THE STEEL EUROPEAN STOCK MARKET EFFICIENCY

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Abstract: *Testing the hypothesis of informational efficiency is a permanent preoccupation of researchers because the theories and the models of modern finance are based on it. This paper presents the results obtained after testing the efficiency hypothesis, in the weak form, for the European stock market of the companies that belong to the economic steel sub-sector. Following the use of both linear and non-linear tests of autocorrelation of returns we can conclude that the European stock market in the economic steel sub-sector is inefficient from an informational point of view and the investors in these stocks may obtain better results than those of the European market in general.*

Keywords: steel & iron subsector; stock; return; BDS test; Runs test
JEL Classification: G15; C58

Introduction

In 1900, Bachelier anticipated, the efficient market concept, in his Ph.D. thesis in mathematics, at Sorbonne (Bachelier, 1900). He wrote that "past, present and even discounted future events are reflected in market price, but often show no apparent relation to price changes".

In the field of finance, Eugene Fama formulated the efficient financial market hypothesis, in 1965 (Fama, 1970). The studies in this field are justified by the fact that the theories and models of modern finance rely on the efficient market hypothesis.

The efficient market theory appears as a statement of the pure and perfect market theory, as presented by Adam Smith and by the economists belonging to the 19th century, applied to the field of finance.

Eugene Fama identified three types of informational efficiency, depending on the available information and on the velocity of the incorporation of this information in the asset prices: weak, semi-strong and strong. The weak form of informational efficiency implies that the current price of the assets reflects all the information about the assets market: previous prices, transactions volume. When the markets are efficient in the weak form, the prices should change only when new information appears on the market. The prices do not follow a trend that could be subsequently identified. According to the semi-strong form of informational efficiency, the assets prices instantly modify as a consequence of new public information, such as: the division of assets, economic and politic

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novelties, company balance sheets. The strong form of informational efficiency implies that all pieces of public or privileged information are reflected in stock exchange price. If all new pieces of information (named shocks) that appear on the market are instantaneously reflected in the prices of financial assets, then an investor may obtain a profit from holding an asset portfolio but the return obtained is not higher than that of the market as a whole. Yet, if the capital market is not efficient, the asset returns can be forecasted and an investor can get a higher profit than the market from the anticipation of the evolution of asset prices.

Literature mainly focuses on testing the informational efficiency in the weak form (Hazan et *al*., 2012; Dumitrescu *et al*., 2011). Even if the majority of studies approach the testing of the efficiency of the capital market of certain countries (Oprean *et al*., 2014; Pele and Voineagu, 2008; Dragota and Mitrica, 2004) or a region (Enninful and Dowling, 2013) there are also studies that focus on testing the efficiency of the monetary market, for instance EUR/USD market (Boboc and Dinica, 2013).

In order to test the efficiency, the benchmark indices are usually used for the analyzed stock markets (Dragota *et al.*, 2014) but the variations of the currency exchanges (returns) of the stocks listed on that respective market are also applied (Urquhart, 2014).

For testing the informational efficiency in the weak form the most used methods are: autocorrelation test, Runs test, variance ratio test and BDS test.

The results obtained when testing the informational efficiency hypothesis are contradictory. A. Urquhart (2014) tests the efficiency of ten European Union countries and confirms the clear efficiency for Netherlands and Germany, certain non-efficiency for Spain, Ireland and Finland, while for the other countries the results are contradictory in accordance with the test used.

Dragota and Tilica (2014) study 20 East European former communist countries by means of the analysis of market indices as well as for the most liquid stocks. The period under consideration comprises the time lapse 2008-2010 corresponding to the latest financial and economic crisis. The results confirm the inefficiency of the markets studied regardless of the test used.

The present study brings a new approach to what has previously existed. If the previous studies focus on studying the informational efficiency of a stock market in a country, in several countries or in a geographical region, we focus on studying the informational efficiency of the market comprised of the stocks of a single economic activity field from the European stock market. We consider the firms from the steel subsector (comprised in the index STOXX® Europe TMI Industrial Metals) in order to test the informational efficiency in the weak form for the European steel stock market. The stocks studied are not all listed on a national stock market since they belong to the European market.

