On Transaction-Based Metrics as a Proxy for Profitability of Financial Asset Recommendation

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Financial Asset Recommendation

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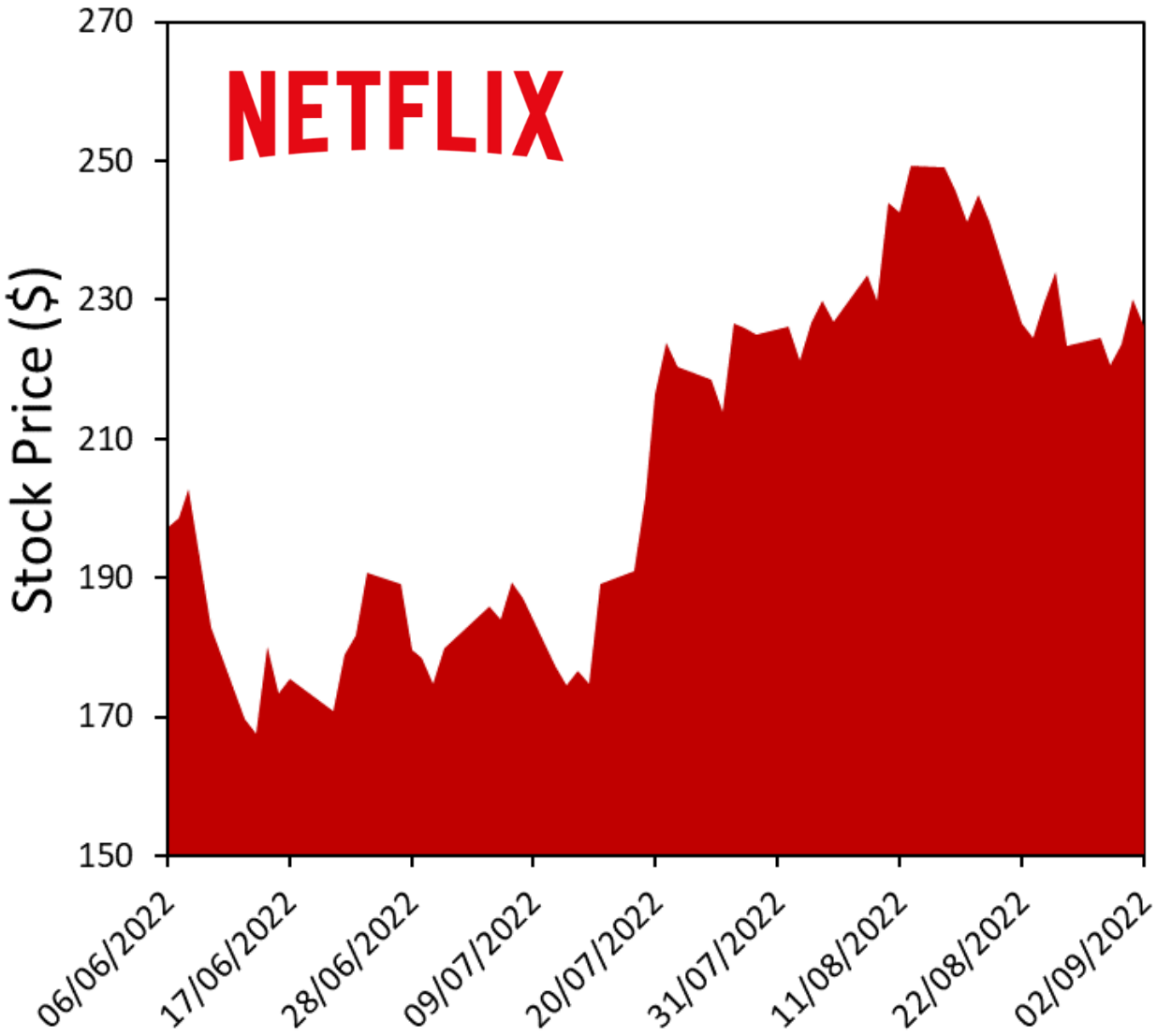
Customer's goal: Earn money

