ANALYSIS OF THE UKRAINIAN FERROUS METALS INDUSTRY AND SENSITIVITY OF METALS EXPORTS TO EXCHANGE RATE FLUCTUATIONS

by

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LIST OF ABBREVIATIONS

GDP – Gross Domestic Product

MMT – million metric tones (1 metric ton equals to 1000 kilograms)

UAH – Ukrainian hryvnia

CAGR – Compound annual growth rate

OLS – Ordinary least squares

YOY – Year-over-year

PJSC – Public Joint Stock Company

kWh – Kilowatt-hour (a unit of energy equal to 3600 kilojoules)

MWh – Megawatt-hour (equals to 1000 kilowatt-hours)

CHAPTER 1. INTRODUCTION

The industry of ferrous metals production is one of the basic, fundamental industries, which allows all of the other companies to construct machines, buildings, everyday furniture and many others. Nowadays it is hard to imagine any other material that can possibly replace steel in the production of the overwhelming majority of goods and constructions. Together with other countries that need for production resources, infrastructure, and plants to create final steel products, Ukraine is present on the world map of steel production and takes a significant position in it, having almost 3% of all iron deposits worldwide and, therefore, being on the 7th place in a ranking of iron reserves by countries. Among the companies operating inside of the country, there are leaders that belong to Top-50 metals-producers worldwide.

Metallurgy is also one of the key industries for the Ukrainian export and the sector which is actively participating in the budget forming of the country. Overall, Ukraine is 13th in ranking of the top steel-producing countries as of 2018. By the results of 2019, mining and metals sector in Ukraine generated 12% of the country's GDP, its export share in a total amount of goods sold to the foreign partners was 26%, more than 600 thousands of people living in Ukraine have a job in mining and metals industry [1]. However, in 2019 in Ukraine the theme of large problems in the Ukrainian metallurgy industry arose. From the May of 2018, the base metal price was steadily declining until the beginning of 2020. This fact has appeared on the background of the decline in demand for steel in the world and fast Ukrainian hryvnya appreciation. The growth rates of steel demand in the largest countries-consumers and therefore in the world are slowing, so that so the facilities producing base metals facing the problems of price decline, drop of a quantity of steel demanded, and after all, squeezing the profits.

After providing a few facts above it is obvious that the importance of the metallurgy sector for the country is hard to question. Also, it is important to understand how the Ukrainian metallurgy market is functioning nowadays and what kind of characteristics it has. This thesis is aiming to answer the following questions, which are stated in order to give the understanding of current Ukrainian metallurgy shape for potential investors:

- What is the overall industry characteristics? Who buys Ukrainian metals? How competitive environment inside of the market is? Which barriers can possibly stop an investor from starting a company in metallurgy?
- Does the exchange rate in Ukraine affect the amount of metals export?

Additionally, to the questions presented above, there will be shown that the Ukrainian ferrous metals industry is quite concentrated, groups of companies constantly building vertically-integrated holdings in order to be the largest market participant in the country. Competition between companies continues not only in the volumes of production, but every market player in this industry competes also for cheaper Ukrainian inputs, comparing to external raw materials, such as coking coal or iron ore.

CHAPTER 2. INDUSTRY OVERVIEW AND RELATED STUDIES

There were quite a few overviews of the ferrous metals industry of Ukraine, among them are the paper "Place of Ukraine on the World Steel Market" published in "Ekonomichnyy visnyk Donbasu" #4, 2013 and the overviews of the industry made by GMK Center. This first paper mentioned is now quite outdated due to the numerous changes in the world and the metallurgy industry in particular, and the overviews made by GMK Center are usually containing information answering distinct aspects of the industry or summing up the results of Ukrainian metallurgy for a separately taken year.

The main contribution of this thesis is to give fresh generalized information about market conditions and answer the question about the sensitivity of export volumes to exchange rate fluctuations. Question about the dependence between export and exchange rate arose for the author of this work at the end of the year 2019 when Ukrainian mass-media were full of news with titles telling that Ukrainian metallurgy is suffering from the UAH appreciation. To answer the question about a sensitivity to exchange rate fluctuation author will address to the paper written by Bussière et al (2016). In previously mentioned study authors researched the exchange rate elasticities on the export and import basing on the measuring exchange rate pass-through and quantity elasticities. The part of this thesis about exchange export sensitivity to the exchange rate will be described in the parts about methodology and the results of the research.

2.1. Place of Ukraine in the world ferrous metals production.

Overview of the metallurgy industry in the context of Ukraine should be started from a worldwide overview of steel production since Ukrainian facilities mostly oriented on supplying metals to other countries, rather than to Ukraine.

The first point that is important to mention is a starting capacity, meaning the reserves of ore containing iron in the world. The table below is representing the countries

with the largest iron ore reserves, according to the data from United States Geological Survey (2018).

Table 1. Ranking of countries with largest deposits of iron ore, MMT

Country	Crude ore reserves	Iron content
Australia	50,000	24,000
Brazil	32,000	17,000
Russia	25,000	14,000
China	20,000	6,900
India	5,400	3,200
Canada	6,000	2,300
Ukraine	6,500	2,300
Iran	2,700	1,500
Kazakhstan	2,500	900
South Africa	1,200	770
United States	2,900	760
Sweden	1,300	600
Other countries	18,000	9,500
World total (rounded)	170,000	84,000

Source: United States Geological Survey.

