Day-of-the-week effect on Romanian foreign exchange market during quiet and turbulent times

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Abstract: Some calendar anomalies could have different characteristics during quiet and turbulent times. This paper approaches the behavior of day-of-the-week (DOW) effect on the Romanian foreign exchange market for three periods: January 2010 - December 2014, January 2015 - December 2019 and January 2020 - August 2022. The results suggest there were differences between characteristics of the DOW effect in quiet and turbulent circumstances.

Keywords: DOW Effect; persistence in time of the calendar anomalies; Romanian foreign exchange market

JEL: F31, G14, G40

1. INTRODUCTION

In the last decades, several forms of calendar anomalies were identified not only in stock markets but also in foreign exchange markets (e.g. McFarland et al., 1982; Jaffe et al., 1989; Yamori and Kurihara, 2004; Berument et al., 2007; Ke et al., 2007; Anwar et al., 2021). Some particularities of calendar anomalies from foreign currency markets could be linked to the type of foreign exchange rates regime applied (e.g. Jeanne and Rose, 2002; Rose, 2011).

Among the calendar anomalies that were found on foreign exchange markets there is the day-of-the-week (DOW) effect which refers to the abnormal returns that occur in some certain days of the week. The DOW effect was among the first discovered calendar anomalies associated to stock markets. Initially, it was revealed that, in average, returns from Fridays tend to be larger than returns from Mondays (e.g. Cross, 1973; French, 1980). Several explanations were given for this anomaly known as the weekend effect: the impact of the delay between settlement and clearing of the transactions, the arrival of important news during the weekend, the nervosity of investors about the events that could occur Saturday or Sunday (e.g. Lakonishok, and Levi, 1982; Dyl and Maberly, 1988; Rystrom and Benson, 1989; Fishe et al., 1993). Many studies investigated the weekend effect and some of them revealed that abnormal returns occurred not only on Fridays and Mondays but also in other days of the week (e.g. Gibbons and Hess, 1981; Keim and Stambaugh, 1984; Rogalski, 1984; Jaffe and Westerfield, 1985; Solnik and Bousquet, 1990; Brooks and Persand, 2001). There were also studies that found that, as in the case of other calendar

anomalies, the DOW effect on stock markets or foreign exchange markets was not necessarily persistent in time (e.g. Jaffe et al., 1989; Kohers et al., 2004; Marquering et al., 2006; Kumar, 2018). Sometimes, the changes in DOW effects were caused by the passing from a relatively quiet period to a turbulent one (e.g. Holden et al, 2005; Dumitriu and Stefanescu, 2013).

This paper approaches the DOW effect persistence in time on the Romanian foreign exchange market. Although the central bank of Romania (NBR – National Bank of Romania) adopted, in 2005, the inflation targeting, it maintained a consistent intervention in the foreign exchange market, in order to prevent major shocks. NBR's intervention is directed to the two official exchange rates that express the prices of Romanian national currency (the Romanian leu - RON) against the euro (RON/EUR) and US dollar (RON/USD). A previous investigation for the period January 2005 – February 2010 identified some significant changes on the DOW effect for the two exchange rates in the context of turbulences generated by Global Financial Crisis and European debt crisis (e.g. Dumitriu & Stefanescu, 2010). In this paper, in order to find if the DOW effect on RON/EUR and RON/USD is persistent in time, we investigate this calendar anomaly for three sub-samples:

- the first one, from January 2010 to December 2014 was affected by the Great Recession and by the European debt crisis;
- the second one, from January 2015 to December 2019 could be considered as a relatively quiet one;
- the third one, from January 2020 to August 2022 was marked by events such as political and commercial tension between USA and China, the COVID-19 pandemic, the recent global energy crisis, and Russian invasion of Ukraine.