Financial assets

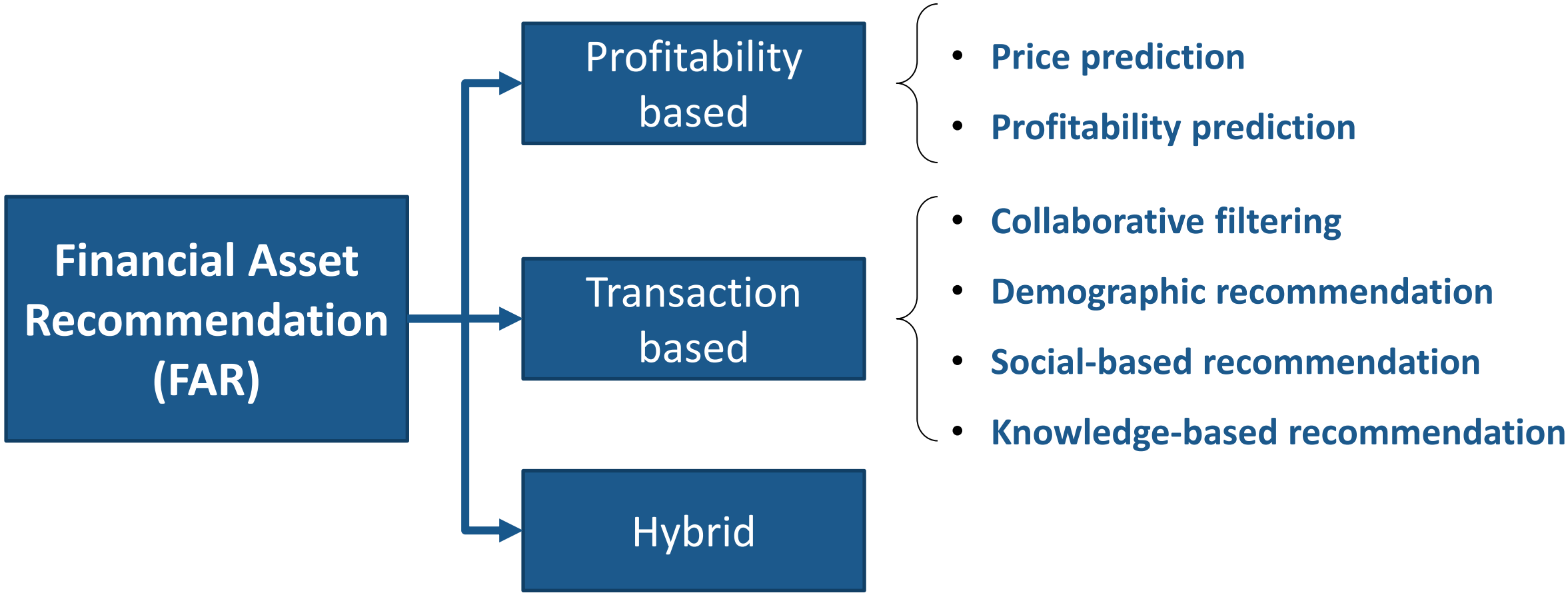
- Stocks
- Bonds
- Mutual funds

Price changes

- External factors (market)
- Important for evaluation



Algorithms


Financial Asset Recommendation (FAR)
Profitability based
Transaction based
Hybrid
Price prediction
Profitability prediction
Collaborative filtering
Demographic recommendation
Social-based recommendation
Knowledge-based recommendation

Evaluation

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Financial Asset Recommendation

Profitability / Performance ⟵ | ⟶ **Transaction-based**

Do our customers earn money?

- Aligned with customer interests.
- Ignores customers actual investments.

Can we predict future investments?

- Investment transactions indicate strong preference.
- Relevant transactions: acquisitions.
- Ignores temporal pricing information.

In both cases, metrics look at a fixed time interval

- **Metrics:** Key performance indicators
  - Return on Investment (ROI)
  - Net profit

- **Metrics:** IR / RecSys metrics
  - Precision
  - nDCG

On transaction-based metrics

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If customers invest intelligently

- Expected high correlation between transaction-based and profitability metrics.
- In that case, transaction-based metrics should be superior.

They consider customer preferences

But, is that the case?

RQ1. Can we indistinctively use transaction-based and profitability-based metrics for evaluating financial asset recommendations?

