Impact of mining industry growth on sustainable development indicators

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Abstract:Recently, the idea of sustainable development has become moreand more widespread, which is why many countries and companies have questions about how to assess the correctness and compliance of their actions with this trend. This topic is particularly relevant for countries with resource-based economies. This paper examines various approaches to this assessment using the mining industry as an example. It alsotests the hypothesis of whether the activities of the mineral sector can contribute to the development of the country in the unity of economic, social and environmental components by conducting a correlation analysis in this work. The study was conducted on the example of Mongolia as a country with a resource-based economy.

1 Introduction

Issues related to the development specifics of resource-based economies have been discussed for a considerable time. In the 1950s and 1960s, it was believed that rich natural resources contributed to the rapid growth of the country, but in the last two decades, many began to see natural resources as an obstacle to successful development. Even the termof "resource curse" has appeared in the literature [1].

However, in the 2000s, works aimed at the rebuttal of this established vision began to appear. Thus, researchers [2], using certain statistical models, concluded that the impact of the "resource curse" is nothing more than a function of the quality of the institutional environment of the state, so it can be minimized or completely avoided by creating a special economic and political framework.

Since the 1980s, the spread of ideas for sustainable development has begun, which has now reached a very large scale. That conception implies sucha way of functioning and living that meets the needs of the present generation without compromising the ability of future generations to meet their own needs [3]. And at present, many enterprises and countries (especially those which are involved in the exploitation of minerals) have questions about the possibility of their actions to comply with this trend, as well as how to assess this compliance.

Taking into account all the above, the purpose of this work is to identify statistical links between the development of the mining industry in a country with a resource-based economy and its growth, as well as to determine the impact of this process on the macroeconomic indicators of sustainable development.

The study was performed on the example of Mongolia as a country whose economy is based on natural resources.

It is necessary to solve the following problems:

1. Determine whether Mongolia meets the criteria for the category of the resource-based economy country
2. Choose a way to assess the impact of the mining industry on the main macroeconomic sustainable development (SD)indicators
3. Assess the correlation between the development of the mining sector and SD indicators.

The hypothesis of the study:the functioning of the mining industry can contribute to the development of a country with a resource-based economy in the unity of economic, social, and environmental components.

Research methods: desk studies, analysis, structuring, synthesis of information, correlation analysis.

2 Results and discussion

The main criteria for resource-based economies are [4]:

1. Generating more than 10% of GDP from mining revenues
2. The share of natural resources in exports is more than 40%.

Based on the statistical information found, the share of mining in the total GDP of Mongolia is 15-20%; the share of minerals in exports is about 90%, which accounts for 60% of the country's budget; 75% of foreign direct investment goes to this sector.

At the present moment, 34 types of minerals have been identified in Mongolia, which accounts for about 1,900 deposits. OnDecember 31, 2018, there were 3185valid mining licenses in the country in the ratio of 54% for operation and 46% for exploration. In total, they cover more than 5% of the country's area. The leading mineral by the number of operating licenses in Mongolia is gold (551 licenses), followed by coal and construction materials (314 licenses) [5].

Mongolia's total mineral reserves include (A+B+C):

- 38 billion tonnes of coal
- 48 million tonnes of fluorite
- 3000 tonnes of gold
- 60 million tonnes of copper
- 6 million tonnes of zinc
- 330 million tonnes of oil, etc.

If wetake into account the annual extraction capacity of major natural resources such as copper – 1.3 million tonnes/year, gold – 15 tonnes/year [6], coal – 110 million tonnes/year [7], we can estimate the country's mineral endowment for a long period (about 45 years – copper, 200 years – gold, coal – more than 300 years). Mongolia also has significant reserves of rare-earth elements. In this regard, some experts are considering the possibility of developing non-traditional areas of the mining industry [8]. Domestic consumption (processing) of mineral resources in Mongolia is still insufficient, which confirms the long-term orientation of the mining industry for export. Given all the above, we can be objectively conclude that Mongolia is reasonably considered as one of the countries with a resource-based economy at present and in the near future.

The problem is how to turn the country's current resource revenues into investments for future high-tech efficient production, which will lead to a significant improvement in macroeconomic indicators in the future, including from the perspective of sustainable development and growth of public welfare.

The analysis of the literature [9-11] has shown that various approaches can be used to assess the impact of mining on the country's economy and sustainable development indicators:

1. Assessingtheeconomicimpactofaparticularsectorby multiplier effect
2. Evaluating indicators at the macro level.

The multiplier effect approach is interesting because it takes into account not only direct but also indirect and induced effects.