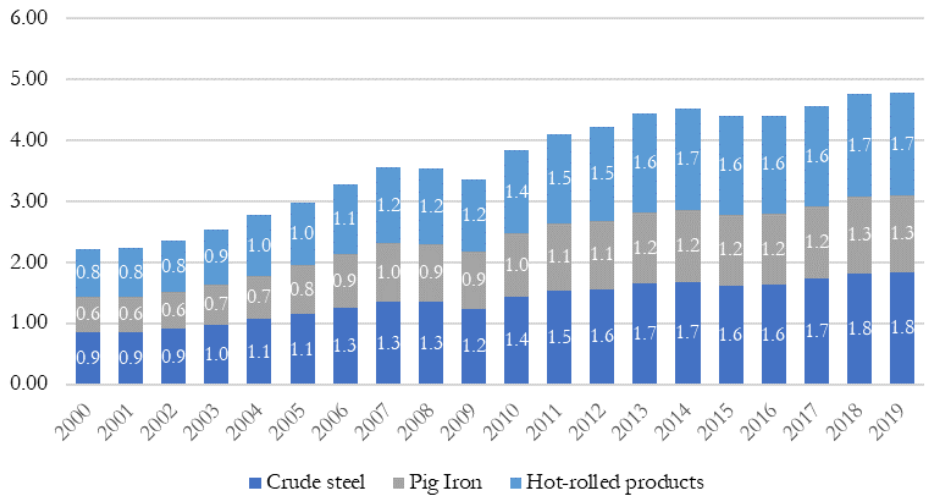
As it can be observed, Ukraine placed is placed 7th in the ranking by the amount of iron in ores located inside of the country's borders. The indicator of iron deposits even at the start of this thesis shows the great potential of the country on the world market.

The situation with actual ferrous metals production, processed resource (in particular crude steel, pig iron, and hot-rolled products), is showing quite different leaders

in the industry. The amount of the ferrous produced is growing with CAGR 4.38% from the year 2000 and up to 2019 when the total ferrous metals production reached 4,777 million tones. However, the growth rates of the ferrous metal's production is showing a declining trend for the second year in a row: YOY in 2018 – 4.37% and in 2019 YOY is already 0.53%. This decreasing trend is mainly based on the slowing of steel consumption by the countries that are the largest consumers of steel, in particular the consumption trend slowdown in China, the United States, India, and Japan.

Nevertheless, despite the slowing of demand trend in the world, the level of ferrous metals production is the highest in the history of the industry, as it can be observed from the graph.

Figure 1. Volumes of worldwide steel production, billion tones



Source: World Steel Association.

By the end of 2018, the absolute leadership on the market has been taken by China, who has produced 2.55 billion tones of crude steel (53.54% of world total production),

India – 0.28 billion tones (5.91% of total), Japan – 0.27 billion tones (5.72% of total). Ukraine produced 0.06 billion tones of steel (1.26% of world total production) [1].

According to the data of World Steel Association, the ferrous metals produced is mainly consumed by in infrastructure and development (47% of world total consumption by the result of the year 2017), and the other resource is going to engineering industries (15%), an industry of energy (14%), automotive industry (12%), household metalware sector (7%) and finally shipbuilding industry (5%) [2].

2.2. Ukrainian ferrous metals industry: production level, export volumes, major plants.

After the short description of the worldwide metallurgy industry, it is time for the deeper overview of the Ukrainian industry of metals. For the purpose of research, the author is mostly concentrated on the sector of ferrous metals and in Ukraine since this type of metals contributes the largest part into the export of Ukrainian metals (85% of all metals export in both 2018 and 2019).

In general, the industry of metals and mining in Ukraine generated approximately 12% of the country's GDP in 2018 and the share of metals in exports of Ukrainian goods was 24%, which is equivalent to 11.6 billion USD and 20.4% (or 10.3 billion USD) by the results of 2019 [3]. This amount of export earnings already includes the earnings from the ferrous metals, which are equal to 9.9 billion USD in 2018 and 8.7 billion USD in 2019.

Therefore, the export of base metals, especially ferrous metals, contributes the fifth part of foreign exchange earnings to Ukraine.

The key driver for the largest metals producers like China, the US, or India is domestic consumption, which is the highest across the world in the quoted countries.

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[1] Source of data: World Steel Association.

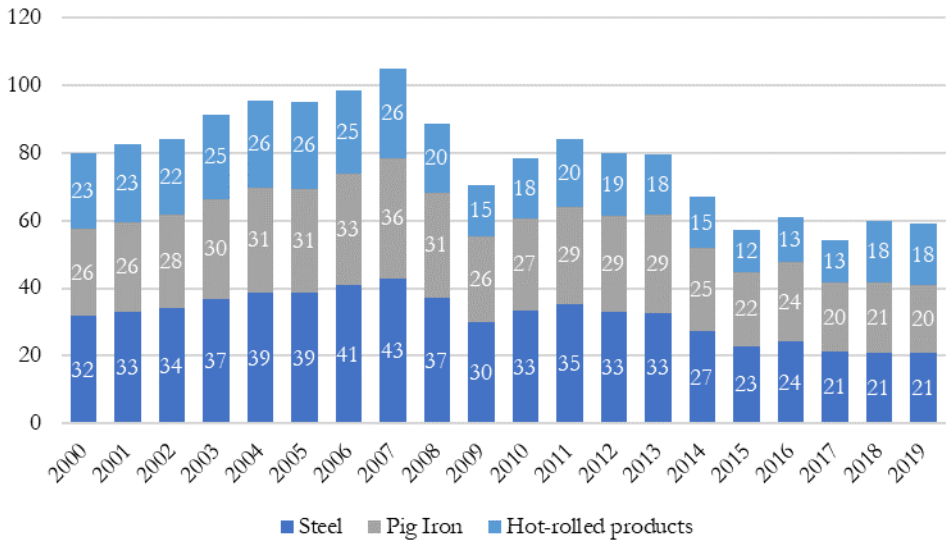
[2] Source of data: Metallurgy Global Trends and Challenges for Ukraine. GMK Center

[3] Source of data: State Statistics Service of Ukraine

Unfortunately, the internal market of Ukraine is not so attractive, the annual consumption of ferrous metals in 2018 was 5.6 million tones, which is an extremely small number in comparison with China (869 million tons), Japan (71 million tons), or our neighboring Poland (16.6 million tons). In relative terms, by the end of 2019, the share of internal consumers of Ukrainian ferrous metals was 17.9%, while the share of exports was 82.1%. Thus, Ukrainian metallurgy is mostly oriented on exports.

Production of ferrous metals by the end of 2019 amounted to approximately 59 million tones. Production structure of ferrous metals was more or less proportional: the share in the whole volume of the production of steel equals 35.6%, pig iron – 33.8%, and hot-rolled products – 30.6%.

Figure 2. Volumes of steel production in Ukraine, million tones



Source: World Steel Association.

