Targeting innovation activities of arctic enterprises in developing mineral and energy resources

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Abstract. The Arctic zone of the Russian Federation is the most important raw material base of the country's economy, but for the further effective industrial development of Arctic resources at the enterprises operating here, a significant increase in labor productivity due to use of the latest technology and production technology is required. This is prevented by the lack of a system of targeting innovation revitalization by enterprises. Developing the theory of endogenous economic growth we propose to use a coefficient of technological effectiveness level of production to assess the pace of technological progress in enterprises and industries. Its values are calculated at macro, meso and micro levels on the basis of statistical reports, and the values achieved at the best enterprises of industries can be used by enterprises as target values in technological innovations. The increase in the value of the coefficient of technological effectiveness level is directly related to the renewal of the active part of fixed assets and the growth of capital productivity of enterprises, which leads to an increase in productivity; so, it is possible to assess the achievability of its target value based on the existing financial capabilities of enterprises and the possibility of obtaining financial support from the state and regions, including on the terms of private-public partnership.

1. Introduction
The regions of the North and the Arctic are historically the main base for the country's economy for the extraction of mineral and fuel and energy resources [1,2]. In almost all Arctic regions of the Federation, the predominant share in the structure of the gross regional product is mining and primary processing of minerals. Resources concentrated in land-based fields are gradually being depleted (mainly oil and gas). At the same time, geological exploration which is being actively conducted on the shelf of the northern seas show the presence of new powerful oil and gas fields. In addition, the main industrial infrastructure to develop these deposits has already been practically created, since the development of minerals located in the Arctic zone of the Russian Federation (the Russian Arctic) was possible due to the development of the regions located in this zone with the involvement of labor resources from other regions of the country. Accordingly, science and education were actively developing in the Arctic regions. A network of regional scientific centers of RAS has been created. In most regions there are universities where highly qualified personnel are trained, including in specialties that will be required for further development of the Arctic. State policy is also aimed at the development of the Arctic regions, as the Arctic occupies an important geopolitical location to ensure the country's defense.
However, the above-mentioned opportunities for further development of the Arctic are limited by the following. First, for the shelf of the northern seas to be developed, further socio-economic development of the subjects of the Federation located in the Russian Arctic is required, and therefore, it is necessary to further develop industry in these areas, and on an innovative basis [3,4]. This will, for example, solve the long-standing problem of complex use of mineral raw materials.

Second, so far, the state - despite the Federal law "On Industrial Policy in the Russian Federation" issued in December 2014 - has not yet developed effective measures to stimulate innovative industrial development, for example, in the framework of long-term investment contracts with enterprises which are considered in this law. In our opinion, for innovation-active industrial enterprises located in the regions of the Russian Arctic, it would be possible to allow the use of our "quasi-self-financing" system [5] on the terms of private-public partnership. However, this is prevented, in our opinion, by the lack of clear guidelines for innovative industrial development for the state and enterprises, that is, the goals to be achieved. Accordingly, the aim of the work is the theoretical and methodological understanding of the possibility of setting such goals on the example of resources use of the Arctic regions.

2. Materials and methods
In the second half of the XX century, the theory of endogenous economic growth replaced the theory of exogenous economic growth [6,7], which showed that the most important source and resource of economic development of nation, in addition to traditional factors of production, is technological progress, but it could not explain - how technological progress can affect the rate of economic growth. The development of the theory of endogenous economic growth took place in different directions [8,9]. One of the first directions is creation of a "Research & Development" model, that is, the explanation of different rates of economic growth conditions by the emergence and use of technological innovations [10,11]. Active research on the influence of scientific and technological progress on the development of the country's economy and its individual sectors was carried out in the 80s of the XX century by different teams of scientists in the USSR as well [12,13], including Acad. V. A. Trapeznikov and his colleagues. In particular, V. A. Trapeznikov proposed an indicator that determines the pace of scientific and technological progress (NTP) in the country's economy, which was referred to as the "level of knowledge and skills" indicator [14]. Its value is determined by the level of knowledge accumulated in the relevant industry, and management skills to use it. In work [14] on the example of NTP development in pipeline transport of the USSR it was shown that this indicator as NTP rate depends on growth rates of labor productivity (LP) and decrease rates of fixed capital per worker (FC), i.e. it actually depends on growth rates of capital productivity (CP). Unfortunately, this indicator was obtained by transforming models of economic growth, which were based on a set of production functions, so, it was not considered at the level of individual enterprises.

Having compared initial assumptions and factors that affect the change in values of this indicator, we have shown [15] that it practically corresponds to the coefficient of technological efficiency level of production (k) either as the ratio of capital intensity of production to material intensity of products or as the ratio of material productivity to capital productivity. Its absolute value depends on the level of enterprise’s fixed capital, and the growth dynamics is determined by the increase in the level of capital productivity due to the use of the latest technologies in production, which allow material intensity of product to be reduced.

