

The Role and Importance of the Mineral Resource Complex for National Economies: Solid Minerals

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Abstract—As the economy grows, it becomes more difficult for the emerging economies to maintain a high stable rate of economic development, primarily due to the increase in the production of mineral raw materials, expansion of mineral export, and the recovery of mineral rent. However, despite the fact that the direct contribution of mining and processing of solid minerals to the national economy is decreasing, the mineral resource complex has acquired a new function of providing related industries with the required mineral raw materials, it remains an important factor of further accelerated economic growth, contributes to the state budget, participates in solving the employment problem, and creates multiplicative scale effects in the economy.

Keywords: mineral resources, mineral raw materials, mining of mineral raw materials, mineral resource base, mineral resource complex, mineral economics

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INTRODUCTION

One of the important causes for the formation of a series of negative trends in the development of the mineral resource base in recent decades in Russia (Strategy ..., 2019) has been the underestimation of the contribution, importance of the problems, place and role of the mineral resource complex with a mineral resource base integral component for the country economy. The role and value of the reserves, mining and export of energy carriers are usually beyond dispute, but what is said about underestimation is completely fair about solid minerals.

Meanwhile, the mineral resource complex (MRC) is the first link in the supply chain of materials that are used to produce all the things needed for the modern civilization and is an important component of the world economy. Later, it is understood as a set of industry branches (mining and metallurgical, mining and chemical, noble metals, precious and semi-precious stones, cement and construction materials), which are based on mining and processing of solid minerals until the first or second commercial product is made. The production of mineral raw materials and metals makes an important contribution to ensuring stable development, fight against poverty, and creation of jobs. However, the contribution of the MRC to the economy is strongly changing in countries and depends on the stage of economic development; its value is unobvious and it is not always easy to substantiate.

Mining contribution index. It is suggested that the value of mining of solid minerals for the economic

development of 190 countries be estimated by the mining contribution index (MCI) based on the concept proposed by the International Council on Mining and Metals (ICMM) (International ..., 2019), but with important alterations and additions (Dergachev, 2019).

The MCI is a composite index, it is calculated based on five factors: (1) the ratio of the cost of the produced mineral raw materials to the GDP of a country (%), (2) the change in this ratio in 2014–2016 (in percentage points, pp), (3) the share of mineral raw materials and metals in the cost of the whole goods export of a country (%); (4) the change in this index in 2014–2016 (pp); and (5) mineral rent expressed in fractions of a country's GDP (%). To determine the contribution of each listed parameter ($mci_1, mci_2, mci_3, mci_4, mci_5$) to the MCI index of a particular country, each of these values was first normalized to its maximum value in a series of 190 countries and then was multiplied by 100. The MCI index (%) was then estimated as an arithmetic mean of these five values (or three in those comparatively infrequent cases when there was no information for a country about the cost of MRC products and dynamics of its change).

The data on the cost of the MRC products made in 2014 and 2016 were taken from the published works of the International Council on Mining and Metals (ICMM) (International ..., 2019) and the data on the share of mineral raw materials and metals in goods export were obtained from the database of the United Nations Conference on Trade and Development (UN Trade Statistics, 2019). The mineral rent is a surplus

