



## Quarterly Journal of Quantitative Economics

Journal Homepage:

[www.jqe.scu.ac.ir](http://www.jqe.scu.ac.ir)

Print ISSN: 2008-5850

Online ISSN: 2717-4271



### A Method Based on Wavelet Denoising and DTW Algorithm for Stock Price Pattern Recognition in Tehran Stock Exchange

Rahim Ghasemiyeh\*<sup>ID</sup>, Hasanali Sinaei\*\*, Elnaz Ghalambor Dezfuli\*\*\*

\* Associate Professor of Management, Department of Management, Faculty of Economics and Social Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran. (Corresponding Author)

Email: [r.ghasemyeh@scu.ac.ir](mailto:r.ghasemyeh@scu.ac.ir)



[0000-0002-1042-3918](https://orcid.org/0000-0002-1042-3918)

Postal address: Golestan street, Golestan, Department of Management, Faculty of Economics and Social Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Khuzestan, Postal code: 61357-93113, Iran.

\*\* Professor of Financial Management, Department of Management, Faculty of Economics and Social Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

Email: [h.sinaei@scu.ac.ir](mailto:h.sinaei@scu.ac.ir)

\*\*\* Master of Financial Management, Department of Management, Faculty of Economics and Social Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

Email: [e-ghalambor@stu.scu.ac.ir](mailto:e-ghalambor@stu.scu.ac.ir)

---

#### ARTICLE HISTORY

Received: 07 November 2022

Revision: 24 February 2023

Acceptance: 20 May 2023

#### JEL

#### CLASSIFICATION

G17, C30, C61

#### KEYWORDS

Dynamic time warping,  
wavelet denoising, stock  
prediction

---

#### FURTHER INFORMATION:

The present article is taken from the MBA dissertation of Elnaz Ghalambor Dezfuli with Supervisor of Dr. Sinaei and Rahim Ghasemiyeh. at the Shahid Chamran University of Ahvaz, Ahvaz, Iran.


**ACKNOWLEDGMENTS:** Acknowledgments may be made to individuals or institutions that have made an important contribution.

**CONFLICT OF INTEREST:** The authors declare no conflict of interest.

**FUNDING:** The authors received no financial support for the research, authorship, and publication of this article.

**How to Cite:**

Ghasemiyeh, Rahim, Sinaei, Hasanali & Ghalambor Dezfuli, Elnaz. (2024). A Method Based on Wavelet Denoising and DTW Algorithm for Stock Price Pattern Recognition in Tehran Stock Exchange. *Quietly Journal of Quantitative Economics (JQE)*, 21(1), 1-28.

 <https://doi.org/10.22055/jqe.2023.42285.2521>



© 2024 Shahid Chamran University of Ahvaz, Ahvaz, Iran. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0 license) (<http://creativecommons.org/licenses/by-nc/4.0/>)

## EXTENDED ABSTRACT

### INTRODUCTION

The primary reason most people invest in stocks is the potential return compared to alternatives such as bank certificates of deposit, gold, and Treasury bonds. This requires accurate information about the stock market, price changes and predicting future trends. The main purpose of this study is to present a method based on wavelet denoising and dynamic time warping to identify the stock price pattern in the Tehran Stock Exchange. Instead of focusing and summarizing different and numerous methods to predict stock prices, this research concentrates on neural networks and wavelet denoising, and dynamic time warping to identify the stock price patterns. This methodology has been approved by researchers as a new effective technique.

### METHODOLOGY

The required data has been collected from the website of the Tehran Stock Exchange Organization. Excel software was used to categorize the research data and MATLAB version 9.11 software was used to analyze the research data. Basic metal such as steel and copper in Iran constitute the most important part of the country's non-oil exports. This industry in Tehran Stock Exchange also has the highest correlation with the stock index. About 15% of the total value of the Tehran Stock Exchange is owned by the Basic Metals Group, and the Isfahan Mobarake Steel, Khuzestan Steel, and Khorasan Steel companies have the largest share of the total capital market value, respectively, compared to other Metals Group companies. As a result, among



other industries active in the Tehran Stock Exchange, the basic metals industry and among the shares of companies active in the metals industry, the aforementioned 3 shares were selected as the statistical population of the research. The required data, 1300 data for each company, were collected during a four-year period. Also, the K-fold method has been used to divide the stock transactions of each company into training and test sections.

### **FINDINGS**

Findings indicate that the forecast trend of Isfahan Mobarakeh Steel Company stock price, that the proposed method is exactly on the actual price chart. This shows the high accuracy of the proposed research method (dynamic time warping equipped with wavelet denoising step). However, the prediction of the price trend according to the compared method, the dynamic time convolution method without wavelet denoising step, has low power and the predicted trend is not in accordance with the actual price trend.