The importance of studying the steel stock market resides in the fact that this economic sub-sector is connected with a progressing development of the global economies (Jonek-Kowalska, 2015).

For testing the efficiency we used the Ljung-Box Q-statistic test, Runs test and the BDS test. The results obtained confirm the inefficiency of the European stock market in the economic steel sub-sector.

1.Methods and data

If the capital market is efficient, the returns (prices variation) of the financial assets cannot be predicted. If the capital market is not efficient, the asset returns may be forecasted based on its previous values because they are autocorrelated. Therefore, in order to test the informational efficiency in the weak form, statistical tests of serial correlation of returns are being used.

To test the serial correlation of returns we will resort to linear and non-linear tests because a series may have a non-linear correlation even if it does not have a linear correlation.

For testing the informational efficiency, in the weak form, we will use: the autocorrelation test (Ljung-Box Q-statistic) and Runs test which represent tests of linear correlation and the BDS test which is a test of non-linear autocorrelation.

The test Ljung-Box Q-statistic is computed on the basis of the covariances in the following way:

$$\rho_k = \frac{\gamma_k}{\gamma_0}$$

where: ρ_k - autocorrelation coefficient of order k , γ_k, γ_0 - covariance at lag k and respectively the variance.

The null hypothesis of the test Ljung-Box Q statistic, H_0 implies that we have an autocorrelation coefficient equal to zero which means the series follows a random, non-predictable process and the alternative hypothesis H_1 implies that we have a statistically significant autocorrelation coefficient meaning that there is a series that can be forecasted.

The BDS test was introduced by Brock, Dechert, LeBaron and Scheinkman in 1996 (Brock *et al.*, 1996) to determine the correlation dimension. The null hypothesis of the BDS test supposes that the observations are independent and identically distributed and the alternative hypothesis is not specified. The rejection of the null hypothesis formulated on the errors in the model is a sign of the presence of the non-linearity phenomenon.

In order for the results obtained by means of the BDS test to be influenced by the presence of linear serial dependence and/or a conditional heteroscedasticity, we will use the methodology employed by A. Urquhart (2014). Firstly, the BDS test will be applied to the initial data obtained for return. Then the linear serial dependence and the conditional heteroscedasticity will be excluded through the estimation of the model AR(p)-GARCH(1,1) corresponding to each series and the BDS test will be applied for the standardized residuals. The rejection of the null hypothesis (of the BDS test) formulated on the errors is a sign of the presence of the non-linearity phenomenon (Jula D. and Jula N.M., 2015).

The estimated model AR(p)-GARCH(1,1) has the form:

$$r_t = \beta_0 + \sum_{i=1}^{p} \beta_i r_{t-i} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 \varepsilon_{t-1}^2$$

where: r_t the compound continuous return, β_0, β_i the parameters of the equation of the mean of heteroscedastic model, $\varepsilon_t, \varepsilon_{t-1}$ the residual variable obtained from the mean equation at the moment t respectively t-1, h_t, h_{t-1} the conditional variance at the moment t respectively t-1.

2. Results of analysis

The study takes into consideration the most liquid stocks of the companies in the iron & steel sub-sector. The selected companies and the notations for their log-returns are: Acerinox (ACE), Acelormittal (ACR), Aperam (APE), Evraz (EVR), Ferrexpo (FER), Kloeckner&CO (KLO), Salzgitter (SAL), Ssab A (SSA), Ssab B (SSB), Tenaris (TEN), Voestalpine (VES). Thomson Reuters Datastream is the source for the data on the price of these stocks. The study period is comprised during 3/01/2011 – 30/01/2015, for each stock existing 1065 daily observations. APE and EVR are the exception because for them we have 1046 and respectively 845 daily observations.

Table 1 - Descriptive statistics for returns

Returns	Mean (%)	Kurtosis	Jarque-Berra
ACE	-0,115	5.3	237.6
ACR	0.001	5.3	250.5
APE	-0,026	5.9	408.4
EVR	-0,086	5.5	230.3
FER	-0,199	5.6	309.6

KLO	-0,081	16.3	8146.0
SAL	-0,086	6.2	493.9
SSA	-0,098	5.8	371.6
SSB	-0,097	7.1	767.4
TEN	-0,037	9.4	1870.3
VES	-0,013	6.3	522.8

Note: a, b and c indicate statistical significance at 1%, 5% and 10% levels.

