KU LEUVEN

Performance of candlestick patterns on intraday market data

Thesis defence

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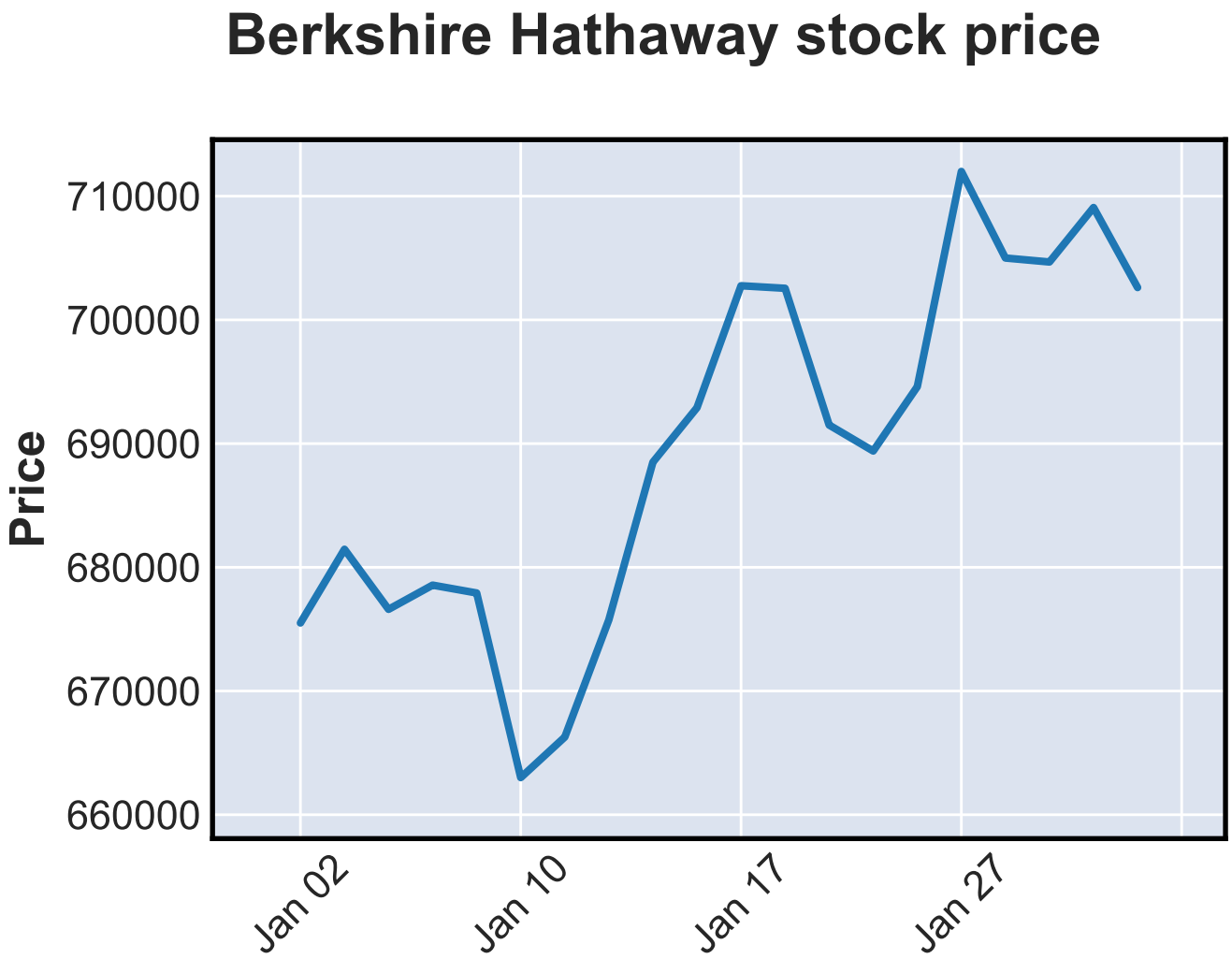
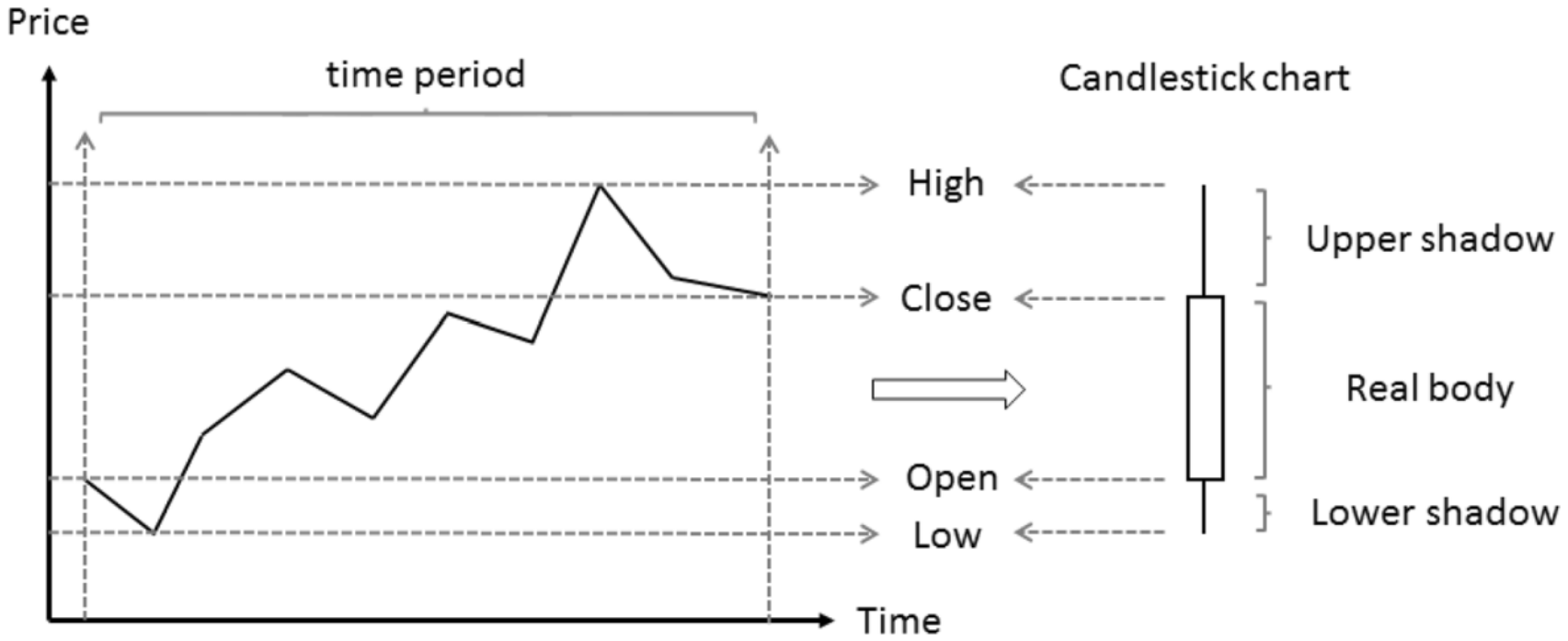
Can you predict what is going to happen on the stock market and make a profit based on these predictions?

