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IMPRESSUM

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THE WEEKEND EFFECT: AN EXPLOITABLE ANOMALY IN THE UKRAINIAN STOCK MARKET?

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Abstract

This paper provides some new empirical evidence on the weekend effect (one of the best known anomalies in financial markets) in Ukrainian futures prices. The analysis uses various statistical techniques (average analysis, Student's t-test, dummy variables, and fractional integration) to test for the presence of this anomaly, and then a trading simulation approach to establish whether it can be exploited to make extra profits. The statistical evidence points to abnormal positive returns on Fridays, and a trading strategy based on this anomaly is shown to generate annual profits of up to 25%. The implication is that the Ukrainian stock market is inefficient.

Keywords: *Efficient Market Hypothesis; Weekend Effect; Trading Strategy*
JEL classification: *G12, C63*

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1. Introduction

Since Fama (1970) introduced the Efficient Market Hypothesis (EMH), the behaviour of asset prices has been extensively investigated to establish whether it is consistent with this paradigm. One of the best known anomalies is the so-called “day of the week” or weekend effect. Cross (1973) reported that asset prices tend to increase on Fridays and decrease on Mondays. A number of subsequent papers have tested for this anomaly (see, e.g., Sias and Starks, 1995; Schwert, 2003; Olson et al., 2011; Kazemi et al. 2013)) providing mixed evidence, but none has looked at the Ukrainian stock market, which is the focus of the present study. Specifically, the analysis uses various statistical techniques (average analysis, Student's t-tests, dummy variables, and fractional integration) to test for the presence of this anomaly, and then a trading simulation approach to establish whether it can be exploited to make extra profits.

The layout of the paper is as follows. Section 2 briefly reviews the literature on the weekend effect. Section 3 describes the data and outlines the empirical methodology. Section 4 presents the empirical results. Section 5 offers some concluding remarks.

2. Literature review

Cross (1973) analysed Standard & Poor's Composite Stock Index data from January 1953 to December 1970 and claimed to have found some patterns in the behaviour of US asset prices, namely an increase on Fridays and a decrease on Mondays. French (1980) extended this analysis to 1977 and reported negative returns on Mondays. Gibbons and Hess (1981), Keim and Stambaugh (1984), Rogalski (1984) and Smirlock and Starks (1986)also found the positive-Friday / negative-Monday pattern. Agrawal and Tandon (1994) examined 19 equity markets around the world, and found the “day of the week” effect in most developed markets. Further evidence was provided by Olson et al. (2011), Racicot (2011), Singal and Tayal (2014), and Caporale et al. (2014), who found some evidence of a weekend effect in

the US stock market, FOREX, and commodity markets as well as in the Russian stock market; in particular, fractional integration techniques suggest that the lowest orders of integration occur on Mondays.

Possible explanations for the weekend effect are: the psychology of investors who believe that Monday is a “difficult” day of the week and have a more positive perception of Friday (Rystrom and Benson, 1989); the closing of speculative positions on Fridays and the establishing of new short positions on Mondays by traders (Kazemi et al., 2013 and Chen and Singal, 2003), and the trading patterns of institutional investors (Sias and Starks, 1995). Another possible reason is that over the weekend market participants have more time to analyse price movements and, as a result, on Mondays a larger number of trades takes place. Alternatively, this might be due to deferred payments during the weekend, which create an extra incentive for the purchase of securities on Fridays, leading to higher prices on that day.

Evidence that the weekend effect has become less important over the years has been reported by Fortune (1998, 1999), Schwert (2003), and Olson et al. (2011). Further, Caporale et al. (2014) show that this anomaly cannot be exploited to make abnormal profits (and therefore it is not inconsistent with the EMH) by taking a trading robot approach.

3. Data and methodology

We use daily data for UX index futures. The sample covers the period from May 2010(the first available observation) to the end of December 2014. The data source is the Ukrainian Exchange (http://www.ux.ua/en/).