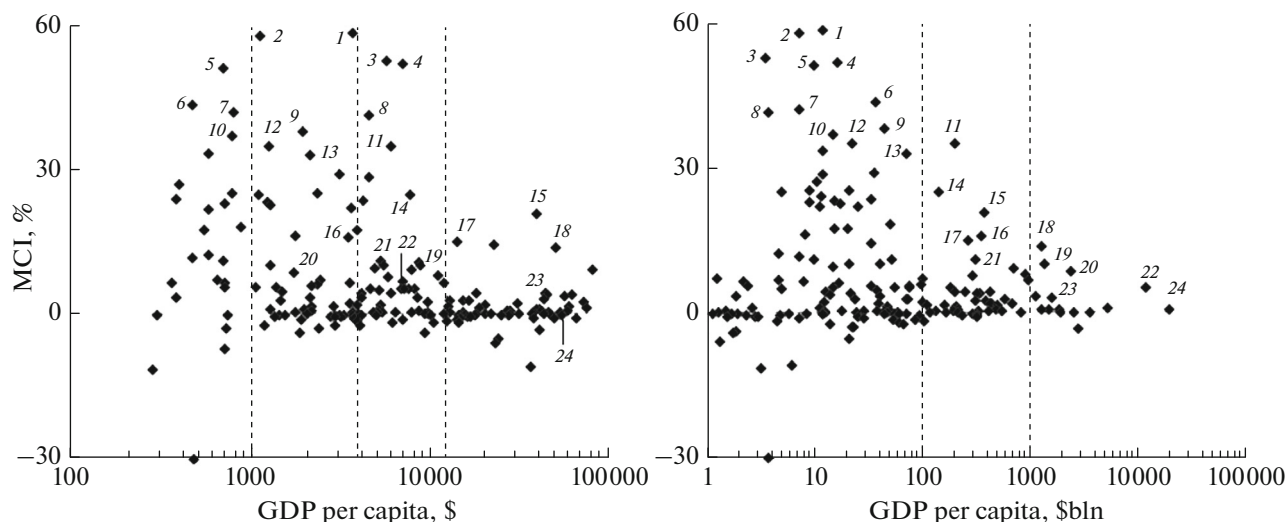


Fig. 1. The differentiation of countries by the value of contribution of the mineral resource complex to their economies (according to the MCI index, %) in 2016. The numbers designate the countries: (1) Mongolia; (2) Kirghizia; (3) Surinam; (4) Botswana; (5) Guinea; (6) DR Kongo; (7) Tajikistan; (8) Guyana; (9) Ghana; (10) Mali; (11) Peru; (12) Zambia; (13) Uzbekistan; (14) Kazakhstan; (15) UAE; (16) Egypt; (17) Chili; (18) Australia; (19) Russia; (20) India; (21) RSA; (22) China; (23) Canada; (24) United States.

value, which is derived in developing mineral resources and is formed due to the natural factors that exist in a country: larger mineral reserves, higher quality of raw material, especially favorable mining and geological conditions, and convenient location of deposits relative to the existing infrastructure. Information on mineral rent (in the fractions of a country's GDP) is published by the World Bank (The World Bank, 2019).

The MCI index is not a measure of the economic prosperity and success of a country, it does not reflect its position in the world market of the mineral raw materials or its share in the global mining of mineral resources. However, it may be a good starting point for studying the dependence of a country on the MRC based on considering different aspects of its influence on the economy. In this case, a higher MCI index is indicative of a greater role of the MRC in the economy and the value of this index can be used to compare countries.

ANALYSIS OF THE RESULTS

In 2016, the MCI value varied from -28.9 to 58.9% for 190 countries. Out of 41 countries with negative MCI values, the GDP did not exceed \$100 bln in 37 countries. Thus, negative MCI values are typical primarily of small economies that are strongly dependent of the situation in the MRC. Therefore, further comparison in the MCI value is performed within the groups (\$, bln) of large (>1000), medium-sized (100–1000) and relatively small (≤ 100) economies. In each group, the economies with $MCI \leq 10\%$ are dominant. However, the upper limit of the MCI values naturally decreases

from one group to another upon transition to the countries with the larger GDP per capita (Fig. 1).

An MCI index in the range of 10–30% was recorded for 24 small economies and only 5 medium-sized and 2 large economies (Australia and Russia). The MCI index exceeded 30% only in 13 out of 190 countries, which except for Peru were comparatively small economies. Among all of the countries, the most MRC dependent in 2016 were (MCI, %) Mongolia (58.9), Kirghizia (58.2), Surinam (52.9), Botswana (52.2), Guinea (51.5), DR Kongo (43.9), Ghana (38.4), and Mali (37.3), although the cost of the raw material mineral products made in these countries was relatively small and varied from \$0.9 to 7.9 bln.

It is noteworthy that out of ten countries where mining of solid minerals in 2016 was estimated at more than \$30 bln, much lower MCI values (%) were found even for Australia (13.8) and Chili (15.4). RSA (11.5), Russia (10.4), India (9.0), Indian Asia (6.9), and China (5.7) were characterized by small index values, while Canada, Brazil, and United States had extremely low ones (from 3.3 to 0.9). These countries provided almost 80% of the world production of mineral raw materials (in value term) and contributed over 34% to the global export of these products. However, due to the immense size of their GDP and goods export, they corresponded to low values of the MCI index, i.e., the direct contribution of the MRC to their economies is relatively small and decreases as their economies have been developing.