Stock price [1]

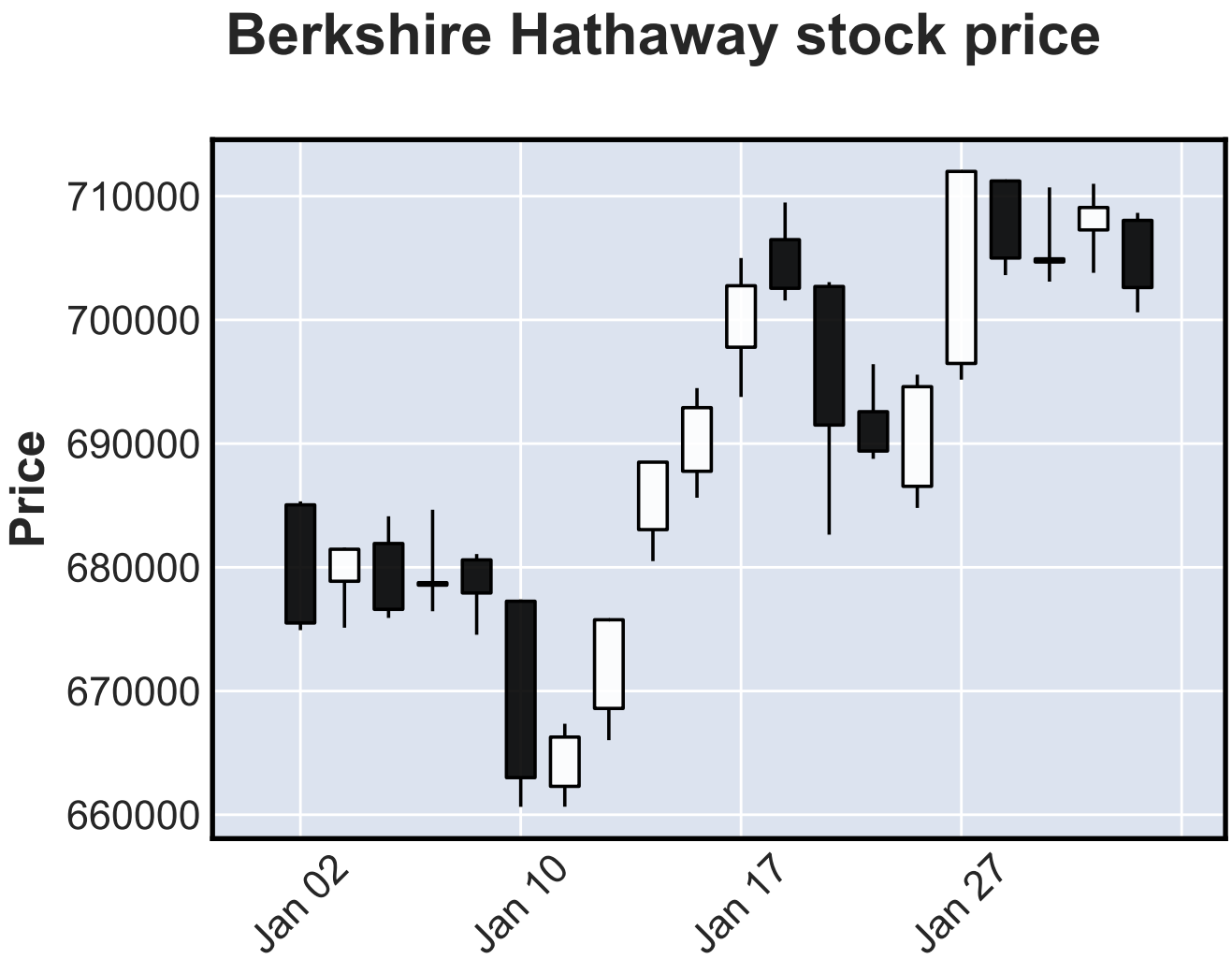


Candlestick construction

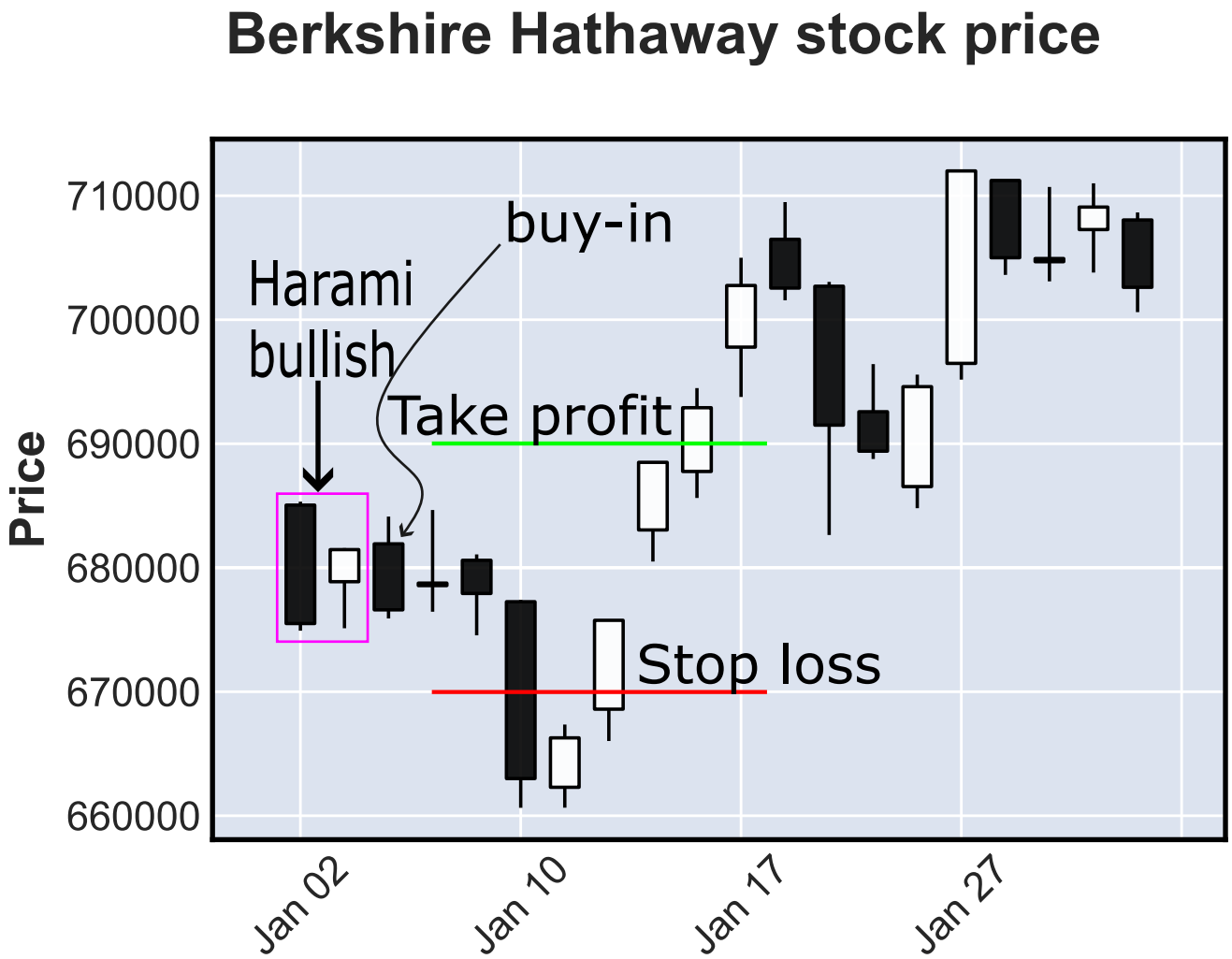


Construction of a candlestick [2].

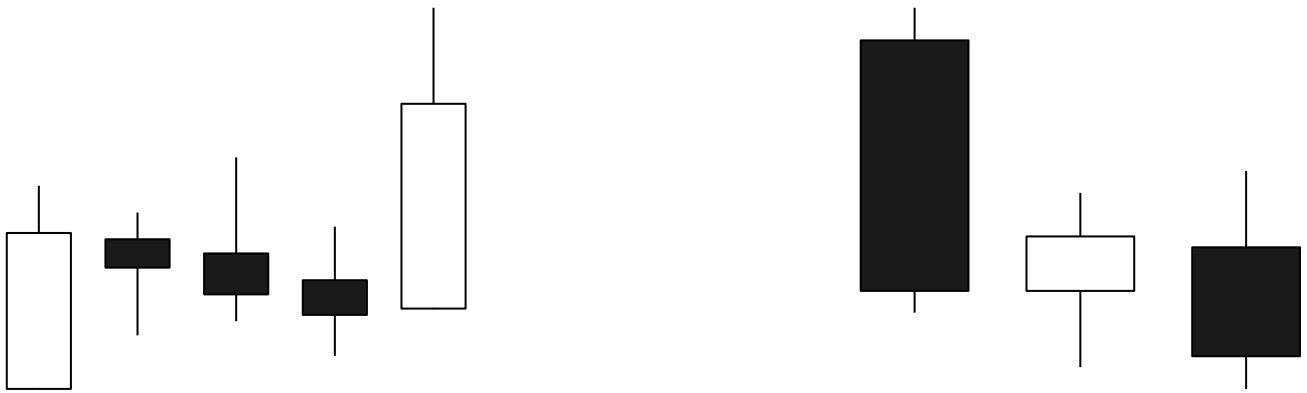
Stock price [1]



Stock price [1]



Candlestick pattern examples



“Rising Three Methods” and “Stick Sandwich”

History

- Developed in the 1700s in Japan.
- Remained exclusive to the East until 1991.
- Has become a well-known technique, used by many traders.