### **CONCLUSION**

Due to the problems in predicting stock prices using the simple dynamic time convolution method (without wavelet denoising), the wavelet denoising approach was used as a pre-processing step. In contrast to the other current survey studies that concentrate on summarizing many methods used for forecasting the stock market, this research concentrates on neural networks and wavelet denoising, and dynamic time warping to identify the stock price patterns. There are many smart techniques, each of which has advantages and disadvantages, one of the new smart methods that has better results than some other methods is the dynamic time warping (DTW).

The proposed framework started with the pre-processing step of wavelet denoising in order to reduce the examples of useless transactions and remove noise from the trading signals of the shares of the three companies Mobarakeh Isfahan Steel, Khorasan Steel and Khuzestan Steel.

Then, the prediction of trading signals was modeled with dynamic time warping problem. At the end, the results obtained from the dynamic time warping method with the preprocessing step of wavelet denoising and the results obtained from the simple dynamic time warping method without wavelet denoising were compared. The results of the findings showed that the algorithm proposed in this research compared to simple dynamic temporal convolution has more accuracy and at the same time less error in predicting

the stock price trend and provides more correct results, so both developed hypotheses research were confirmed.

## References

- Asgari Oskoei, M. R. (2002). TIME SERIES PREDICTION BY NEURAL NETS. *Iranian Journal of Economic Research*, 4(12), 69–96. Retrieved from [https://ijer.atu.ac.ir/article\\_3830.html](https://ijer.atu.ac.ir/article_3830.html) [In Persian]
- Asadi, G. H., Abdoh Tabrizi, H., Hamidizade, M. R., & farazmand, S. (2023). Investigation of stock price Herding in Tehran Stock Exchange. *Quarterly Journal of Quantitative Economics (JQE)*, 20(3), 1-34. doi: 10.22055/jqe.2021.36054.2310 [In Persian]
- Bao, D. (2008). A generalized model for financial time series representation and prediction. *Applied Intelligence*, 29(1), 1–11. Retrieved from <https://doi.org/10.1007/s10489-007-0063-1>
- Cottis, R. A., Homborg, A. M., & Mol, J. M. C. (2016). The relationship between spectral and wavelet techniques for noise analysis. *Electrochimica Acta*, 202, 277–287. Retrieved 15 July 2023 from <https://doi.org/10.1016/J.ELECTACTA.2015.11.148>
- Feghehmajidi. Ali, & Shahidi.Fariba. (2018). The Impacts of Industrial Index, Financial Index and Macroeconomic Variables on Tehran Stock Exchange: Markov-Switching Approach. *Quarterly Journal of Applied Theories of Economics*, 5(2), 1–26.
- Ghasemiyeh, R., Darzian Azizy, A., Salehi, M., & Sana, S. S. (2024). A Novel Methodology for Evaluating Quality of Websites: A Hybrid Approach of Bipolar Neutrosophic Numbers (BNN)-SWARA-TOPSIS. *International Journal of Applied and Computational Mathematics*, 10(2), 40
- Ghasemiyeh, R., Moghdani, R., & Sana, S. S. (2017). A hybrid artificial neural network with metaheuristic algorithms for predicting stock price. *Cybernetics and Systems*, 48(4), 365-392.
- Han, T., Peng, Q., Zhu, Z., Shen, Y., Huang, H., & Abid, N. N. (2020). A pattern representation of stock time series based on DTW. *Physica A: Statistical Mechanics and Its Applications*, 550, 124161.

- Hoseini Ebrahimabad, S. A., Jahangiri, K., Ghaemi Asl, M., & Heydari, H. (2020). Investigation of the volatility spillover effect and dynamic conditional correlations in Tehran Stock Exchange using wavelet-based Bayesian conditional variance heteroscedasticity. *Quarterly Journal of Applied Theories of Economics*, doi. [10.22034/ECOJ.2020.10724](https://doi.org/10.22034/ECOJ.2020.10724) 7(1), 149–184. [In Persian]
- Izakian, H., Pedrycz, W., & Jamal, I. (2015). Fuzzy clustering of time series data using dynamic time warping distance. *Engineering Applications of Artificial Intelligence*, 39, 235–244. Retrieved 15 July 2023 from <https://doi.org/10.1016/J.ENGAPPAI.2014.12.015>
- Jafari Samimi, A., & Baloonejad, R. (2013). Applying Semi-parametric and Wavelets Methods to Study Persistent Rate of Inflation in Iran. *Economic Modelling*, 7(23), 15–30. Retrieved from [https://eco.firuzkuh.iau.ir/article\\_555332.html](https://eco.firuzkuh.iau.ir/article_555332.html) [In Persian]
- Jiang, Y., Qi, Y., Wang, W. K., Bent, B., Avram, R., Olgin, J., & Dunn, J. (2020). EventDTW: An Improved Dynamic Time Warping Algorithm for Aligning Biomedical Signals of Nonuniform Sampling Frequencies. *Sensors*, 20(9). Retrieved from <https://doi.org/10.3390/s20092700>
- Khaidem, L., Saha, S., & Dey, S. R. (2016). Predicting the direction of stock market prices using random forest. *ArXiv Preprint ArXiv:1605.00003*.
- Khaloozade, H., & Khaki Sedigh, A. (2005). Modeling and forecasting stock prices using stochastic differential equations. *Journal of Economic Research (Tahghighat- E- Eghtesadi)*, 40(2). Retrieved from [https://jte.ut.ac.ir/article\\_11454.html](https://jte.ut.ac.ir/article_11454.html) [In Persian]
- Kim, S. H., Lee, H. S., Ko, H. J., Jeong, S. H., Byun, H. W., & Oh, K. J. (2018). Pattern matching trading system based on the dynamic time warping algorithm. *Sustainability*, 10(12), 4641.
- Leal, M. M., Costa, F. B., & Campos, J. T. L. S. (2019). Improved traditional directional protection by using the stationary wavelet transform. *International Journal of Electrical Power & Energy Systems*, 105, 59–69.

