

A Market Analysis of the Bitcoin Economy

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¹The statements reflect the personal views of the speaker and do not necessarily coincide with the position of the Deutsche Bundesbank.

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DIGITAL CURRENCIES: PRINCIPLES, TRENDS, OPPORTUNITIES, AND RISKS

This report is the first comprehensive study on digital currencies that provides a joint, deep quantitative analysis of their technological, entrepreneurial, economic, and legal aspects.

It is the result of over 2 years of work, including an extensive monitoring of the digital currency markets, involving the collection and analysis of data from over **30 different sources**.

The results of our analysis are summarised in over **60 different descriptive statistics** and original results on the (in)efficiency and dynamics of digital currency markets distributed across over **100 pages**.

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Bitcoin as Payment Network. Network Expansion

The average amount transferred per Bitcoin transaction is larger than in any other major payment network.

During the period 2011–2015, the average amount (in USD equivalent) per transaction constantly increased, and remained larger than in the major payment networks such as Visa, Mastercard, Discover, or Western Union.

- The Bitcoin network is mostly used to remit money from user to user.²

²Studies show that the amount migrants send per transaction typically ranges between USD 100 and USD 1,000 for international remittances (e.g., Sander C., 2003);

Bitcoin as Payment Network. Network Expansion

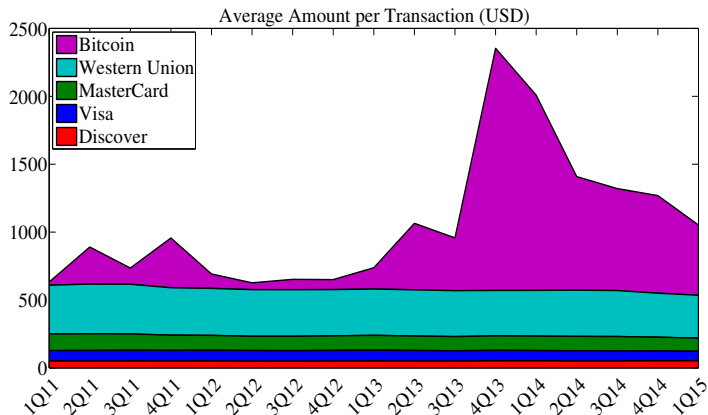


Figure : Comparison between different payment networks. Average daily USD amount per transaction from 1Q2011 to 1Q2015. Data source: Bitcoin blockchain, VISA, MasterCard, Discover, Western Union performance reports. Internal calculation.

Bitcoin as Currency. Network Expansion

The relative capitalisation of Bitcoin with regard to other digital currencies is receding in favour of Ripples.

- Until mid-2014, Bitcoin dominated the digital currency market by covering up to **95%** of its total volume.
- Since the 2nd part of 2014, the Bitcoin dominant position has been eroded by Ripple, which now covers about **10%** of the total market capitalisation.
- Even though Bitcoin remains dominant on the digital currency market, the relative currency strength of Bitcoin has **decreased** – on average –, compared to that of the other (almost) existing 500 digital currencies.

Bitcoin as Currency. Network Expansion

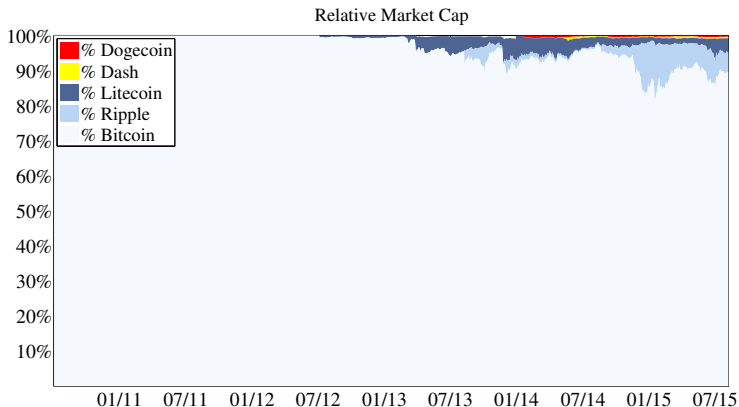


Figure : Relative market capitalisation of Bitcoin, Ripple, Litecoin, Dash, Dogecoin. Data source : Coinmarketcap. Internal calculation.