Literature

- Literature split between machine learning and rule based approach.
- Results are very split.
- Very few publications about intraday market data.

Research question

Do candlestick patterns possess predictive power on intraday market data?

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Overview

- Selection of data sets.
- Preprocessing of the data.
- Trends and technical indicators.
- Pattern detection.
- Pattern evaluation.

Data sets

- BND: Bonds.
- GLD: Gold.
- QQQ: Stocks.
- SPY: Stocks.
- Geometric Brownian motion: Generated.

Preprocessing

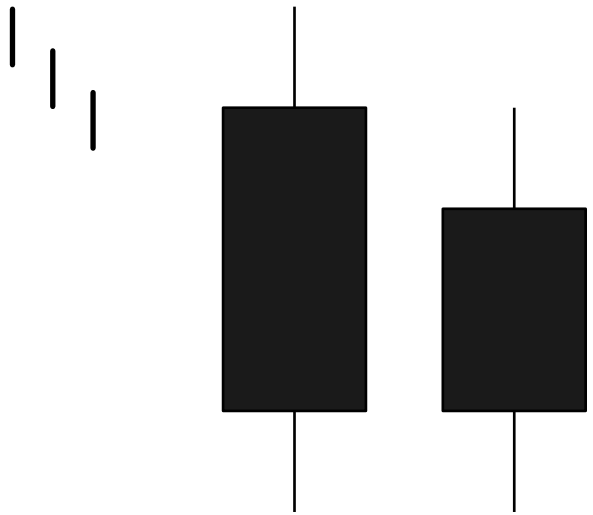
- Filter pre/after-market.
- Aggregation.
- Cross-validation to avoid bias and overfitting.

Preprocessing: calibration

	Doji	Short	Normal	Tall	Extremely tall
Real body	[0 – 10)	[10 – 30)	[30 – 70)	[70 – 100]	
Shadow	[0 – 10)	[10 – 30)	[30 – 70)	[70 – 90)	[90 – 100]

Percentiles of real bodies and shadows [3].

Matching low



Preprocessing: calibration

- Assumes length and color candle independent.
- Has to be checked $\rightarrow$ Kolmogorov-Smirnov test.

$$H_0 : W = B \qquad H_1 : W \neq B.$$

- Reject at 5% significance.

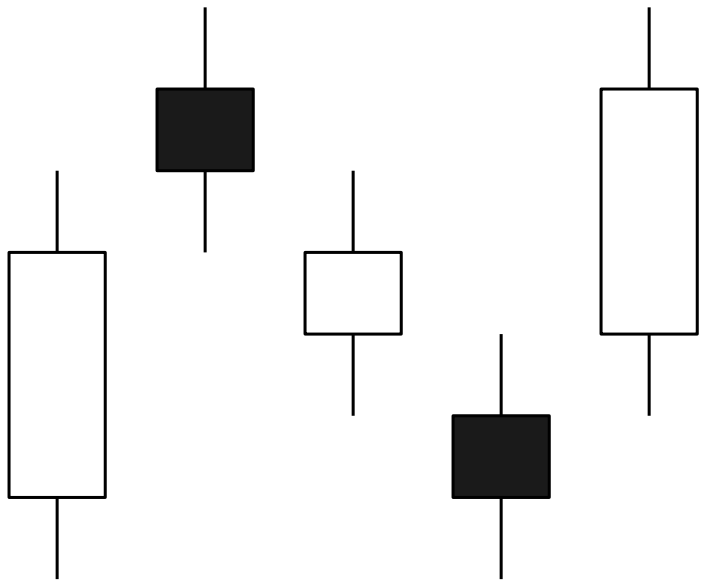
Trend

- Many patterns are only valid when the correct trend is present.
- Multiple ways of defining the trend in the literature.
- Example: count in/decreases in the moving average.

Pattern detection

- Patterns are vaguely defined at best: a rigid classification is necessary.
- The paper “A formal approach to candlestick pattern classification in financial time series” does exactly this [4].
- Define 103 candlestick patterns with strict conditions.
- Multiple comparisons problem addressed through Benjamini-Yekutieli.

Pattern detection: example



"Mat Hold"

Pattern detection: prediction

- Typically classified as buy/sell signal.
- Look at the results themselves instead of the predictions.

Pattern evaluation: stop-loss/take-profit

- Buy after pattern is detected.
- Make use of stop loss/take profit margins.
- These are based on the ATR technical indicator so they scale with market activity.