To examine whether there is a weekend effect we use the following techniques:

– average analysis

– Student’s t-tests

– regression analysis with dummy variables

– fractional integration tests

Average analysis provides preliminary evidence on whether there are differences between returns on different days of the week. Student's t-tests are carried out for the null hypothesis that returns on all days of the week belong to the same population; a rejection of the null implies a statistical anomaly in the price behaviour ona specific day of the week.Given the size of our dataset, it is legitimate to argue that normality holds on the basis of the Central Limit Theorems (see Mendenhall, Beaver and Beaver, 2003), and therefore these are valid statistical tests. As a further check for normality, we also apply Pearson's criterion: we randomly select 100 consecutive UX index futures values for the period 2014 (Table 1) and calculate the critical value of the distribution. These confirm that the data are normally distributed and therefore Student's t-tests are valid, since their critical values do not exceed those of the chi-square distribution.

Table 1: "Normality" test of the UX index futures data

Parameters	Values
Observations	100
Average	1233
Standard deviation	65
Confidence level	0.95
Chi-square values	8.98
Chi-square distribution critical value ($hi_{(p=0.95,\ f=5)}$)	11
Conclusion	Data are normally distributed

The t-statistic is calculated as follows:

$$t = \frac{|M_1 - M_2|}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}} \quad (1)$$

where M_1 – mean of the population of returns on the day whose effects are being tested;

M_2 – mean of the population of all returns except the observations on the day whose effects are being tested;

σ_1 – standard deviation of the population of returns on the day whose effects are being tested;

σ_2 – standard deviation of the population of all returns except the observations on the day whose effects are being tested;

N_1 – size of the population of returns on the day whose effects are being tested;

N_2 – size of the population of all returns except the observations on the day whose effects are being tested;[1]

The test is carried out at the 95% confidence level, and the degrees of freedom are N – 1 (N being equal to N_1+ N_2).

Returns are computed as follows:

$$R_i = \left(\frac{Close_i}{Open_i} - 1\right) \times 100\%, \quad (2)$$

where R_i – UX index futures returns on the*i-th*day in %;

$Open_i$ – open price on the*i-th*day;

$Close_i$ – close price on the*i-th*day.

We also run multiple regressions including a dummy variable for each day of the week, specifically:

$$Y_t = b_0 + b_1 Monday_t + b_2 Tuesday_t + b_3 Wednesday_t + b_4 Friday_t + \varepsilon_t \quad (3)$$

where Y_t – difference between average returns during a week and the dayof the week whose effects are being tested;

[1] This is the day which is being analysed for the presence of an anomaly.

b_0–difference between average returns during a week and on Thursdays (this is chosen as a typical day of the week, no anomalies in price behaviour have previously been detected on this day);

b_n– difference between average returns on the*n-th* day of the week included in the model and on Thursdays;

$Monday_t$–dummy variable for Monday, equal to 1 on that day of the week, and 0 otherwise.

The size, sign and statistical significance of the dummy coefficients provide information about possible anomalies on individual days of the week.

As an additional test, we estimate the degree of integration of the series for different days of the week. Specifically, we use the Whittle function in the frequency domain (Dahlhaus, 1989) in the following model:

$$y_t = \alpha + \beta t + x_t; \quad (1-L)^d x_t = u_t, \tag{4}$$

where y_t is the observed time series; α and β are the intercept and the coefficient on the linear trend respectively, x_t is assumed to be an I(d) process where d can be any real number, and u_t is assumed to be weakly I(0) autocorrelated. Rather than specifying a parametric ARMA model, we follow the non-parametric approach of Bloomfield (1973), which also produces autocorrelations decaying exponentially as in the AR case. If the estimated order of integration for a particular day, specifically Monday or Friday, is significantly different from that for the other days of the week, then it can be argued that there is evidence of a weekend effect.