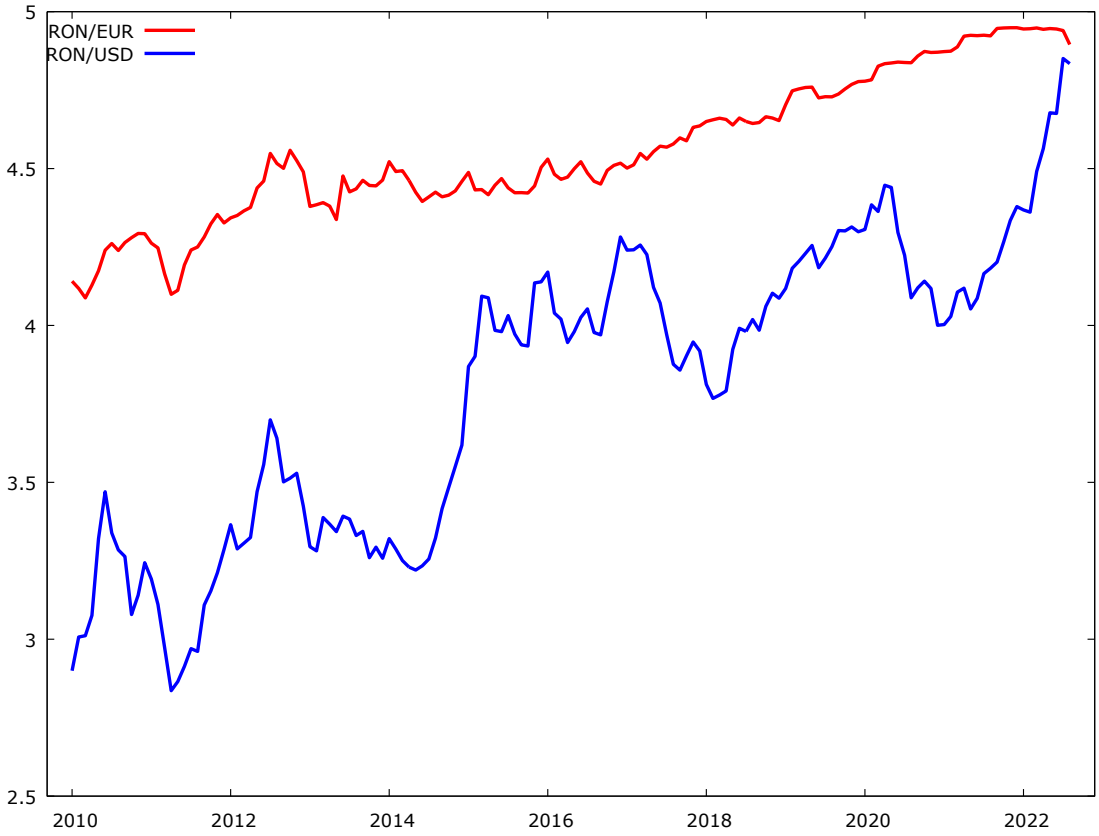
The rest of this paper is organized as it follows: the second part describes the data and the methodology employed to reveal the presence of the DOW effect, the third part presents the empirical results, and the fourth part concludes.

2. DATA AND METHODOLOGY

2.1. Data

In this investigation about the DOW Effect presence on the Romanian foreign exchange market we employ the daily closing values of the two official exchange rates (RON/EUR and RON/USD), as provided by NBR. The Figure 1, that presents the monthly values of the two variables, indicates ascendant trends for both variables and a volatility more consistent for RON/USD in comparison with RON/EUR. The sample of data was split into the three sub-samples mentioned in the previous chapter.

Fig. 1. Evolution of the monthly official exchange rates for the Romanian leu against euro (RON_EUR) and United States dollar (RON_USD) from January 2010 to August 2022



Source of data: National Bank of Romania

We compute, for both exchange rates, the logarithmic returns ($r\_S_{j,t}$) using the formula:

$$r\_S_{j,t} = 100 \times \ln\left(\frac{S_{j,t}}{S_{j,t-1}}\right) \quad (1)$$

in which $S_{j,t}$ and $S_{j,t-1}$ are the closing values of the exchange rate j on the days t and t-1, respectively.

Tab. 1. Descriptive statistics of the exchange rates returns for the three sub-samples

Statistics	**First sub-sample**		**Second sub-sample**		**Third sub-sample**	
	r_RON/EUR	r_RON/USD	r_RON/EUR	r_RON/USD	r_RON/EUR	r_RON/USD
Mean	0.005	0.018	0.005	0.012	0.003	0.020
Median	-0.007	-0.010	0.002	0.009	0.001	0.015
Minimum	-1.607	-2.881	-0.764	-2.526	-0.369	-1.637
Maximum	1.710	2.876	0.902	3.200	0.426	2.062
Std. Dev.	0.274	0.699	0.153	0.552	0.058	0.465
C.V.	59.568	38.969	29.949	47.955	23.306	23.376
IQ range	0.268	0.817	0.145	0.591	0.036	0.540
Jarque-Bera test	1428.25***	132.873***	1046.34***	455.351***	6167.53***	89.6857***

Source of data: National Bank of Romania

Note: *** means significant at 0.01 levels.

