ASSESSMENT OF AVERAGE MARKET PRICE OF FERROUS SCRAP IN THE REGION: COMPARATIVE ANALYSIS OF DIFFERENT APPROACHES

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Abstract

The paper offers the analysis of common price setting methods from the point of view of their applicability to pricing of ferrous scrap by metallurgical plants for the regions on the competitive market. We used the average regional prices for 3A ferrous scrap purchased by the OJSC MMK in 22 regions to compare the accuracy of the price setting methods, found out the advantages and disadvantages of their application and made a conclusion about the practical applicability of these methods. The approach based on the perceived value of the final product cannot be applied here because it results in significant underestimation of the price. The approach based on the level of current prices is easy to use in the process of forming price proposals by the plants in different regions and this approach makes it possible to take into account the influence of all the key factors of price setting, which is included into the price proposals of the enterprises. However, when this approach is applied, distorted information about the prices of competitors, lack or unavailability of such information may result in obtaining inaccurate or biased estimations.

Key words: pricing, pricing methods, econometric approach/methods, ferrous scrap

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Introduction

The major consumers of metal scrap are large iron and steel plants, and, in conditions of free market economy, they pursue their own interests and that is why they have to compete with each other for ferrous scrap, thus, each plant has to plan its strategy of scrap purchase in order to buy the necessary amount of scrap, on the one hand, and to reduce the purchase costs, on the other hand. That is why planning the pricing policy of the company is one of the key elements providing its competitiveness. The key elements of setting the final price are the understanding of the market conditions and the choice of the price strategy based on the assumption of the demand for ferrous scrap. The result of the analysis of the market conditions for ferrous scrap

in the region is the assessment of the average market price for ferrous scrap. Within the chosen price strategy, this assessment can be used to set up the final scrap price of the plant in the region. In order to assess the average market price of scrap, one can make use of different pricing methods.

1 Review of pricing methods

All the pricing methods developed and commonly applied in practice today can be broadly classified into the following three groups: cost-based, econometric and market ones. *Cost-based pricing methods* are based mainly on accounting the production costs and the costs of sales. However, on the ferrous scrap market, which is a consumer market, these methods do not work. Purchasing prices in the region, from the minimum to the maximum ones, are formed on the basis of the purchasing prices of metallurgical plants and they are (mainly) determined by the consumer. *Econometric methods* take into account consumer and performance characteristics of the product. *Market pricing methods* consist of the study of the demand and competition on the market, i.e. making use of marketing methods (Larichkin, 2003; Esipov, 1999).

Among the econometric and market methods, one can single out the following approaches to ferrous scrap price forming, which are described in scientific literature: the approach based on the level of current prices; the approach based on the perceived value of the product; the approach based on equalization of domestic and export prices; the econometric approach.

Within the framework of the current price level approach of the price setting for ferrous scrap in the region, the main method is the Comparable Uncontrolled Price Method (P.6 of A. 22. of Federal Law RF № 44-FZ dated 05.04.2013. "About contract system in the procurement of goods, works and services for state and municipal needs"). Commercial proposals of companies are used as initial data for the calculations; in this case, commercial proposals are the regional prices for the scrap of certain kind; these proposals are usually made by metallurgical plants. We can recommend to use at least three prices for the commodity or services offered by different companies. The fair market value of scrap determined by the Comparable Uncontrolled Price Method is calculated as the weighted average price of the purchasing prices of scrap proposed by metallurgical plants where the weights are the purchase amounts of scrap:

$$(P_{month})^r = \frac{\sum_i ((AP_{month})_i^r * (V_{month})_i^r)}{\sum_i (V_{month})_i^r} \quad (1)$$

where $(P_{month})^r$ is the weighted average actual purchase price in the region r; $(AP_{month})_i^r$ is the weighted average actual price of the i-th company in the region r in the analyzed month; $(V_{month})_i^r$ is the actual purchase amount of scrap by the i-th company in the region r in the analyzed month.

In accordance with the perceived value pricing approach, the price of ferrous scrap is formed on the basis of the price of the primary metal, in particular, the price of cast iron, and ferrous scrap is the equivalent substitute product of cast iron. Technological value characterizing consumer properties of ferrous scrap as a substitute for cast iron is calculated as the product of cast iron price by the coefficient of the material value of ferrous scrap; this technological value is less than unity. Technological value characterizes the overall price level of secondary ferrous metals for which the economic performance of the steel industry is similar for both steel production from cast iron and from ferrous scrap. In order to calculate the final price, the costs of scrap processing and the costs of scrap delivery from the scrap stockist to the consumer are subtracted from the technological value (Graphov, 2010).