Dataset

- **Greek market:** stock, bonds, mutual funds and other banking products
- **Period:** 1st January 2018 – 21st March 2021
- **Combines**
  - Time series data (pricing information)
  - Customer investments
- **Time series data:**
  - 5,371 financial assets (2,025 assets with investments)
  - 1,768,128 data points
- **Customer investments**
  - 52,390 customers
  - 313,004 transactions

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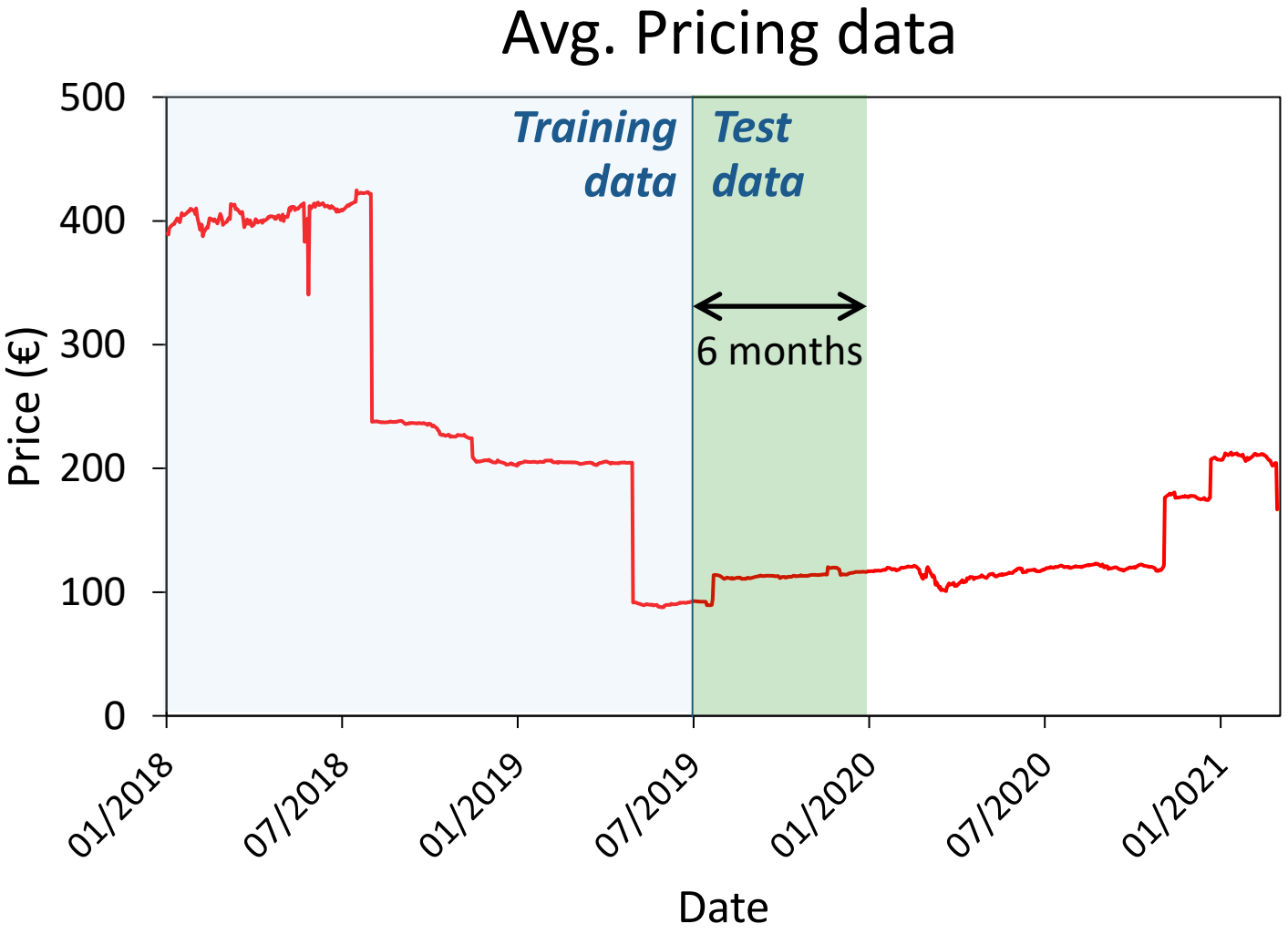
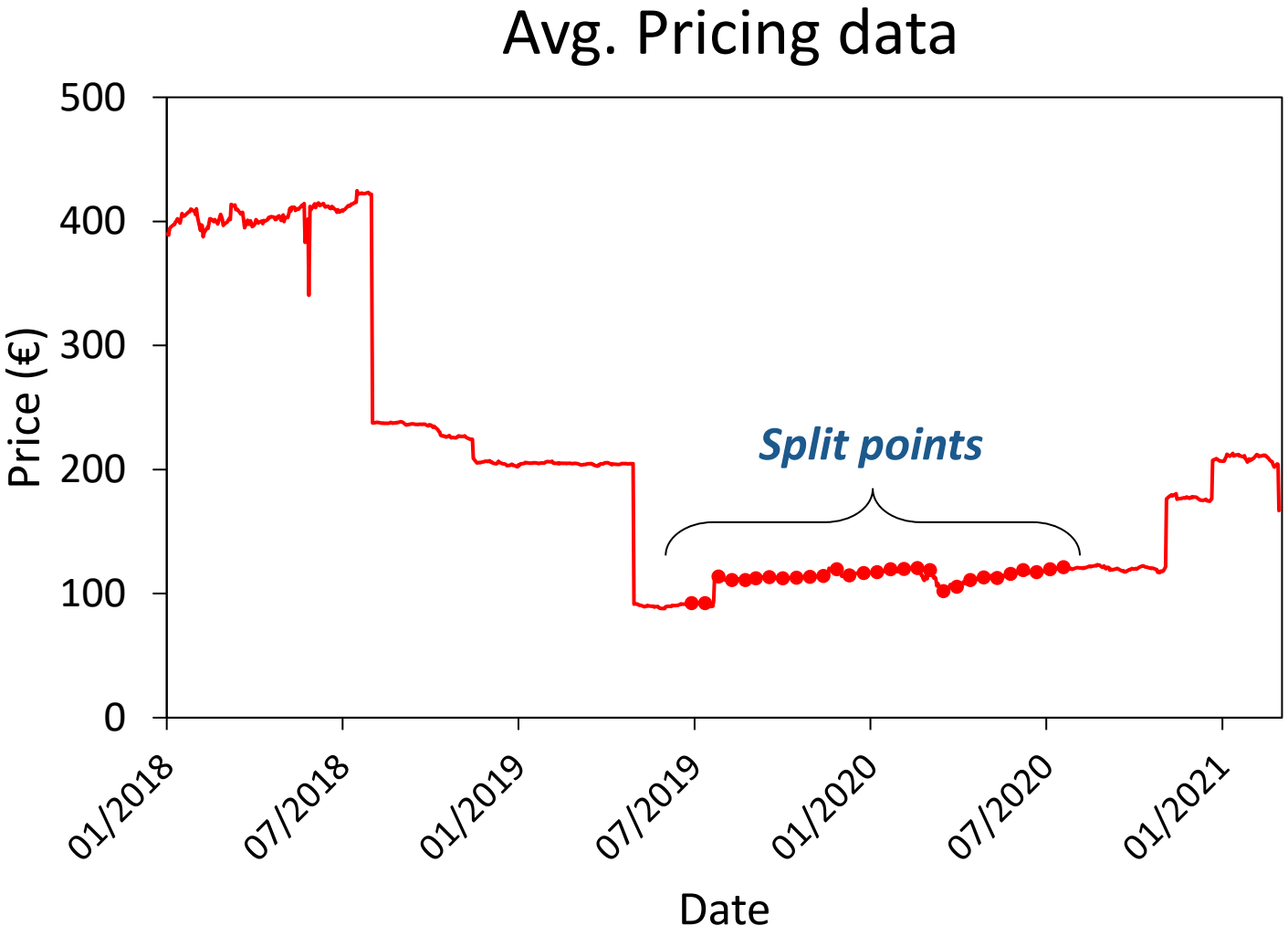
Experimental procedure



