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APPLYING INFORMATIONAL ENTROPY TO THE FIELD OF METALLURGY

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This article aims at analysing whether the field of metallurgy in Romania is informationally efficient or not. This field is important for the real Romanian and world-wide economy, that is why the answer to this dilemma is important, and it will determine the investment behaviour of portfolio managers. The Shannon Entropy is our measure for the informational efficiency of the field of metallurgy. The results obtained indicate that the field of metallurgy in Romania is characterized by a weak informational efficiency. Perhaps the most important effect of this result is the impossibility to make predictions in this field. In this context, a technical or chartist analysis is useless.

Key words: metallurgical industry, informational entropy, market efficiency, Romania

INTRODUCTION

Looking at the historical development of global steel production, there can be distinguished three phases. The first phase, ending in the mid-1960s, was marked by post-war reconstruction which led to an increase in steel demand and production. This period was followed by a phase of almost stagnation lasting until the late 1990s, when a reduction of the amount of steel needed per unit of final product was recorded, which became possible through new techniques. The third phase in global steel demand began in the late 1990s, when production started to grow again. At the time, emerging markets were the driving force, as they entered a stage of economic development.

World crude steel production totalled 1,607 million tonnes (Mt) for the year 2013, a record high for the industry, up by 3,5 % compared to 2012 (Figure 1). The increase mainly came from Asia and the Middle East, while crude steel production in all other regions decreased in 2013 compared to 2012.

Despite the fact that 2013 proved yet again to be challenging for the steel industry, with issues relating to overcapacity and raw materials costs, world steel demand still grew by 3,6 % as compared to 2012, largely due to increased infrastructure and construction activity, especially in Asia. Demand in China has been the major driving force for world steel consumption in the last decade. Figure 2 shows the evolution of crude steel production and demand in the world during the last ten years. Despite structural issues and volatile financial markets in emerging markets, the majority of demand (apparent steel use) was still propelled by these economies (+ 4,9 % in 2013 compared to 2012). The Asian construction market remains the main driver of growth in this steel subsector capturing almost 40 % of total construction spending.

After a decade of rapid expansion, Chinese companies are now responsible for more than half of global production. The incredible growth is primarily driven

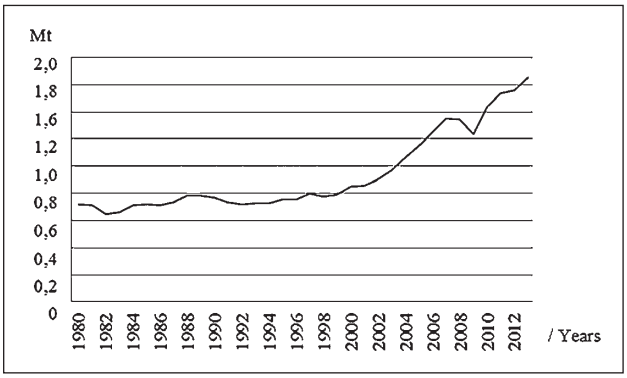

Figure 1 Crude steel production in the world, 1980-2013
Source: Authors` elaboration based on dates from [1]

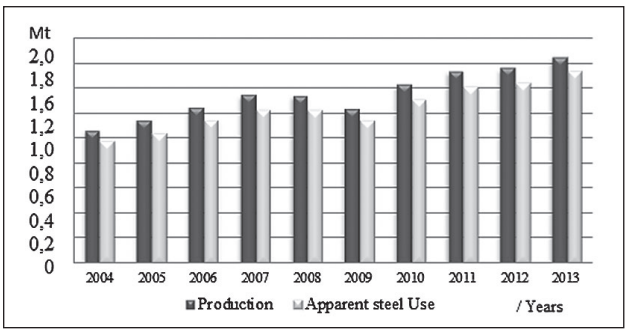

Figure 2 Crude steel production and demand in the world, 2004-2013
Note: Demand measures apparent steel use of finished steel products, expressed in volume terms as deliveries of finished steel minus net exports of steel industry goods; supply measures total production of crude steel.
Source: Authors` elaboration on dates from [1]

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by government pro-growth policies and large investments in infrastructure. According to the World Steel Association (Worldsteel), in 2015 is expected that the steel demand growth in developed to moderate economies, while the growth is projected to pick up in emerging and developing economies. The key market players are subjected to fierce competition from the new companies in developing economies.

The remainder of the paper is organized as follows: section 2 presents the evolution and the current state of the field of metallurgy in Romania; section 3 presents conceptual aspects regarding the efficient market hypothesis; section 4 presents empirical methodology, data and discusses estimation results and section 5 concludes the paper.