The cause of this is that GDP growth in a particular country is unlimited in principle, while the size of the contribution of the MRC to the GDP is naturally lim-

ited: the number of deposits and the mineral reserves are not everlasting, while mining and export of mineral raw material cannot increase for a long period of time at the same rate as a country's GDP (especially in rapidly-growing economies) and the goods export in general. If doubling a country's GDP each time required, e.g., a double increase in mining of mineral raw materials, their export etc., the problem of economic growth would become unsolvable with time, even with the abundant resources.

In countries with a small GDP, the influence of the MRC on economic development is especially evident. As an example, the economy of Botswana (MCI = 52.2%) depends strongly on diamond recovery. In the 1970s–1990s, the beginning or expansion of production at each of the three largest kimberlite pipes of the country resulted in increasing added value in the MRC and its direct contribution to the GDP, as well as a high growth rate of the economy in general (25% in 1971 and 1972 compared to 8.7% on average in 1961–1970; 15% in 1978; 13.1 in 1983 after the recovery increased from 1.17 to 4.83 mln carat and 19.4% in 1988). Diamond recovery also contributed to the growth in goods export, the creation of new vacancies, and replenishment of the state budget. Even in 2016, diamond recovery added 20.5% to the country's GDP, ensured the receipt of 88.3% of all foreign trade earnings and approximately one-third of the government income, and the creation of one vacancy in the MRC gave 3–5 additional workplaces in the related areas.

In Botswana and many other countries, at the initial stage of industrialization, the MRC was a driver of economic development in the country in general, since the investments to mineral mining gave impetus to the growth in the other sectors of economy, including in the sphere of transport, construction, and financial services. As a result, in 1966–2014, with respect to the GDP growth per capita (on average, 5.9% a year) calculated by purchasing power parity, Botswana was in the first place among the African countries, although it was outperformed by other rapidly developing countries, first of all, by South Korea (6.3%) and China (7.5%).

However, in this model, the acceleration of the economic development is reached due to the growth in mining of mineral raw materials (which often occurs significantly faster than the GDP growth); to increase the GDP in 1975–2015 by a factor of 15 and to provide a comparatively high average rate of its growth, Botswana would have had to increase the diamond recovery by a factor of 48. At the same time, in this relatively small country, the resources of conveniently located large and rich deposits of high-quality diamonds are not infinite and it is impossible to increase the production in the MRC without limit. In addition, since 2000 no new significant deposits have been discovered in this country.

As a result, after reaching the maximum value of 24 mln carat in 2006, the recovery of gem diamonds in Botswana decreased by 2018 to 16 mln carat, and the contribution of added cost in the country's MRC dropped from 45% to 16.4% in 2001. Despite the variations caused by the change in the market demand for diamonds, after the discovery of large new kimberlite pipes was terminated and new large mining enterprises were not opened, the growth of diamond recovery slowed down. While in 1976–1990, the physical volume of recovery of gem diamonds increased in the country by 37.6% on average, in 1991–2018 the recovery slowed to 1.9% a year. This has become one of the most important causes for deceleration in GDP growth in Botswana from 13.2% on average, in 1968–1990 to 4.5% in 1991–2017, and in the recent decade, the rate of GDP growth was lower than average for the African countries south of Sahara. In 1995–2009, the contribution of the MRC to goods export also decreased from 71.7 to 54.3%. The decrease in goods export in 2007–2009 by 33% was caused primarily (by 75%) by the decrease in the export of crude diamonds. The accelerated economic development of Botswana became impossible because of the increase in added cost in the MRC and the export of crude diamonds. With rising unemployment, this required the government of the country to take urgent actions to diversify the economy.

The experience of many countries on the path of industrialization shows that under conditions of a crisis of possibilities, there is a task to increase added cost by gradually extending the technological series for processing of mineral raw material products. When the possibilities of economic growth have been exhausted because of the expanded recovery and export of mineral raw materials, the MRC is increasing its function to provide optimal conditions for the development of the economy diversified by the industries through the supply of raw materials to processing industries that make and export the products of a higher value-added level in the value-added chain, rather than cheap ores and concentrates. In the case of Botswana, e.g., this role was played by several tens of diamond lapidary plants that made up the largest sector of processing industry in the country. After they were established in the middle 2000s, Botswana received significant investments, thousands of new jobs were created; export of diamonds became possible, and when the first jewelry plants were started, jewelry could be exported as well. As a result, the tendency to a decrease in the contribution of the MRC to the goods export of Botswana, which increased to 90.1% in 2017 after the reduction in 1995–2009, was reversed. It is assumed that in the future, an increasing share of crude diamonds recovered in Botswana will be processed in the country and will be made into jewelry products for export. In this case, the share of crude diamonds in goods export will continue to decrease and the share of products made by the processing industries will

increase. This means that under conditions of a growing GDP and decreasing recovery at the largest kimberlite pipes the contribution of the MRC to the economy will decrease.