Procedure

1. Select recommendation time t
2. Split into training / test
   - **Training:** From 1st Jan 2018 to t
   - **Test:** From t to $t + 6$ months
3. Train models
4. Execute recommendations at t
5. Evaluate

Experimental procedure



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29 split points

- One every two weeks
- From: 1st July 2019
- To: 22nd July 2020

Metrics

Profitability-based: return on investment (ROI@10)

- Relative increase w.r.t. the initial investment after some time Δt
- **Initial price:** price at recommendation time
- **Final price:** price at recommendation time + Δt
- Δt: six months

Transaction-based: nDCG@10

- Higher nDCG indicates our model predicts future customer investments.
- Ranking-based IR/RecSys evaluation metric
- Relevant transactions:
  - Asset acquisitions (buys)
  - Up to 6 months after recommendation

Algorithms

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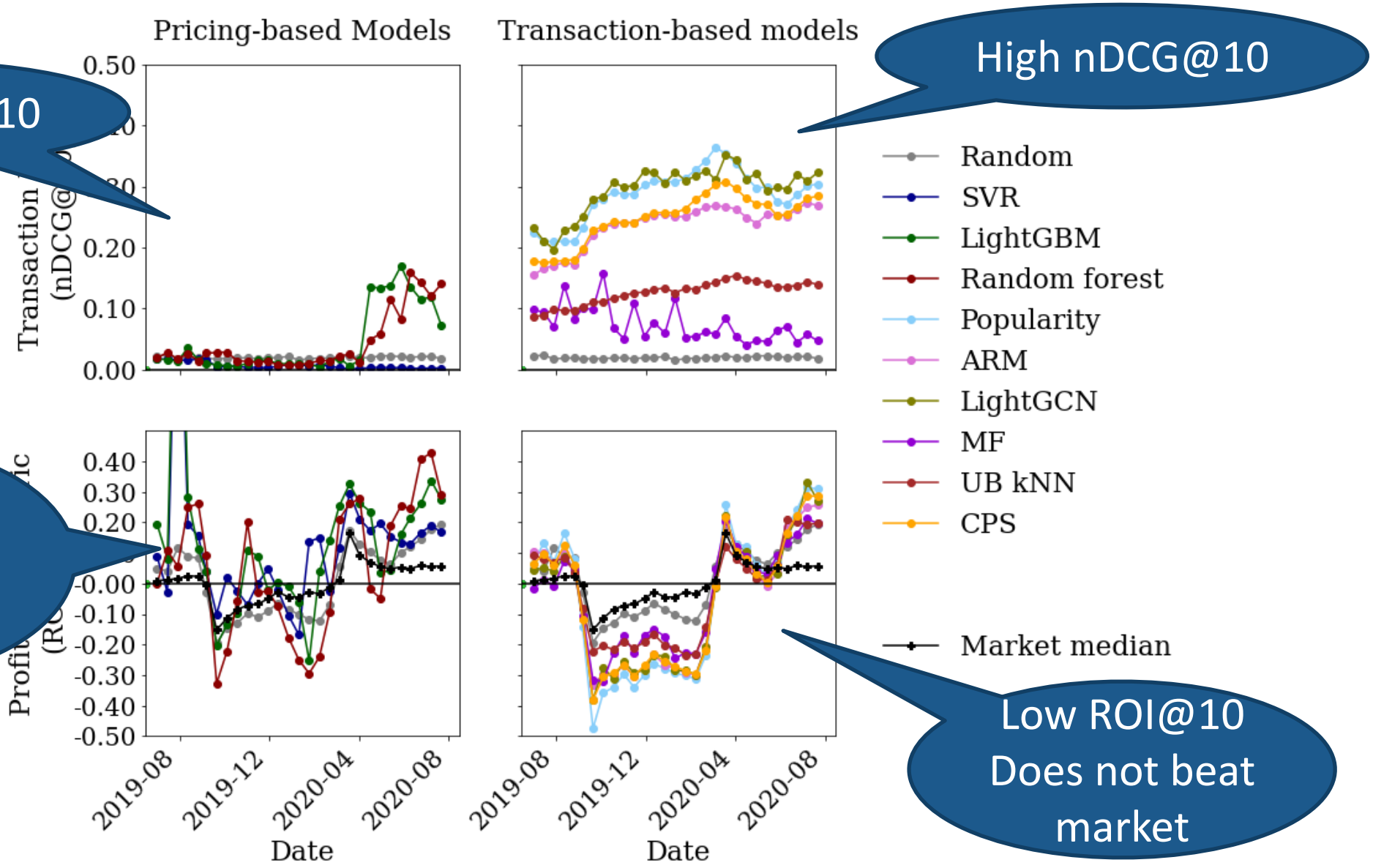
Profitability-based regression models

- Support vector regression (SVR)
- Random forest
- LightGBM

Transaction-based models

- **Not personalized:** popularity-based, random
- **Collaborative filtering:** LightGCN, MF, UB kNN, association rule mining
- **Demographic methods:** UB kNN with customer information

RQ1. Can we exchange transaction-based and profitability-based metrics?



Low nDCG@10

High nDCG@10

High ROI@10
Beat market

Low ROI@10
Does not beat market

RQ1. Can we exchange transaction-based and profitability-based metrics?

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- We observe many differences between nDCG and ROI.
- But… are they even correlated?
- We take:
  - Average metric values (ROI@10 / nDCG@10) for each algorithm / split point
  - Compute Pearson correlation between both metrics
- Result: **-0.22**!
- Increasing nDCG ⇒ money losses!

CONCLUSION: We cannot exchange both metrics. But why?

RQ2. What are the main factors that influence transaction-based metrics?