The structure of production of metals by companies has changed considerably after the years 2014-2015 when the occupation of the part of Ukrainian territory occurred. To be more precise, on the occupied area were left such factories as Alchevsk Iron and Steel

Works and Yenakiieve Iron and Steel Works, which contributed 12.7% and 8.8% of steel production as of 2013, respectively. Alchevsk factory was the major facility of the "Industrial Union of Donbass" Corp., which had lost a large share of the market after the occupation. The factory of Yenakiieve was a part of "Metinvest Group" facilities, which is still the market leader in ferrous metals production in Ukraine.

By the end of 2018, the situation with industry participants is looking in the following way. There are five major steel producers, who are contributing together 88.3% of all crude steel production in 2018. Among them: PJSC "ArcelorMittal Kryvyi Rih" – 22.6% (4,764 thousand tones) of all crude steel production, PJSC "Zaporizhstal" (facility of "Metinvest Group") – 19.5% share (4,105 thousand tones), PJSC "Azovstal Iron & Steel Works" (facility of "Metinvest Group") – 19.4% (4,085.6 thousand tones), PJSC "Ilyich Iron & Steel Works" (facility of "Metinvest Group") – 15.4% (3,241.8 thousand tones) and PJSC "Dniprovskyi Iron & Steel Works" ("ISD" Corp.) – 11.4% (2,409.1 thousand tones). 11.7% of remaining steel production held by other facilities [4].

So, as it can be observed, the market is highly concentrated taking into consideration the shares of final goods produced in the industry. As it was mentioned before, the largest share of the ferrous metal's production is going for the export.

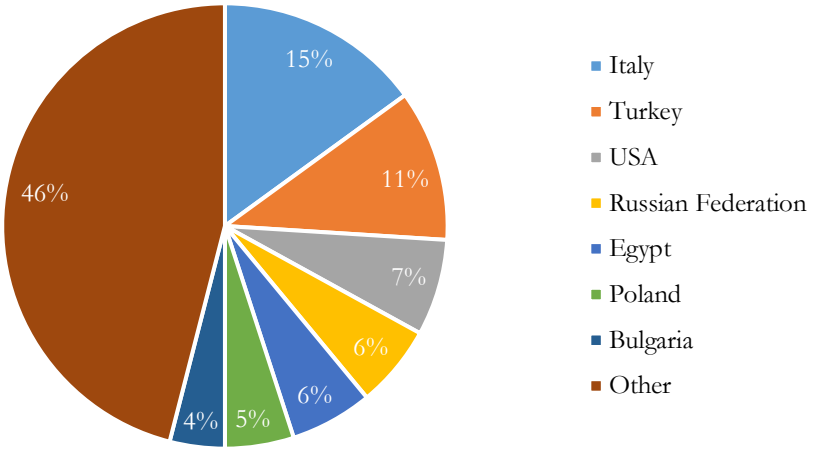
However, some Ukrainian industries also create demand for metals, which is amounted to 4.87 million tones as of 2018. Especially, this demand is driving by the construction industry, consuming 68% of all internally sold metal, machinery industry which consumes 23% and some other sectors of the economy that are buying another 9% of the metal sold for Ukrainian enterprises.

The situation with foreign partners of Ukrainian metallurgy is not so stable. Importers of ferrous metals are changing constantly, but there are some regular countries-recipients of Ukrainian steel, such as Italy, Egypt, and Turkey. These three country accounts for the largest share of ferrous metals export from Ukraine for the last 8 years. In

[4] All the shares calculated basing on "Ukrainian Iron & Steel Industry in figures" report.

2018 the structure of ferrous metals export by the countries-recipients was looking as following on the graph below.

Figure 3. Structure of Ukrainian ferrous metals export by country, %



Source: UN Comtrade (Trade Map website).

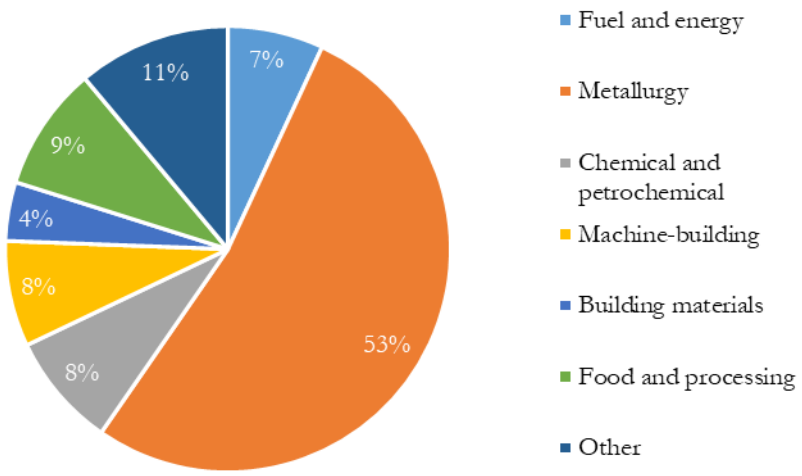
2.3. Essential inputs for the ferrous metals production and description of situation around their availability and prices.

After providing the information about export operations of Ukrainian ferrous metals it is important to point out the issues regarding the inputs for the metal's production. In the process of steel smelting, three major types of raw materials are necessary, among them: coking coal (to keep the fire in the ovens for smelting process), iron ore (major component, raw material from which the steel and steel products are produced) and electricity.

Starting from the last input with, on the Figure 4 it can be seen that metallurgy is the largest consumer of electricity in Ukraine among the industries. By the end of 2019 metallurgical plants consumed 2234.1 million kWh, which is standing for 53% of electricity consumption among industries, and at the same time, this amount is 20.5% of all electricity

consumed in Ukraine. Comparing to a similar indicator of 2018 it is less by approximately 12.6%.