The approach based on equalization of domestic and export prices takes into account that, on the whole, supply of scrap in the Russian Federation exceeds the domestic demand. When this approach is applied, one can say that in the process of price setting, scrap stockists can consider an alternative of selling their scrap abroad (Ivanova, 2017). That is, the domestic price of scrap quoted by scrap stockists can be calculated as the scrap price in the port where scrap is transported for export minus the costs of scrap transportation from the scrap stockist to the export port. The shipping ports, which are used to export ferrous scrap are referred to as "export hubs", while the price quoted by the scrap stockist and formed in accordance with the method mentioned above is referred to as "export parity price".

The "export parity price" taking into account the possibility of the scrap stockist to choose the best sales terms through several "export hubs" is calculated by the following formula:

$$\mathrm{c_i^{EP}} = \max_{1\le k\le 5}\{\mathrm{CP_k} - \mathrm{T_{i,k}}\},\ \mathrm{i} = 1,..,n, \tag{2}$$

where $\mathrm{c_i^{EP}}$ are the prices of scrap stockists calculated by the "export parity" principle; $\mathrm{T_{i,k}}$ are logistics freight rates between the i-th scrap stockist and the k-th "export hub"; i is the number of the scrap stockist; n is the amount of scrap stockists; k is the number of the export hub; $\mathrm{CP_k}$ is the adjusted price of the 3A ferrous scrap for the k-th export hub in roubles calculated by the following rule:

$$\mathrm{CP_k} = (\mathrm{PP_k} - \mathrm{Tax} - \mathrm{CC_k}) \cdot \mathrm{R} + \mathrm{PTS},\quad \mathrm{k} = 1,..,5, \tag{3}$$

where PP_k is the price in the shipping port k (without taking into account the freight); Tax is the duty paid to the budget of the Russian Federation; CC_k is the cost of cargo transshipment; R is the exchange rate of the US dollar to the Russian Federation rouble; PTS is the premium for scarp quality.

Econometric approach assumes that the price proposal is formed on the basis of a mathematical model in the form of a regression equation or in the form of an econometric system of equations. In papers (Albertson, 1996; Angus, 2012; Evans, 2006; Gruver, 2005, Sheppard, 1992) ferrous scrap prices of the key domestic consumers are simulated on the basis of multiple regression models where macro- and microeconomic environment factors are chosen as explanatory variables.

2 Calculation of regional prices for ferrous scrap using the OJSC MMK as an example

Let us consider how the approaches described above are implemented using the assessment of average regional prices of the 3A ferrous scrap for the OJSC MMK as an example.

The following information was used as initial data: data on rail transportation of ferrous scrap in the Russian Federation furnished by JSC Russian Railways (dispatching stations and receiving stations, shipper-user and receiving company, etc.); reference book of railway rates 10-01 between the railway stations of the RF; statistical data on prices of 3A ferrous scrap in "export hubs" (sea ports: St. Petersburg, Novorossiysk, Rostov-on-Don, Vladivostok and the border-crossing point with the Republic of Belarus); dollar exchange rate; quotation of purchasing prices of 3A ferrous scrap for a number of metallurgical plants in the regions of the RF according to the data of Metal-Courier Information Agency.

According to the database on ferrous scrap transportation by JSC Russian Railways, in May of 2015 the OJSC MMK purchased ferrous scrap in 22 regions of the RF. We will describe the calculations using purchases in the Republic of Bashkortostan as an example.

The approach based on the level of current prices. On the basis of the data of Metal-Courier Information Agency on purchasing prices of ferrous scrap for competing plants and the data of JSC Russian Railways on amounts of scrap purchased by the plans in the Republic of Bashkortostan (Tab. 1), we calculated the weighted average price by the formula (1). The price of scrap was 9447 roubles per ton.

Tab. 1: Prices and amounts of scrap purchased by scrap consumers in the Republic of Bashkortostan in May of 2015

Enterprise/plant	Price, roubles per ton	Purchased amount, ton
OJSC Izhstal	9620	1150
OJSC NSMMZ	9338	11284
OJSC STZ	9440	3384
OJSC PNZ	9670	2986
OJSC ChMK	9735	1382

Source: author's own work

The approach based on the perceived value of the product (cast iron). Taking into account the assessment of cast iron value, costs of processing and transportation of scrap, we calculated the purchasing price of scrap in the Republic of Bashkortostan (RB) for the OJSC MMK (Tab. 2). The price was 5093 roubles per ton of scrap.