Bitcoin as Currency. Currency Competition

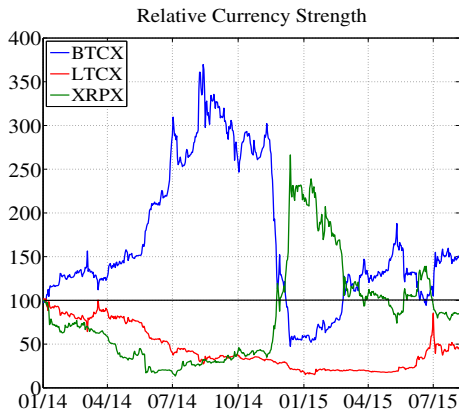


Figure : Comparison between relative index strengths. Ba= 100 on 01.01.2014 (BTCX, LTCX, XRPX). Internal calculation.

Bitcoin as Currency. Currency Competition

- BTCX: rel. strength of BTC wrt LTC and XRP, weighted by: (1) their respective rel. market cap. expressed in USD; (2) the inverse of the BTC exchange rate volatility.
- LTCX: rel. strength of LTC wrt both BTC and XRP, weighted by: (1) their respective rel. market cap. expressed in USD; (2) the inverse of the LTC exchange rate volatility.
- XRP: rel. strength of XRP wrt both BTC and LTC, weighted by: (1) their respective rel. market cap. expressed in USD; (2) the inverse of the XRP exchange rate volatility.

Currency competition expressed in currency strength indices

$$BTCX := \Delta_{BTC} \times \text{Exp} \left\{ \text{Log} \left[\frac{BTC/LTC}{\sigma(BTC/LTC)} \right] (W_{BTC}) + \text{Log} \left[\frac{BTC/XRP}{\sigma(BTC/XRP)} \right] (1 - W_{BTC}) \right\}$$

$$LTCX := \Delta_{LTC} \times \text{Exp} \left\{ \text{Log} \left[\frac{LTC/BTC}{\sigma(LTC/BTC)} \right] (W_{LTC}) + \text{Log} \left[\frac{LTC/XRP}{\sigma(LTC/XRP)} \right] (1 - W_{LTC}) \right\}$$

$$XRPX := \Delta_{XRP} \times \text{Exp} \left\{ \text{Log} \left[\frac{XRP/BTC}{\sigma(XRP/BTC)} \right] (W_{XRP}) + \text{Log} \left[\frac{XRP/LTC}{\sigma(XRP/LTC)} \right] (1 - W_{XRP}) \right\}$$

where:

$$W_{BTC} = \left(\frac{\omega_{LTC}}{\omega_{LTC} + \omega_{XRP}} \right); W_{LTC} = \left(\frac{\omega_{BTC}}{\omega_{BTC} + \omega_{XRP}} \right); W_{XRP} = \left(\frac{\omega_{BTC}}{\omega_{BTC} + \omega_{LTC}} \right);$$

- Δ_{BTC} , Δ_{LTC} and Δ_{XRP} are normalisation factors;
- ω_{BTC} , ω_{LTC} , ω_{XRP} : market capitalisation of BTC, LTC and XRP expressed in USD.

Groups of Interest. Investors

Bitcoin startups raised almost USD 1 billion in three years with an annual investment growth rate of about 150%

- Capital investments in Bitcoin-related startups is a recent trend that started in 1Q 2012.
- Since 1Q 2012, the Bitcoin industry represents the **fastest growing sector** for capital investment.
- Within the Bitcoin sector, the **Mining** and **Payment & Remittance** industries drove the funding race.
- 21 Inc alone covered over half of the capital raised by the Mining industry and Coinbase one third of the capital raised by the whole Payment & Remittance industry.