Figure 4. Consumption of electricity by industry in Ukraine, %

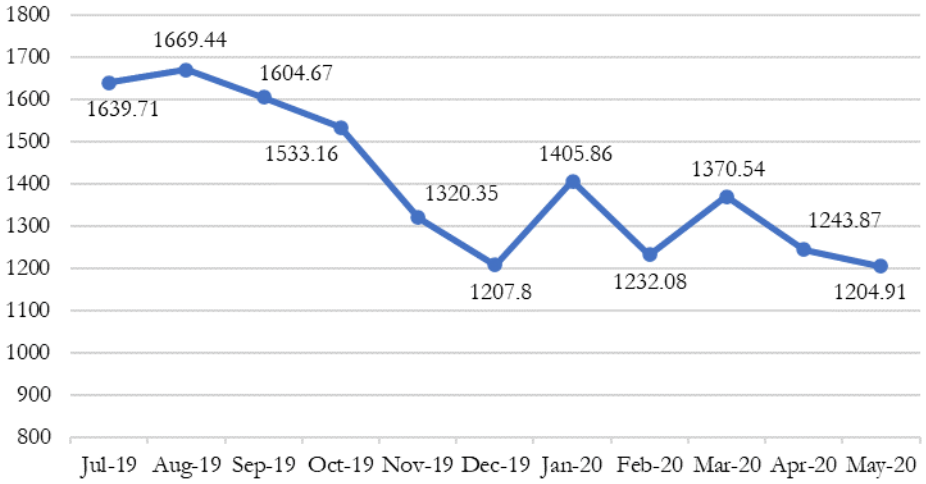


Source: Ukrenergo National Energy Company

Also, from July of 2019 Ukrainian electricity market has opened. From that period in time industries of Ukraine that consume a large share of electricity directly depend on the market-price fluctuations on the newly opened market, not on the state-owned institution "Enerhorynok" which was calculating the electricity price for industrial consumers before. The opening of the electricity market directly affects the efficiency of the production process on the plants, as it can be observed, the volatility of prices for power is quite high since the market had opened. Based on the information about market prices provided by "Market Operator" (state-owned institution responsible for the market

functioning), for the first week since the market was opened the price of the input increased by more than 35%[5].

Figure 5. Market prices for electricity (Day-Ahead Market), UAH per 1 MWh



Source: Market Operator

The next input, iron ore, is the most important for the production and its availability on the market on the prices suitable for the ferrous metals producers is essential. The main point important to mention in this section is that the largest metallurgical plants already bought or merged with companies which have licenses for iron ore mining. Therefore, companies that will be mentioned later in the text have built partially vertically integrated holdings.

Nowadays in Ukraine, only 10 companies are working on iron ore mining and its further enriching. One of them - JSC "ArcelorMittal Kryvyi Rih" (iron ore mining company of Arcelor Mittal plant), PJSC "Poltava GOK" and LLC "Eristovsky GOK" that are in the

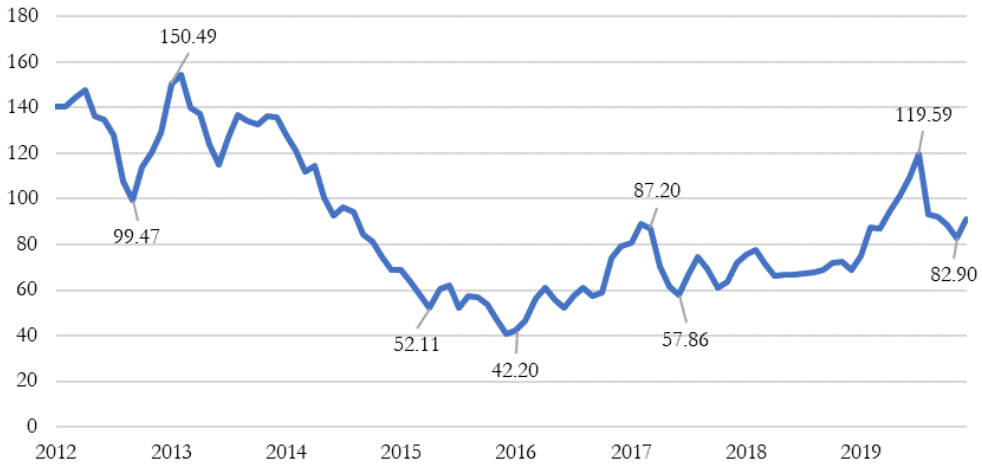
[5] Source of data: Energy industry media-website Kosatka.Media

"Ferrexpo PLC" structure, JSC "Sukhaya Balka" which is a part of "DCH Investments". The other six mining and processing plants are in the "Metinvest Group": PJSC "Severny GOK", PJSC "Yuzhny GOK", PJSC "Inguletsky GOK", PJSC "Central GOK", PJSC "Krivbasszhelezrudkom" and PJSC "Zaporizhzhya Iron Ore Plant".

Companies represented above are probably the most important assets of metallurgical holdings in Ukraine since they allow them to cut the prices for the raw material which will be used later on in ovens in order to get the final steel products ready for sale.

The price of iron ore is also changing constantly, like every other raw material its price strictly depends on the demand of the final goods, so when the global metallurgical companies are buying iron ore excessively, therefore, raising up its price. Holdings in Ukraine that have such an asset also have a possibility to slightly cut their inputs costs for steel production, increasing their competitiveness level on the global market.

Figure 6. Iron ore Global Prices, USD per Metric Ton



Source: Federal Reserve Bank of St. Louis

The last input needed for the steel production process is coking coal. The situation with coal is quite similar to the previous input, it is an essential part of the steel production process, which, as for today, global metallurgy cannot fully substitute.

Some Ukrainian companies added coke plants to the portfolio of their assets and overall, the situation with coke plants owners is quite similar to iron ore example.

Before 2014 Ukraine had 12 coke-producing plants, but due to occupation of the eastern part of Donetsk and Lugansk oblast Ukrainian metallurgy now can only depend on 8 plants. Officially, five of eight coke plants are the part of "Metinvest Group" – PrJSC "Zaporizhcoke", coke plant of PJSC "Azovstal Iron & Steel Works", share in PJSC "Dniprovs′kyy Koksokhimichnyy Zavod" (73%) [6], share in "Yuzhkoks" plant (23.71%) and JSC "Avdeyevskiy Coke Plant" (the largest European coke plant), which partly supply metallurgical plants of "Metinvest". The other company with its own coke plant is "ArcelorMittal Kryvyi Rih", which is now a part of the Kryvyi Rih metallurgical plant.