THE ROMANIAN FIELD OF METALLURGY

Iron and steel industry is an important field of the real Romanian economy, knowing the fact that, generally, metallurgy is a very important indicator of internal consumption. Because of the privatization of the iron and steel industry that took place over the past 20 years, a number of international metallurgy groups decided to invest in Romania, and now dominate the local industry. The most important ones are ArcelorMittal, Mechel, TMK and Tenaris, which make up almost 87 % of the field's turnover, employing 82 % of the industry's workforce.

However, the global crisis has shown the vulnerability of Romanian metallurgy. Steel production has been reduced by almost a half, the global turnover of the Romanian iron and steel field has dropped by more than 40 % and the staff was also reduced by a fifth [2]. Figure 3 shows the production of crude steel in Romania versus selected European Union member states in the year 2013.

The importance of iron and steel industry is quite clear. Last year, the metallurgical companies have covered about 11 % of the country's exports. Analysis by field at the Bucharest Exchange shows that the extractive industry holds the biggest share (17,61 %) of the aggregate market capitalization. At the same time, it

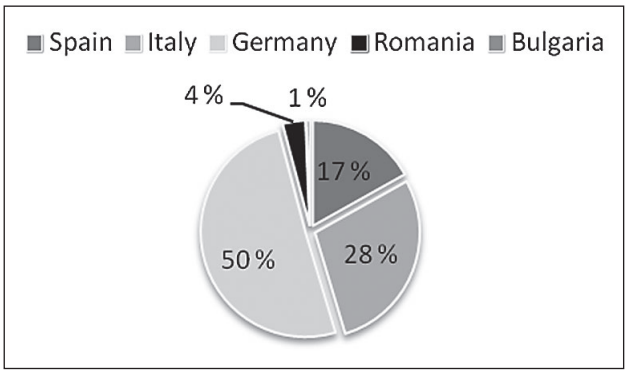

Figure 3 Share of crude steel production in the EU by member state, 2013
Source: Authors` elaboration on dates from [1]

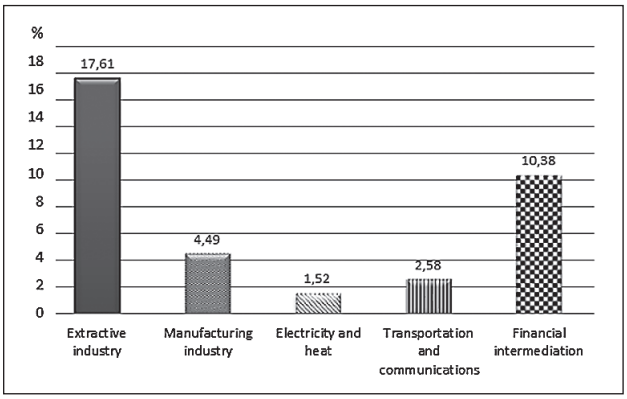

Figure 4 Field analysis at the Bucharest Exchange

holds the highest value of equity, compared to other activity fields represented at the Bucharest Exchange (BVB) [3] (Figure 4).

Therefore, the Romanian economy benefits from having some of the world's biggest steel producers, but, without government support, the increase in energy prices will continue to put further pressure on margins and may force further temporary closures of plants, or, in the worst-case scenario, force steel companies to look to other countries with cheaper energy prices.

IS THE FIELD OF METALLURGY IN ROMANIA INFORMATIONALLY EFFICIENT?

The answer to this dilemma is important because, if the portfolio manager believes that the market is efficient, the best passive strategy is to own a portfolio that should be equal to the market; if the market lacks efficiency, the best strategy is to manage one's portfolio actively.

E. Fama [4] operationalized the hypothesis of efficient markets. In his 1970 study, Efficient Capital Markets: A Review of Theory and Empirical Work, which will permanently mark the theory of efficient markets, Fama gives the following definition: "an efficient market is a market where prices always fully reflect available information". This paper distinguishes between the three levels of efficiency: strong-form efficiency, semi-strong efficiency and weak-form efficiency.

Under the efficient markets hypothesis, all the information available at a certain moment is included in the trend. At any moment, the trend is an unbiased estimate of the trends of the upcoming period.

On such a market, investors cannot hope to repeatedly have information which has not already been updated by the other investors in the trends. Therefore, investors cannot systematically make abnormal rates of return.

The rate of return an investor can hope for will depend on the kind of risk he is willing to take. As a consequence, the concept of informationally efficient market has a series of extreme implications in the practice of portfolio management: the only investors who bene-

fit from privileged information will have the possibility to have abnormal gains.

In this article, the entropy can be seen as a measure of informational efficiency of financial markets. In the terms of information entropy, market efficiency is equivalent to having maximum entropy, complexity, or uncertainty levels.