In order to determine the stock returns we use log-returns which are calculated according to the relation (Chirila V. and Chirila C., 2015):

$$r_t = \left(\ln \mathrm{P}_t - \ln P_{t-1}\right) \cdot 100$$

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

In the first stage of estimation of AR(p) model the unit root tests Augmented Dickey-Fuller and Philips-Perron were used (Asandului, 2012). The results obtained confirm the stationarity of all returns.

The mean of daily returns of the stocks is negative which implies that investors should not expect to obtain profit from holding each and every action for one single day. The exception is made by ACR which has a daily positive but very small return. The results obtained for the Jarque-Berra test confirm that the return distribution does not follow a normal law and the possible cause for that is the kurtosis excess of the returns presented in Table 1. The kurtosis excess of returns also suggests the possibility of modelling the returns by means of heteroscedastic models. This idea is numerically supported by the results of the dependence tests (the Ljung-Box Q-Statistic test performed on the square of returns) which are not presented here due to lack of space.

The results of testing the autocorrelation of stock returns present in Table 2 show that the returns are not autocorrelated for a taken risk of 1% and for different lags.

Table 2 - Autocorrelation statistics and runs of test z-statistics for the returns of European steel stocks

	Autocorrelation test			Runs test
Returns	lag 1	lag 3	lag 5	z-statistic
ACE	0.018	1.569	6.91	-0,204
ACR	0.256	3.262	8.99	-0,204
APE	4.576b	11.950a	20.66a	-0,959
EVR	2.374	4.161	17.16a	-2,382b
FER	0.473	3.846	5.09	-0,757

KLO	6.414b	29.150a	35.97a	-0,488
SAL	2.239	5.304	6.02	-2,204b
SSA	2.712	4.287	8.06	-2,945a
SSB	5.078b	6.857	10.54c	-3,243a
TEN	0.030	4.438	6.06	0,203
VES	3.998	6.263	17.28	-1,172

Note: a, b and c indicate statistical significance at 1%, 5% and 10% levels.

The stocks APE, KLO and SSB represent the exception which are autocorrelated if we take a higher risk (of 10%). Therefore, this test indicates the informational efficiency in the weak form for the stocks in the steel sector.

The results obtained for the Runs test confirm the lack of autocorrelation for the majority of returns of the stocks studied. The exception is represented by four of the eleven stocks: EVR, SAL, SSA and SSB. This test also confirms the informational efficiency.

Table 3 - The BDS test results for the returns of European steel stocks

Returns	Embedding dimension ($\sigma = 1$)			
	2	3	4	5
ACE	3.560a	6.125a	7.410a	8.687a
ACR	1.915b	3.152a	4.134a	4.825a
APE	3.818a	7.248a	8.878a	10.089a
EVR	0.497	0.737	0.843	0.825
FER	1.954b	3.386a	4.651a	5.831a
KLO	1.498	3.166a	3.285a	3.413a
SAL	3.569a	5.786a	6.804a	8.027a
SSA	4.932a	6.535a	6.890a	7.326a
SSB	4.483a	6.128a	6.475a	6.827a
TEN	4.363a	5.381a	5.800a	6.461a
VES	6.773a	8.269a	9.671a	10.989a

Note: a, b and c indicate statistical significance at 1%, 5% and 10% levels.

The linear tests used (the test Ljung-Box Q-Statistic and Runs test) do not detect the autocorrelation of stock returns. In exchange, the results of testing the non-linear autocorrelation by means of the BDS test highlight the presence of the non-linearity phenomenon. Therefore, the BDS test confirms the inefficiency of the European steel stock market. As a consequence, the investors through the investments in these stocks, may obtain following the arbitrages performed better results than the general European capital market.

Conclusions

The study undertaken took into consideration the most liquid stocks of the companies in the economic steel sub-sector from the European area in order to test the efficiency of the stock market from this field. The results obtained by means of the linear autocorrelation tests confirm the hypothesis of efficiency but the use of non-linear tests reveals the fact that the returns are autocorrelated and the analyzed market is therefore inefficient.

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