Thus, during the economic development of the countries that mine mineral raw materials, a decrease occurs in their abilities to maintain a high stable rate of economic growth primarily due to the extensive factor, an increase in the volume of recovered mineral raw material, and an increase in its share in goods export and recovery of a mineral rent. This is frequently erroneously considered as a decrease in MRC value, including the value of the mineral resource base, for the economy of a country. Although the direct contribution of the MRC to the economy estimated by the MCI value decreases in fact, it acquires a new function, to provide raw materials to the related industries. In this case, the mineral resource complex continues to play an important part in forming the state budget and in solving the problems of unemployment, creates large multiplicative effects in the country economy, etc.

Similar processes occurred at different times in the largest global economies, e.g., in the Chinese economy. The first decade of economic reforms in China (after 1978) was marked by a rapid growth in export of all types of mineral products. As an example, at the beginning of the period, in 1978, China provided 9.3% of the world's production of fluorite (fourth place in the world); 60% of Chinese fluorite was exported. In 1978–1989, the recovery of this raw material increased by a factor of 3.8 (28.7% of the global output); the physical volume of its export grew by a factor of 4.5, and its consumption in the country grew by only 2.8 times (Fig. 1). The increase in fluorite mining in 1978–1989 was stimulated by the growth in internal demand by only 26% and by the growth in export, the desire of economic entities that gained more freedom, to earn foreign currency, by 74%. As a result, in 1981–1982, export reached 118% of the official ore recovery and the apparent domestic consumption (recovery + export + import) went below zero. In general, in this period China implemented a model of an export-oriented MRC that acted as an important source of foreign trade earnings, a source of funds required for accelerated industrialization, and creation of the modern infrastructure in the country. The development of the MRC became one of the priority tasks of economic policy for the Chinese government.

Later, as the ferrous metal industry, aluminum, and chemical industry developed, the domestic consumption of fluorite grew tremendously in China and increased by a factor of 7.1 in 2016 compared to 1989. At the same time, mining of fluorite in China reached its maximum in 2010 and after that began to decrease gradually for different reasons. In general, in 1989–2016, it increased only by a factor of 2.5; therefore, the growth in the consumption of the different fluorite grades by the rapidly growing Chinese industry was

reached only by 75% due to an increase in mining of raw materials, but almost by 25% due to the reduction of its export by 2016, by a factor of 3.5 compared to 1998. In 2016, only 5% of the Chinese ore production of fluorite was exported compared to 56% in 1998.

In 1998–2016, net export of fluorite from China decreased from 1321.9 to 375 thousand t, and the income from foreign trade of fluorite decreased from \$130.1 to 72.7 mln. However, the reduction of raw material export became one of the conditions for the sudden growth of the production in the country, e.g., fluorhydric acid and expansion of its export increased from 9.7 to 233.6 thousand t; this resulted in an increase in foreign trade earnings by \$229.5 mln, which exceeded the loss of income from the reduction of crude fluorite export with a surplus. As the economy developed, China, similarly to many other countries that support or even expand the scales of mining of mineral raw materials, first decreased their export and then sometimes became a net importer, preferring to sell derivatives with higher added cost abroad rather than relatively cheap raw materials.

Thus, at the different times, for different types of minerals, China gradually transited to mostly domestic consumption of mineral raw materials and in many respects it has already lost the position of an important exporter in the global market. The contribution of the MRC to the goods export of the country and often an absolute size of the commodity export decreased due to the growth in the domestic consumption and (or) the growth of the goods export cost in general, including the expansion of export of production for rapidly forming new industrial fields. As an example, in China, against the background of the growing costs of exported pearls and precious and semi-precious stones by a factor of 4.6, ores and metal concentrates by a factor of 5.9, nonferrous metals by 9.1, industrial metals and mining-chemical raw materials by a factor of 2.8 in 1997–2017, the total contribution of these items of mineral export to the total cost of goods export of the country decreased from 2.3 to 1.3%. As a natural consequence, the value of the mci_3 decreased, and in some circumstances, mci_4 decreased as well.