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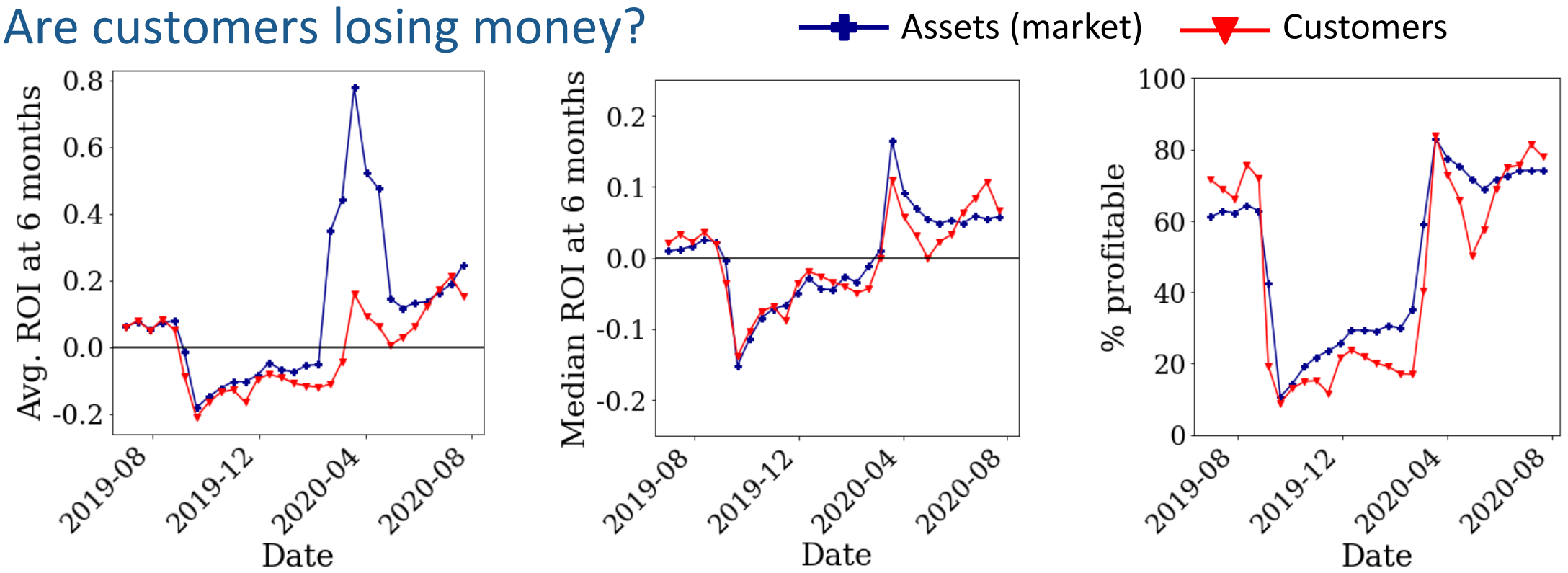
We consider three factors:

- Effectiveness of the customers
  - Do our customers invest well?
- Market changes
  - Pandemics, wars, economic crises, etc. affect market prices
  - Example: Covid-19 sank the markets
- Customer strategy
  - How much time do customers hold assets?