Pattern evaluation: stop-loss/take-profit

- This gives us a winning rate $\hat{\pi}$.
- Obtain a "null win rate" $\hat{\pi_0}$ through random sampling.
- Test significance with binomial test.

$$H_0 : \hat{\pi} = \hat{\pi_0} \qquad H_1 : \hat{\pi} > \hat{\pi_0}$$

Pattern evaluation: profitability score

$$\text{Adjusted } z\text{-score} = \overbrace{\frac{\hat{\pi} - \hat{\pi}_0}{\sqrt{\frac{\hat{\pi}_0(1-\hat{\pi}_0)}{n}}}}^{z\text{-test}} \cdot \overbrace{\ln(\min\{n, 5000\})}^{\text{Frequency adjustment}}$$

This encapsulates:

1. The number of detected patterns.
2. The win rate.
3. The significance.

Pattern evaluation: excess return

1. Also consider the "excess return" $\hat{\pi} - \hat{\pi_0}$
2. Duvinage et al. estimate that at least 0.05% is required to be economically viable [5].

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Detection results

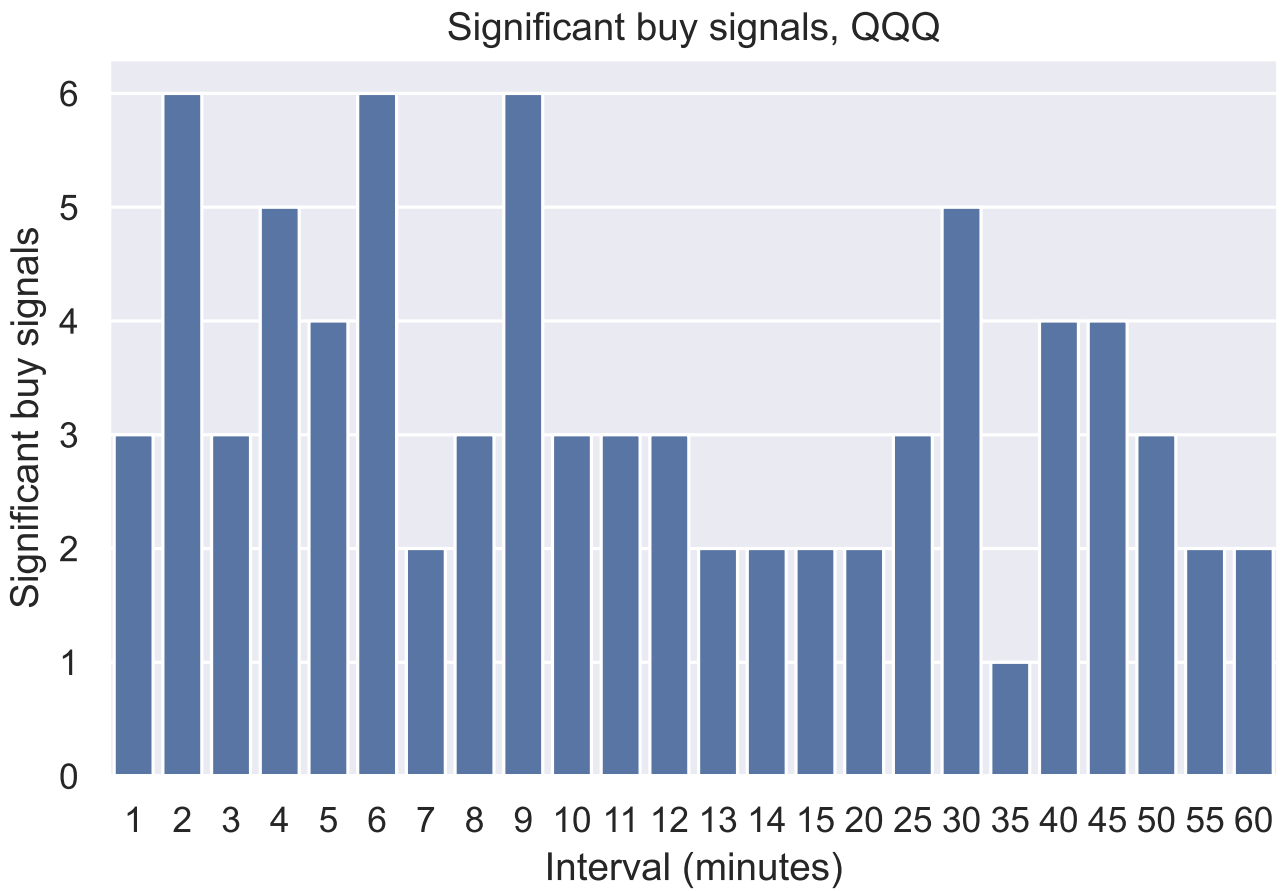
- Not many “gapping” patterns.
- Some patterns are rare due to stringent conditions.

“Window, Falling” and “Evening Star”