Finally, having tested for possible weekend effects, we examine whether they give rise to exploitable profit opportunities by means of a trading simulation approach. Specifically, we use an algorithm based on the weekend effect to replicate the behaviour of a trader who opens positions on the UX futures and holds them for a certain period of time.

We use the following procedure to simulate the trading process. First we compute the percentage result of the deal:

$$\%\, result = \ 100\% \times P_{open}/P_{close}\ , \qquad (5)$$

where P_{open} – opening price

P_{close} – closing price

Then this difference is converted into Ukrainian hryvnas (UAH).

$$UAHresult = \%\, result \times 1000\ , \qquad (6)$$

where $UAHresult$ – is result of the deal in UAH.

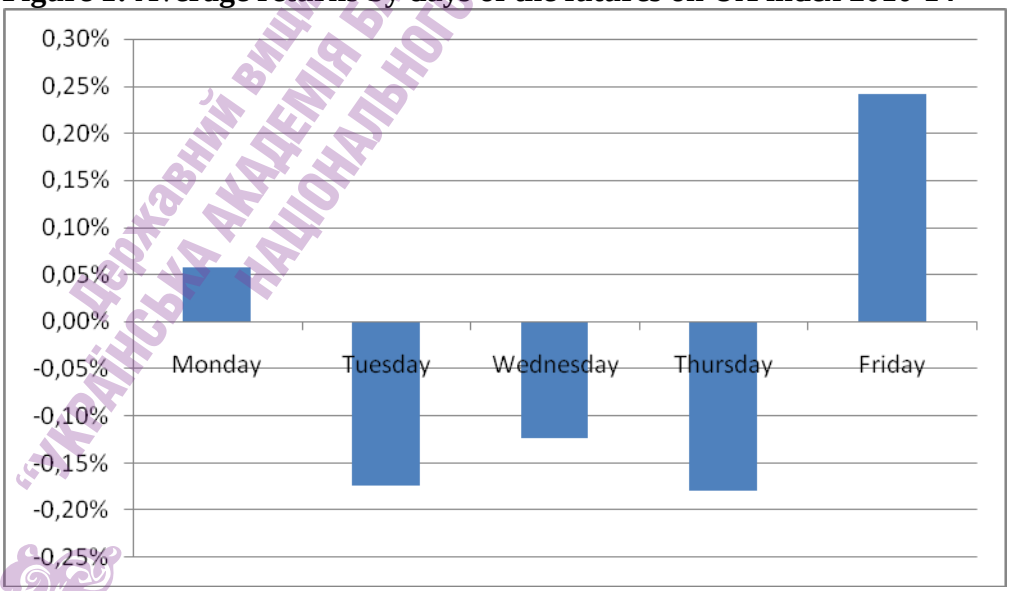
The sum of results from each deal in UAH is the total financial result of trading.

A strategy resulting in a number of profitable trades > 50% and positive total profits is defined as indicating an exploitable market anomaly.

4. Empirical results

We start with some simple average analysis. The results are displayed in Figure 1.

Figure 1: Average returns by days of the futures on UX index 2010-14



As can be seen, the biggest positive returns occur on Fridays. Returns are also positive on Mondays, but negative on the other days of the week. Therefore, there is preliminary

evidence of a possible weekend effect. Next, we carry out some formal statistical tests as specified above.

The Student's t-test results are presented in Table 2.

Table 2: T-test of the daily returns for different days of the week for the futures on the UX index during 2010-2014

Parameter	Monday	Tuesday	Wednesday	Thursday	Friday
Population 1 (data without day of analysis)					
Mean,%	-0.06%	0.00%	-0.01%	0.00%	-0.11%
Standard deviation,%	2.01%	2.16%	2.21%	2.23%	2.21%
Number of observations	948	929	924	925	930
Population 1 (data for the day of analysis)					
Mean,%	0.06%	-0.17%	-0.12%	-0.18%	0.24%
Standard deviation,%	2.75%	2.17%	2.00%	1.89%	1.95%
Number of observations	216	235	240	239	234
T-test results					
t-criterion	0.59	-1.10	-0.73	-1.28	2.39
t-critical (p=0,95)	1,96				
Null hypothesis	Not rejected	Not rejected	Not rejected	Not rejected	Rejected

They imply that the only day of the week with statistically significant abnormal returns is Friday, and therefore the presence of the weekend effect in the Ukrainian stock market is confirmed.