Groups of Interest. Investors

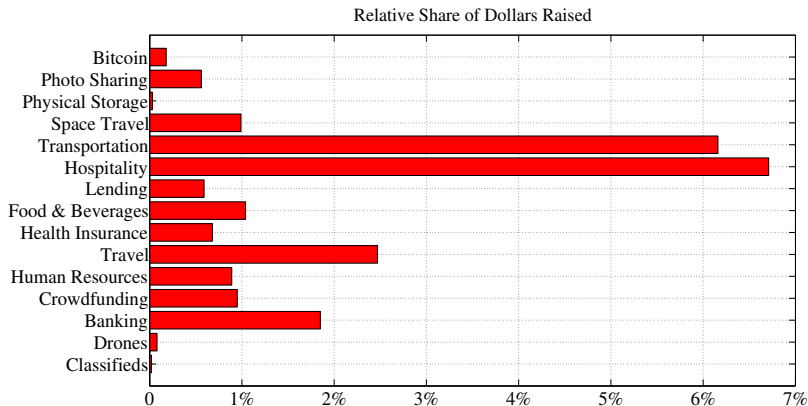


Figure : Relative Capital investment into different startup businesses during the period mid-2012 till mid-2015. Data source: Mattermark. Internal calculation.

Groups of Interest. Investors

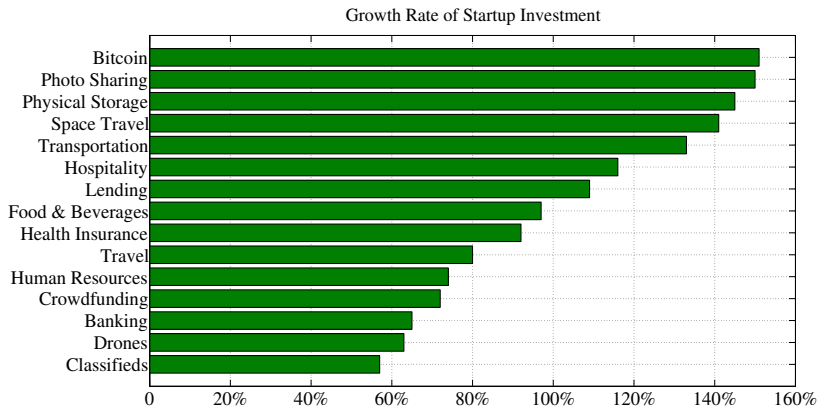


Figure : Relative rate of growth of capital investment into different startup businesses during the period mid-2012 till mid-2015. Data source: Mattermark. Internal calculation.

Groups of Interest. Investors

Capital Market	Payment and Remittance	Financial Services	Blockchain Application	Mining Industry	Miscellaneous
Exchange	Payment	Accounting	Smart Contracts	Mining Solutions	Bitcoin Faucet
Derivatives	Remittance	Security	Blockchain API	Mining Pool	Tipping
Commodity	Wallet	ATM			Messaging
Institutional Trading		Market and			
Crowdfunding and		Data Analysis			
Crypto Equity					

Table : Classification of business categories in the Bitcoin industry.

Groups of Interest. Investors

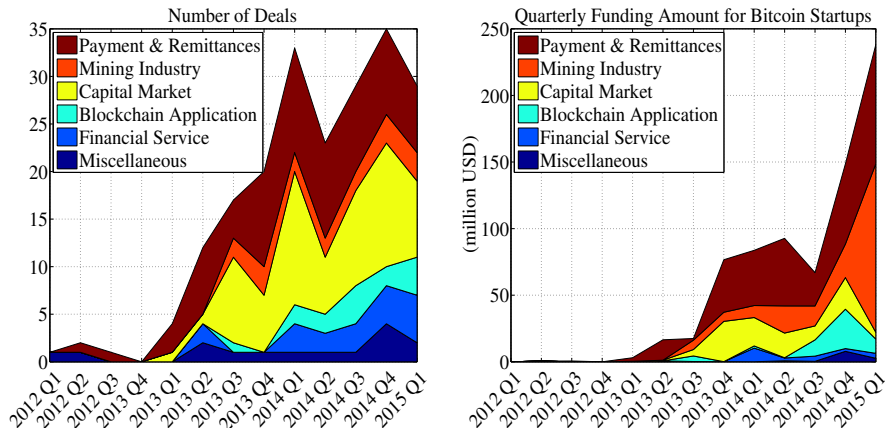


Figure : Left: Quarterly number of deals for startups in different Bitcoin industries. Right: Quarterly funding amount for startups in different Bitcoin industries. Data source: Bitangel, Cbinsight, Coinfilter, Coindesk, Crunchbase. Internal calculation.