The authors [12] claimthat this effect can be described in terms of iterative logic. It means that an increase in the productionvolume in any activity implies a simultaneous increase in production costs. This can lead to an increase in output in related sectors, which, in its turn, creates a boost in production demand for products from a wide range of industries. With each such iteration, the initial impulse fades, and thuscauses smaller and smaller contributions to the final increase in gross output in the economy.

A schematic presentation of this concept on the example of the mining industry functioning is shown in Figure 1.

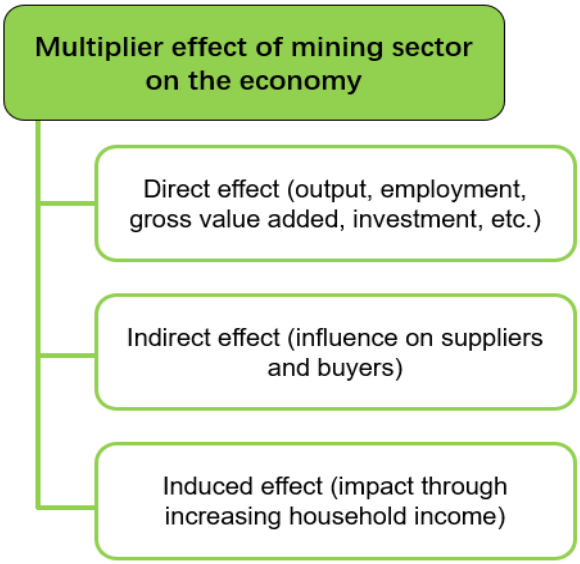

Fig 1. Schematic presentation of the multiplier effect of the mining industry (ULAANBAATAR CITY GROUP 2012-2017).

The direct effect refers to the following indicators in terms of value: output in the mining industry, direct employment in the mining industry, gross value added, investment, various payments to the state, and so on.

The indirect effect is the added value generated in the industries that supply goods and services to mining companies, and it also takes into account the impact on buyers

Induced effects are changes in economic activity due to an increase in household income as a result of direct and indirect effects [13].

The concept of this method reflects its high efficiency and usefulness. A large amount of research after the Keynesian revolution in economics was devoted to this topic. In particular, attention was paid to the use of this effect as an argument in favour of state support for investment [14].

However,the main problem is the method of evaluating this multiplier effect. It is based on the use of “input-output” analysis, which implies a complex and time-consuming process, which raisesthethorny issue of the lack of relevant information at a certain time.

For example, the basic tables for analysis for 2011 in Russia were published by the State Statistics Service only in 2017.

A similar situation is observed in Mongolia. Therefore, it is difficult to determine the actual total impact of the mining industry on the country's economy at the moment. In general, only individual statistical agencies undertake such calculations. As an example of displaying the concept in practice,there can be considered the graph based on the data provided by the Ulaanbaatar group on statistics in 2017. It illustrates the growth rate of Mongolia's income in 2010-2014, taking into account the impact of direct, indirect, and induced effects of the mining sector (Fig. 2).

If the issue of providing the necessary statistics more quickly is resolved in some way, it may be a new step in the economic assessment of effects and results at the national level.

The second highlighted approach to assessment is the use of SD indicators at the macro level. The analysis of sources (OECD, SDG Indicators, World Bank) has revealed that indicator systems and integrated indices remain the main solution.They have been developed for more than 30 years in the methodologies of various international organizations (the methodology of the UN Commission, the methodology of the World Bank, OECD, universities, etc.).

There are some conclusionsthatweremade after analyzingthe structure and evaluation system of these methodologies:

1. All of them contain a really large number of indicators. This, on the one hand, allows us to consider certain aspects in detail, but, on the other hand, makes it difficult to assess the overall situation of the country.
2. There is the problem of comparability of most indicators/indices when performing comparative analysis at the national level or, for example, ranking countries [11].