In 2016, among 22 countries with GDPs larger than \$500 bln, China had the lowest value of the mci_3 (1.4%) and demonstrated negative dynamics of the mineral raw material contribution to goods export in 2014–2016 ($mci_4 = -0.8%$). In 2011–2016, China showed a stable tendency to a decrease in the contribution of the mining rent to the GDP from 2.8 to 0.4% (the value of mci_3 decreased). Such a decrease was only partially (by 52%) explained by the GDP growth by a factor of 1.8 (in constant prices) and was determined by 48% by the exhaustion and worsening of the reserve quality for the most commercial deposits. At the same time, due to natural causes the cost of the MRC products from China has a slower growth rate than the GDP over a long period of time, and in the worst case

demonstrated negative dynamics, which means an unavoidable decrease in the values of mci_1 and mci_2 indices.

It is seen that during the economic development in China, important components of the complex MCI index decreased, which indicates a reduction in the direct contribution the MRC to the country's economy and a change in its role. Its major function became guaranteed provision of the national economy with mineral raw materials from its own sources, and thus, the creation of optimal conditions for the growth in industrial production and support of the high rate of the economic development.

China has a large territory that is characterized by an extraordinary variety of geological settings of ore formation and as a consequence a huge mineral resource base that is diversified with respect to the types of raw materials, which is an important part of the powerful national MRC. Thus, the task of the most abundant provision of the Chinese economy with many, although far from all, kinds of mineral raw materials using its own deposits for a long period of time was solved quite successfully.

However, there are countries where the MRC and its important component, the mineral resource base, could not handle a similar situation during industrialization. This refers in particular to South Korea, which has a shortage of natural resources, including mineral raw materials, and has one of the lowest integrated indices of the contribution of the MRC to the economy among 22 countries with a GDP greater than \$500 bln (MCI = 0.97%). In the absence of an important prerequisite of the accelerated development of industry, a powerful MRC and large sources of mineral raw material in the national territory, the average rate of economic growth in South Korea decreased by a factor of almost 2 compared to 1999–2007 and was maintained in 2008–2017 at the level of 3.1% per year only as a result of transformation of the country into one of the major purchasers of mineral raw materials and their derivatives on the global market (10th place in the world by the cost of mineral import). Thus, South Korea was forced to pass to the geopolitically unsafe model of providing its national industry with scarce mineral materials increasingly due to their import.

The booming economies of China, India, Brazil, Turkey, Indonesia, and other countries are now following the same path. Under conditions of a rapidly increasing crisis of possibilities since 2007, China has completely turned into a net importer of mineral raw materials and a largest buyer of such products (26.2% of MRC products purchased in the world market in 2017); numerous Chinese companies actively invest in the mining of minerals all over the world. Earlier, by 1995, countries with poorer mineral resources, where the contribution of the MRC to the economy was systematically decreasing, including India, South Korea,

and Turkey, became net importers, and even Brazil has been a net importer since 2017; after 2011 net export of mineral products from Indonesia and Mexico began to decrease.

Much earlier, the same path of development was followed by Italy, Spain, Netherlands, France, Germany, Great Britain, United States, and Sweden, which were characterized in 2016 by the lowest MCI values in the group of the 22 largest economies. Most of these countries have an aggravating deficit of territory, water, forest, fuel and energy, and mineral raw material resources to some extent, where reorientation to a post-industrial economic structure and gradual relocation of material-intensive processing industries outside the national territory were compulsory and became a reaction to the crisis of their abilities to continue industrial development. An orientation towards assessing its prospects can be a contribution of the MRC to an economy. As an example, due to attention of the country's government to the development of the mineral resource base and mining industry, the contribution of the MRC to the Chinese economy is one of the most significant (MCI = 5.7%) among the largest economies and strongly surpasses this index not only in the United States (0.91%) and in five other of the world's largest economies (with GDPs greater than \$2000 bln) but also in many postindustrial countries that are far behind China with respect to their GDP, e.g., in Spain (0.90), in Sweden (0.68); Italy (0.48), and the Netherlands (0.46).

