Stimulating Innovation Activity in Enterprises within the Metallurgical Sector: the Russian and International Experience

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Abstract **– This paper examines some of the Russian and international experience with regard to stimulating innovation activity in enterprises within the metallurgical sector. The key focus is on implementation issues regarding innovations within the sector and possible ways to resolve them. The authors explore the current state of innovation activity in metallurgical enterprises and examine some of the most promising areas for innovation in metallurgy. The paper brings forward a set of measures designed to enhance the stimulation of innovation activity in Russian metallurgical enterprises based on the experience of other European countries. The authors examine some of the most promising tenets of a government program on innovation-driven development within Russia's metallurgical sector, which includes various measures of direct and indirect stimulation of innovation within metallurgy.**

Keywords **– metallurgy, innovation, innovation activity, stimulation of innovation.**

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1. Introduction

By tradition, metallurgical production has always been an important element in Russia's economy. Mainly being export-oriented, this sector is the second in significance comprising energy (oil and gas), with the nation possessing metallurgical capacities having production potential that exceeds domestic demand.

In Russia, metallurgy has developed mainly under the influence of corporate strategies that do not always align with national social and economic objectives, with a lack of an integral vision of the sector's development. Instead of adopting and following a uniform scientifically substantiated modernization strategy, the government has provided support in a mixed fashion – often in times to the disadvantage of other social and economic areas. There have been a few strategic documents dealing with this [1], but most of them are merely declaratory and offer few to no effective tools to help achieve the objectives.

The operation of Russia's industrial infrastructure is predicated on the use of its own resources and differs significantly from that in the majority of other European countries, with its relative share of production of raw materials surpassing its volumes of production at the final product. This has been behind the prevalence of large vertically integrated holdings, which wholly cover the production cycle, are less sensitive to fluctuations in raw materials prices, and owing to their ability to better cope with potential recessionary situations in the market, it appears to be gaining an increasingly large share within the sector at the moment.

2. Literature and Methods

This paper employs a set of various research methods, including methods of economic/statistical analysis, which has helped identifing some of the key characteristics of innovation activity in metallurgical enterprises.

A significant amount of scientific research is devoted to innovations in the metallurgical industry, both organizational and technological.

The work [2] describes methods in the field of innovation management at Polish metallurgical plants. The authors, using the example of metallurgical enterprises, postulate the need to use innovative management to implement an effective development strategy.

The study [3] is devoted to innovative methods for the disposal of solid waste from metallurgical enterprises. The authors identify and describe in detail four innovative methods that are the result of their original research.

The study [4] gives recommendations on managing strategic risks when investing in innovations in metallurgy; sectoral strategies for innovative growth are presented as well. The researchers specify the methodology of risk reduction and describe examples from the practice of investing in intellectual property in the field of metallurgy.

The subject of the research [5], [6] is the introduction of eco-innovations in the metallurgical industry as a factor in the implementation of the sustainable development strategy of metallurgical enterprises. The studies substantiate the need for investment in environmental innovations and new technologies, as well as showing the relationship of environmental innovations with technical, organizational and marketing changes in the activities of metallurgical enterprises.

In [7], the necessity is substantiated and recommendations are proposed on the introduction of innovative technologies at various stages of metal production from ore. Specific technological innovations in the processes of obtaining non-ferrous metals, their recovery from household and industrial waste and combining existing innovative technologies in a single complex which are described.

Numerous studies present technological innovations in the field of metallurgy, such as innovative technologies for the recovery of non-ferrous metals in the process of reprocessing solid household waste [8], the issues of metallurgy of silicon cells of solar cells [9], as well as innovations in powder metallurgy using laser technologies [10] and methods of mechanical mixing [11].

Issues related to stimulation of innovation activity have been explored by a number of foreign researchers, such as B. Bozeman [12], I. Feller, C.P. Ailes, J.D. Roessner [13], S.B. Brunnermeier, M. Cohen [14], and others, and Russian scholars, such as V.V. Klochkov [15], V.V. Filatov [16], A.I. Kuznetsova, A.S. Zurabyan [17], and others. However, it should be noted that most of this research is focused on stimulating innovation activity in industrial enterprises as a whole, while little to no attention has been devoted to the metallurgical sector specifically.