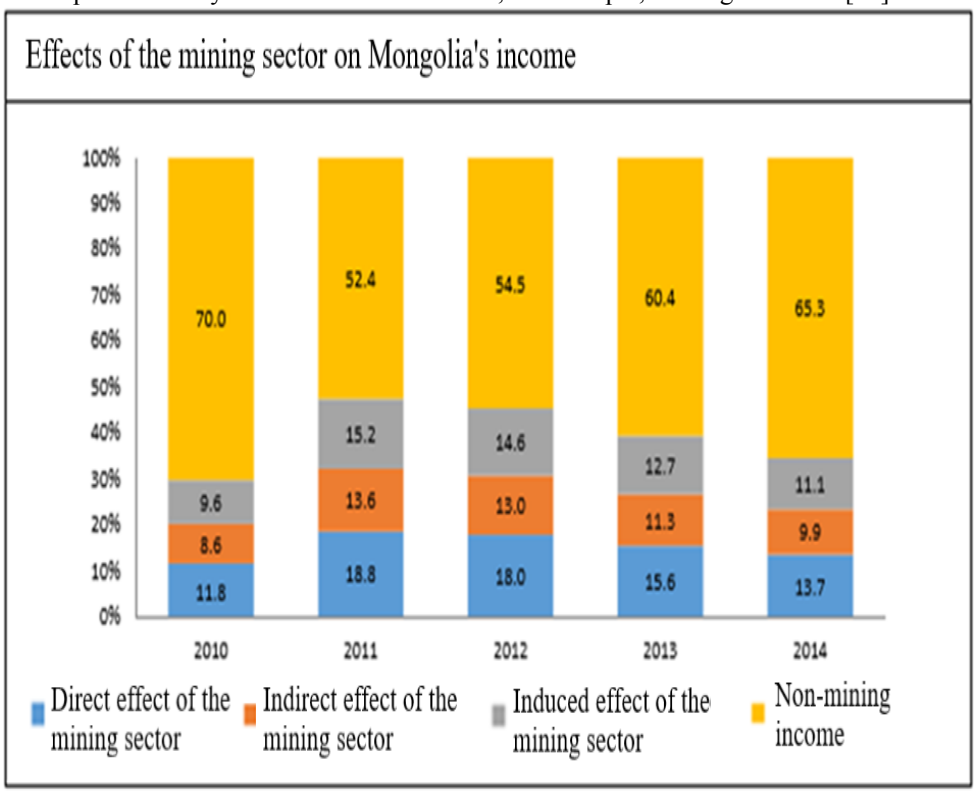

Fig. 2. Mongolia's income growth rate in 2010-2014, taking into account direct, indirect, and induced effects of the mining sector (ULAANBAATAR CITY GROUP 2012-2017).

To meet the challengesof this work, it was decided to create a set of special indicators/indices that would allow assessing the levelof the country's achievements in the field of sustainable development.

As a result, there was selected the following group of indicators and indices:

1. GDP (constant 2010 US$)
2. Industry value added in GDP (constant 2010 US$)
3. Employment, total
4. Human Development Index (HDI)[1]
5. Environmental Performance Index (EPI)[2]
6. Sustainable Society Index (SSI)[3].

The main emphasis of the sample was placed on the coverage of all components of SD (economy, society, ecology), as well as on the potential correlation between the indicators/indices and the dynamics of the mining industry.

The selected indicators for Mongoliawere evaluated for the period 2010-2018: information was collected from data of international organizations such as the UN, OECD, World Bank, etc. (Table 1). Table 1 also presents data on the mining industry resultsof Mongolia – GDP of the mining industry in 2010-2018 in constant prices 2010.

To identify if there aresome dependencies between the development of the mining industry and the country's economy, as well as SD indicators, a correlation analysis between the GDP values of the mining sector in Mongolia and a previously defined sample of indicators/indices was used. The results of the calculations are presented in Table 2.

The highest degree of correlation is between the GDP of the mining industry and the total GDP: 0.94. This result was expected because of the analysis of the situation with the use of mineral resources in Mongolia, but it once again confirms the point of view of the fundamental importance of natural resource exploitation for the country's economy.

The Industry value added in the GDP correlates quite closely with the indicatorsof the mineral resource complex, which is quite reasonable, since the mining sector is one of the main parts of the country's industry.

An interesting situation arose with the employment indicator: the correlation coefficient is -0.4, which indicates an average negative degree of connection. This conclusion may sound strange bearing in mind the effect that the mining industry creates for the country. However, according to statistical data, despite the scope of activity of the mineral sector in the economy, direct employment in it is about 5% of employed in all sectors of the economy. Besides, the reasons may be increasing productivity and automation processes. Also, the growth of the GDP might be influenced by the price factor, and not by the growth of production in physical terms.

Table 1. Values of indicators/indices for Mongolia in 2010-2018(SSI official website, SDG Indicators Database, OECDDatabase, World Bank Open Data, ULAANBAATAR CITY GROUP 2012-2017)

	2010	2011	2012	2013	2014	2015	2016	2017	2018

[1]HDI is a summary measure of achievements in three key dimensions of human development: a long and healthy life (life expectancy), access to knowledge (expected and mean years of schooling) and a decent standard of living (GNI per capita). More detailed information can be found at UN Development Programmeofficial website.

[2] EPI provides use of 32 performance indicators across 2 huge issue categories - ecosystem vitality and environmental health. More detailed information can be found at EPI official website.

[3] SSI shows at a glance the level of sustainability along three dimensions – human wellbeing, environmental wellbeing, economic wellbeing –each of which, in turn, is characterized by a number of indicators. More detailed information can be found at SSI official website.