The descriptive statistics for the three sub-samples are presented in the Table 1. Jarque-Bera tests indicate, for all the three sub-samples, that returns of the two exchange

rates didn't follow normal distributions. The values of mean suggest that devaluation of the Romanian national currency was more abrupt in the case of US dollar than in the case of euro. Based on the standard deviation, coefficient of variation and interquartile range we could conclude the most consistent volatility occurred in the first sub-sample. A special context occurred during the period from January 2020 to August 2022 when NBR resorted to active interventions to prevent a sharp devaluation of the national currency against euro but it had to allow a substantial increase of RON/USD exchange rate (in this period, US dollar significantly appreciated against euro). The interquartile range indicates, for the third sub-sample, that returns of RON/USD had a higher volatility in comparison with the return of RON/EUR.

The methodology of this investigation includes performing regressions in which the returns of the two exchange rates are dependent variables. In order to avoid the false regressions, we investigate the returns stationarity by employing Augmented Dickey – Fuller unit root tests for two variants: with and without constant (Dickey & Fuller, 1979; Dickey & Fuller, 1981). The results, presented in the Table 2, indicated, for all three sub-samples, the returns stationarity.

Tab. 2. Results of the Dickey – Fuller unit root tests

Variable	**Test without constant**		**Test with constant**	
	Number of lags	Test statistic	Number of lags	Test statistic
First sub-sample				
r_ RON/EUR	12	-9.5594***	12	-9.5956***
r_ RON/USD	21	-6.6393***	21	-6.6861***
Second sub-sample				
r_ RON/EUR	11	-9.8454***	11	-9.91104***
r_ RON/USD	12	-11.2456***	12	-11.2624***
Third sub-sample				
r_ RON/EUR	16	-3.5426***	16	-3.5223***
r_ RON/USD	15	-6.5095***	15	-6.5877***

Source of data: National Bank of Romania

Notes: Akaike (1974) Information Criterion was used to identify the optimum number of lags; *** means significant at 0.01 levels.

2.2. Methodology

In order to identify the DOW Effect presence we test the null hypothesis that, for each five trading days of the week, the averages of returns are equals. The rejection of this hypothesis is allowed if the results indicate, for at least one trading day, that averages of the returns are statistically different from the average of any other day.

First, we test the null hypothesis by employing Ordinary Least Square (OLS) models with dummy variables and no intercept. For each five trading days of the week (Monday, Tuesday, Wednesday, Thursday and Friday) we define dummy variables $D_{k,t}$ taking the values:

$$D_{k,t} = \begin{cases} 1, \ if \ t \ coincides \ with \ the \ k \ trading \ day \ of \ the \ week \\ 0, \ otherwise \end{cases} \quad (2)$$

In order to prevent the autocorrelation in residual terms we introduced lagged value of the dependendent variables (the returns of exchange rates). The optimum lag order is identified by Akaike (1974) Information Criterion. The OLS models have the equation:

$$r_{j,t} = \sum_{k=1}^{5} \varphi_k \times D_{k,t} + \sum_{i=1}^{n} \xi_i \times r_{j,t-i} + \varepsilon_t \quad (3)$$

where:

- φ_k is the coefficient associated to the dummy variable $D_{k,t}$ which expresses the average return of exchange rate j on the day k;
- ξ_i is a coefficient associated to the i lagged value of the index j returns;
- n is the number of lagged value of the returns;
- ε_t is the residual (error) term.

The error term is supposed to follow a normal distribution with zero mean and a constant variance h ($\varepsilon \sim N(0,h)$). For each OLS model, the presence of heteroskedasticity in the residual (error) terms is investigated by the White (1980) test, with the null hypothesis of homoskedasticity.