Groups of Interest. Investors

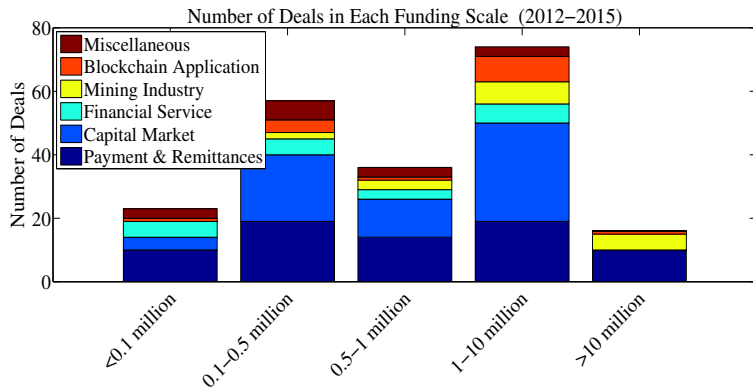


Figure : Number of deals in each funding scale (Q1/2012 to Q1/2015). Deals in each funding scale are further divided into business categories. Data source: Bitangel, Cbinsight, Coinfilter, Coindesk, Crunchbase. Internal calculation.

Groups of Interest. Investors

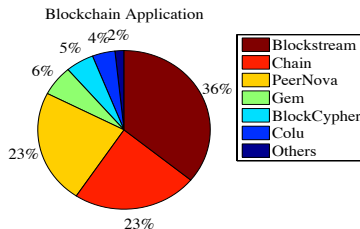
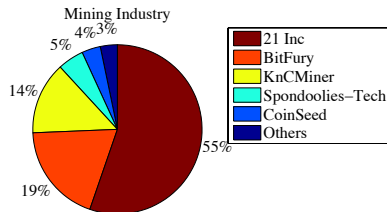
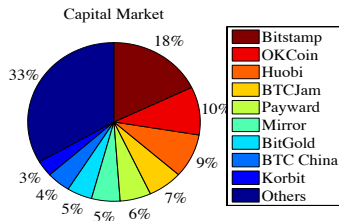
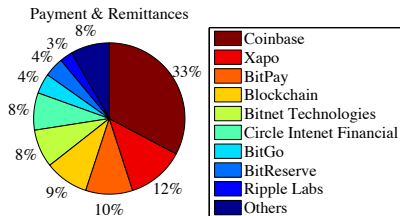


Figure : Funding distribution among startups within main categories (Q1/2012 – Q1/2015).

Data source: Bitangel, Cbinsight, Coinfilter, Coindesk, Crunchbase. Internal calculation.

Distribution of Income and Wealth.

The wealth distribution in the Bitcoin ecosystem is highly unequal, and this inequality is growing.

- The inequality of the distribution of Bitcoins amongst addresses, summarised by the Gini coefficient grew **from 0.09 in 2010 to 0.99 in 2015**.
- During the period 2009-2015, the top 100 richest addresses kept a constant relative wealth, totalling about **20% of the total value** of the Bitcoin economy.
- The Bitcoin mining market is under control by 5 to 7 major mining pools.
- During the period 2013-2015, the cumulative market share of the largest 10 pools relative to the total market hovered in the **70% – 80%** range.

Distribution of Income and Wealth. Users

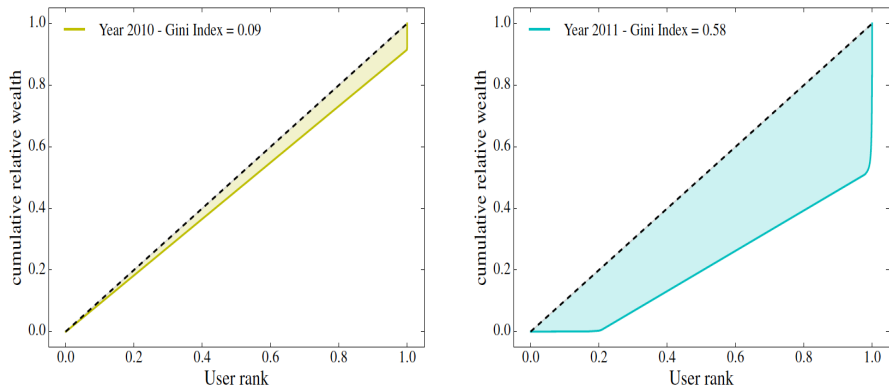


Figure : Lorenz Curve and Gini Coefficient for the Bitcoin Economy. Percentile of addresses sorted by wealth wrt to the percentile of the wealth own.

