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INVESTMENT ADVANTAGES OF THE ESTABLISHING OF ALUMINIUM CLUSTERS

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Abstract

This paper gives the analysis of the volatility of primary aluminium prices within the period of 1967-2013 in nominal and real terms and underlines the economic problems of aluminium smelters activity.
The production process flow diagram of aluminium cluster, consisted of alumina bearing feedstock mine, alumina refinery, primary aluminium smelter, processing plant and power station, is proposed. An economic model of aluminium cluster functioning with minimal risks in regards with market volatility and financial-economic crises is developed.

Introduction

One of the meanings of the word "cluster" is interpreted as "swarm of bees" [1]. It is well known that in wild life the bee is considered a "social insect" that has many typical traits inherent to the behavior of human society [2]. One of the most amazing features of the swarm (cluster) is that the distinction is blurred between the individual and collective behavior of these insects; therefore they manage to work towards the common goal [3]. It is the high degree of mutual confidence that is the basis for the establishment of business networks, the cluster being a particular case of them [4]. The fundamentals of cluster concept for the development of such networks were formulated by Michael Porter [5]. According to Porter's definition "cluster" is a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and externalities" [6].

Methods of aluminium enterprises integration

The history of the world aluminium industry development shows that merging forms, similar to clusters, were always present in various countries with aluminium businesses. In some major aluminium companies there were production chains, covering the bauxite mining, alumina production, primary aluminium production and production of aluminium alloys-based products. As a rule such companies held themselves out as "vertically integrated companies" [7]. In such companies legally independent enterprises forming the chains of process production and products sales are controlled and managed by the same owner; owner's resources not consisting of fixed and current assets but of his enterprises control stock.
In case of the cluster formation the enterprises being legally independent from their common owner would merge at the informal base to gain benefits in the competition. Such conditions like initiative, innovations, information, integration, interest should be available in order that the cluster would establish itself as a successful and efficient organization [8]. So, clusters could be identified as a group of companies-market players, linked by long-term contracts for the efficient use of resources and specific advantages to jointly implement business projects. The efficiency of clusters operation is already shown in different industrial production facilities, such as nuclear power generation industry, space, aviation, ship building, different kinds of weaponry, agriculture, civil construction, clothes manufacturing and many others [4]. More recently information was published about the establishment of clusters in the aluminium industry [9, 10]. However, the information available does not show of the specific financial-and-economic advantages from merging aluminium business enterprises into an aluminium cluster. It is therefore of interest to develop the concept of economic model for establishing aluminium clusters.

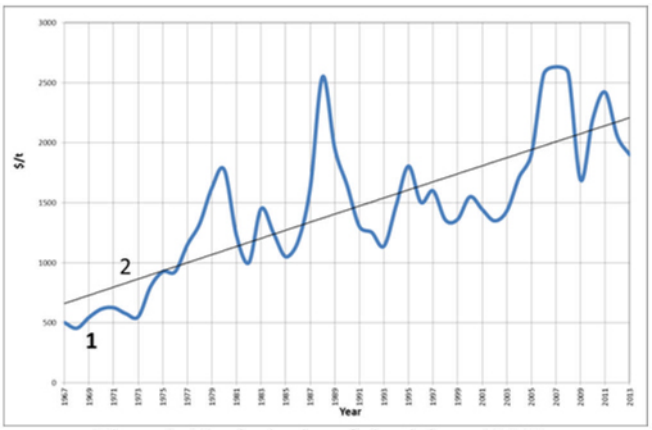

Figure 1. Nominal price of aluminium at LME.