Tab. 2: Estimated values of price on the basis of perceived value of the product, May of 2015

No.	Parameter	Value
1	Manufacturing cost of cast iron for the OJSC MMK, roubles per ton	9900
2	Coefficient of material value of cast iron	0.798
3	Costs for scrap processing (average costs according to the data furnished by scrap stockists), roubles per ton	1970
4	Average transportation costs of scrap from Bashkortostan, roubles per ton	837
5	Purchasing price of scrap in Bashkortostan, roubles per ton	5093

Source: author's own work

The approach based on equalization of domestic and export prices. In the Republic of Bashkortostan, to calculate the scrap prices by "export parity", they use the prices of 3A ferrous scrap in "export hubs", which are calculated by the formula (3) for five export hubs (Tab. 3). Then, using the formula (2), the price is assessed by the "export parity" for each railroad station in Bashkortostan, which ships ferrous scrap. After that weighted average price is calculated by the "export parity" in the region taking into account the amounts of the shipped scrap. For Bashkortostan this price was 8826 roubles per ton.

Econometric approach. Within the framework of the econometric approach, in order to solve the problem of ferrous scrap price modeling in the region, methods of correlation-regression analysis were used. The model was defined and the assessment of scrap pricing

model parameters was carried out on the basis of monthly data for the period of 2013-2015 throughout the RF and the Republic of Bashkortostan.

Tab. 3: Calculation of scrap price in "export hubs", May of 2015

Parameter	«Export hub»				
	Saint Petersburg	Rostov-on-Don	Novorossiysk	Vladivostok	Border with Belarus
FOB price, $/t	260	250	249	237	187
Transshipment cost, $/t	18	15	17	18	0
Export duty, share	0.1	0.1	0.1	0.1	0
Actual average dollar exchange rate by the data of the Central Bank of the RF, roubles/$	50.64	50.64	50.64	50.64	50.64
Surcharge for scrap quality, roubles/t	300	300	300	300	0
Price calculated according to the econometric approach, roubles/t	11 243	10 944	10 797	10 195	9 506

Source: author's own work

The response variable is the purchasing price of scrap in the RF (Y). A priory set of independent variables in the process of model development consisted of: X1 – consumption of scrap by the domestic market of the RF, ton; X2 – consumption of scrap in the RF with a time lag -1, ton; X3 – consumption of scrap in the RF with a time lag -2, ton; X4 – change in scrap consumption in the RF, ton; X5 – change in scrap consumption in the RF with a time lag -1; X6 – scrap consumption in the RB, ton; X7 – scrap consumption in the RB with a time lag -1, ton; X8 – scrap consumption in the RB with a time lag -2, ton; X9 – change in scrap consumption in the RB, ton; X10 - change in scrap consumption in the RB with a time lag -1, ton; X11 – US dollar exchange rate, roubles per dollar; X12 - US dollar exchange rate with a time lag -1, roubles per dollar; X13 - US dollar exchange rate with a time lag -2, roubles per dollar; X14 – change in US dollar exchange rate, roubles per dollar; X15 - change in US dollar exchange rate with a time lag -1, roubles per dollar; X16 - change in US dollar exchange rate with a time lag -2, roubles per dollar; X17 – scrap price by the "export parity" in the RB, roubles per ton; X18 – scrap price by the "export parity" in the RB with a time lag -1, roubles per ton; X19 – scrap price by the "export parity" in the RB with a time lag -2, roubles per ton; X20 – purchasing price of scrap in the RB with a time lag -1, roubles per ton; X21 - purchasing price of scrap in the RB with a time lag -2, roubles per ton.

Taking into account elimination of multicollinearity of independent variables, we developed a regression equation with significant coefficients:

$$Y = 1216.92+0.86\times X_{20}+47.99\times X_{15}+0.001\times X_4+36.28\times X_{16}. \quad (4)$$

(14.35) (2.65) (3.31) (2.07)

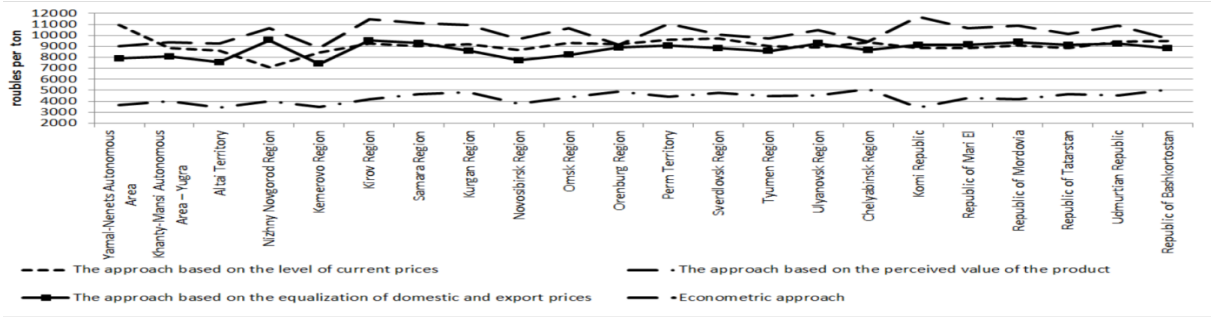
Assessment of coefficient significance was carried out using Student t-test (the observed values of the t-test for the coefficients are given in the parentheses under the equation), while the assessment of the equation significance was carried out using F-test: $F_{obs.}$=71.692 for the significance level of 0.05. The determination coefficient was R^2=0.9. In accordance with the developed regression equation, the 3A scrap price in May of 2015 in Bashkortostan must be

Y=1216.92+0.86·10723+47.99·(-7.34)+0.001·(-190421)+36.28·(-4.52)=9699 roubles per ton.