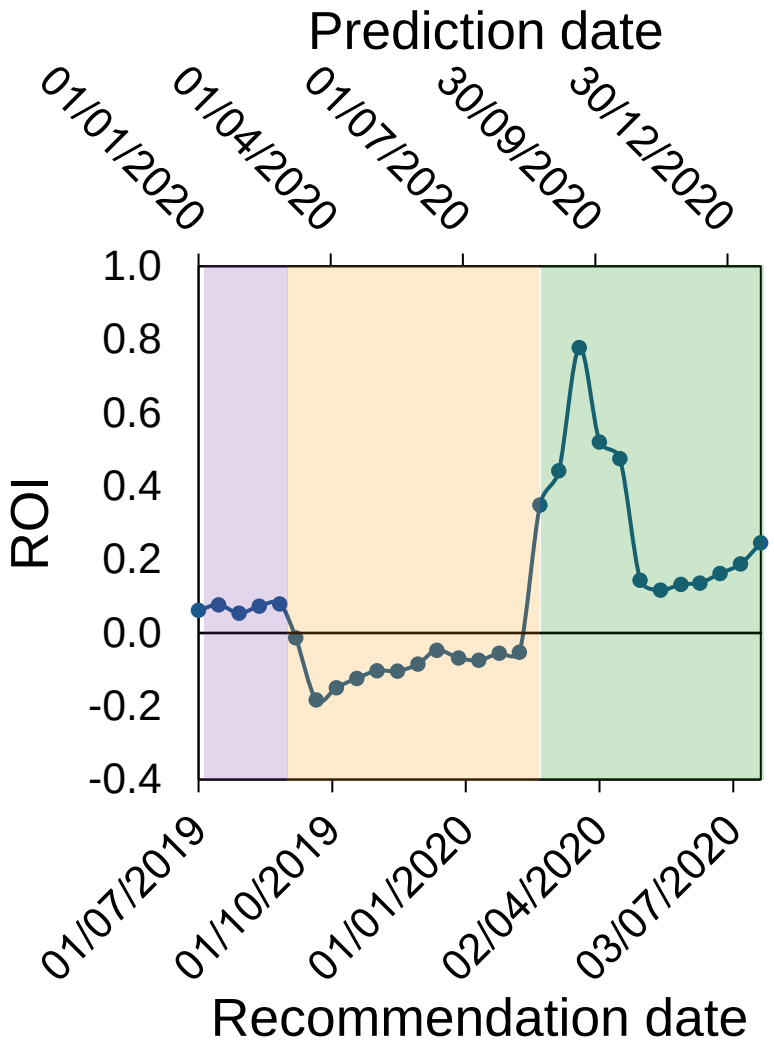
Effectiveness of the customers

- If customers invest intelligently, we would expect positive correlation
- Are customers losing money?



- Customers in our dataset are not particularly good investors.
- This explains lack of correlation between ROI and nDCG

Market changes



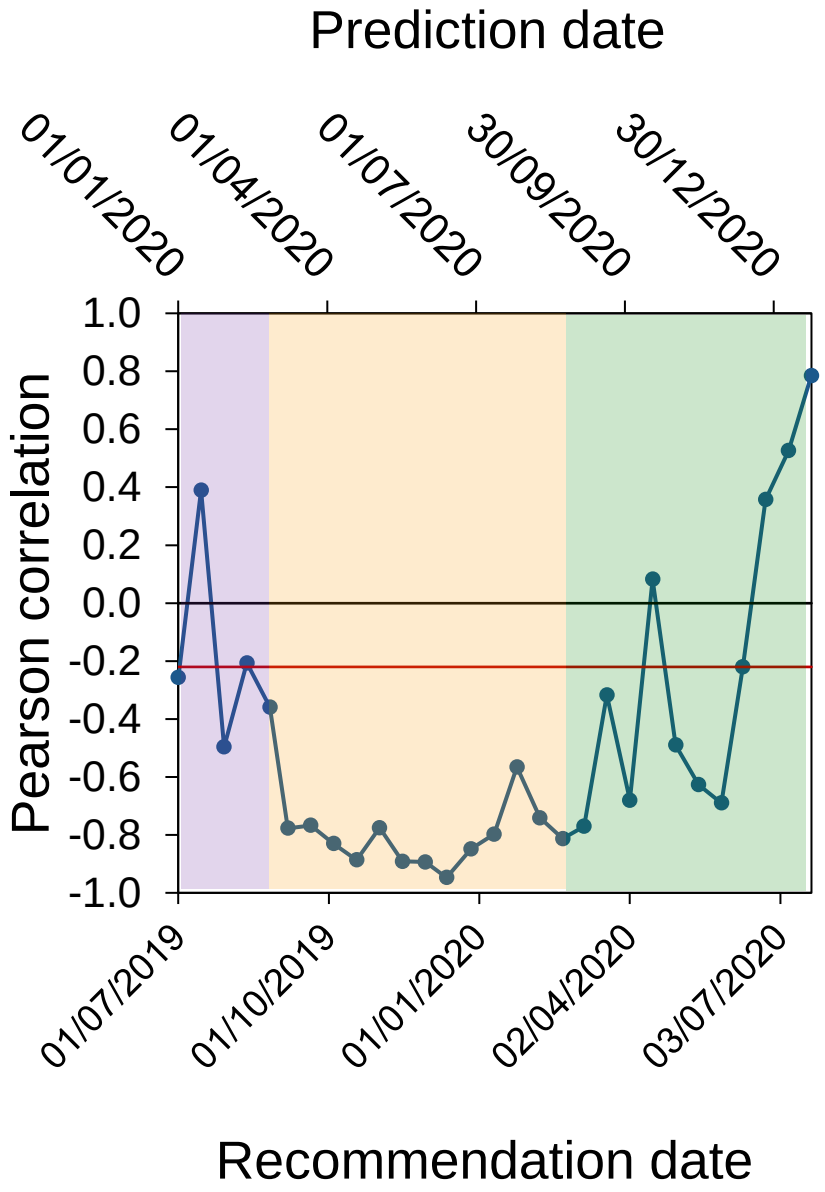
- We observe our profitability at 6 months
- Changes in asset profitability over time

- ***PERIOD 1:*** January 2020 – March 2020
  - Normal period
  - Market growth (slow)

- ***PERIOD 2:*** March 2020 – September 2020
  - Great loss period
  - Impact of Covid-19 pandemic

- ***PERIOD 3:*** September 2020 – January 2021
  - Recovery period
  - Great market growth

Market changes (II)



Do these changes affect the correlation between the metrics?