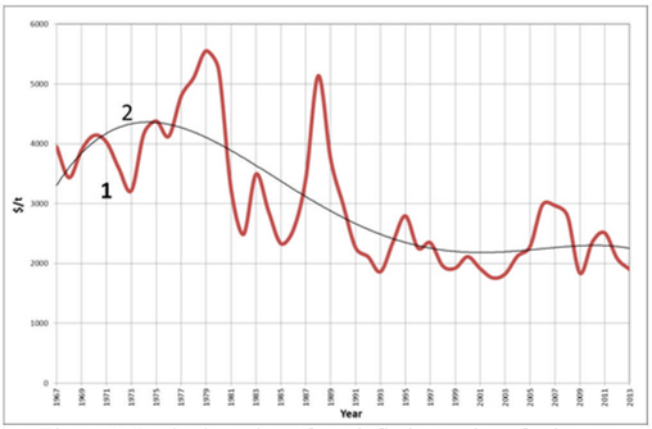

Figure 2. Real (cleared out from inflation) price of primary aluminium at LME at the 2013 values.

Figure 1 curve 1 shows the values of nominal primary aluminium price during the period of 1967-2013. The notion "nominal" means that these are calculated annual average values. Curve 2 reflects the approximation of curve 1 in form of linear relationship. Data shown on Figure 1 are determinative for the definition of the investment attractiveness of primary aluminium smelters construction and for the estimation of the economic efficiency of production facilities currently in operation. The analysis of linear correlation coefficient for curve 2 shows that

over the time period under analysis the annual average increase of nominal aluminium price was 2.75%. Based on that, the aluminium price is expected to exceed 3000 t/$, for example, by 2020.

At first glance this fact looks encouraging. However, this calculation does not take into consideration the inflation, which reflects the real situation better. The rise in aluminium prices is accompanied by an increase of direct and indirect production costs. Curve 1 on Figure 2 shows the dynamics in changes of real primary aluminium price at the 2013 values. The calculation used the Consumer Price Index (CPI), recommended by Bureau of Labor Statistics. It can be seen that since around 1996 the rise in aluminium prices is comparable with inflation rate. Therefore the average price of aluminium over the period of 1996-2013 (curve 2 Figure 2) remains at about 2200 $/t at the 2013 values.

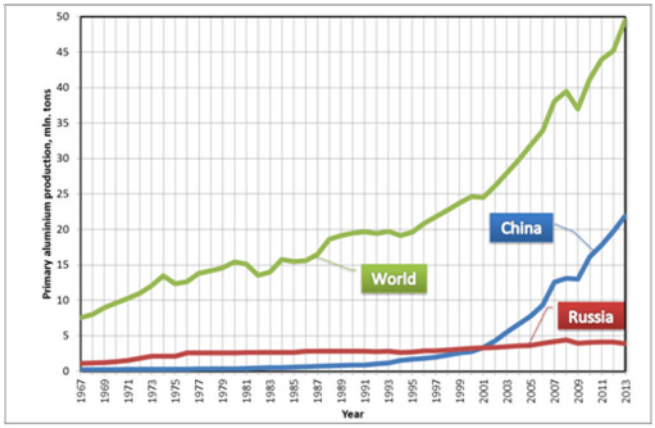

Figure 3. Primary aluminium output during the period of 1967-2013.

Economic background for the merging into aluminium clusters

From figure 3 we also see that since around 1996 the fast growth of primary aluminium output is observed in the world. This growth is mostly driven by production increase in China.

According to the Law of supply and demand, formulated by Alfred Marshall in 1890, the higher the price on goods the lower the quantity demanded should be, and the higher the price on goods, the bigger the quantity supplied is.

Considering the long-term period, based on data from Figure 2 curve 2, we can see that the nominal LME price of primary aluminium increases. However, at the same time the real price (Figure 2 curve 1) rather falls and even stabilizes at the level of 2200$ per ton.