Distribution of Income and Wealth. Users

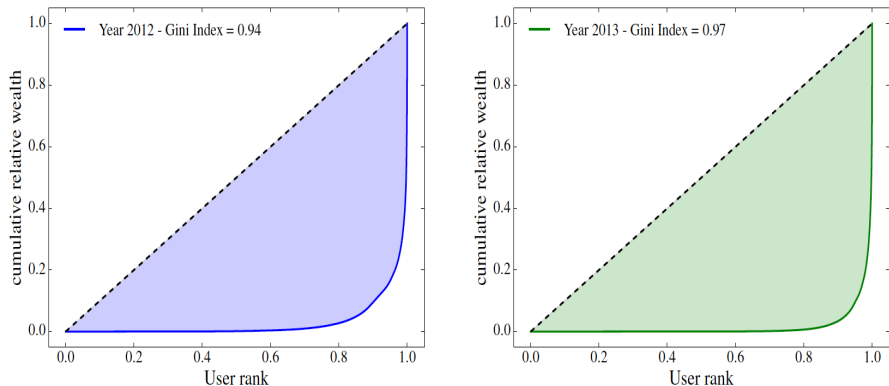


Figure : Lorenz Curve and Gini Coefficient for the Bitcoin Economy. Percentile of addresses sorted by wealth wrt to the percentile of the wealth own.

Distribution of Income and Wealth. Users

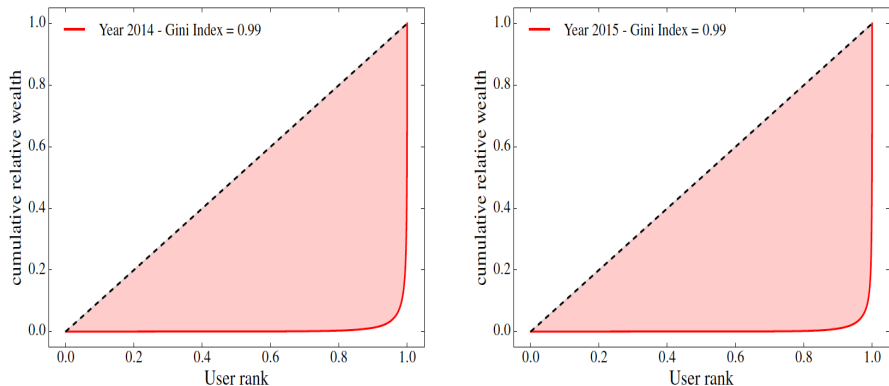


Figure : Lorenz Curve and Gini Coefficient for the Bitcoin Economy. Percentile of addresses sorted by wealth wrt to the percentile of the wealth own.

Distribution of Income and Wealth. Users

The Gini coefficient (G) is an inequality index of income or wealth.³

G can be calculated from unordered size data as half of the Relative Mean Difference (RMD), which is the average absolute difference between every possible pair of values, divided by the mean size μ ,

$$G = \frac{RMD}{2} \text{ with : } RMD = \frac{MD}{\mu}, MD = \frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n |x_i - x_j|$$

- $G=0$: every person receives the same income;
 - $G=1$: theoretical value for $n \rightarrow \infty$ where a single person receives 100% of the total income and the remaining people receive none
-
- x_i : income or wealth of person i .
 - n : population size.

³Gini C., Variabilita' e mutabilita', 1912, reprinted in Memorie di metodologica statistica (Ed. Pizetti E, Salvemini, T). Rome: Libreria Eredi Virgilio Veschi 1955.

Distribution of Income and Wealth. Users

The Lorenz curve can be represented by a function $L(F)$ where:

- F is the cumulative portion of the population represented by the horizontal axis;
- L is the cumulative portion of the total wealth or income represented by the vertical axis.