The multiple regression analysis shows that the only statistically significant dummy variable is the Friday one (see Table 3): its coefficient is positive, it is the biggest, and it is statistically significant at the 95% confidence level. However, the model does not appear to be entirely data congruent (see Appendix A).

Table 3: Parameters of the multiply regression with dummy variables of daily returns for different days of the week for the futures on the UX index during 2010-2014

	Value	Standarderror	t	Pr> |t|	Lowerbound (95%)	Upperbound (95%)
Intercept	-0.0017	0.0014	-1.2174	0.2237	-0.0045	0.0011
Monday	-0.0009	0.0020	-0.4230	0.6724	-0.0048	0.0031
Tuesday	0.0014	0.0020	0.7103	0.4777	-0.0025	0.0054
Wednesday	0.0025	0.0020	1.2296	0.2191	-0.0015	0.0064
Friday	**0.0042**	**0.0020**	**2.1008**	**0.0359**	**0.0003**	**0.0082**

Finally, we use fractional integration techniques to estimate the fractional differencing parameter d for each day of the week under the three standard parameterisations of no deterministic terms, an intercept, and an intercept with a linear time trend in order to see if there is any evidence of a weekend effect. The results are displayed in Table 4.

Table 4: Estimates of d based on fractional integration

	No regressors	An intercept	A linear time trend
Monday	**-0.14 (-0.23, -0.03)**	**-0.14 (-0.23, -0.03)**	**-0.14 (-0.23, -0.03)**
Tuesday	0.03 (-0.07, 0.15)	0.03 (-0.07, 0.15)	0.00 (-0.11, 0.14)
Wednesday	-0.10 (-0.18, 0.01)	-0.10 (-0.19, 0.01)	-0.10 (-0.19, 0.01)
Thursday	0.06 (-0.04, 0.19)	0.06 (-0.04, 0.19)	0.06 (-0.05, 0.19)
Friday	-0.02 (-0.09, 0.09)	-0.02 (-0.10, 0.09)	-0.03 (-0.12, 0.08)

The lowest estimate of d is found for Mondays (-0.14 for the returns, which implies a value of about 0.86 for the log prices). In fact, for this particular day of the week, the I(0) hypothesis is rejected in favour of anti-persistence ($d < 0$, or alternatively, mean reversion ($d < 1$) in the log prices), whilst it cannot be rejected for the remaining days of the week. The results presented in the table are based on white noise errors. Those allowing for autocorrelated (Bloomfield) errors are fairly similar; however, the confidence intervals are wider and the I(0) hypothesis cannot be rejected in any single case.