- Correlation between nDCG and ROI at every recommendation point
- Red line: overall correlation (-0.22)

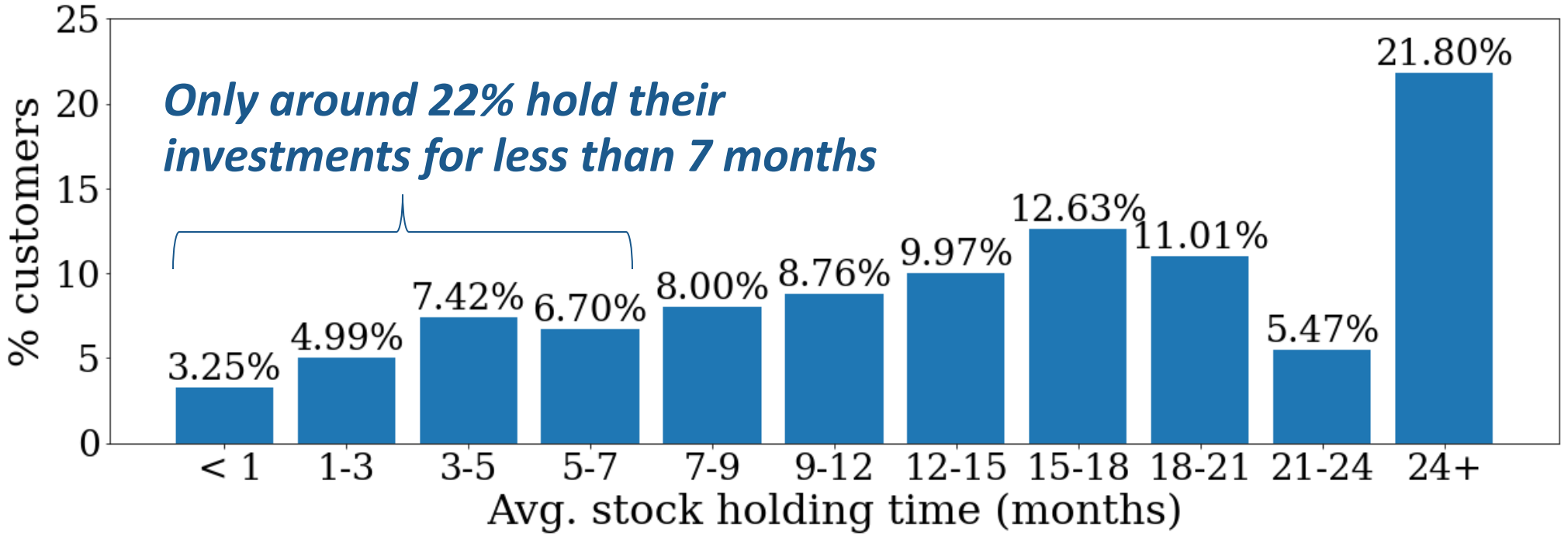
- ***PERIOD 1:*** Positive to mildly negative correlation (Between -0.5 and 0.5)
- ***PERIOD 2:*** Very negative correlation (< -0.7)
- ***PERIOD 3:***
  - Slow growth of Pearson correlation
  - Ends in high correlation (around 0.7)

- Market conditions affect correlation

Customer strategy

Is six months a reasonable future time target?

- We analyze how long people hold their investments (on average)



- Investments captured by nDCG might not necessarily align with a 6 month investment horizon.

Conclusions

- **We cannot use transaction-based metrics in exchange of profitability-based metrics – negatively correlated.**
- **Reasons**
  - Customer underperform the market average.
  - Global events impact on profitability patterns.
  - Customers might have different investment horizons / strategies.
- **Recommendations**
  - Consider changing market conditions when testing financial recommendation algorithms.
  - Customer strategies might confound our evaluation

Thanks for your attention

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Link to the paper

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