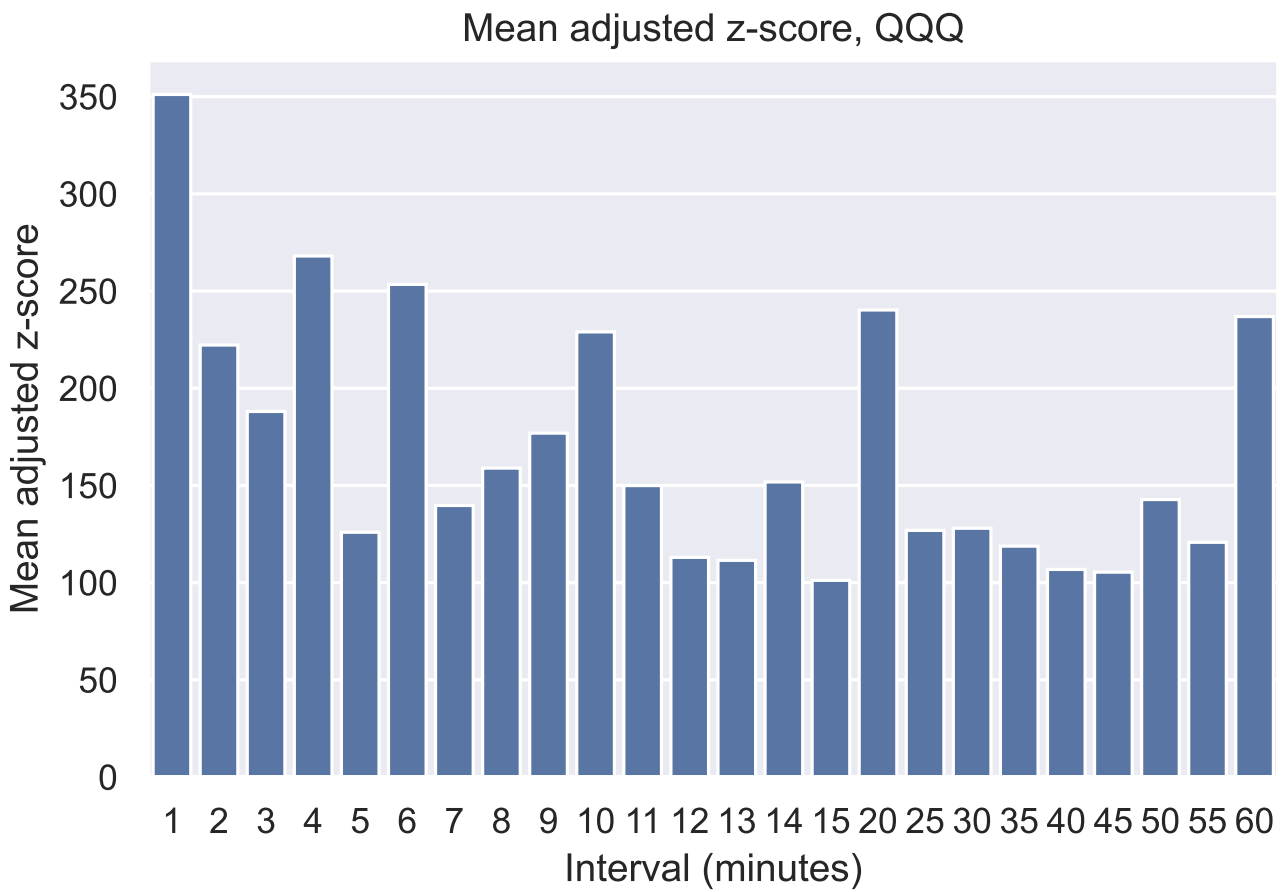
Evaluation results: significance

- Significant patterns are found.
- More significant buy than sell signals.
- A lot of variance between data sets/asset types.
- Aggregation decreases significance and z-score, but not excess return.
- Profit margins too small to be economical.