Figure 2: Estimates of d based on a semi-parametric Whittle method

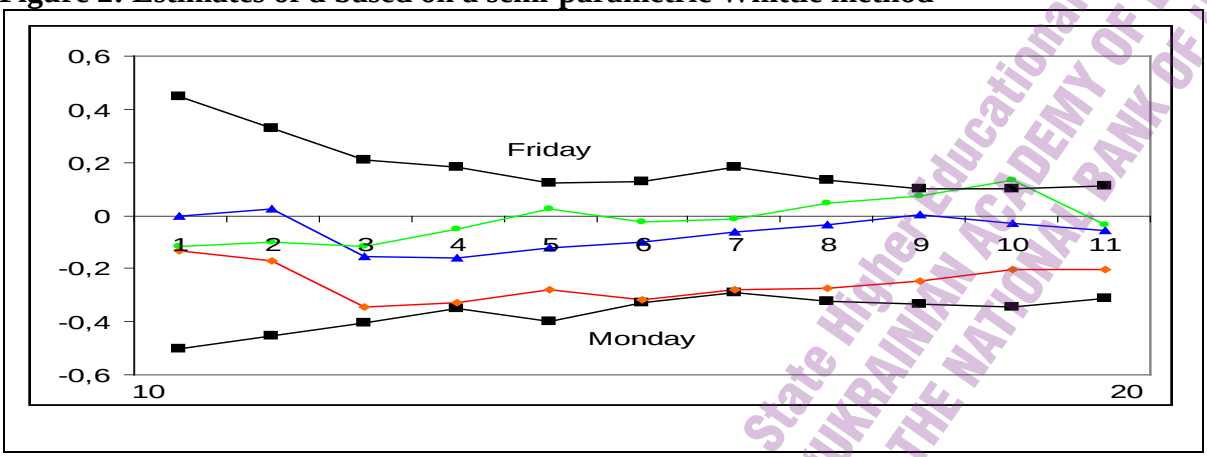


Figure 2 displays the semi-parametric estimates of d based on the Whittle function in the frequency domain (Robinson, 1995) for a selected range of values of m, the bandwidth parameter, namely for m = 10, 11, …, 20, including the case of m =$(T)^{0.5}$, often considered in empirical studies. The lowest estimates of d are obtained on Mondays, while the highest ones are those for Fridays.

On the whole, our analysis suggests that the only day of the week with a statistically significant anomaly is Friday, when returns are abnormally high. Next we examine whether this can be exploited through appropriate trading strategies. The trading algorithm is quite simple and is based on the finding of abnormal positive returns on Fridays. This implies that a trader should open long positions in future contracts on the UX index on Friday open. The only remaining question is when these positions should be closed. We consider different closing times, and therefore develop the following three trading strategies:

1) Strategy 1: “Friday close” – the position is closed at the end of the Friday.
2) Strategy 2: “Monday open”– the position is closed at the beginning of the Monday.
3) Strategy 3: “Monday close”– the position is closed at the end of the Monday.

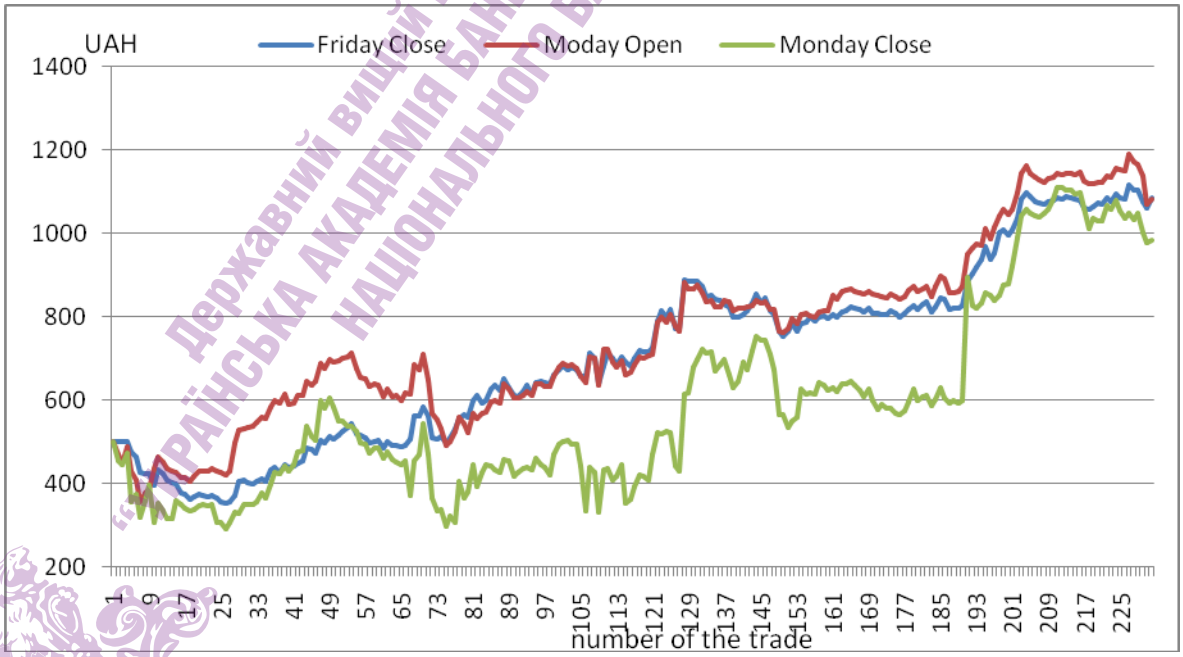
We simulate trading future contracts on the UX index with a trading deposit of 500 UAH. The marginal requirements on these future contracts are 214 UAH per contract, therefore 500 UAH is a sufficient deposit to trade with 1 future contract and cover possible draw downs which may occur during trading.