- Mallat, S. (2009). A wavelet tour of signal processing: the sparse way. *AP Professional, Third Edition, London*.
- Mohammadi, A., Mosleh Shirazi, A., Abbasi, A., & Akhlaghpour, S. (2019). Scenario planning of factors affecting market capitalization of Tehran stock exchange using system dynamics approach. *Financial Management Perspective*, 9(26), 33–68. Retrieved from <https://doi.org/10.52547/jfmp.9.26.33> [In Persian]
- Myers, C., Rabiner, L., & Rosenberg, A. (1980). Performance tradeoffs in dynamic time warping algorithms for isolated word recognition. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, 28(6), 623–635.
- Osoolian, M., & Koushki, A. (2020). Investigating the Crisis Forecasting Ability of the Cumulative Residual Entropy Measure by using Logistic Map Simulation Data and Tehran Stock Exchange Overall Index. *Financial Management Perspective*, 10(31), 9–27. Retrieved from <https://doi.org/10.52547/jfmp.10.31.9>
- Paliwal, D., Choudhur, A., & Govandhan, T. (2014). Identification of faults through wavelet transform vis-à-vis fast Fourier transform of noisy vibration signals emanated from defective rolling element bearings. *Frontiers of Mechanical Engineering*, 9, 130–141.
- Raei, R., Mohammadi, S., & Fendereski, H. (2015). Forecasting Stock Index With Neural Network and Wavelet Transform. *Journal of Asset Management and Financing*, 3(1), 55–74. <https://www.sid.ir/paper/245714/fa> [In Persian]
- Rezagholizadeh, M., elmi, Z., & mohammadi majd, S. (2023). The Effect of Financial Stress on the Stock Return of Accepted Industries in Tehran Stock Exchange. *Quarterly Journal of Quantitative Economics (JQE)*, 20(1), 32-73. doi: 10.22055/jqe.2021.35405.2284 [In Persian]
- Raofi, A., & Mohammadi, T. (2018). Forecasting Tehran Stock Exchange Index Returns Using a Combination of Wavelet Decomposition and Adaptive Neural Fuzzy Inference Systems. *Iranian Journal of Economic Research*, 23(76), 107–136. Retrieved from <https://doi.org/10.22054/ijer.2018.9514> [In Persian]



- Sadeghi, H., & Beheshti Tabar, M. (2019). Application of Dynamic Time Warping (DTW) method to measure the distance of financial time series. In Yazd University (Ed.), . *4th Conference on Financial Mathematics and Applications* (102-106). Yazd: Reasearch Center For Mathematical Modeling. <https://research.shahed.ac.ir/> [In Persian]
- Shojaei, A., & Heidarzadeh Hanzaei, A. (2021). The Comparison of Cryptocurrency Returns Prediction Based on Geometric Brownian Motion and Wavelet Transform. *Financial Engineering and Portfolio Management*, 12(47), 92–111.
- Tehrani, R., Mohammadi, Sh., & Mohammad Alizadeh, A. (2010). Investigating the Relationship between Stock Returns and Inflation in Tehran Stock Exchange at Different Times Using Wavelet Transform. *journal of Economic Research*, 11(2), 225-244. [https://joer.atu.ac.ir/article\\_2591.html](https://joer.atu.ac.ir/article_2591.html) [In Persian]
- Zolfaghari, M. (2018). Investigating the effect of macroeconomic variables on the value of stock transactions on the stock exchange. *Tehran Stock Exchange Publications*, 38–51. <https://www.noormags.ir/view/fa/articlepage/1487990/> [In Persian].