In addition to OLS regression we use the Engle (1982) and Bollerslev (1986) GARCH method, in which the error term is allowed to have a time varying variance (heteroskedasticity). The values of residuals depend on the information that is available from the preceding period (I_{t-1}):

$$\varepsilon_t \mid I_{t-1} \sim N(0, h_t) \quad (4)$$

We use GARCH (1,1) models that, along with the equations of the OLS models, have variance equations with the formula:

$$h_t = \lambda + \alpha_1 \times \varepsilon_{t-1}^2 + \beta_1 \times h_{t-1} \quad (5)$$

where:

- λ is a constant term;
- α_1 is a coefficient associated to the lagged squared residuals;
- β_1 is a coefficient associated to the lagged variance.

3. EMPIRICAL RESULTS

3.1. Results for the first sub-sample (January 2010 - December 2014)

The coefficients of return and variance equations for the period January 2010 - December 2014 are presented in the Table 3. For both RON/EUR and RON/USD exchange rates, the OLS models have significant positive values for the φ_4 coefficient, while the return equations of the GARCH models have no significant coefficients. In the case of RON/EUR, the White Test didn't confirm the homoskedasticity of the OLS residuals.

Tab. 3. Coefficients of the OLS and GARCH models for the first sub-sample

Coefficient	RON/EUR		RON/USD	
	OLS	GARCH(1,1)	OLS	GARCH(1,1)
Return equation				

φ_1 (Monday)	-0.0334 (0.0173)	-0.0185 (0.0136)	0.0146 (0.0446)	0.0124 (0.0377)
φ_2 (Tuesday)	0.0222 (0.0170)	0.0112 (0.0130)	0.0302 (0.0436)	0.0009 (0.0373)
φ_3 (Wednesday)	-0.0016 (0.0171)	0.0148 (0.0132)	-0.0086 (0.0439)	0.0372 (0.0378)
φ_4 (Thursday)	0.0358** (0.0170)	0.0119 (0.0134)	0.0764* (0.0439)	0.0460 (0.0372)
φ_5 (Friday)	-0.0018 (0.0170)	-0.0008 (0.0136)	-0.0231 (0.0436)	0.0090 (0.0369)
ξ_1	0.1086*** (0.0280)	x	x	x
White Test for OLS residuals	156.8022***	x	3.0161	x
Variance equation				
λ	x	0.0036*** (0.0010)	x	0.0016 (0.0011)
α_1	x	0.1695*** (0.0030)	x	0.0354*** (0.0085)
β_1	x	0.7877*** (0.0344)	x	0.9608*** (0.0093)

Source of data: National Bank of Romania

Notes: Standard errors are within parentheses; ***, ** and * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

3.2. Results for the second sub-sample (January 2015 - December 2019)

The Table 4 reports the results of OLS and GARCH models for the period January 2015 - December 2019. In the case of RON/EUR exchange rate, for both models, the φ_1 coefficient have significant negative values, while the φ_3 coefficient have significant positive values. The φ_5 coefficient has a significant positive value only for OLS model. In the case of RON/USD exchange rate, we found significant negative values of the φ_4 coefficient for both OLS and GARCH models (the results of White Test suggest the heteroskedasticity of OLS residuals), while the φ_3 coefficient has a significant positive value only for the GARCH model.

Tab. 4. Coefficients of the OLS and GARCH equations for the period January 2015 - December 2019

Coefficient	**RON/EUR**		**RON/USD**	
	OLS	GARCH(1,1)	OLS	GARCH(1,1)
Return equation				
φ_1 (Monday)	-0.0180* (0.0098)	-0.0146* (0.0075)	0.0140 (0.0351)	-0.0104 (0.0305)
φ_2 (Tuesday)	0.0117 (0.0096)	0.0078 (0.0074)	0.0162 (0.0344)	0.0170 (0.0301)
φ_3 (Wednesday)	0.0189** (0.0096)	0.0185** (0.0074)	0.0487 (0.0344)	0.0502* (0.0303)
φ_4 (Thursday)	-0.0056 (0.0096)	-0.0011 (0.0075)	-0.0848** (0.0343)	-0.0603** (0.0302)
φ_5 (Friday)	0.0164* (0.0096)	0.0065 (0.0074)	0.0549 (0.0345)	0.0451 (0.0300)
White Test for OLS residuals	2.2568	x	8.9241**	x
Variance equation				
λ	x	0.0006*** (0.0002)	x	0.0008 (0.0012)

α_1	x	0.1307*** (0.0234)	x	0.0143*** (0.0038)
β_1	x	0.8571*** (0.0234)	x	0.9848*** (0.0044)

Source of data: National Bank of Romania

Notes: Standard errors are within parentheses; ***, ** and * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

3.3. Results for the third sub-sample (January 2020 - August 2022)

The results of OLS and GARCH equations for the period January 2020 - August 2022 are presented in the Table 5. In the case of RON/EUR exchange rate we found, for both models, significant positive values of the φ_2 coefficient (the White Test failed to confirm the homoskedasticity of the OLS residuals). In the case of RON/USD exchange rate the return equations of the two models have no significant coefficients.