For a discrete probability function $f(y)$, let y_i , $i = 1, \dots, n$, be the points with non-zero probabilities indexed in increasing order ($y_i < y_{i+1}$). The Lorenz curve is the **continuous piecewise linear function** connecting the points (F_i, L_i) , $i = 0, \dots, n$, where $F_0 = 0$, $L_0 = 0$, and for $i = 1, \dots, n$:

$$F_i = \sum_{j=1}^i f(y_j)$$

$$L_i = \frac{S_i}{S_n} \quad \text{with } S_i = \sum_{j=1}^i f(y_j)y_j$$

Distribution of Income and Wealth. Users

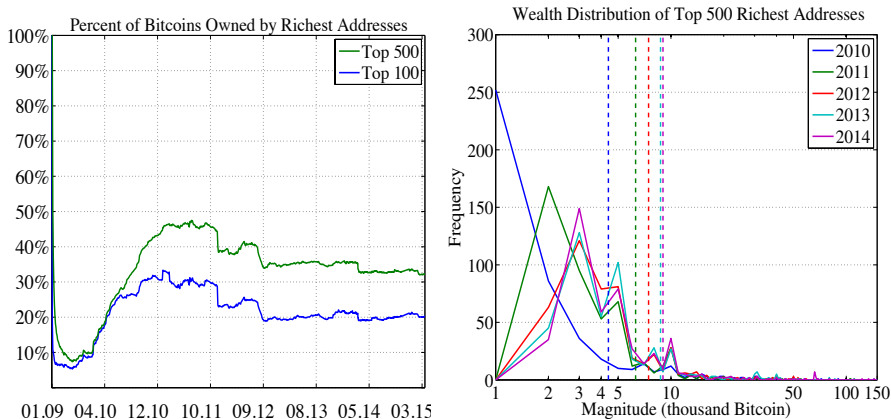


Figure : Left: Relative wealth of the top 100 and 500 richest Bitcoin addresses. Right: Wealth distribution among the top 500 richest Bitcoin addresses (with x-axis log-transformed). Data source: Bitcoin blockchain. Internal calculation.

Distribution of Income and Wealth. Users

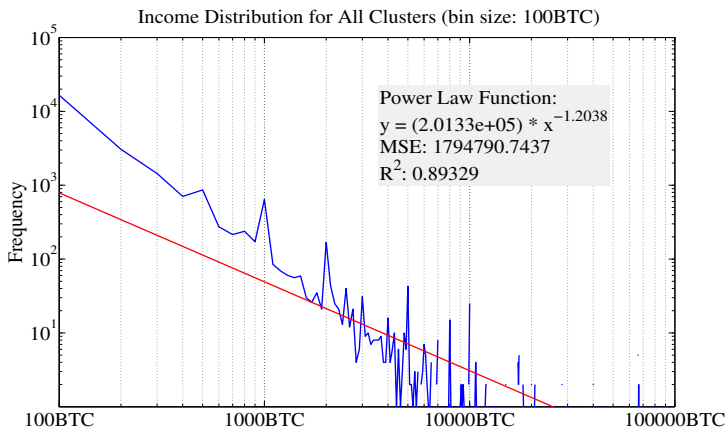


Figure : Income distribution for all clusters. Data source: Bitcoin Core parsed from the 3rd of January 2009 until the 8th of May 2015. Total nr. addresses: 75,191,953. Total nr. clusters (contains at least addresses): **30,708,660** ($9,847,999 \geq 2$ nodes) and 4,810,342 with non-zero balance. Total TXs between clusters: 88,950,021. Internal calculation.

Distribution of Income and Wealth. Miners

- Ghash.IO hashing power was close to “51% attack” for several times.

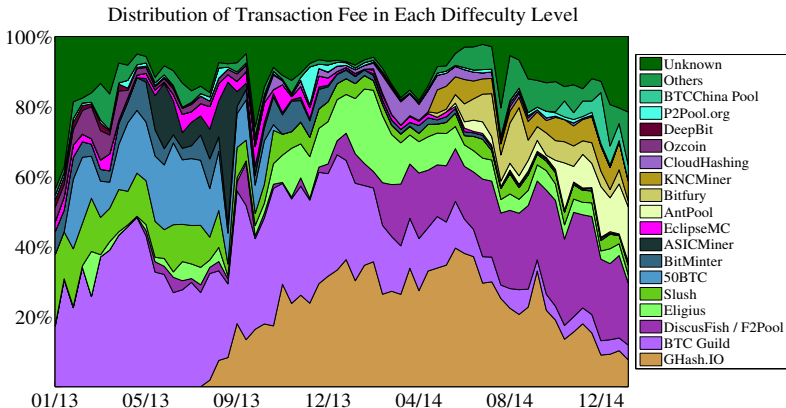


Figure : Top 17 mining pools (out of 40) per relative amount of fees earned. In each difficulty level, transaction fees collected by each mining pool are summed up and compared to the total fees earned and collected by the market. Period: From January 2013 to February 2015. Data source: Blocktrail. Internal calculation.