The analysis of the data for 22 of the world's largest economies (GDP \geq \$500 bln) shows that for half of them the MCI index did not exceed 1.2%, and the average rate of economic growth in 2012–2016 was lower than the average world value; this varied from –0.5 to 2.8% per year regardless of the contribution of the MRC to the economy (Fig. 2). The highest average growth rate of the GDP for the largest economies was reached in the countries with a high contribution of the MRC to the economy ($5.7 < \text{MCI} < 9.0$ in 2016), including (% per year) in China (7.3), India (6.9), Turkey (5.5), and Indonesia (5.3). This confirms the conclusion made earlier that a high rate of economic growth at the stage of industrial development is possible only with the appropriate support by the national mineral resource complex (Dergachev and Starostin, 2018).

The large contribution of the MRC to the economy (a high MCI value) is an important prerequisite, an obligatory but not sufficient condition for providing a high rate of growth. It provides undeniable economic and social advantages; however, how and to what extent they will be used depend on many factors, among which a decisive role is played by the quality of the management system. This is illustrated well by the Australian and Russian economies.

Australia is a country of emigrant capitalism, where the economic structure, like, e.g., in Canada, New Zealand, or RSA, was originally formed by emi-

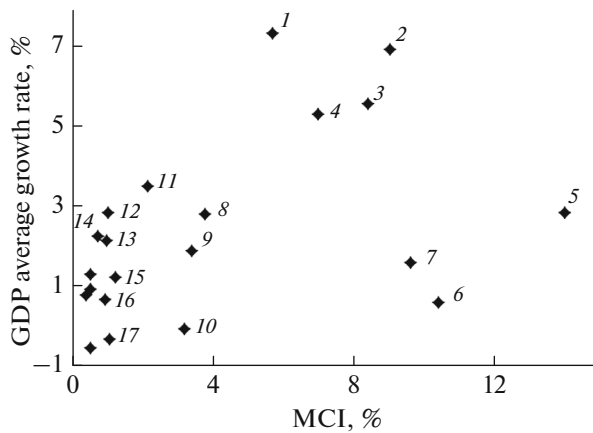


Fig. 2. The percent of the contribution of the MRC to the 22 largest economies (GDP \geq \$500 bln) in 2016 and the average growth rate of these economies in 2014–2016. The numbers designate the countries: (1) India; (2) China; (3) Turkey; (4) Indonesia; (5) Australia; (6) Russia; (7) Switzerland; (8) Mexico; (9) Canada; (10) Argentina; (11) Saudi Arabia; (12) South Korea; (13) United States; (14) Sweden; (15) Japan; (16) Spain; (17) Brazil.

grants from Europe so that the demands of the metropolis for scarce types of resources, including mineral raw materials, could be satisfied. Australia is characterized by a post-industrial type of economic system on the one hand, and on the other hand, by agrarian and raw material specialization of the economy that has existed since colonial times and depends on the metropolitan requirements and later on the needs of its main economic partners. These partners need high-quality Australian iron ores, bauxites, concentrates of nonferrous metals for enterprises, rather than Australian aluminum, steel, or zinc, e.g., and, least of all, machines or other goods manufactured from Australian mineral materials. In 2016, the contribution of the MRC index to the Australian economy reached 14.0% of the maximum value for a large economy. However, this does not represent a basis for the development of other branches of the national economy, since the formed international differentiation of labor interferes with the growth in the processing industries; knowledge-intensive and high-technology production is almost absent in Australia, and it became a post-industrial country by almost skipping the stage of industrial development, rather than due to a crisis of possibilities. In this respect, the goods of the export-oriented Australian MRC and the mineral resource base of the country are not demanded by its economy. At the same time, the demand for Australian mineral commodities in the world market varies with respect to the world market condition and the average growth rate of the country's GDP did not exceed the average world level of 2.9% per year in 2012–2016.

