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STOCK RETURN, SEASONALITY AND ASYMMETRIC CONDITIONAL VOLATILITY IN STEEL & IRON SUBSECTOR

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This paper presents the results obtained following the testing of five hypotheses regarding conditional return and volatility of the most listed European stocks in the steel & iron subsector. The following elements of the stocks are analysed: time variation of volatility, seasonality of return and volatility, relationship between return and volatility and volatility asymmetry. The results obtained confirm for all the analyzed stocks the existence of volatility variation in time, the lack of correlation between return and volatility, the existence of asymmetry phenomenon of volatility and the presence in some stocks of the seasonality effect both for return and volatility.

Key words: steel & iron subsector, stock, return, conditional volatility, Europe

INTRODUCTION

The analysis of return and risk of financial assets holds a special importance for investors [1]. Getting to know their features enables the choice of a specific forecasting model that aims that investors take decisions that lead them to make a profit. A specific feature of financial assets volatility is its variability in time and its presentation by clusters so that "large changes tend to be followed by large changes, of either sign, and small changes tend to be followed by small changes" [2].

Some studies also confirm the existence of the seasonality of financial assets return and volatility which implies that they have a similar behaviour on certain days or on certain months. Bachelier is the pioneer of the study of return seasonality. This phenomenon occurs under the form Monday effect, week-end effect or day of the week effect [3,4].

One of the most important features of financial assets for investors is the presence of the correlation between return and volatility. This implies that once the investors take a greater risk they should expect to obtain a larger return [5]. The appearance of a shock or a new piece of negative information on the market sometimes determines a greater volatility of the market in comparison with a new piece of information of the same width. This phenomenon is known as volatility asymmetry [6]. Although there are numerous studies analyzing the return and risk of stocks listed on the stock market, there are few studies focusing on the return and risk of certain stocks from a certain field of activity. Therefore, the aim of this paper is to test and analyze the previously presented features for the stocks which are the most listed in Europe and belonging to the iron & steel subsector.

DATA AND METHODOLOGY

The stocks from iron & steel subsector are included in the STOXX® Europe TMI Industrial Metals index portfolio.

The data regarding the evolution of this index as well as its component are presented on the website www.stoxx.com. The STOXX® Europe TMI Industrial Metals index also comprises the most listed stocks of the companies in the iron & steel subsector. The stocks of the firms from the iron & steel subsector comprising the previously mentioned index and which will be the focus of our analysis are the following: Acerinox, Aperam, Acelormittal, Evraz, Ferrexpo, Kloeckner&CO, Rautaruukki K, Salzgitter, Ssab A, Ssab B, Tenaris, Voestalpine. The daily closing prices for these stocks have been selected from the Datastream database.

The period of analysis taken into consideration is comprised within the interval 2/03/2011 – 29/01/2014; for each stock a maximum of 761 observations have been registered. The exception is the stock of the company Evraz for which there are available data comprised during the period 11/08/2011 - 29/01/2014.

The study performed uses the continuous compounded return which is computed according to the relation [7]:

$$r_t = (\ln P_t - \ln P_{t-1}) \cdot 100$$

where r_t - continuously compounded return and P_t, P_{t-1} - the stock price at moment t respectively t-1.

In order to test the time variance and the volatility asymmetry as well as the correlation between return and volatility a model AR(p)-GJR-GARCH(1,1)-M must be estimated. For testing the seasonality the

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mean's equation and the conditional variance equation contains the dummy variables as following [8]:

$$r_t = \beta_0 + \sum_{i=1}^{p} \beta_i r_{t-i} + \sum_{i=2}^{5} \lambda_i D_{it} + \gamma h_t + \varepsilon_i$$

$$h_t^2 = \alpha_0 + \alpha^+ \varepsilon_{t-1}^2 + \alpha^- \varepsilon_{t-1}^2 K_{t-1} + \psi h_{t-1}^2 + \sum_{i=2}^{5} \delta_i D_{it}$$

where: r_t is the continuously compounded daily return on day t, r_{t-i} represents the returns of the previous days, case in which there is an autoregressive component in the mean equation and D_{it} is a dummy variable. D_{2t} has the value 1 if t represents a Tuesday and takes the value 0 for the rest of the days, D_{3t} has the value 1 if t represents a Wednesday and takes the value 0 for the rest of the days, D_{4t} has the value 1 if t represents a Thursday and takes the value 0 for the rest of the days, D_{5t} has the value 1 if t represents a Friday and takes the value 0 for the rest of the days.

