Are crypto currencies cryptic or a source for arbitrage: A genetic algorithm approach

Oluwasegun Bewaji, Sania Hamid, Shaun Byck (Payments Canada)
Timothy Aerts, Ronald Heijmans, Ellen van der Woerd (DNB)
DNB data science conference - May 12 2022

DeNederlandscheBank

EUROSYSTEEM

Crypto arbitrage

Research question:

Can we find arbitrage opportunities on crypto platforms by trading different cryptocurrencies? How large is this arbitrage opportunity?

USD -> Bitcoin -> Ethereum -> Monero -> USD

Method: We find the most profitable trade order using an AI algorithm called Genetic Algorithm.

Conclusion: You can become rich doing crypto arbitrage.

Outline

- Crypto arbitrage
- Genetic algorithms
- Results

Crypto arbitrage

We compare:

- Cryptocurrency
- Stablecoins
- Cryptocurrency & stablecoins
- Fiat currency

How price efficient are these markets?

Crypto arbitrage

How can we find the most profitable combination of crypto currency trades?

USD -> Bitcoin -> Ethereum -> Monero -> USD
USD -> Monero -> Bitcoin -> Ethereum -> USD
…

Using 31 cryptocurrencies (market value > 2 billion) and three intermediate trades = 26970 possibilities!

Genetic algorithms

Solution: Genetic algorithms (GA) [Goldberg and Holland – 1988]

Most profitable combination is found using the theory of evolution:

- We start with a small random population of trade orders (500)

  Example: USD -> Bitcoin -> Ethereum -> Monero -> USD

- Population evolves due to:
  - Survival of most profitable trade orders. (250)
  - Mutation. (30%) Example: USD -> Dogecoin -> Ethereum -> Monero -> USD
  - Crossover (reproduction of profitable trade orders). (250)

    Example: USD -> Bitcoin -> Monero -> Dogecoin -> USD

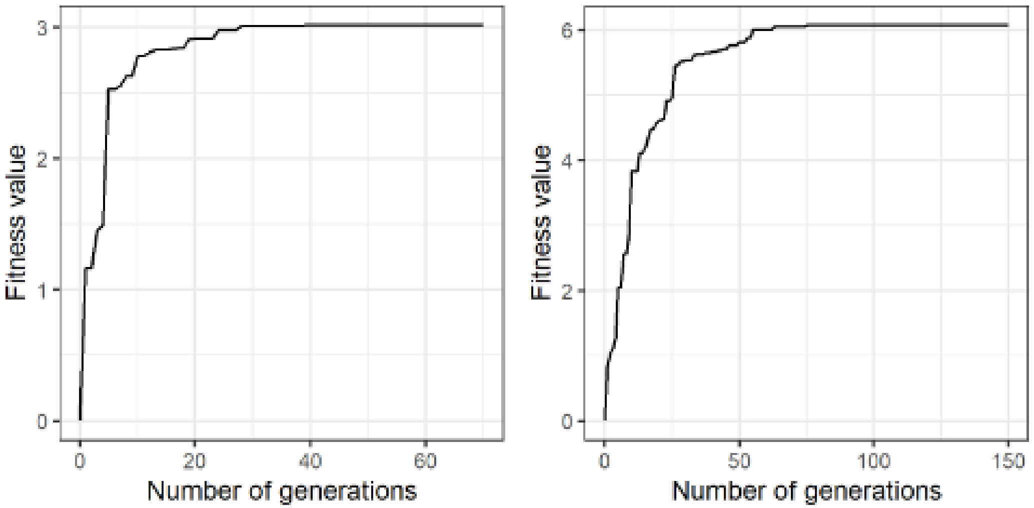
DeNederlandscheBank
EUROSYSTEEM

Genetic algorithms

Generation = 1 iteration.

Training lasts until the profit of the best trade order stabilizes.

All this takes less than a minute to calculate.



(a) Cryptocurrencies. (b) Cryptocurrencies and stablecoins.

Figure 3: Fitness value and number of generations.

Results

Optimal trade order length:

- Longer means more arbitrage opportunities.
- Too long means high transaction costs and little variance in the population.