Note that primary aluminium itself is not a consumer product in full. It is rather feedstock for the production of semi-products. Semi-products are extrusions, wire, sheets, castings etc. As to the goods these are windows, doors, welding wire, cast structures for the transport, machine building and many others. Due to that the aluminium-based goods are not an exchange commodity; it is very difficult to keep on statistics the prices of these goods and to analyze the dynamics of price volatility in different countries over the multi-year period. At the same time specialists in the field of aluminium-based goods marketing know that regardless of volatility of primary aluminium prices the prices on goods made of aluminium, change a little over the years. One can say that they do not practically change and remain at the level of 5000$ per ton of goods. This is a very approximate value as goods based on aluminium vary in purpose and in manufacturing complexity, but, in general, the price of aluminium-based goods is approximately two times higher than the price of primary aluminium. This is certainly a simplified analysis. But a very important conclusion follows from it. Companies that participate in production chain: ore mining – alumina production – primary aluminium production – production of aluminium-based alloys – are under continuous pressure of LME prices, depending on aluminium price dynamics. One day they are in optimistic temper when prices rise and another day they are in pessimistic temper when prices fall. As such it is very difficult to anticipate the profit of enterprises. This means that investment risks in primary aluminium production are very high. Considering that mines, alumina refineries, primary aluminium smelters are very capital-intensive and require investments in hundreds of millions or billions of dollars depending on their capacities, they would be unattractive for investments.

This statement could be easily confirmed by taking into account that during last 50 years the production of primary aluminium in developed European and North American countries is being reduced and in Japan for example, the enterprises producing primary aluminium were entirely closed down. At the same time no country with developed economy reduced the production of aluminium-based goods but increased it with approximate growth rate of 5% per year. As a rule these production facilities have low capacities (10-100 thousand tons per year) and are located in regions where their products are mostly consumed. From the financial stability and investment attractiveness point of view the enterprises producing aluminium-based goods may be said to have more stable positions.

The stabilization of the prices of primary aluminium that we observe (Figure 2, curve 2) is just a result of a certain compromise between problems of the enterprises that are part of the production chain (ore – alumina – primary aluminium – alloys based on aluminium) and the relative gain from the stability of enterprises fabricating aluminium-based goods. This is a very delicate equilibrium. We see the constant increase of the prices on fuel and electric energy, the increase of the costs related to the logistics for the ore and alumina delivery and to the strengthening of environmental requirements. Eventually this should lead to the fall of primary aluminium production. As a result the primary aluminium producers would suffer first, then enterprises that process alunminium would suffer as well.

Consequently it is necessary to come up with solutions to this problem. The experience shows that since 1886 (Hall-Heroult patents) no fundamental progress in the process of aluminium production by reducing cryolite-alumina melts was achieved. Investigations in the field of aluminium production by reduction of chloride melts, by electro-thermal method, by using inert cathodes and anodes did not result in their industrial implementation and did not demonstrate any real cost improvement while producing primary aluminium. Hence, it is necessary to find solutions in structuring of the aluminium business itself and in the search of financial stability and investment attractiveness tools for businesses related to aluminium.

Economic substantiation of aluminium cluster establishment

The best way to show the economic advantage of aluminium cluster is to take the example of the construction of a new aluminium complex with small production capacity. For example, in the Boksitogorsk district of the Leningrad region in Russian Federation there is an alumina refinery that was in operation for

50 years and is now stopped with a certain reserve of red mud. In nearby Volkhov there is a primary aluminium smelter that was stopped, power station, infrastructure and land that could be used for the construction of an aluminium processing plant. Initial capacities of these enterprises are given in Table I.

Table I. Capacities of enterprises being part of Volkhov aluminium cluster

№	Name of the enterprise	Products	Capacity	Capital costs, MUSD
1	Boksitogorsk alumina refinery (BGZ-2) including the mine	Alumina	50,000t	40
2	Volkhov aluminium smelter (VAZ) (reconstruction)	Primary aluminium	20,000t	10
3	Volkhov plant producing aluminium extrusions	Aluminium extrusions	18,000t	100
4	Aluminium cluster (total)			150

Table I also evaluates the capital costs of the construction in connection with actual conditions.