K_{t-1} is also a dummy variable and has the value 1 if the estimated error from the previous day is negative.

The testing of the daily seasonality of return is performed by means of testing the parameters λ_i. If the parameters λ_i, with i varying from 2 to 5, are significant, then the return presents seasonality.

The existence of the correlation between return and volatility is tested by means of the coefficient γ. If γ is significant there is a correlation between return and volatility. Testing the volatility asymmetry phenomenon is also conducted by means of the testing of the parameter α^-.

EXPERIMENTAL WORK

The returns of the stocks considered in the study are noted as follows: LRACE for Acerinox, LRACER for Acelormittal, LRAPE for Aperam, LREVR for Evraz, LRFER for Ferrexpo, LRKLA for Kloeckner&CO, LRRAU for Rautaruukki K, LRSAL for Salzgitter, LRSSA for Ssab A, LRSSB for Ssab B, LRTEN for Tenaris, LRVES for Voestalpine.

The returns for the iron & steel selected stocks are stationary. Their stationarity was tested by means of the Augmented Dickey Fuller and Philips-Perron tests. The results are not presented here due to lack of space.

Table 1 presents several indicators of the descriptive statistics. Since all the returns analyzed are stationary the average returns represent the daily return expected by the investor from holding each stock.

Since all the values of average returns are negative, the investors should not expect to obtain profit each day by holding these stocks.

The fat tails of returns are characterised by asymmetry and excessive kurtosis. Due to the leptokurticity of the fat tails, returns do not follow normal distribution laws (as the Jarque-Berra test also demonstrates). This feature also highlights that investors can obtain either very high profits or very high losses, greater than in the case of a normal distribution.

Table 1 **Descriptive statistics**

	Mean / %	Skewness	Kurto-sis	Jarque-Berra
LRACE	-0,099	0,03	4,96	121,6
LRACER	-0,045	0,01	5,76	240,5
LRAPE	-0,106	0,30	5,39	192,2
LREVR	-0,238	0,44	4,95	11,4
LRFER	-0,126	0,24	5,55	212,4
LRKLO	-0,094	1,38	16,40	5923,2
LRRAU	-0,079	0,85	13,23	3406,2
LRSAL	-0,080	0,28	6,37	370,5
LRSSA	-0,078	0,19	6,07	302,5
LRSSB	-0,077	0,37	6,87	490,6
LRTEN	-0,004	-0,18	9,99	1554,2
LRVES	-0,003	-0,29	5,75	251,2

Table 2 **The estimation of the parameters of the model AR(p)-GJR-GARCH(1,1)-M for LRACE, LRACER, LRAPE and LRFER**

	LRACE	LRACER	LRAPE	LRFER	LREVR	LRKLO	LRRAU	LRSAL
β_0	0,857[c]	0,047	-0,544[b]	-0,729[b]	-0,394	-0,260	-0,284	-0,753[a]
β_7	-	-0,093[b]	-	-	0,081[c]	-	-	-
λ_2	-1,871	-0,125	0,346	0,503	0,187	0,738[b]	-0,201	0,555[b]
λ_3	0,884	-0,020	0,238	0,491	-0,486	0,292	0,605	0,522[b]
λ_4	-0,208	-0,184	0,436	0,344	-0,149	0,547[b]	-0,359	0,413
λ_5	1,133	0,335[c]	0,498[c]	0,764[b]	0,314	0,243	-0,165	0,498[c]
γ	0,857	-0,025	0,014	0,016	0,020	-0,023	0,026	0,049
α_0	0,435	-1,525[a]	0,705	0,278	-4,634[a]	0,065	-0,849	0,667
α^+	-0,810	0,031[a]	-0,016[a]	-0,008	0,031[b]	0,016	-0,011[a]	0,015
α^-	4,749[a]	0,024[b]	0,057[a]	0,102[a]	0,080[b]	0,055[a]	0,100[a]	0,093[a]
ψ	0,868[a]	0,952[a]	0,984[a]	0,937[a]	0,895[a]	0,934[a]	0,867[a]	0,897[a]
δ_2	0,262	1,929[a]	0,863	1,271	6,206[a]	2,088[b]	2,260[c]	-0,456
δ_3	-0,133	3,141[a]	-3,269[a]	0,037	5,675[a]	-0,233	5,481[a]	-0,787
δ_4	0,221	0,472	-0,452	0,608	4,663[a]	-1,428	-0,180	0,024
δ_5	-1,280	2,187[a]	-0,463	-1,958	8,067[a]	0,028	1,284	-1,009

a, b, c - Denote statistical significance at 1 %, 5 % and 10 % level;
where: β_0 is the intercept in the mean equation; β_7 is the coefficient associated with the return that the stock had 7 periods ago; λ_i are the coefficients of dummy variables in mean equation; γ is the coefficient associate with the conditional variance from mean equation; α_0 is the intercept in the conditional variance equation; α^+ is the coefficient associate with precedent shocks; α^- is the coefficient associate with dummy variable K_{t-1}; ψ is the coefficient associate with precedent conditional variance; δ_i is the coefficients of dummy variable D_{it} used for testing of seasonality of conditional variance.

