period from 1st quarter 2011 to 3rd quarter 2021 are visible in the Box-Whisker plot of average quarterly international transaction fees for sending 200 and 500 USD (Graph 4). Maximum amount of BTC fees in the observed period was still more than 2% lower than the minimum fee when sending 500 USD over banks worldwide, and more than 4% lower than minimum for sending 500 USD over traditional financial institutions.

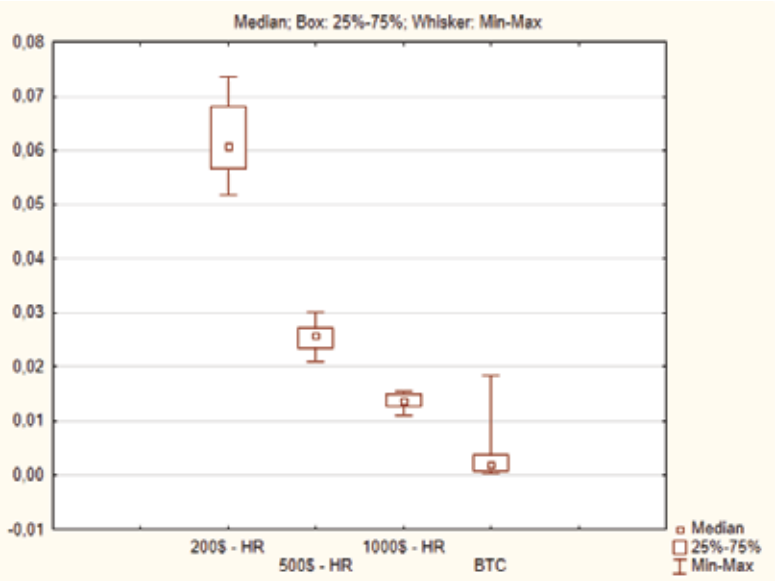
Graph 4: Box-Whisker plot of average quarterly international transaction fees for sending 200 and 500 USD via banks worldwide vs Bitcoin network in the period of 1Q 2011 to 3Q 2021




Source: author, data from World Bank (2022) and Blockchain.com (2022)

The Box-Whisker plot of average quarterly fees in the period of last quarter of 2018 to 1st quarter of 2022 for sending 200, 500 and 1000 USD by using banks in Croatia and by using Bitcoin network (Graph 5) confirms already shown insight about lower costs of transactions over BTC for the end user in regard to international transfers.

Graph 5: Box-Whisker plot of avg. quarterly international transaction fees for sending 200, 500 and 1000 USD via banks in Croatia vs Bitcoin network in the period of 4Q 2018 to 1Q 2022




Source: author, data from CNB (2022b) and Blockchain.com (2022)

Descriptive statistics of two variables attained from the World Bank (sending 200 and 500 USD worldwide) and Bitcoin fees for the period of ten and a half years are presented in Table 1. Bitcoin fees are considerably lower than fees from traditional financial system both when examining means and medians. Coefficient of variance is noticeably higher at BTC and its distribution is positively skewed and leptokurtic. The high variability of BTC fees is evidently a drawback for all potential users.

Table 1: Descriptive statistics of international transaction fees for sending 200 and 500 USD via banks worldwide and Bitcoin network for the period of 1Q 2011 to 3Q 2021

| Variable (transaction amount) | No. of obs. | Mean | Median | Min. | Max. | Variance | Std. dev. | Coef. var. | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| 200$ (World) | 39 | 7,56% | 7,27% | 6,20% | 9,34% | 0,01% | 0,93% | 12,35 | 0,62 | -0,94 |
| 500$ (World) | 39 | 4,71% | 4,58% | 4,13% | 5,54% | 0,00% | 0,38% | 8,15 | 0,82 | -0,39 |
| via BTC | 39 | 0,16% | 0,02% | 0,00% | 1,48% | 0,00% | 0,31% | 188,25 | 2,86 | 8,99 |

Source: author, data from World Bank (2022) and Blockchain.com (2022)