Figure 4 gives the calculation results of the investment model for the construction of the Volkhov aluminium cluster. NPV (net present value), DPP (discounted payback period), COF (cash outflow) curves are shown for each enterprise being part of the project. It is easy to see that from the investment point of view based on these indices the following chain could be formed: alumina refinery – aluminium smelter – plant for aluminium extrusions production.

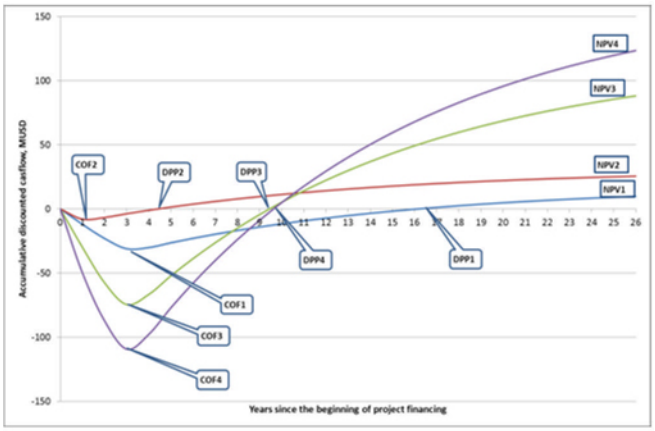

Figure 4. Economic indices of Volkhov aluminium cluster enterprises:
1-Alumina refinery, 2-Aluminium smelter, 3-Aluminium extrusion plant, 4-Aluminium cluster.

Figure 5 shows the dependency of NPV of all enterprises being part of the aluminium cluster construction project on aluminium price at LME and Figure 6 shows the dependency of net margin of Aluminium cluster enterprises on aluminium price at LME.

From Figures 5 and 6 we can see that when the price of primary aluminium rises the economic parameters of the aluminium extrusion plant become worse, but the parameters of alumina refinery and aluminium smelter grow. Vice versa, when the price of primary aluminium falls, the economic parameters of the aluminium extrusion plant become better, but the parameters of alumina refinery and aluminium smelter worsen. Paying attention to curve 4 (figures 4, 5, 6) reflecting the economic indices of the enterprises integrated into the aluminium cluster it can be seen that they are always positive and foreseeable, which is the most important.

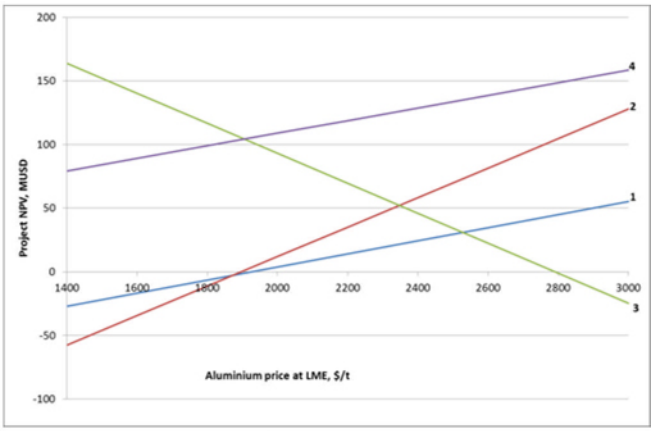

Figure 5. Dependency of NPV on aluminium price at LME: 1-Alumina refinery, 2-Aluminium smelter, 3-Aluminium extrusion plant, 4-Aluminium cluster.