APPLYING INFORMATION ENTROPY TO THE ROMANIAN FIELD OF METALLURGY

Entropy is the measure of both the uncertainty and the complexity of a system, with many applications in physics (the second principle of thermodynamics), in information theory, in biology (the complexity of DNA sequences), in economics (system complexity). In the context of the physical and mechanical approach to the economic phenomenon, the original meaning of the word entropy has its roots in the second principle of thermodynamics: heat always moves from a warmer body to a cooler body and never the other way round. Thus, in a metaphorical way, to reconnect with thermodynamics, it is considered that a certain "temperature" of a system, which increases as the complexity increases and vice versa [5]. In other words, high levels of entropy are obtained in situations of deep uncertainty, while low levels of entropy are associated with low uncertainty situations.

To measure the informational efficiency of financial markets, there is used the Shannon Entropy (this is the inability to predict, on average, a random-walk variable equivalent to its information content. The concept was coined by Claude E. Shannon in his 1948 work "A Mathematical Theory of Communication".) There can be started from the basic assumption that, on an efficient market, prices reflect all available information. As a result, there is noticed that the returns of efficient market securities are not predictable. Measuring efficiency involves two stages. First, the returns are represented to detect its changes over the analysed period. In the second stage, there is applied and calculated the Shannon Entropy to measure the amount of information contained in the returns series. Using the symbolic time series analysis (Symbolic Time Series Analyses – [6]), there can be got more data from a normal time series, the normal data with very different values are turned into a series symbolized by only a few distinct values.

Consequently, there will be denoted negative returns by (0) and positive ones by (1). In fact, in this case, the process is a sequence of Bernoulli trials ((0) and (1)). Thus, there is defined a time series of size T defined as (R_1, R_2, R_3, · · · , R_T), R_t being the security returns at time t, where t = 1, 2, 3, · · · , T.

Returns were measured using the first difference of logarithmic values of daily prices:

$$R_t = d\log_e(C_t) = \log_e(C_t) - \log_e(C_{t-1}) \qquad (1)$$

Then, there is turned the series of returns into a symbolic series in accordance with the following notations:

$$\begin{cases} if\ R_t < 0, s_t = 0 \\ if\ R_t \geq 0, s_t = 1 \end{cases} \qquad (2)$$

In an efficient market, the assumption is that it is not possible to forecast future security prices (or their related returns) using historical values. Thus, the probability of having positive (negative) returns the next day is ½ and the Shannon entropy level is the highest.

To analyse the uncertainty level, there was implemented the Shannon entropy (H) as a measure of informational efficiency. This indicator can take a maximum value of 1, when the process is completely random, and a minimum value of 0, when referring to a certain event. Here is the theoretical expression of H for two events, p (the probability of having negative returns) and 1-p (the probability of having positive probabilities) [7]:

$$H = -[p*\log_2 p + (1-p)*\log_2(1-p)] \qquad (3)$$

Since the above described equation is concave, the maximum (H = 1) is obtained for p = 1/2 (maximum uncertainty) and the minimum is obtained when one of the events is a certain event (p = 0 or p = 1). In the latter case, the market is not informationally efficient and the Shannon Entropy value (H) will be lower than 1.

In this article, data was collected using a representative sample of the companies trading at the BVB in the field of metallurgy. The data consist of 10 traded stocks from the Bucharest Stock Exchange, covering the period between 2003 and 2013. Using the above outlined methodology to determine the Shannon Entropy, the results obtained indicate that the Romanian field of metallurgy is characterized by a weak informational efficiency, if we take into account the value of the Shannon Entropy obtained (0,941064) which is quite close to 1.

Weak form efficiency assumes that the current share prices fully reflect the information contained in the transaction data available on the market. This entails that any transaction rule that depends on previous changes in the quotes or on previous information about the market will be useless. On an efficient market, previous security prices cannot be used in order to "beat" the market or to achieve superior-risk-adjusted returns. In this context, technical or chartist analysis is useless.

The more efficient the market, the more arbitrary the price dynamics; and the most efficient market is that wherein changes in price are completely random and unpredictable. Otherwise one cannot generate additional profits from the information one holds, because such profit has already been incorporated into the price.

CONCLUSIONS

Charging an ordered structure with a minimum degree of uncertainty (lack of knowledge) and a disordered, chaotic structure with a maximum degree of ignorance, we coined the term information entropy as a measure of the degree of uncertainty within a system. The organization of the system is directly proportional to the amount of information stored and inversely proportional to the entropy information of the system [8].

After calculating the Shannon Entropy, the results obtained in this paper indicate that the Romanian field of metallurgy is characterized by a weak informational efficiency. Perhaps the most important effect of financial market informational efficiency is the impossibility to make predictions. Information should not be confined to financial news and research; indeed, information regarding political, economic and social events, together with the way in which investors receive such information, whether true or false, will be reflected in the price of securities. According to EMH, because prices respond only to the information available on the market, and because all participants possess the same information, nobody will be able to reap higher profits than others. On efficient markets, prices become impossible to forecast, but follow a random walk, so that no planned investment strategy can be established or is likely to succeed.

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Note: The responsible translator for the English language is Camelia Oana, Sibiu, Romania