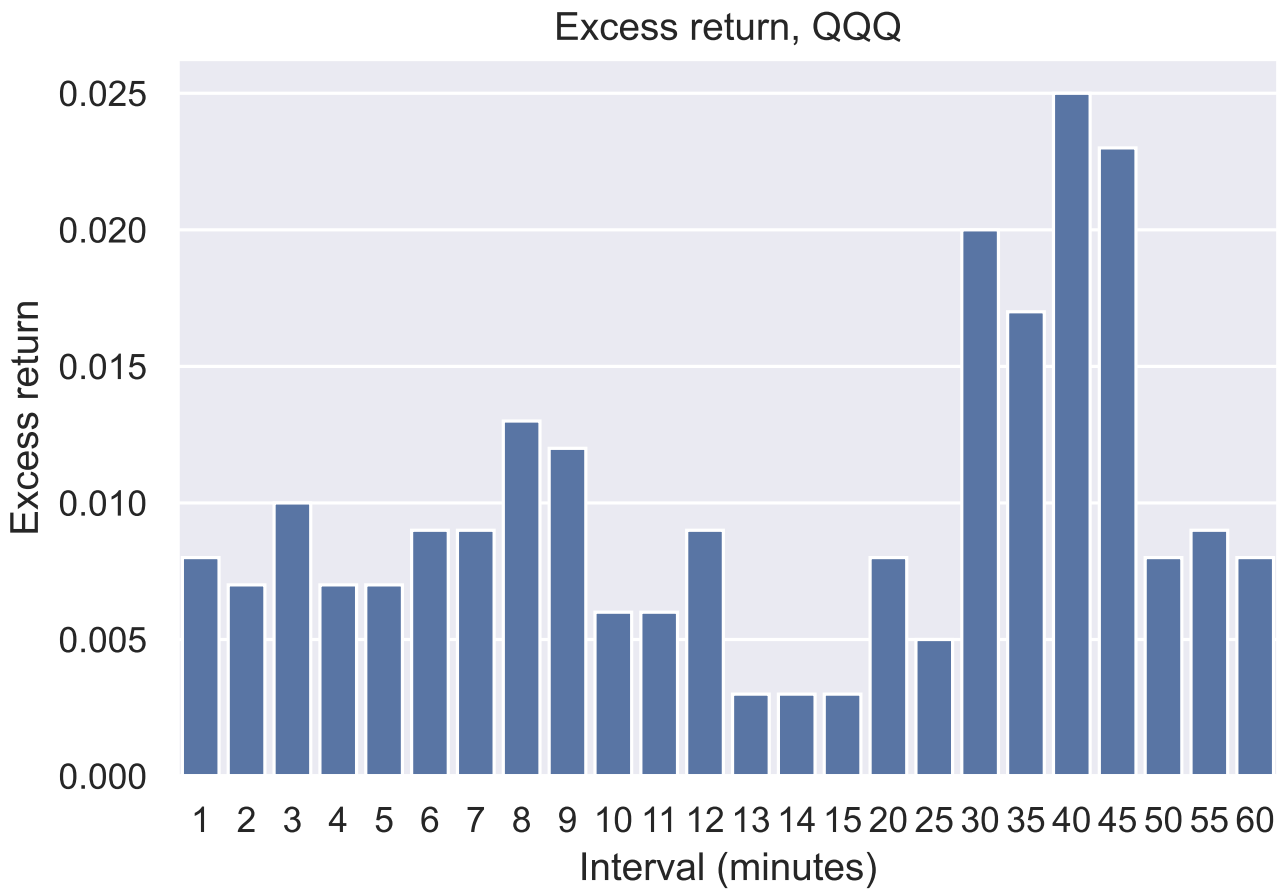
Evaluation results: significance



Evaluation results: significance



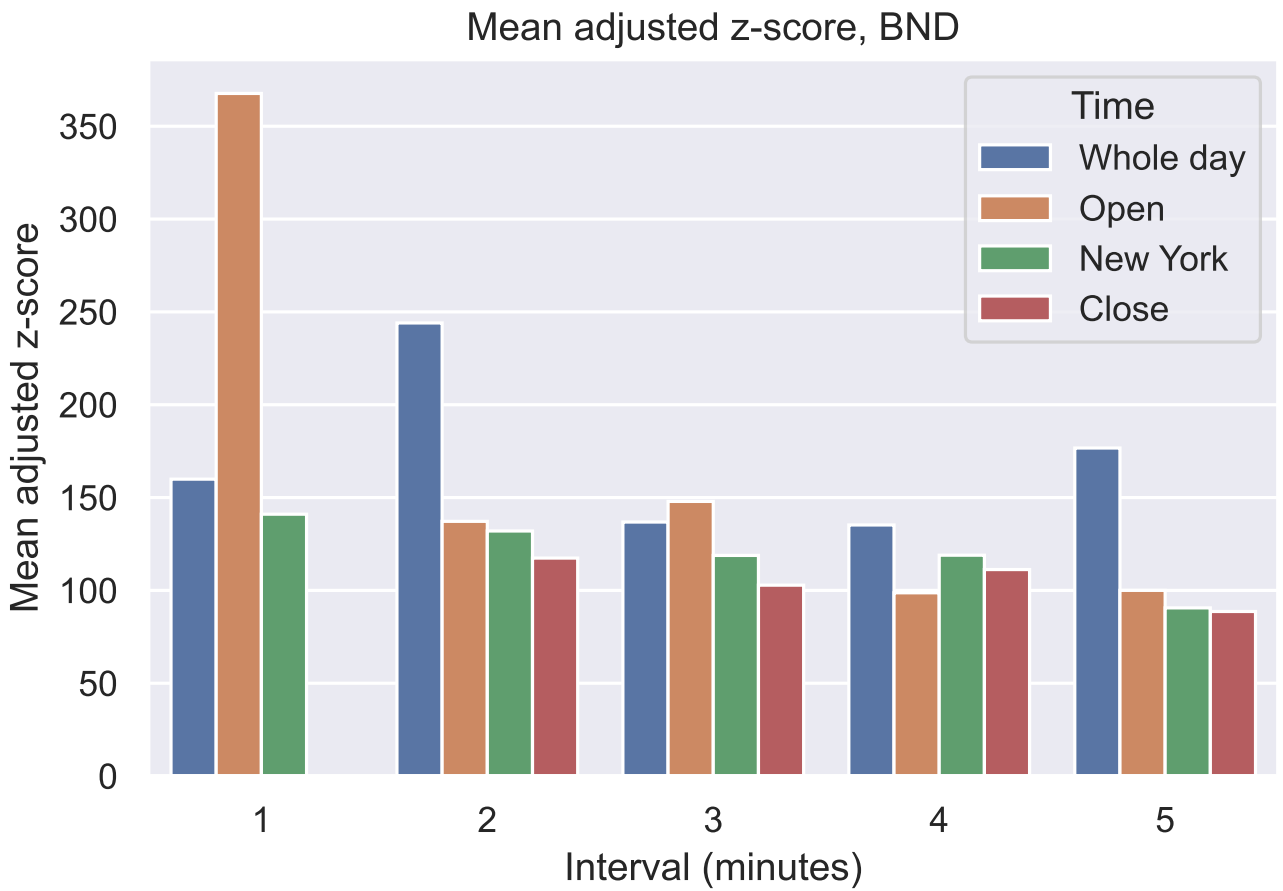
Evaluation results: significance



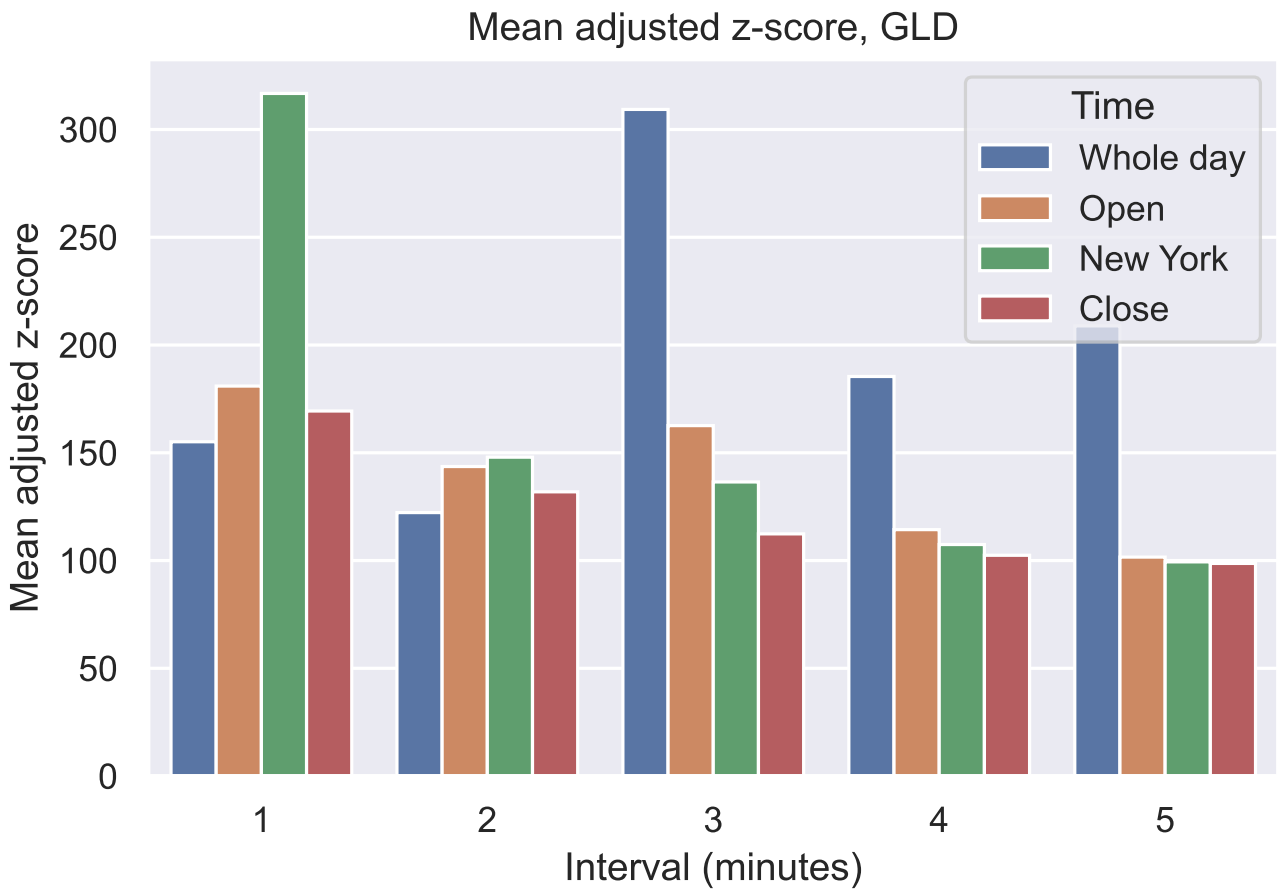
Evaluation results: time of day

- Entire day.
- One hour after open/before close.
- One hour after New York open.
- Limit to maximum 5 minutes.

Evaluation results: time of day



Evaluation results: time of day



Evaluation results: little/no effect

- Trend inclusion.
- Trend defining methods.

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Research question

Do candlestick patterns possess any predictive power on intraday market data?

Conclusion

- Some patterns do appear to possess significant predictive power.
- Typically not consistent.
- This mainly holds true for buy signals.
- There is a lot of variance to these results.
- Not profitable enough to be economically viable.

Further research

- Machine learning-based approach to detection/evaluation.
- Adapting definitions of patterns to market conditions.
- Tick-based candlesticks.