But, not only internal coke plants supply raw materials to Ukrainian metallurgical plants. In 2019 8.43 million tones (95.6%) of coke were supplied to the metallurgy industry by internal coke plants, while the other, smaller share – 0.39 million tones (4.4%) was imported to Ukraine from abroad[7].

In general, in the whole ferrous metals industry of the country two groups of companies have built almost fully vertical-integrated companies – "Metinvest Group" and "ArcelorMittal Kryvyi Rih". It is hard to overestimate the positive impact of such an organizational structure and business model for the functioning of the business. Now it is not surprising, that these two holdings are the largest participants of the Ukrainian metallurgy market and noticeable players on the global market.

[6] Information about share that belongs to Metinvest taken from interfax.com.ua

[7] Source of data: GMK Center.

At the same time, such market conditions inside of our country borders create serious barriers to entry to the industry. Entrants possibly will not be able to compete with companies that have their own suppliers of raw materials and economies of scale.

Summing up, the global trend nowadays is showing a decline in the metallurgy industry. According to the World Steel Association, an excessive amount of ferrous metals production facilities, and global demand for metals shrinking are the major factors making the industry highly competitive in the world.

However, the potential of Ukraine on a worldwide ferrous metals market is hard to underestimate. Given the volume of iron ore in the country, many international companies may try to enter the Ukrainian market, trying to expand their market share.

2.4. Porter's Five Forces

The method of Five Forces Analysis invented by Michael Porter is a universal way to briefly summarize the attractiveness of an industry describing the following aspects of the market: competitive rivalry level, bargaining power of suppliers and consumers, the threat of substitute products and the threat of new entrants.

Bargaining Power of Suppliers

Exactly ferrous metals production is deeply linked to the resources, factors of production. Supplies stated in the 2.3 chapter of this work, as coal, electricity, iron ore are essential and obligatory for production. The biggest Ukrainian metallurgy plants have their own subsidiaries supplying the iron ore for the favorable prices. But in general, for potential entrants the bargaining power of suppliers is considered as moderate, since the iron ore, coal price is dictated by the worldwide market, and the electricity price from the year 2019 is determined by the power-market.

The Threat of Substitute Products

The final good produced by the metallurgy plant cannot be differentiated to a high extent due to the nature of the product – no features or updates can be added. Metals can differ from each other by their density and fusibility. Moreover, due to the globalization of the ferrous metals market, consumers have all the information to choose among the products proposed by the metallurgy plants all over the world.

Bargaining Power of Consumers

This particular force can be characterized as high due to several reasons. The first point here is that such consumers as machines manufacturers, developers, etc. are willing to get the contract for a long term supply of materials for the lowest price. Since the product in this industry cannot be differentiated in a way to receive the advantage among other market players – metallurgy plants have to compete in terms of production and the end-price for consumers.

The Threat of New Entrants

The industry of ferrous metals production requires immense initial capital expenditures to build the production plant. In order to have higher marginality (mostly due to effective and energy-efficient production) metallurgy plant has to be equipped with efficient and modern ovens and machines. Moreover, a future entrepreneurs should take care of long-term contracts with suppliers of raw materials, so there are definitely barriers to entry the industry, therefore the threat of new entrants in the ferrous metals industry is low.

Competitive Rivalry

The following characteristic for the industry of ferrous metals production is rated as high. The key point here is that the plants compete mostly on the world market, as we have seen earlier – the share of sales to Ukrainian consumers is not so large and production

is export-oriented. Share of 1.26% in worldwide ferrous metals production represents intense competition on the market. Even taking into account the presence of world-known, top metals producers located in Ukraine (as ArselorMittal and Metinvest), there are a lot of market participants worldwide competing for survival.

Summing up the industry cannot be described as attractive for the entrance. High entry-barriers and intense competition (both for the inputs and for the supply-contracts) requires massive initial investments in order to build innovative, efficient, and large metallurgical plant. However, Ukrainian ferrous metals industry is could be considered as suitable allocation of new metallurgical plant for worldwide-known, already succeeded metallurgical holding, since the resource base (deposits of coal and iron ore) is one of the richest in the world, workforce is cheap and the country is attractive from the logistics point of view.

CHAPTER 3. METHODOLOGY

The two questions mentioned in the introduction part of this work, in particular, "Does the exchange rate in Ukraine affects the amount of metals export?" and "How world prices of steel affect the exports of base metals?" will be answered using econometric analysis.

While the author was considering the appropriate methodology to answer the question of the sensitivity of export volumes to the fluctuations of exchange rates, the most useful and the suitable related study was conducted by Bussière et al (2016). The authors of this study have researched three questions: exchange rate pass-through level for the import and export operations of 51 countries, quantity elasticity, and effect of exchange rate fluctuations on a trade balance of countries (Marshall-Lerner conditions).

In my thesis, I focus on estimation of export quantity elasticity following the research approach of Bussière et al. (2016). Authors estimated the elasticity of export quantities with respect to the exchange rate using the following econometric model:

$$dlog(q_{ijkt}) = i + x(dlog(s_{ijt}) + g(dlog(y_{jt}) + f_{[i]jk} + e_{ijkt},$$

Where q_{ijkt} is a quantity of product k exported from country i to country j at time t; y_{jt} is an importer's GDP that was added as a control variable for the local demand; and time-varying fixed effect f_{ijkt}.

I modify their model to account for differences in datasets and frequency. Since I use monthly data, GDP data are not available for Ukraine's trading partners and I will proxy market conditions with Industrial Production Index. Also, I include dummy variable to control for the change in the foreign currency basket as discussed below and its interaction with the exchange rate changes.

In order to estimate the econometric model I will use monthly data on the amount of Ukrainian export of ferrous metals (two major ferrous metals goods for two different models), Industrial Production Index, and the exchange rates.

Hence, the first step to conduct the analysis is gathering the data. This step will be described precisely in the next chapter of the work, but it is important to mention that the following variables will be created:

- $\log(Qty_t)$ – logarithm of the quantity of metals exported in a month *t*;
- $\log(Exch_t)$ – logarithm of the weighted nominal exchange rate in a month *t*;
- $dlog(Ind_t)$ – logarithm of Industrial Production Index in a month *t*.