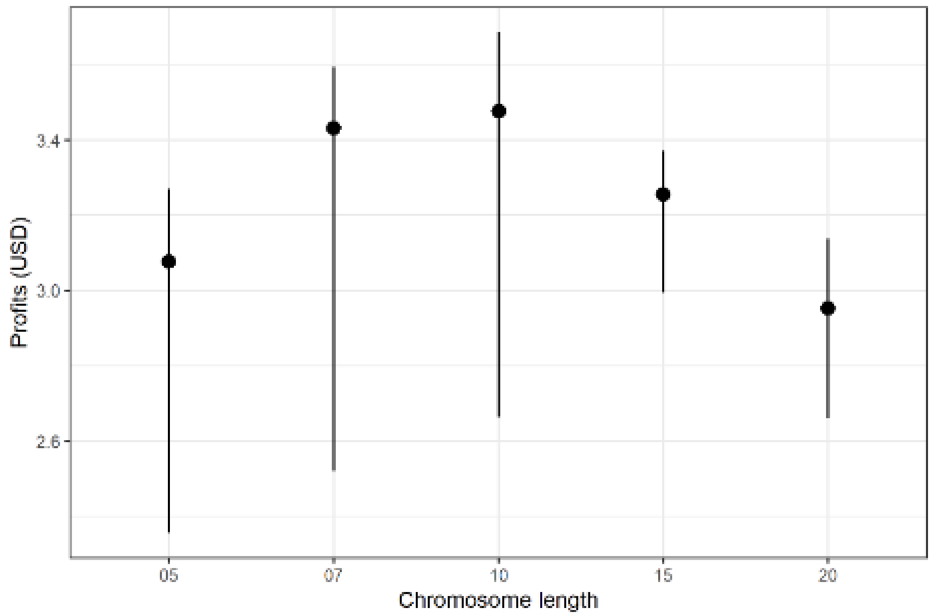
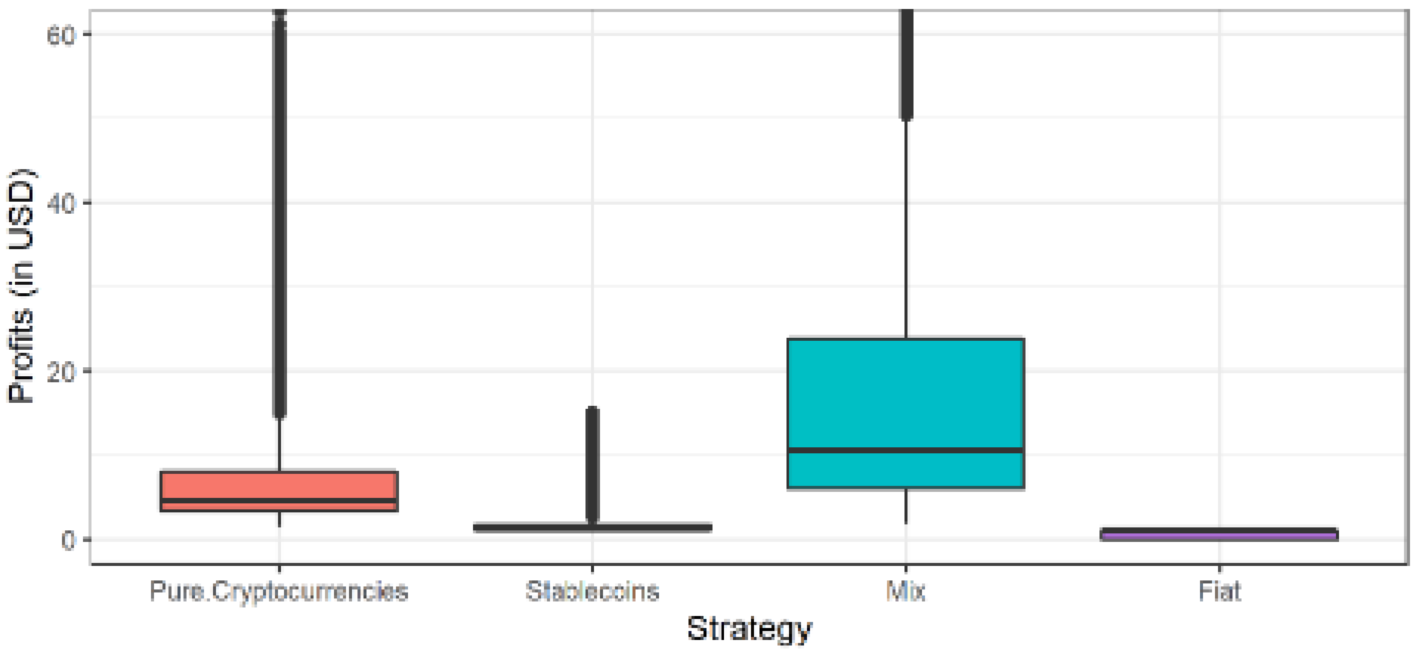


Figure 7: Summary statistics (average, minimum, and maximum) for cryptocurrencies with varying chromosome lengths.