In Russia, the average growth rate of the GDP in 2012–2016 was only 0.6% per year, i.e., it was significantly lower than in other countries with a comparable volume of the GDP and close MCI values. However, among 22 countries with a GDP less than \$500 bln, Russia was outperformed only by China (41.2%) and Australia (8.1%) with respect to its contribution to the value of the world's MRC products (\$91.5 bln or 6.0%). According to the value of the produced mineral commodities normalized to the GDP, only Australia (10.2%) outperformed Russia (7.1%) in this group. Despite the economic problems and the unfavorable external conditions, in 2014–2016 Russia accumulated a value of MRC products (in the GDP fractions) by 2.9 pp; better dynamics was demonstrated only by the Chinese MRC (+4.1 pp). For comparison, in United States, Great Britain, Sweden, Spain, Netherlands, Italy, Japan, Switzerland, South Korea, this index amounted to several hundredth of pp. In terms of a mineral rent contribution to the GDP (1.0%), among 22 largest economies, in 2016 Russia was outperformed only by Australia (4.5%) and Brazil (1.4%), having left behind not only Canada, but also Indonesia and Mexico and surpassing this index in France, Germany, Japan, Italy, South Korea, Netherlands, Spain, Sweden by a factor of tens and hundreds. In terms of the mineral export cost in this group, Russia was only in ninth place and yielded not only to United States and Australia (as well as Switzerland and Great Britain that are actively involved in trading of gold and diamonds produced by the MRC of other countries without mining either of them), but also by Canada, India, and even China. However, the mineral commodities and metals amounted 8.5% in the value of the Russian goods export, which allowed the country to take seventh place (%) after Australia (36.3), India (14.3), Brazil (13.1), Canada (10.1), Turkey (9.5), and Switzerland (29.5). It is noteworthy that in terms of the value of import of mineral commodities (\$3.9 bln), in the group of the 22 largest economies, Russia was among the most important net exporter of mineral commodities (\$20.4 bln), ranking only after Australia (\$65.3 bln).

The mineral export of Russia grew by 115.4% from 2009 to 2012 and then decreased by 33.8% in 2012–2016. At the same periods, the goods export of the country first increased by 73.9% and then declined by 45.6%. Thus, the Russian export of mineral commodities grew faster than the goods export in general during the economic rise and played a stabilizing role in a difficult times for the economy. This is a unique situation among the largest economies, except for India. While half of the 22 countries decreased their contribution of MRC production to the goods export in 2014–2016, the decrease was especially significant in Australia and Brazil, Russia increased its contribution by 2.2 pp; more significant growth (pp) was reached only in Turkey (3.4), India (2.6), and already for an obvious reason in Switzerland (2.5).

Based on the value indices, the Russian MRC is sufficient to satisfy domestic needs for mineral materials; it makes it possible to minimize the country's dependence on their import and related risks, preserves significant export potential, and allows mine rent recovery.

In general, among the 22 largest economies, Russia is ranked after Australia (14%) with respect to the value of the complex MCI index (10.4); thus, the contribution of the MRC to its economy turns out to be much higher than in most countries that are comparable in GDP volume. The value indices should also include at least the extraordinary variety of the mineral types in the territory of the country (in Russia, the reserves of almost all known types of minerals are explored), the still high reserves-to-production ratio estimated for 25–30 years even for strategic and most significant kinds of minerals (Strategy..., 2019), the available competences in the country required for effective exploration using its own resources, prospecting and production, transportation, and processing of large volumes of mineral raw materials.

Despite the accumulated problems and the necessity of in-depth modernization of the mineral resource complex, which deserves separate consideration, in terms of the contribution of the MRC to the Russian economy, raw material stock and reserves that remained after the USSR, as well as preserved abundant subsurface resources, Russia is still in a unique position and has important advantages over most of the largest economies, primarily over the post-industrial countries, whose mineral and raw material potential is not sufficient to meet the needs of their economies or is approaching depletion and requires replenishment with expanding imports of raw material commodities or elimination of many production facilities that consume minerals and raw materials. The high contribution of MRC to the economy of modern Russia indicates the absence of insurmountable natural and raw material limits to continuation of the industrial development that had not been completed at the beginning of the economic reforms in the 1990s, as well as pointing to the absence of natural obstacles to the growth in the country's GDP at a rate of 5% per year that was reached by other countries where industrial development is occurring (China, India, Turkey, and Indonesia) and where, like in Russia, the MRC and its integral component mineral resource base continue to contribute immensely to the economy.

The low rate of the GDP growth in the country is therefore caused not by the crisis of possibilities in the form of exhaustion of the important factor of industrial development, but in the way it was used, in the crisis of needs, and the absence of demand for this natural competitive advantage of Russia. For several decades, industry underwent deindustrialization and primitivization, where entire economic branches were liquidated, the reduction in the volume of industrial

production numbered in the tens of percent per year, the domestic market of mineral raw materials was wound up, mining of some minerals decreased up to the point of full cessation; sluggish growth was recorded for the domestic consumption of only the cheapest mineral products (e.g., construction materials), and the volume of prospecting and exploration operations often did not allow even ordinary replacement of the mineral resource base, not to mention the recovery of its quality.