Some clarification needed for the proposed variables. Weighted exchange rate will be calculated from the exchange rates hryvnia to the currencies of largest countries-importers of Ukrainian ferrous metals based on the share of this country in the amount of metals that Ukraine exported for the particular year. Since the effect of the exchange rate on exports is not contemporaneous this variable will be lagged in the model. One more important point here is that for the purpose of analysis four foreign exchange rates will be included into the variable – currencies of Egypt, Bulgaria, Turkey and Lebanon. This step will be taken since in total these four countries contribute 55%-70% of the whole ferrous metals export during the observed period. Also, Lebanon somewhat decreased the amount of import starting from the year 2013, so the dummy variable to account for the shift in exchange rate variable will be included. The formula below represents the method of variable calculation.

$$Exch_t = \sum(Exchange\ rate_i * weight_i)\ /n,$$

Where *Exchange rate* is a nominal exchange rate of UAH to the currency of country-importer; $weight_i$ is the share of the country-importer in the total amount of Ukraine's export in a given month in a period of 2010-2018.

Variable of the Industrial Production Index is used as a proxy for the demand conditions of the importing countries. In the reference model, authors used GDP to proxy for local demand however, in m. This particular variable will be lagged since the time is needed for exporters to adjust their contracts with customers. A chosen variable will proxy for demand conditions in importing countries instead of GDP of countries, since author did not find the monthly data for the GDP level of some importers of Ukrainian goods.

Finally, the regression for estimating the elasticity of quantity exported with respect to exchange rate fluctuations and Industrial Production Index will look as following:

$$\log(Qty_t) = \beta_0 + \beta_1(\log(Exch_{t-1}) * \beta_2 2013dummy +$$
$$+\beta_3(\log(Exch_{t-1}) * 2013dummy + \beta_4 \,\mathrm{dlog}(Ind_{t-1}) + e_t$$

The econometric analysis is performed using Stata. To evaluate the sensitivity of export value to the exchange rate in Ukraine ordinary least squared (OLS) method will be used. OLS method was chosen to take into account the fact that if the model meets several conditions mentioned in the Gauss-Markov theory, then the ordinary least squares method gives so-called best linear unbiased estimators (BLUE estimators). Later on, in the results part of this work, the Gauss-Markov theorem assumptions will be checked whether they hold or not.

CHAPTER 4. DATA

The data on the performance of the Ukrainian ferrous metals industry mostly is not freely available. There are several Ukrainian sources providing at least some data, including, State Statistics Service of Ukraine, State Fiscal Service of Ukraine, websites of "Metinvest Group", GMK Center, United Nations Comtrade Database. Unfortunately, Ukrainian data sources provide information mostly on an annual basis, so that the data is appropriate mostly for describing the industry, but not for econometric analysis. Due to that fact, I have used several international sources of data that provide information about the export of Ukrainian metals, and one more international source that allows to collect the data for Industrial Production Index.

To conduct the analysis described in the methodology part I collected the data for the monthly exchange rate of hryvnia to the currencies of other countries, monthly amounts of Ukrainian ferrous metals export, and Industrial Production Index.

Data for the exchange rate was collected on the National Bank of Ukraine and CEIC website for the years 2010-2018 on a monthly basis.

Given the composition of Ukrainian metals exports, the following exchange rates to be used for weighted exchange rate variable:

- Turkish lira
- Egyptian pound
- Bulgarian lev
- Lebanese pound

The raw data were converted from the [Currency of another country]/UAH to the form UAH/[Currency of another country] with an aim of having the data about the quantity of other country's currency that can be bought with one hryvnia.

Information on the monthly volumes of metals exports was collected on the website of the United Nations Comtrade Database for the years 2010-2018.

The model will be estimated for two categories of metals exports. The first one, a product category with a code 7207 – semi-finished products of steel and the second one – product category with a code 7208 or hot-rolled flat products (according to Harmonized Commodity Description and Coding Systems classification). Together these two product groups of ferrous metals represent 52% of all ferrous metals export, based on the information from the United Nations Comtrade Database.

Unfortunately, in the database provided by the UN Comtrade some data is missing in the year 2015. Search for the data in other sources has revealed that not only the United Nations Comtrade Database lacks the data for August of 2010 and 10 months of 2015, other sources also have similar problems, so these 11 observations are not included in the sample for the analysis.

The last series of data needed as a proxy for the demand on ferrous metals – "Industrial Production Index" was collected on the website of the Eurostat. It should be mentioned here, that the data for the index is non-stationary, as it can be observed from the Dickey-Fuller Test results below in the Table 2. Since p-value is 0.155, so we fail to reject the null hypothesis that a unit root is present. Therefore, the data has to be differenced but this is in line with methodology discussed above.

Table 2. Dickey-Fuller Test results for Industrial Production Index

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.923	-4.060	-3.459	-3.155
MacKinnon approximate p-value for Z(t) = 0.1550				

After processing and cleaning the data, the dataset for further analysis contains 94 observations with gaps for missing period. No doubt additional data are likely to improve precision of the estimates of the model which can be done once all data for 2019 are available. Nevertheless, the results of the present econometric analysis still will be useful to

understand the way exchange rate fluctuations affect the volume of ferrous metals exported abroad.

Table 3 below outlines the expected signs of the coefficients on the explanatory variables described in the methodology chapter of this work, and data for which were described in this particular chapter of work. I expect positive effect of both exchange rate increase (hryvnia depreciation) and industrial production (higher demand) increase on quantity of metals exports. Dummy 2013 variable controls for the change in exchange rate basket, and the sign on the interaction term a priori is difficult to determine.

Table 3. Expected signs of the variables

Variable	Description	Expected sign
log(Exch)	Exchange rate bundle	Positive
Log(Ind)	Industrial Production Index	Positive
2013dummy	Dummy variable =0 for 2010-2012 and =1 starting from 2013	Positive/Negative
Interaction term	Interaction between log(Exch) and dummy	Positive/Negative

CHAPTER 5. RESULTS

5.1. Exchange rate fluctuation effect on semi-finished steel goods export.

The first regression conducted in order to answer the research question is done for semi-finished products of steel category (product code – 7207). The dependent variable [Qty7207] in the topline of the results table is standing for the dependent variable [Qty] presented in the methodology part and was renamed to explain exactly 7207 category of products.