GDP (constant 2010 US$), billion $	7.19	8.43	9.47	10.58	11.41	11.68	11.82	12.45	13.35
Industry value added in GDP (constant 2010 US$), billion$	2.34	2.64	2.91	3.23	3.59	3.63	4.00	4.77	5.17
Employment, total, %	93.45	95.23	96.1	95.77	95.2	95.14	92.76	93.64	93.68
Human Development Index	0.697	0.711	0.719	0.728	0.733	0.736	0.73	0.729	0.735
Environmental Performance Index	-	-	45.37	-	44.67	-	64.39	-	57.51
Sustainable Society Index	4.6	-	4.77	-	4.57	-	4.58	-	-
GDP of the mining industry (constant prices 2010), billion tugriks	2101.8	2263.7	2452.2	2905.8	3469.3	3957.7	3964.1	3745.6	3958.6

*Dashes forsomeindicators'valueswereplaceddue to the calculation method (period 2 years) or to the lack of data for a certain period

Table 2. The results of correlation analysis between the values of GDP of the mining industry of Mongolia 2010-2018 and a set of indicators/indices

Indicator/Index	Correlation coefficient
1. GDP (constant 2010 US$),	0.94
2. Industry value added in GDP (constant 2010 US$)	0.86
3.Employment, total	–0.4
4.Human Development Index	0.89
5. Environmental Performance Index	0.76
6.Sustainable Society Index	–0.51

The results of the correlation analysis with the values of the Human Development Index and Environmental Performance Index were quite unexpected. The point is in the structure of these indices: the Human Development Index combines social and economic components;the Environmental PerformanceIndex characterizes the country's policy and state situation in the field of environment. And from the values of the correlation coefficients, it turns out that the development of the mining industry can have a positive impact on all threespheres.

The fact of "unexpectedness" is explained by the fact that the development of the mineral resource complex is usually associated with a direct positive impact on the development of the economy (without taking into account the long-term perspective), an average impact on society (sometimes positive, sometimes negative), and a negative impact on the environment. In this regard, the obtained results create new questions and topics for research.

Sustainable Society Index is an index that covers all three areas of SD (equal weights for each component). The correlation analysis performed with it shows a value of -0.51, whichmeans a significant negative connection. This situation does not correspond with the results of the previous two indices. It is worth noting that the obtained value was calculated based on a short dynamic series of 4 values and therefore it is impossible to speak about the high reliability of the result and make categorical conclusions. However, there also is a possible justified reason for this situation: the difference in the methodologies of construction and calculation of the considered indices.

If weconduct a correlation analysis with each component of the index individually,the following resultscan beobtained: correlation coefficient with theindex of human well-being is equal to 0.8, with theindex of environmental well-being to–0.6,with an index of economic well-being to –0.73. Such value of the index of environmentalwell-beingis explained by the fact thatthe consumption of natural resources and using renewable energy sources in the countryare taken into accountin it (not included in the Environmental Performance Index). Returning to the economic component, in addition to the generally accepted GDP and employment, it considers the amount of the country's public debt. The negative impact on SD identified by the SSI should be effectively corrected by state regulation and developing institutions.

In view of these refinements and the retrospective analysis of the situation of Mongolia,we canconclude that the value obtainedis quite objective. In general, we should talk about a more correct approach in the methodology of this index (SSI) because it takes into account significant factors (which were not taken into account in the previous two SD indices), which can seriously change the picture of what is happening.

Thus, it is impossible to make a definite conclusion as to whether the hypothesis of this study has been confirmed. The results established that the repeated results of the assessment of the impact of the mining industry in resource-based countries depend on the choice of specific indicators of interest to the researcher and are determined by the unsolved problem of SD assessment.

3 Summary

1. The feasibility of categorizing Mongolia as a resource-based economy was confirmed. The fact that 15-20% of GDP and 90% of exports are generated from natural resources indicates that the necessary criteria are met.

2. The possibility of using the concept of multiplier effect to assess the impact of a particular sector on the country's macroeconomic indicators was analysed; the main problems of applying that approachwere identified.

3. The use of indicators at the macro level was considered to be the optimal method of assessment. The analysis of international methodologies made it possible to create a sample of indicators and integrated indices that meets the objectives of this work and make it possible to assess with compressed accuracy the country's achievements in the field of SD.

4. The correlation analysis revealed certain relationships. Thus, the highest values of the correlation coefficient were obtained between the GDP of the mining industryand the indicators of total GDP (0.94), Industry value added (0.86), as well as aggregate SD

indices:HDI (0.89) and EPI (0.76). A negative correlation was found with the employment indicator (-0.4) and SSI (-0.51). The results of the correlation analysis also confirmed the existing problematic issue of the lackof a unified generally accepted methodology for assessing SD.

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