Crypto: 10
Stablecoins: 7
Crypto + Stable: 20
Fiat: 3 (with a loss)

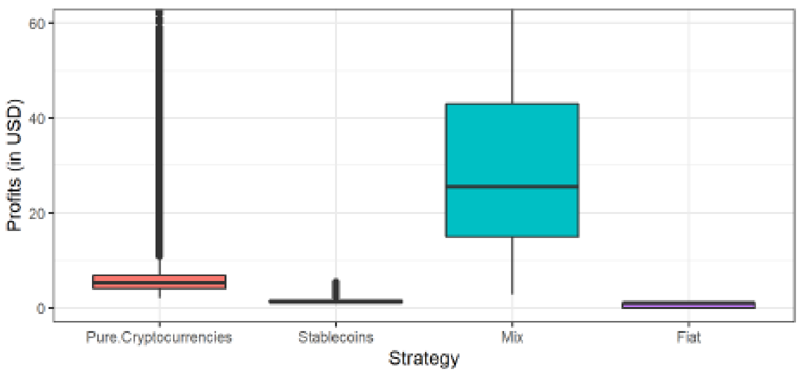
Results – January 2020

Cryptocurrency = $5
Stablecoins = $2
Mixed = $11
Fiat = $0.98 (loss)

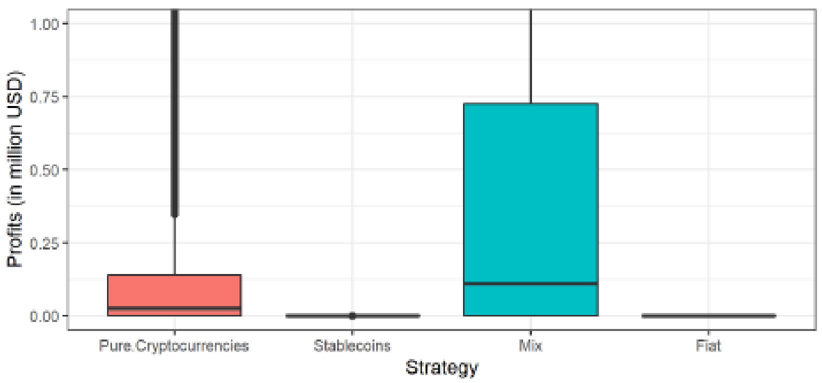


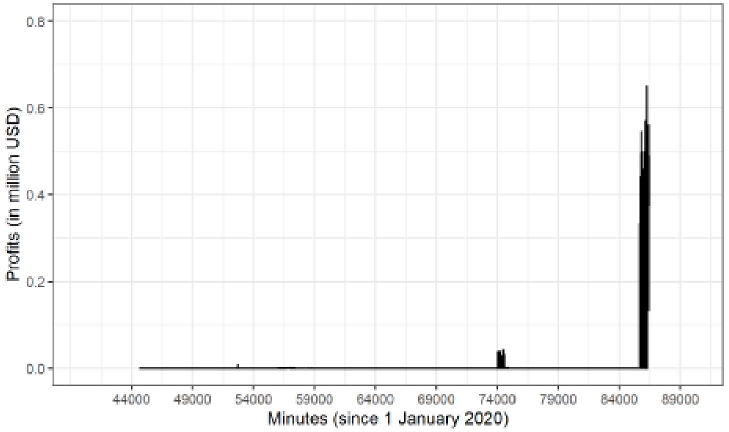
Results – February & March 2020

February

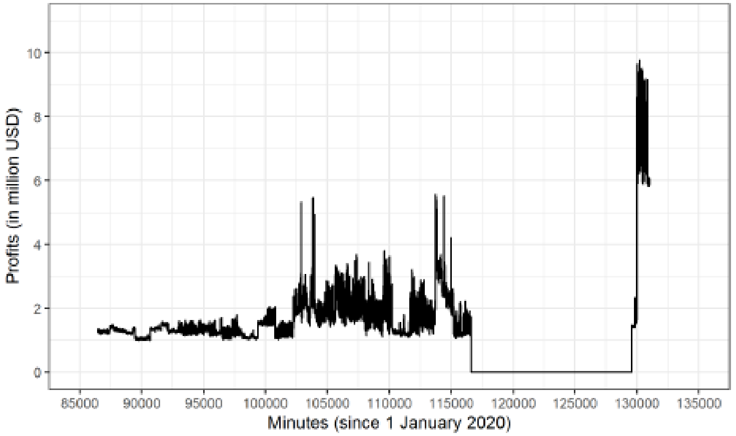


March





(b) Mix of cryptocurrencies and stablecoins.



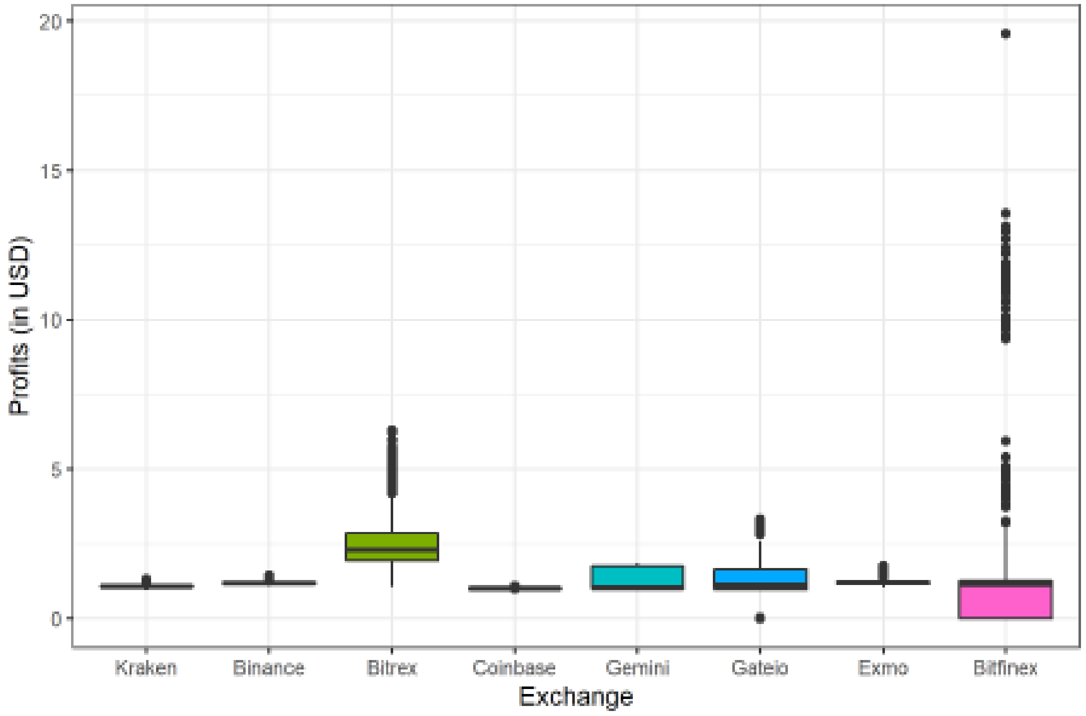
(a) Stablecoins

More and more extreme outliers.
What is going on?

- COVID-19 leads to extreme volatility.
- Results don’t take into account order book depth and therefore the profit becomes unrealistic.

Results – Arbitrage on one platform

- Less profit on individual platforms.
- The larger the platform the smaller the profit.
- Larger fragmentation, in which case different currency pairs cannot be exchanged into one another, on a platform leads to larger profits and less price efficiency.



Conclusion

- If you want to become rich, you should go into crypto arbitrage.
- In ‘normal’ periods it is possible to earn $5 on average with crypto currencies and $11 with a mix of stablecoins and crypto. This indicates price inefficiency.
- This inefficiency is mainly caused by differences between exchanges and smaller more fragmented exchanges.

Conclusion – why isn't everyone doing this?

- It does happen, but not on a large enough scale to eliminate the arbitrage opportunities.

- To use this algorithm in practice one should do further research into:
  - Orderbook depth.
  - How long does a solution remains profitable.