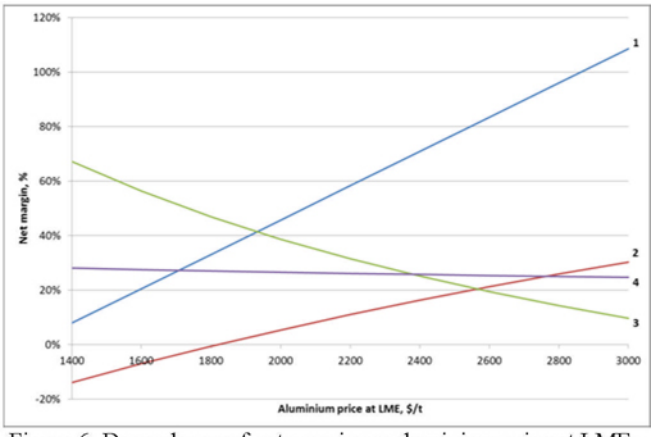

Figure 6. Dependency of net margin on aluminium price at LME: 1-Alumina refinery, 2-Aluminium smelter, 3-Aluminium extrusion plant, 4-Aluminium cluster.

A net margin of 25-30% (curve 4 Figure 6) would be a positive sign for any investor to invest into an aluminium cluster as this would allow demonstrating the payback of investments within 7-8 years.

Data from figures 4-6 were calculated for an aluminium cluster of small capacity in terms of primary aluminium. Let's say, this is a small regional cluster. At the same time the economic model would not change if the capacity of primary aluminium and its products would increase, for example, to 250,000 tons or more. In this case the limiting factor would be the market capability to sell the end products. In general, the model of aluminium clusters should be guided by careful analysis of the aluminium products consumer markets in each region.

The example given for economic model of a new aluminium cluster is fully applicable for aluminium clusters that would be established based on the integration of existing enterprises.

Such integration should be based on maintenance of existing forms of enterprises ownership, internal management structure and production relationships, in other words it should be based on maintenance of the enterprises independence. At the same time the enterprises being integrated into the cluster in a voluntary basis aiming to generate common profits and distribute it depending on the aluminium product market situation and the primary aluminium price at LME. In many countries the legislation provides for special laws for such integration. For example, the Civil Code of Russian Federation provides for the formation of "Simple Partnership", under which several enterprises could jointly act to make profit without forming any legal body [11]. The financial activity of the "partnership" is regulated by Federal Law of Russian Federation №335-ФЗ dated 28.11.2011 "Of Investment Partnership" [12]. According to these laws one of the "partners" could be authorized to keep accounting records.

The accounting shows the share of the enterprises in common activity, their share in common contract obligations and their share in common profits. As a result such kind of common activity organization allows mitigating the negative effects of LME price volatility onto financial and operational activities of the production chain (alumina, primary aluminium and aluminium products) by optimization of the taxes under legislation valid in the country.

The optimum case is when the accounting within the aluminium cluster is authorized to the enterprise that produces and directly sells aluminium products. When aluminium prices fall the profits made at the final production stage, would be re-distributed between the enterprises that at this moment would be at a temporary disadvantage maintaining them in operation. When the LME price raises, the enterprises of pre-production cycle (ore, alumina, primary aluminium) conduct the reasonable price policy in respects to their products, being aware of the interests of the aluminium processing enterprises serving the common interests of the aluminium cluster as well. Acting like the swarm of bees eliminates the distinction between individual and collective behavior.

Obviously, while forming aluminium clusters it is necessary to judge if it would be advisable to integrate a more comprehensive membership, including supporting institutions, production and commercial structures such as producers, suppliers, scientific organizations and engineering companies. The inclusion of municipal authorities into the aluminium cluster by their contributions in form of plots of lands could be very prominent. It is not obligatory that the aluminium cluster should be focused upon the integration of companies and organizations, similar in production cycle and geographically interconnected. These could be trans-regional and national unions. Joint efforts of businessmen, control bodies, investment and innovation activity entities would give significant advantages in the competition, contribute to the rationalization of production-market processes, to the re-distribution of the risks and flexible policy, which is necessary under conditions of rapidly changing environment.

Conclusions

The establishment of aluminium clusters based on existing enterprises of production chain: ore – alumina – primary aluminium – aluminium products as well as the investment into the construction of new aluminium enterprises allows mitigating the negative effects of LME price volatility, improving the stability, predictability and profitability of aluminium business.

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