Table 3 **The estimation of the parameters of the model AR(p)-GJR-GARCH(1,1)-M for LREVR, LRKLO, LRRAU and LRSAL.**

	LRSSA	LRSSB	LRTEN	LRVES
β_0	-0,224	-0,527a	-0,304b	-0,264
β_7	-	-	-	-
λ_2	0,146	0,217	0,325	0,235
λ_3	0,528b	0,212	0,303	0,345
λ_4	0,020	0,410c	0,250	0,386
λ_5	0,451c	0,106	-0,008	0,241
γ	-0,007	0,044	0,027a	0,009
α_0	-0,519	-0,679	0,043	1,727a
α^+	0,058a	-0,004	-0,053a	0,003
α^-	0,012	0,076a	0,088a	0,060a
ψ	0,919a	0,939a	0,999a	0,953a
δ_2	1,927a	0,483a	0,112	-2,929a
δ_3	0,156	2,268	-0,020	-1,173b
δ_4	0,100	0,121	0,330	-2,173a
δ_5	1,047	1,367	-0,461	-2,100a

a, b, c - Denote statistical significance at 1 %, 5 % and 10 % level;
where: β_0, β_7, λ_i, γ, α_0, α^+, α^-, ψ, δ_i have the same meaning as in Table 2.

The estimated models AR(p)-GJR-GARCH(1,1)-M for all the analyzed returns are presented in the Table 2 and in Table 3.

The results presented in Table 2 prove that both the returns and volatilities of the stocks present seasonality. The returns LRACER, LRAPE and LRFER present day of the week effect on Friday and the volatilities of the returns LRACER, LRAPE present day of the week effect on Wednesday while the volatilities of the return LRACER also present a day of the week effect on Tuesday. All fours returns presented in Table 2 present the asymmetry phenomenon of volatility. None of the companies such as Acerinox, Acelormittal, Aperam and Ferrexpo have stocks whose return should be correlated with volatility.

The estimation of the model AR(p)-GJR-GARCH (1,1)-M for the returns LREVR, LRKLO, LRRAU and LRSAL highlight the following features:

- the existence of the day of the week effect on Tuesday for LRKLO, LRSAL, on Wednesday for LRSAL, on Thursday for LRKLO and on Friday for LRSAL;
- the volatility asymmetry for LREVR, LRKLO, LRRAU and LRSAL;
- the day of the week effect of return's volatility on Tuesday for LREVR, LRKLO, LRRAU, on Wednesday for LREVR, LRRAU, on Thursday for LREVR and on Friday for LREVR.

The stocks of the companies Evraz, Kloeckner&CO, Rautaruukki K and Salzgitter do not have the stock returns correlated with volatilities.

Table 3 highlights the following features of the last stocks analyzed:

- there is no correlation between return and volatility for the stocks of the companies Ssab A, Ssab B, Tenaris and Voestalpine;
- the stocks LRSSB, LRTEN and LRVES present the asymmetry effect of volatility;
- the returns present the day of the week effect on Wednesday for LRSSA, on Thursday for LRSSB and on Friday for LRSSA;
- volatilities present the day of the week effect on Tuesday for LRSSA, LRSSB and LRVES, on Wednesday, Thursday and Friday for LRVES.

CONCLUSIONS

For the testing of the five hypotheses one used a heteroscedastic model which comprised dummy variables for the testing of the seasonality of returns and conditional volatility. The estimated model for the returns analyzed highlighted that all the stocks in the iron & steel subsector are not characterised by the existence of the correlation between return and volatility and almost all of them (excepting one) also present the volatility asymmetry phenomenon. As a consequence, the investors in these stocks should expect not to get daily a return in accordance with the risk taken and should also consider that a shock or a new negative piece of information determines a higher volatility than a positive shock or a positive, favourable piece of information.

The presence of the seasonality on stock return and volatility also provides information to the investors regarding the days of the week when returns are higher or smaller in comparison with other days, making possible the choice of a favourable moment for buying or selling stocks.

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