Tab. 5. Coefficients of the OLS and GARCH equations for the period January 2020 - August 2022

Coefficient	**RON/EUR**		**RON/USD**	
	OLS	GARCH(1,1)	OLS	GARCH(1,1)
Return equation				
φ_1 (Monday)	-0.0023 (0.0051)	-0.0044 (0.0029)	-0.0058 (0.0411)	0.0210 (0.0373)
φ_2 (Tuesday)	0.0102** (0.0050)	0.0059** (0.0029)	0.0189 (0.0400)	0.0101 (0.0363)
φ_3 (Wednesday)	0.0012 (0.0050)	0.0047 (0.0030)	0.0392 (0.0399)	0.0582 (0.0367)
φ_4 (Thursday)	-0.0028 (0.0049)	-0.0036 (0.0029)	0.0276 (0.0397)	0.0183 (0.0358)
φ_5 (Friday)	0.0043 (0.0051)	0.0062* (0.0032)	0.0180 (0.0406)	0.0090 (0.0366)
ξ_1	0.1566*** (0.0384)	0.1475*** (0.0524)	x	x
White Test for OLS residuals	56.7506***	x	9.4091**	x
Variance equation				
λ	x	0.0002*** (0.0001)	x	0.0026 (0.0018)
α_1	x	0.3530*** (0.0529)	x	0.0446*** (0.0138)
β_1	x	0.6470*** (0.0441)	x	0.9456*** (0.0184)

Source of data: National Bank of Romania

Notes: Standard errors are within parentheses; ***, ** and * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

4. CONCLUSIONS

The results of investigation indicate, for the three sub-samples, significant differences in the levels of volatility and in the characteristics of DOW Effect. For the first sub-sample (period January 2010 - December 2014), when the volatility of both exchange rates reached high levels, the daily seasonality wasn't prominent. We found no DOW Effect for RON/EUR

while, in the case of RON/USD, significant abnormal high returns were revealed on Thursdays but only by OLS model.

During the period January 2015 - December 2019, corresponding to the second sub-sample, the two exchange rates volatility was relatively low. In the case of RON/EUR, OLS and GARCH models indicate abnormal low returns on Mondays and abnormal high returns on Wednesdays. We found also, but only for OLS model, abnormal high returns on Fridays. In the case of RON/USD, the GARCH model indicate abnormal high returns on Wednesdays and abnormal low returns on Thursdays.

For the third sub-sample (period January 2020 - August 2022) the evolutions of two exchange rates had different characteristics. The euro's appreciation was not so drastic as US Dollar's. In these circumstances, we found, for the returns of RON/EUR, abnormal high returns on Tuesdays and Fridays, while for the returns of RON/USD no DOW effect was revealed.

Such results indicate that DOW Effect behaved differently in quiet and turbulent contexts. The investigation of calendar effects presence on the Romanian foreign exchange could be extended to other types of seasonality.

REFERENCES

1. Akaike, H., 1974. A new look at the statistical model identification. IEEE transactions on automatic control, 19(6), pp.716-723.
2. Anwar, C. J., Okot, N. and Suhendra, I., 2021. Day-of-the-week effect of exchange rate in developing countries. The Journal of Asian Finance, Economics and Business, 8(2), pp.15-23.
3. Berument, H., Coskun, M. N. and Sahin, A., 2007. Day of the week effect on foreign exchange market volatility: Evidence from Turkey. Research in International Business and Finance, 21(1), pp.87-97.
4. Bollerslev T., 1986. Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 31(3), pp.307-27.
5. Brooks, C. and Persand, G., 2001. Seasonality in Southeast Asian stock markets: some new evidence on day-of-the-week effects. Applied Economics Letters, 8(3), pp.155-158.
6. Cross, F., 1973. The behavior of stock prices on Fridays and Mondays. Financial Analysts Journal, 29(6), pp.67-69.
7. Dickey, D.A. and Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366a), pp.427-431.
8. Dickey, D.A. and Fuller, W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica: Journal of the Econometric Society, pp.1057-1072.
9. Dumitriu, R. and Stefanescu, R., 2010. Changes in the DOW effects in the Romanian Foreign Exchange Market. Manager Journal, 11(1), pp.163-179.
10. Dumitriu, R. and Stefanescu, R., 2013. DOW effects in returns and in volatility of stock markets during quiet and turbulent times. Proceedings of the 5th International Conference on Economics and Administration, pp.143-169.
11. Dyl, E. A. and Maberly, E. D.,1988. A Possible Explantion Of The Weekend Effect. Financial Analysts Journal, 44(3), pp.83-84.