The authors' investigation into the degree to which the subject of stimulation involved in innovation activity in metallurgical enterprises has been developed has helped to reveal the insufficient coverage of the issue at this time, and a lack of focus on the determination ways to galvanize the sector's innovation-driven development, which is what has determined this paper's principal purpose – to analyze a set of ways to stimulate and galvanize innovation-driven development within Russia's metallurgical sector.

3. Results

An analysis of the current condition of the metallurgical sector around the world indicates that among the key motivating factors for innovation within the sector are the cost of energy and the level of environmental requirements [18].

Today, most manufacturing countries are dropping costly natural gas in favor of pulverized coal fuel, which is not only cheaper but environmentally cleaner as well.

Concurrently, in Europe the use of the Emission Trade System (ETS) is providing the impetus for the implementation of technological innovations, although the further toughening of requirements on reducing C02 emissions could be viewed as an obstacle to competition in the world market [19].

Unlike some other European nations, Russia has abundant cheap energy resources. Albeit the cheapness of energy does not motivate Russian metallurgy to implement innovations, it does generate revenue. Specifically, in the period 2010–2017, Russian metallurgists invested an average of $8–10 billion annually (around $80–120 per a ton of steel). With that said, the nation's share of continuously-cast steel rose from 44% in 2010 to 92% in 2017, with its production of steel in open-hearth furnaces declining from 12% in 2005 to zero in 2018, its atmospheric pollution decreasing 15%, and its energy expenditure approaching the world's top standards.

An analysis of Russia's current practices with regard to stimulation of innovation within the metallurgical sector indicates that a foreign company has not got into the complete steel production cycle

market in Russia yet. Concurrently, up to 2008 in search for access to high-tech markets Russian holdings were active in acquiring foreign assets, often resorting to loans. However, since the introduction of sanctions in 2014 by the US, the EU, Japan, Canada, Switzerland, Australia, and other nations, mainly within the financial sphere, the potential for refinancing debt and lending toward new innovation projects has declined significantly.

In this regard, it may be worth just focusing on the analysis of the international – particularly European – experience with regard to stimulating innovation activity in industrial enterprises, including metallurgical ones.

It is worth noting that issues related to innovation are among those of the highest priority for the EU as a whole and its specific member states in particular. The overwhelming majority of strategic documents in the EU stress the importance of innovation for economic development in EU member states. In addition, each EU member state is also trying to provide support and implement innovation projects at its own expense.

A crucial part of support for innovation activity is the analysis of available technology that could help to reduce the need for energy resources and/or minimize greenhouse gas emissions. In metallurgy, there are numerous technological and constructive solutions that could ensure reductions in energy expenditure and harmful discharges into the environment. Some of them have been employed successfully in production, while others have not been implemented yet.

Innovation solutions have been combined into collections of so-called 'best available techniques' (BAT), most of which are compiled by reputable institutions at the national and international levels. The BAT concept is quite dynamic. These collections are continually updated, as there continually come out new ones and they get streamlined existing technologies and emerge new best practices for implementing them.

The BAT reference document for iron and steel production [20] has been developed by the Institute for Prospective Technological Studies (IPTS), based on input from relevant experts, under the aegis of the European Commission. Signed into the law in February 2012 via an EC directive, it is regarded as one of the most fundamental documents containing detailed descriptions of technological processes, the nature of harmful discharges and the way they are formed, as well as measures to prevent their formation.

A key objective behind tax concessions is to help step up the private sector's spending on R&D, which is one of the key indicators of innovativeness in the EU, based on increases in enterprises' own funds. In contrast with grants-in-aid, whereby the size of expenditure on R&D is determined at the time the budget is approved, tax concessions empower the actual private sector (the market) to make decisions on the size of that expenditure. Under these conditions, enterprises themselves can make the decision whether to use the opportunities provided by the state or turn them down.

A key attribute of the tax concessions is their predictableness. An enterprise will be in a position to use tax concessions as long as it will be able to fulfill certain conditions for obtaining them. This kind of guarantee is a significant attribute of innovation policy in enterprises that invest in strategic R&D projects.

The tax systems in different countries use different measures to stimulate innovation. For the most part, EU member states employ tax credits and tax reimbursement. Note that tax credits are employed more often than tax reimbursement, which is the case within the tax systems of Austria, Belgium, Denmark, and Great Britain. In both cases, the determining condition for a company to be able to obtain a tax concession is that it will direct its "saved" money toward R&D.