In the other economies with the largest GDPs during the transition to an innovative or post-industrial stage of development, industrial production facilities were preserved, were upgraded, and were used as a basis. Conversely, since the early 1990s Russia was among few countries where upgrading, structural transformations in the economy, and transitions to the post-industrial model were understood as the necessity to destroy industries and consequently the MRC that provided mineral materials to the country. The high contribution of the MRC to the country's economy and export was considered as an indication of its archaic structure, while there were many reasons to believe that it pointed to weakness and low competitive ability of the other economic branches. Naturally, the expediency of expenses for geology-prospecting works was in question as well as supporting the industrial economy basis, that is, the mineral resource base of the country, without which Russia would inevitably have faced the necessity to decrease traditional mineral and raw material export followed by a raw material shortage for the processing industries. The exchange of the crisis of needs for the current crisis of possibilities would have been a question of time. It seems highly unlikely that the geopolitically unsafe South Korean model of providing national industry primarily due to imports of mineral materials will occur. However, the domestic consumption of some scarce metallic minerals, industrial minerals, and mining chemical feedstock is already covered by imports or from the stored reserves.

The reserves of some minerals are quite high with the current volume of mining. However, for Russia, raising the standard of living is one of the strategic national priorities; it must be supported by economic growth at a rate that exceeds the worldwide average. The experience of many countries shows that service economy cannot ensure that the GDP growth rate will be much higher than the average worldwide rate. This problem can be solved only if industrial development is occurring; the growth in living standards and industrial production will inevitably increase the domestic consumption of mineral raw materials. The model of economic growth implemented by the government until 2035 suggests the acceleration of industrial production growth primarily due to non-resource areas. However, as was shown earlier in (Pushcharovskii et al., 2018), to attain and maintain the average GDP growth rate of the countries that have been rapidly

developing in recent 35 years (China, India, Turkey, and Indonesia), Russia might require an increase in the production of mineral materials by 2.5–5.0% per year and the equivalent replacement of the mineral resource base in the nearest future.

Based on the example of the economies of Botswana, China, the United States, and South Korea, the above-considered pattern of transition from the export-oriented model of the MRC to the model of primarily domestic consumption of mineral raw materials extracted by related industries and then to the model of dominant import of scarce mineral materials and finally to a post-industrial economy, relocation of material intensive production facilities outside the national territory, and to import of goods and exporting primarily services is also likely to spread in Russia. In this respect, there can be little doubt that during its economic development Russia will not be immune to a decrease in the MCI index. The question is that of the reasons, in which way, and for how long.

There are not many countries in the world where such transitions were made by authoritative action until the possibilities of the national MRC were exhausted and the crisis occurred for the model of industrial development, which is able to provide more rapid economic growth. In most countries, these transitions occurred gradually and evolutionary, with the formation of new elements already in the former model, and were determined by the impossibility of further growth in the economy without gradual transformations of the model.

CONCLUSIONS

By the early 2010s, the understanding prevailing in Russia was that modernization of the economy should combine the creation and development of new knowledge-intensive areas and production facilities with ongoing industrialization and infrastructure development in controlled proportions. An integral part of the goal to build such economy is maintaining a high contribution of the MRC, which can provide for the growing domestic needs of Russian industry for mineral materials and positions of the country in global mineral and raw material supply with important kinds of solid minerals, as well as to replace the mineral resource base of the country, to extend the technological chains of processing mineral raw materials for the production of goods with higher added cost, and many

other issues. This is the only basis upon which Russia can thrive under global competition and preserve its sovereignty.

Taking the immensity of the mineral and raw-material potential into account, we may assume that the MCI index will decrease in Russia more slowly than in other large economies, except perhaps for Australia. Under the appropriate efforts, it may take several decades for the contribution of the MRC to the economy to decrease to the present level of the EU countries, where Russia will retain an important advantage in economic development. During all of this time the use of mineral raw materials will play a crucial role in the formation of the gross domestic product, and its place and role in the world will be determined not only by mineral resources obtained from nature, but also by the contribution of its MRC to the economy and the transition to a new technological mode.

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