12. Engle, R.F., 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: Journal of the Econometric Society, pp.987-1007.
13. Fishe, R. P., Gosnell, T. F. and Lasser, D. J., 1993. Good news, bad news, volume, and the Monday effect. Journal of Business Finance & Accounting, 20(6), pp.881-892.
14. French, K., 1980. Stocks returns and the weekend effect. Journal of Financial Economics 8(1), pp.55–69.
15. Gibbons, M. R. and Hess, P., 1981. Day of the week effects and asset returns. Journal of Business, pp.579-596.
16. Holden, K., Thompson, J. and Ruangrit, Y., 2005. The Asian crisis and calendar effects on stock returns in Thailand. European Journal of Operational Research, 163(1), pp.242-252.
17. Jaffe, J. and Westerfield, R., 1985. The week-end effect in common stock returns: The international evidence. The Journal of Finance, 40(2), pp.433-454.
18. Jaffe, J. F., Westerfield, R. and Ma, C., 1989. A twist on the Monday effect in stock prices: Evidence from the US and foreign stock markets. Journal of Banking & Finance, 13(4-5), pp.641-650.
19. Jeanne, O. and Rose, A. K., 2002. Noise trading and exchange rate regimes. The Quarterly Journal of Economics, 117(2), pp.537-569.
20. Ke, M. C., Chiang, Y. C. and Liao, T. L. (2007). Day-of-the-week effect in the Taiwan foreign exchange market. Journal of Banking & Finance, 31(9), pp.2847-2865.
21. Keim, D. B. and Stambaugh, R. F., 1984. A further investigation of the weekend effect in stock returns. The Journal of Finance, 39(3), pp.819-835.
22. Kohers, G., Kohers, N., Pandey, V. and Kohers, T., 2004. The disappearing day-of-the-week effect in the world's largest equity markets. Applied Economics Letters, 11(3), pp.167-171.
23. Kumar, S., 2018. On the disappearance of calendar anomalies: have the currency markets become efficient?, Studies in Economics and Finance, 35(3), pp.441-456.
24. Lakonishok, J. and Levi, M., 1982. Weekend effects on stock returns: a note. The Journal of Finance, 37(3), pp.883-889.
25. Marquering, W., Nisser, J. and Valla, T., 2006. Disappearing anomalies: a dynamic analysis of the persistence of anomalies. Applied Financial Economics, 16(4), pp.291-302.
26. McFarland, J., Pettit, R. and Sung, S., 1982. The distribution of foreign exchange price changes: Trading day effects and risk measurement. Journal of Finance 37(3), pp.693–715.
27. Rogalski, R. J., 1984. A further investigation of the weekend effect in stock returns: Discussion. The Journal of Finance, 39(3), pp.835-837.
28. Rose, A. K., 2011. Exchange rate regimes in the modern era: fixed, floating, and flaky. Journal of Economic Literature, 49(3), pp.652-672.
29. Rystrom, D. S. and Benson, E. D., 1989. Investor psychology and the day-of-the-week effect. Financial Analysts Journal, 45(5), pp.75-78.
30. Solnik, B. and Bousquet, L., 1990. Day-of-the-week effect on the Paris Bourse. Journal of Banking & Finance, 14(2-3), pp.461-468.
31. White, H., 1980. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. Econometrica, 48(4), pp.817-838.
32. Yamori, N. and Kurihara, Y., 2004. The day-of-the-week effect in foreign exchange markets: multi-currency evidence. Research in International Business and Finance, 18(1), pp.51-57