Distribution of Income and Wealth. Miners

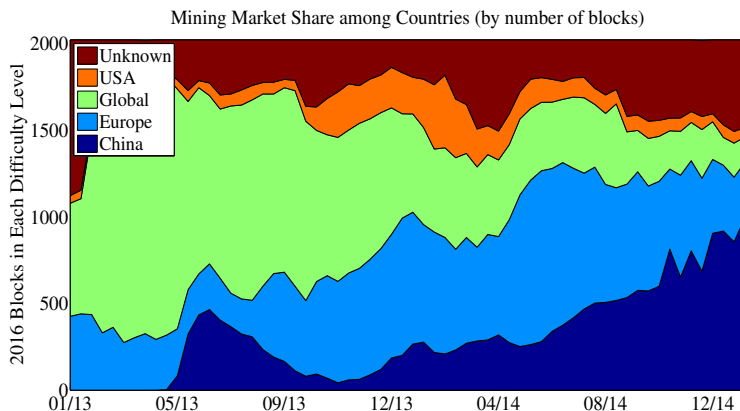
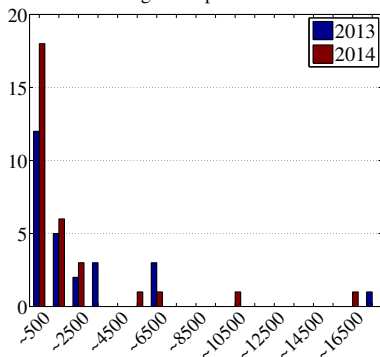


Figure : Top mining activity per country. Mining pools are classified per country of operation. Many mining pools operate in different countries (e.g, BTC Guild and BitMinter run their mining operation in both USA and Europe), so they are classified as “Global”. Period: from January 2013 to February 2015. Data source: Blocktrail, Bitcoin Wiki (comparison of mining pools). Internal calculation.

Distribution of Income and Wealth. Miners

Ditrib. of Mining Pools per Nr. of Blocks Mined



Market Share of Top 5/10 Mining Pools

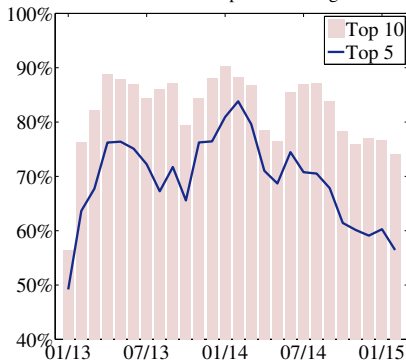


Figure : Left: Distribution of mining pools per number of blocks. Right: Market share of top 5 and 10 mining pools. Data source: Blocktrail. Internal calculation.

Take-Home Message

- ① The average amount transferred per Bitcoin transaction is larger than in any other major payment network.
- ② The relative capitalisation of Bitcoin with regard to other digital currencies is receding in favour of Ripple's.
- ③ China is the largest country in the world per: (1) number of active Bitcoin clients; (2) mining capacity; (3) volume of Bitcoins exchanged via electronic trading platforms.
- ④ Bitcoin startups raised almost USD 1 billion in three years with an annual investment growth rate of about 150%.
- ⑤ In Jan. 2015 the Bitcoin volume exchanged on electronic trading platforms reached 50% of the total number of Bitcoins ever mined at that time.
- ⑥ During the year 2014, the transaction costs in digital currencies dropped significantly.
- ⑦ The year 2014 saw fewer incidences and less arbitrage opportunities than the previous years. In effect, the digital currency market is becoming more efficient.
- ⑧ The wealth distribution in the Bitcoin ecosystem is highly unequal, and this inequality is growing.
- ⑨ The Mining industry is consolidating as an oligopoly.