The trading results for the different strategies are presented in Table 5. The dynamics of the equity of the trading deposit for different strategies during 2010-2014 is shown in Figure 3.

Table 5: Trading results for different strategiesfor the period 2010-2014

Strategy	Number of trades	Number of successful trades	% of successful trades	Financial result, UAH	Financial result, %	Annual financial result, %
Friday close	231	118	51.1%	586	117.2%	26.0%
Monday open	231	123	53.2%	582	116.4%	25.9%
Monday close	231	121	52.4%	484	96.9%	21.5%

Figure 3: Dynamicsof the equity of the trading account for different strategies during 2010-2014



All three strategies appear to be profitable. The “Monday close” strategy is the least profitable and most volatile. The other two (“Friday close” and “Monday open”), produce

positive profits in all cases (25% annual profits), with an average of 2.5 UAH. However, the analysis does not incorporate transaction costs, such as spread, commissions per deal to the exchange and the broker, payments for money transfers and registering procedures. More precisely, the average net profit per trade becomes 1-1.5 UAH after taking into account the spread (on average 1 UAH per contract) and the commission per deal (between 0.5 and 1 UAH depending on type of the deal – short or long-term) – this is smaller than calculated before, but still positive given the available free margins and leverage strategies.

5. Conclusions

In this paper we have examined one of the most recognised anomalies, i.e. the weekend effect, in the Ukrainian stock market applying different methods to UX futures daily data. Using a wide range of statistical instruments (average analysis, regression analysis with the use of dummy variables, t-tests and fractional integration), we find some evidence of this anomaly in the form of positive returns on Fridays.

To examine whether or not this anomaly gives exploitable profit opportunities we have replicated the actions of a trader using trading algorithms based on the weekend effect. All the strategies considered appear to be profitable, especially that based on opening long positions on "Friday open" and closing them on "Friday close", which generates profits of up to 25% per year (excluding transaction costs) with no leverage in trading. Consequently, in the case of the Ukrainian stock market the weekend effect (positive returns on Friday) is not only a statistical anomaly but also an exploitable one, since abnormal profit can be made by trading with the UX index futures. This represents evidence of inefficiency for this particular market.

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Appendix A

Results of the regression analysis for daily returns on different days of the week for the futures on the UX index during 2010-2014

Table A.1: Goodness of fit statistics:

Observations	995
Sumofweights	995
DF	990
R2	0.0080
Adjusted R^2	0.0040
MSE	0.0004
RMSE	0.0201
DW	1.8447

Table A.2: Analysis of variance:

Source	DF	Sumofsquares	Meansquares	F	Pr> F
Model	4	0.0032	0.0008	1.9956	0.0931
Error	990	0.3997	0.0004		
CorrectedTotal	994	0.4029			