Descriptive statistics of three variables procured from the Croatian National Bank (sending 200, 500 and 1000 USD worldwide) and Bitcoin fees for the period of four years are presented in Table 2. Consistently with previous analysis, transaction parties in Croatia would be significantly better of (in terms of transaction fees) if they would send money internationally by using Bitcoin network than by using banks, which is emphasised in situation where the amount to be sent is somewhat lower. Following this insight it should be noted that the fee calculation structure within banks in Croatia is such that to transfer 1000 USD from Croatia to another (non-EU) country users on average needed to pay almost five times lower fees than to transfer 200 USD (in terms of percentage). Such fee calculation arrangement makes international transfer of lower amounts of money internationally via banking system in Croatia unfavourable. It is reasonable to assume that lower transaction amounts are executed by users with lower income, and charging higher fees to users with lower income could be described as a discriminating practice. This is important in the context of the intentions and propositions of blockchain technology as a tool of financial inclusion of the unbanked, mostly low-income population.

Table 2: Descriptive statistics of international transaction fees for sending 200, 500 and 1000 USD via banks in Croatia and Bitcoin network for the period of 4Q 2018 to 1Q 2022

| Variable (transaction amount) | No. of obs. | Mean | Median | Min. | Max. | Variance | Std. dev. | Coef. var. | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| 200$ (Croatia) | 14 | 6,18% | 6,07% | 5,18% | 7,35% | 0,00% | 0,70% | 11,39 | 0,26 | -1,15 |
| 500$ (Croatia) | 14 | 2,55% | 2,58% | 2,09% | 3,01% | 0,00% | 0,28% | 10,83 | -0,01 | -0,78 |
| 1000$ (Croatia) | 14 | 1,36% | 1,36% | 1,11% | 1,54% | 0,00% | 0,14% | 10,42 | -0,32 | -0,98 |
| via BTC | 14 | 0,39% | 0,21% | 0,03% | 1,85% | 0,00% | 0,51% | 130,46 | 2,18 | 4,67 |

Source: author, data from CNB (2022b) and Blockchain.com (2022)

It is legitimate to question if the differences between Bitcoin and bank fees for international transactions are random, unsystematic, or if they are statistically credible and valid. Prior to ANOVA tests for normality were made. Table 3 displays the results of Kolmogorov-Smirnov, Liliefors and Shapiro-Wilk's tests.

Table 3: Tests for normality for all variables in the study

| Variable | Kolmogorov-Smirnov *d* | K-S *p* | Lilliefors *p* | Shapiro-Wilk *W* | S-W *p* |
|---|---|---|---|---|---|
| 200$ (World) | 0,168 | >0.20 | <0,01* | 0,902 | 0,003* |
| 500$ (World) | 0,207 | <0,10* | <0,01* | 0,892 | 0,001* |
| BTC* | 0,298 | <0,01* | <0,01* | 0,587 | 0,000* |
| 200$ (Croatia) | 0,170 | >0.20 | >0.20 | 0,945 | 0,488 |
| 500$ (Croatia) | 0,149 | >0.20 | >0.20 | 0,966 | 0,819 |
| 1000$ (Croatia) | 0,120 | >0.20 | >0.20 | 0,936 | 0,368 |
| BTC** | 0,303 | <0,15 | <0,01* | 0,702 | 0,000* |
| * Averaged in parallel to WB data<br>** Averaged in parallel to CNB data | | | | | |

Source: author, data from World Bank (2022), CNB (2022b) and Blockchain.com (2022)

Since the hypothesis that the respective distribution is normal should be rejected in the case of Bitcoin fees as well as those attained from The World Bank, nonparametric tests were applied to assess significance of differences between means.

Because the underlying distributions are not normal, Friedman ANOVA is applied as a nonparametric alternative with the null hypothesis that the variables contain samples drawn from the populations with identical medians.