After the analysis using the OLS regression method I have checked the model for the problems of multicollinearity and heteroscedasticity.

For the heteroscedasticity, the Breusch-Pagan test was chosen and with a p-value of 0.0002, from the output listed below (Table 4), the null hypothesis of the homosckedasticity was rejected. Hence, robust standard errors will be used in estimation.

Table 4. Breusch Pagan test for 7207 products category

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of Qty7207
chi2(1) = 13.72
Prob > chi2 = 0.0002

The correlation matrix, which can be observed in Table 8, shows that the correlation between independent variables is moderate, so that the multicollinearity does not seem to be a problem.

Table 5 below presents the estimation results for the exports of 7207 product category without (Model 1). and with an interaction term (Model 2).

Table 5. The model for semi-finished products of steel category (category 7207)

VARIABLES	Model (1) Qty7207	Model (2) Qty7207
Change in weighted exchange rate	0.103***	-0.656***
	(0.037)	(0.879)
Change in industrial production index	-1.233	-7.383*
	(5.768)	(4.080)
2013 dummy	0.321	0.028
	(0.238)	(0.493)
Change in weighted exchange rate * 2013 dummy		1.349***
		(0.175)
Constant	20.295***	22.619***
	(0.123)	(0.269)
Observations	91	91
R-squared	0.3214	0.5896

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As it can be observed, Model (1) gives an output with the following results: three added explanatory variables collectively explain 25.2% of the dependent variable variance. Thus, these explanatory variables explain 25.2% changes in the dependent variable. Also, at this stage of analysis, the variable standing for the Industrial Production Index is

insignificant, and the exchange rate variable is significant at the 1% level. Overall, F-statistics for this model with a value of 13.8 gives an understanding that all the coefficients are jointly significant, rejecting the null hypothesis that coefficients equal to zero.

With a purpose of obtaining improved results, lagged interaction variable included to the model as follows:

$$interact = \log(Exch) * 2013dummy$$

Interaction variable is significant at 0.001 level and the Adjusted R^2, *Exchange rate* variable coefficient and p-value have changed. Now the model explains 57.05% of the changes in the dependent variable and *Exchange rate* becomes even more significant, leaving Industrial Production Index still insignificant.

Finally, in the model for semi-finished steel products category the *Exchange rate* variable is significant at a 1% significance level and its increase by 1% before the year of 2013 will lead to a decrease in the exported volume of semi-finished steel products category by 0.66% one month later. At the same time, the effect of exchange rate increase in the year of 2013 and further is positive, and increase by 1% in exchange rate bundle will cause an increase in the exported volume of 7207 product category by 0.69% (taking into account the effect of *interact* variable). It should be noticed that the *interact* variable considerably increased the value of R^2 – from 29.8% to 57%, the F-statistics indicator also increased significantly - from 13.7 to 30.8, telling that independent variables are jointly significant. It should be noticed that the coefficient of *Exchange Rate* also represents the elasticity of demand for semi-finished steel products with respect to changes in the exchange rate. The analysis had shown that the demand for the 7207 product category is relatively inelastic (0.69).

5.2. Exchange rate fluctuations effect on hot-rolled steel goods export.

After providing for the previously described model there should be evaluated the second model to represent the effect of exchange rate fluctuations on hot-rolled flat products export volumes (code of product category – 7208).

Following the procedure as in the previously described model the Breusch-Pagan test was conducted, and the result from Table 6 represent the presence of the heteroscedasticity problem (p-value – 0.6772), so the robust standard errors will be used in this case as well.

Table 6. Breusch-Pagan test for hot-rolled flat products category model (7208)

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of Q7208
chi2(1) = 0.17
Prob > chi2 = 0.6772

Matrix from Table 9 describing correlation issues between the variables had shown quite similar to the previous model's outcomes – the correlation between variables is moderate.

Outcomes of two models for hot-rolled flat products category will be described as for semifinished goods previously. In Table 7 the results for Model (1) (without interaction variable) and for Model (2) (with interaction variable) are presented.

F Statistic in Model (1) is greater than critical value (11.2), therefore, in general, the model is significant. The variable in which the author was interested is statistically significant at a 5% significance level. Adjusted R^2 provides information that independent variables explain 25.2% of hot-rolled flat products category export volume variance.

Table 7. The model for hot-rolled flat products category

VARIABLES	Model (1) Qty7208	Model (2) Qty7208
Change in weighted	0.064**	-0.334***
exchange rate	(0.030)	(0.079)
Change in industrial	-0.183	-3.414*
production index	(4.783)	(3.989)
2013 dummy	0.153	-0.031
	(0.197)	(-0.056)
Change in weighted		0.709***
exchange rate* 2013 dummy		
		(0.151)
Constant	19.736***	20.957***
	(0.101)	(-0.246)
Observations	91	91
R-squared	0.2771	0.3918

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Finally, an improved Model (2) for hot-rolled flat products has much better outcomes in a way that an Adjusted R^2 is explaining 36.4% of hot-rolled flat products category export volume variance (approximately 20% lower than semifinished steel products category indicator). And the key point of the model - a coefficients behind explanatory variables of *Exchange Rate* and intersection variable are significant at 1% significance level. Similarly to the model for semi-finished goods, there are two effects on

the export volumes – before and from the year of 2013. Before the year 2013 the effect of exchange rate bundle appreciation by 1% has negative impact on export volumes – 1% appreciation cause -0.33% decline in hot-rolled flat products export. However, the effect of exchange rate appreciation in 2013 and further is positive - 1% increase in the exchange rate bundle will lead to a 0.37% increase in export volumes of 7208 products category. For the hot-rolled flat products category the demand with respect to exchange rate fluctuations is again inelastic (elasticity coefficient equals 0.37).

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

This work contains the analysis of the whole industry of Ukrainian ferrous metals: information on the place of the country in the worldwide market, competitiveness level, analysis of inputs for the production and its sources for Ukrainian producers, regression analysis conducted to answer the research question – whether exchange rate fluctuations impact the volumes of ferrous metals exports. Based on this information several conclusions can be made.