Another tool for stimulating innovation is government procurement. For the most part, the level of innovativeness within the economy depends on demand for innovative products. This demand can also be fostered by the government. In the EU, government procurement contracts for innovative products in the form of offers have to be published mandatorily in the Official Journal of the European Union for the purpose of stimulating competition among local and foreign potential contractors. The greatest success with regard to government procurement policy has been recorded in Great Britain, where government procurement is an indispensable component in the nation's innovation strategy.

One of the key instruments for stimulating innovation in Europe is public-private partnerships (PPPs), which incorporate various forms of long-term cooperation between the government and the private sector. When the state, as one of the "partners", establishes clear objectives for government policy that need to be achieved in implementing a specific project, the private sector, as the other "partner", is going to be responsible for the entire process of implementing the project. With that said, the active participation of both "partners" in management and in decision making could guarantee a greater contribution on the part of the industrial sector and boost the potential for commercializing the outcomes of R&D.

PPPs have been a success in Austria. Back in 1999, the Austrians launched two PPP programs –

Kplus and Kind/Knet. The objective was to bolster the relationships between the industrial sector and science, and remediate the key weakness of the Austrian innovation system – insufficient cooperation along the industry – science line. The programs have resulted in the creation of several joint centers focused on research and projects on technological development both for science and for industry. These programs have made it possible to work out a set of innovative and competitive procedures for the choice of innovation-focused projects.

Sweden, which holds top positions in most European indices and rankings on innovation, has focused on innovation through the lens of the quality of education. As was mentioned above, openness to innovation was, above all, cultivated during the process of education. The objective of many economically developed nations is to successfully compete in the global market which is based on the ability to generate knowledge and use it toward economic growth. With this in mind, a typical attribute of the Swedish economy is significant spending on science. Vinnova, the Swedish government agency that administers state funding for R&D and innovation, has always regarded the role of education in economic and societal development especially crucial [21]. The organization has been putting significant effort to help modernize the nation's universities. It is on its initiative that the government has worked out an optimum innovation model based on the integration of education, research, and innovation.

4. Discussion

The findings from this study indicate there is a current need to come up with a state program for the innovation-driven development of Russia's metallurgical sector that would incorporate measures of direct and indirect stimulation of innovation. A program of this kind could be implemented based on the "state – science – business" trinity only. Below there are just some of the key tenets that are crucial to exploring the subject:

1. At the level of the government, the following measures may need to be employed:

a) direct stimulation of innovation: instituting tax deductions for metallurgical enterprises to enable them to carry out the deep modernization and ecologization of production and simplifying the standardization procedure at the state level to help remove the obstacles impeding the process of creation and implementation of innovations.

b) indirect stimulation of innovation: creating a comfortable tax climate for enterprises that invest in innovation-driven development and modernization; providing state subsidies toward the implementation of innovation-focused projects (state investments and concessionary loans); facilitating the international transfer of the latest technology into the metallurgical sector (including reducing through the rate of import duties on parts and equipment within the sphere of the latest technology in metallurgy); pursuing a policy of state support for the development of Russian research institutes, design bureaus, research and production facilities, and engineering companies engaged in the creation of innovative products, state-of-the-art equipment, and cutting-edge management technology in metallurgy.

2. At the level of science and education – as part of a program on preparing human resources for innovation-related restructuring, implementing new curricula for students at technical colleges factoring in the latest trends in metallurgical production; with assistance from the government, encouraging enterprises within the sector and field-specific colleges to enter into agreements on the conduct of research.

3. At the level of enterprises – ensuring sufficient investment in innovation and upgrades to production operations; encouraging participation in state and international innovation projects, the exchange of technology with a focus on attracting foreign investment, and the export of technology within the framework of corporations.

5. Conclusion

Implementing innovations within the metallurgical sector requires significant investment. In this regard, it will be hard to effectively resolve the issue of innovation-driven development of metallurgical enterprises without the participation of the government and implementation of relevant activities on stimulating this development, such as:

– identifying priority areas for R&D and promising technology – in particular, resource-saving technology and technology for processing secondary raw materials;

– relevant mechanisms for stimulating innovation activity in priority areas through the provision of tax concessions, no-interest loans, and loans guaranteed by the state;

– providing tax discounts to banks on condition that their loan portfolio contains the established share of long-term investment loans;

– expanding the funding of R&D organizations toward obtaining patents for inventions;

– developing the innovation infrastructure – R&D centers, technology parks, and business incubators.

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