The similar calculations were done for the rest of the 21 regions (Ivanova, 2016). The results of the price calculation according to the models in May of 2015 are given on the graph (Fig. 1). From the graph one can see that the approach based on the perceived value of the product (cast iron) gives significantly lower prices. For the other three approaches, the analysis of the consistency of regional prices using Friedman test and taking into account the lack of reference values showed certain differences for the significance value 0.01 ($\chi^2_{r\,obs.} = 17.8 > \chi^2_{r\,table} = 9.21$). Analysis of pairwise scattering Bland-Altman graphs showed systematic discrepancy and scattering of price values by the considered methods.

Lack of consistency assumes that characteristic properties of assessment approaches introduce into the calculated values some regular element, which either overstates or understates prices as compared with the calculated values of prices according to the other approaches. That is why in practice we can recommend to assess the price on the basis of several approaches.

Fig. 1: Results of assessment of average regional purchasing prices for 3A scrap in the regions of the RF, May of 2015



Source: author's own work

Conclusion

Practical implementation of the considered approaches made it possible to reveal the following advantages and disadvantages of their application to assess the regional prices of ferrous scrap.

The approach based on the level of current prices is simple and easy to use. The initial data are prices of competitors; these data are used for price assessment and they contain the information about the state of market in the considered period. However, when this approach is applied, it should be taken into account that the quality of assessment to a great degree depends on the reliability of the data on the prices of competitors and on the price sample size. Analysis of price proposals of metallurgical plants shows that in some regions, which are not considered to be the major scrap stocking regions, a plant that does not expect any significant supplies from the local scrap stockists can offer the so called "stop-prices", that is significantly underestimated prices, which are unprofitable for the scrap stockists. Another extreme is offering "special" prices in the region to one supplier or to a number of suppliers. As a rule, such prices are not offered for the public access thus resulting in misrepresentation of the information about the market prices in the region and in underpricing. For the regions with insignificant amounts of supplied scrap, the reliable information about the prices of competitors can be unavailable altogether. Distorted information about the prices of competitors, incomplete information or its unavailability may cause incorrect or biased estimations.

The main disadvantage of regression models is the need of manual adjustment of the model for each region of the RF and the need of monthly revision of model parameters taking into account new data.

The approach based on the perceived value of the product (cast iron) does not take into account the current state of the ferrous scrap market of the regions in the process of price proposal forming and it cannot be applied here because it results in significantly underestimated price assessment. That is why the price calculated on the basis of the perceived value of the product can be considered only as a reference point, which makes it possible to assess the efficiency of using scrap in the steel-making process as compared with using cast iron.

When *the approach based on the equalization of domestic and export prices* was used, the analysis of actual domestic prices showed that in the considered period the actual prices differed from the "export parity" prices. For regions located far from the "export hubs", with high shipping cost to the "export hubs", it was found that the actual prices were higher than the export parity prices. The "export parity" price for such regions does not cover the costs of scrap stockists on scrap picking and processing, that is why the scrap stockists have to set the prices, which are higher than the parity ones. In some regions, the actual price was lower than the "export parity" price. Besides, the analysis of price behavior in 2013-2015 showed that in case

of non-equilibrium of demand and supply on the ferrous scrap market, the "export parity" prices differ significantly from the actual domestic ones. When scrap supply exceeds significantly the demand, the "export parity" prices are much higher than the actual ones; when demand exceeds supply, they are lower than the actual prices. It should be taken into account that setting of the domestic price equal to or lower than the "export parity" price does not necessarily result in changing of scrap supplies to export, because not all of the scrap stockists are able to meet the requirements imposed on scrap quality, amount, delivery dates and other terms of export supplies. The price calculated on the basis of the "export parity" approach can be considered as a reference point showing if the domestic market is the premium or discounted one as compared with the overseas market.

Thus, in practice we can recommend to use the approach based on the level of current prices as the major pricing method and to adjust the obtained assessments taking into account the average regional prices calculated on the basis of the econometric approach or on the basis of equalization of domestic and export prices.

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