At first, it should be highlighted that given all the strong positions of internal Ukrainian participants with their vertically integrated structures, the industry is not attractive for newly opened companies, but there is still a place for building up a new metallurgical plant in addition to those already functioning in a large metallurgical holding. The reasons for it are quite straightforward: reserves of iron are the highest in Europe, country location is suitable for international trading and shipments, lower cost of low-qualified labor force compared to the European or Asian ferrous metals producing countries.

But some negative sides also should be mentioned, among them: quite volatile prices of electricity due to recently opened market and constantly changing rules, regulations from the side of the government and state-owned regulator - National Commission for State Regulation of Energy and Public Utilities. As it was shown in the industry overview part, the ferrous metals industry is a major national consumer of power, so this factor of production may lead to significant changes in the profitability of plants. Also, vertically integrated companies can have an impact on the starting campaign of newcomers on the market.

The second point regarding the effect of exchange rate fluctuations on the ferrous metals industry is also important factor to take into account for the very export-oriented industry like ferrous metals. As econometric analysis shows, both semi-finished steel products and hot-rolled flat products are sensitive to changes in exchange rates. From the

economic sense, it was obvious that mostly export-oriented industry must be sensitive to such indicator, but the borders of this issue and its direct impact was uncertain. Now results of models provide the level of dependence between the volumes of export and the exchange rate: 0.37% - 0.69% - an average export volumes change in a month while exchange rates of major countries-recipients move up or down by 1%. For some of the producers, the process of rewriting contract conditions with their consumers may take a bit more time, but still, this finding is still very useful for business and government.

The value of information provided in this paper is simple – it gives an understanding of what effect appreciation or depreciation of the currency will be for day-to-day business. According to the movements of the currency company can build the strategy to tighten its volumes of export waiting for better times or to expand and ship even more products abroad, therefore, receiving larger amounts of foreign currency on hands.

Summing up, results of this work can be used for:

- Strategic planning, making optimistic, pessimistic and neutral forecasts of future sales based on the sensitivity of sales with respect to exchange rate.
- Considering whether it makes sense for investors to enter the market or not, based on the information provided about the current industry structure

At the same time, governmental institutions, regulators also can rely on these results while taking the decision that may have an impact on the ferrous metals industry. While appreciation occurs and its consequences for the industry are crucial or fatal – they should take supportive actions towards the industry, since more than 20% of foreign currency is coming exactly from the ferrous metals industry.

Governmental institutions can make the following steps to support the industry in the periods of national currency strengthening:

- Give a possibility to buy an electricity directly from nuclear power plants, therefore reducing the costs of production and increasing the overall profitability of the industry
- Reduce the tariffs for railway transportation of metals industry products and raw materials

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APPENDIX

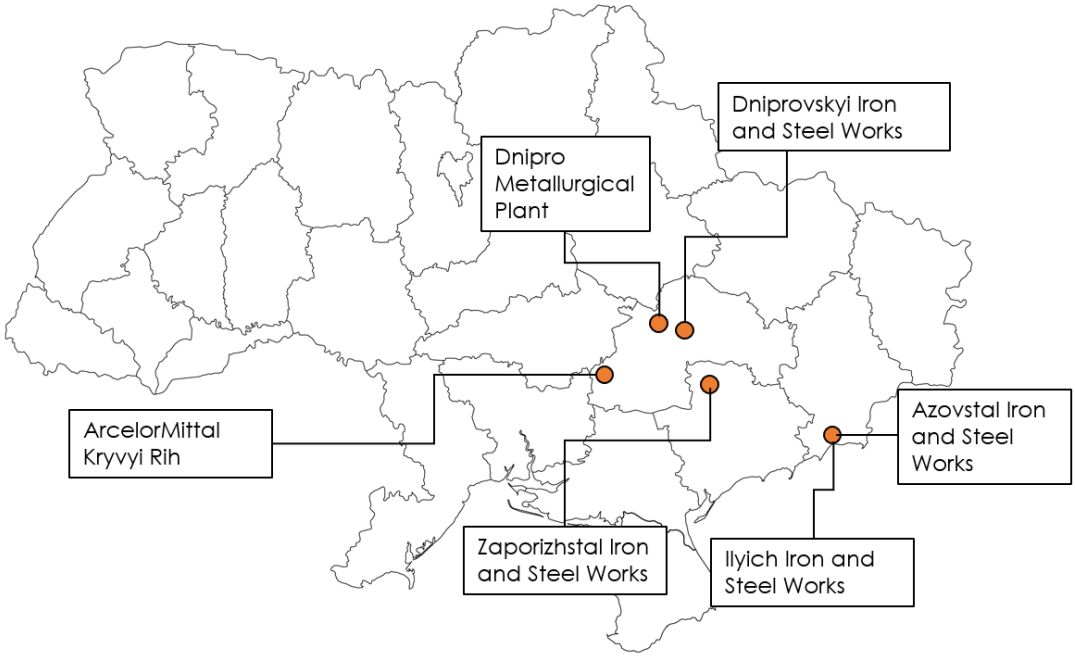
Table 8. Correlation matrix for semi-finished products of steel category

	Q7207	Change in Industrial Production Index	Change in weighted exchange rate	Change in weighted Exchange rate * 2013dummy	2013dummy
Q7207	1				
Change in Industrial Production Index	-0.0351	1			
Change in weighted exchange rate	0.5535	-0.0125	1		
Change in weighted Exchange rate * 2013dummy	0.5911	-0.0007	0.9972	1	
2013dummy	-0.5096	-0.0060	-0.9719	-0.9652	1

Table 9. Correlation matrix for hot-rolled flat products category

	Q7208	Change in Industrial Production Index	Change in weighted exchange rate	Change in weighted Exchange rate * 2013dummy	2013dummy
Q7208	1				
Change in Industrial Production Index	-0.0155	1			
Change in weighted exchange rate	0.5216	-0.0125	1		
Change in weighted Exchange rate * 2013dummy	0.5456	-0.0007	0.9972	1	
2013dummy	-0.4903	-0.0060	-0.9719	-0.9652	1

Figure 7. Map of major Ukrainian metallurgical plants.



Source of data: GMK Center.