Table 4: Non-parametric tests for the variables in the study

| Variables | Friedman ANOVA | Kendall coefficient of concordance |
|---|---|---|
| WB: 200$, 500$, BTC | $\chi 2$ (N = 39, df = 2) = 78,00; p = 0,00000 | 1,00 |
| CNB: 200$, 500$, 1000$ BTC | $\chi 2$ (N = 14, df = 3) = 40,89; p = 0,00000 | 0,97 |

Source: author, data from World Bank (2022), CNB (2022b) and Blockchain.com (2022)

Non-parametric tests were applied and the null hypothesis that the transaction costs for paying over traditional financial system and over Bitcoin network contain samples drawn from the populations with identical medians was firmly rejected. High Kendall concordance coefficients were calculated which conveys almost perfect agreement in the rankings of the variables among cases, which further solidifies the finding that transaction costs in Bitcoin network have the lowest ranking among the analysed variables.

## Conclusion

The primary motivation behind this study was to examine the fulfilment of the proposition made by the inventor(s) of the first globally acknowledged and most widespread cryptocurrency – Bitcoin, regarding formation of an alternative, secure and cost-effective payment system. Even though Bitcoin is often observed only as a speculative asset, it also functions as a distributed, decentralized transaction network which can be used to transfer money internationally.

From a global perspective, with additional focus on Croatia, this paper aimed to provide a comparative analysis of transaction fees – costs of transferring money abroad – between traditional financial systems and Bitcoin network.

Data on international transaction fees was collected from The World Bank. Local emphasis and relevance was provided with the database provided exclusively for the purpose of this study by the Croatian National Bank. These were then contrasted with transaction fees within Bitcoin network.

It was found that when transferring 200 USD, banks worldwide charged on average approx. 30 times more in fees than Bitcoin miners. To send 1,000 USD abroad required approx. three times less in fees by using Bitcoin network than by using banks in Croatia. The worldwide median difference between international transfer of 200 USD over traditional financial system and over Bitcoin network is 7,25%. The calculation structure of bank fees required higher costs for transferring lower amounts, which hinders financial inclusion.

Since the Bitcoin network operated non-stop (24/7/365), without interruptions and outages since March 2013, it could be stated that it's functioning is itself a proof of concept that democratization of financial systems might be possible, and that blockchain technology could be a tool of financial inclusion by providing lower costs for essential financial services. Smaller fees to send money worldwide could attract the unbanked, mostly low-income population, especially since bank fees are designed so that lower transaction amounts require higher costs. Disintermediation, as proposed by decentralized ledger technologies, does lower costs primarily by removing rent-extracting organizations which insert layers of fees that are eventually paid by the end users.

However, it would be a misstep to declare Bitcoin network as ultimately superior over traditional money transfer systems, since there are certain limitations and shortcomings of this system, and they have to be addressed.

Costs of conversion from and to fiat currencies is not addressed in this paper, and should be added to the Bitcoin transaction fees. However, adding these costs most likely will not change the overall findings of this study, since they are practically lower than 1%.

Energy costs of operating Bitcoin network are high; it currently consumes cca 150 TWh per year, which is approx. 0.7% of global electricity production (Cambridge

Center for Alternative Finance, 2022). However, the issue of the energy consumption is debatable and somewhat controversial (Carter, 2021), since it is argued that the backing of cryptocurrency is in electricity as opposed to fiat currencies which have no explicit backing (Dujak & Sajter, 2019, p. 28). Nevertheless, indirect costs to maintaining both traditional and innovative financial systems should be taken into account.

Future researchers should try to include both costs of conversion from and to fiat currency. The environmental costs should be addressed not only vis-à-vis operation of cryptocurrencies, but also regarding functioning of traditional financial systems which also require significant amount of resources to be effective. Finally, the question of extreme volatility of cryptocurrency prices should also be raised in the context of transferring money, since in the period of to finalize the transaction there is always a possibility of loss due to ever-changing price of cryptocurrencies.

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NOTES

[1] https://www.buybitcoinworldwide.com/bitcoin-uptime/ (accessed 4. 4. 2022.)

[2] There are many instances where private keys were stolen and consequently cryptocurrencies taken. This can be likened to stealing private keys to the safe at the "bank", but the "bank" itself (Bitcoin blockchain) was never broken into or compromised.

[3] https://www.investopedia.com/tech/how-much-does-it-cost-buy-cryptocurrency-exchanges/ (accessed 4. 4. 2022.)

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