- Many alternative methods to define trends and to evaluate performance.

[1] finance.yahoo.com.
https://finance.yahoo.com/quote/BRK-A/.
[Accessed 10-05-2025].

[2] Jun-Hao Chen and Yun-Cheng Tsai. "Encoding candlesticks as images for pattern classification using convolutional neural networks". In: Financial Innovation 6.1 (June 4, 2020). DOI: 10.1186/s40854-020-00187-0. URL: http://dx.doi.org/10.1186/s40854-020-00187-0.

[3] Stefan Etschberger et al. "The classification of candlestick charts: laying the foundation for further empirical research". In:
From Data and Information Analysis to Knowledge Engineering: I
Springer. 2006, pp. 526–533.

[4] Weilong Hu et al. “A formal approach to candlestick pattern classification in financial time series”. In: Applied Soft Computing 84 (Nov. 2019), p. 105700. DOI: 10.1016/j.asoc.2019.105700. URL: http://dx.doi.org/10.1016/j.asoc.2019.105700.

[5] MATTHIEU DUVINAGE, PAOLO MAZZA, and MIKAEL PETITJEAN. “The intra-day performance of market timing strategies and trading systems based on Japanese candlesticks”. eng. In: Quantitative finance 13.7 (2013), pp. 1059–1070. ISSN: 1469-7688.

Questions?