3. Results
Indicators of k, CP and MP values were calculated by us for each of the three types of industrial activity in all regions of the Arctic - subjects of the Russian Federation for 2005-2016 (table). In [16] we show that all the three indicators, depending on the direction of change in their values (increase or decrease) are indicators of four possible directions of development of industrial production and two options of two directions. The best one is the first option of the first direction (innovation-effective), when the values of all indicators increase simultaneously. On this basis, in [16] we present a graphical
model of the life cycle of production technology. It allows you to determine the prospects for technological renewal of production and the need for future actions of enterprises’ management concerning technological innovations, as, firstly, all indicators can be calculated quickly and in a simple way in dynamics according to the accounting (financial) statements of enterprises. On the one hand, this makes it possible to identify the trend of change in the value of the coefficient of technological effectiveness level of production k, and, on the other hand, determine the direction number and option number of enterprise’ development direction and their stability during the analyzed period of time. Secondly, it is possible to compare the results with those of other companies in the industry and identify the best company as a leader in technological innovation. In this case, the value of the coefficient k, as well as MP and CP values of this enterprise can be targeted by other enterprises of the industry. As for the leading enterprise itself, the values of the same indicators achieved by similar enterprises in developed countries can be used as target values. Thirdly, because of the need to achieve the target values of the coefficient k and the index of material intensity as a reverse to the indicator of material productivity, the target value of capital productivity indicator can be, on the one hand, the basis for determining the target value of labor productivity indicator, and, on the other hand, it allows you to calculate - depending on the achievement of the required volume of production and sales revenue - future volume of fixed assets of the enterprise, and therefore the amount of necessary investment in fixed capital. Further, on the basis of the available value of the financial leverage ratio, the possible additional amount of borrowed capital in the form of bank loans and (or) the required amount of financial assistance from the state or regions-subjects of the Russian Federation, including in the form of "quasi-self-financing" on the terms of private-public partnership in signing investment contracts by enterprises, can be determined.

Table 1. Indicators of development directions in different types of industrial production in the Arctic regions.

| Regions | Indicators | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  |
|---------|------------|-------|-------|-------|-------|-------|-------|-------|
| Nenets Autonomous district | Mining | MI | 0.253 | 0.286 | 0.330 | 0.282 | 0.272 | 0.268 | 0.185 |
|         |            | CP  | 0.590 | 0.595 | 0.509 | 0.493 | 0.455 | 0.418 | 0.346 |
|         |            | k   | 6.69  | 5.87  | 5.95  | 7.19  | 8.07  | 8.91  | 15.62 |
|         |            | N   | 4-2   | 3     | 4-2   | 2     | 2     | 2     | 2     |
| Nenets Autonomous district | Processing | MI | 0.746 | 0.610 | 0.592 | 0.524 | 0.905 | 0.947 | 0.964 |
|         |            | CP  | 4.212 | 3.050 | 3.455 | 1.889 | 10.670 | 19771 | 38.96 |
|         |            | k   | 0.32  | 0.54  | 0.49  | 1.01  | 0.10  | 0.05  | 0.03  |
|         |            | N   | 3     | 2     | 1-2   | 2     | 3     | 3     | 4-1   |
| Murmansk region | Mining | MI | 0.224 | N.d | 0.471 | 0.413 | 0.343 | 0.357 | 0.405 |
|         |            | CP  | 0.837 | N.d  | 0.750 | 0.825 | 0.888 | 0.801 | 0.901 |
|         |            | k   | 5.33  | N.d  | 2.83  | 2.93  | 3.28  | 3.50  | 2.74  |
|         |            | N   | 4-2   | 4-1   | 1     | 1     | 4-2   | 3     |       |

Note: a) The data are given in terms of thousands of rubles; b) N.d - not determined.
|                      | CP     | 1.246 | 0.599 | 0.527 | 0.583 | 0.428 | 0.489 | 0.525 |
|----------------------|--------|-------|-------|-------|-------|-------|-------|-------|
|                      | k      | 1.86  | **4.10** | **4.50** | **4.24** | **4.46** | **4.44** | **4.37** |
|                      | N      | 2     | 4-2   | 1-2   | 4-2   | 1-2   | 1-2   | 1-2   |
| Processing           | MI     | 0.539 | 0.546 | 0.614 | 0.625 | 0.650 | 0.683 | 0.726 |
|                      | CP     | 2.971 | 2.590 | 2.707 | 2.273 | 2.667 | 3.027 | 2.896 |
|                      | k      | 0.62  | **0.71** | **0.60** | **0.70** | **0.58** | **0.48** | **0.48** |
|                      | N      | 3     | 4-2   | 3     | 4-2   | 3     | 3     | 4-2   |
| MI                   | 0.539 | 0.546 | 0.614 | 0.625 | 0.650 | 0.683 | 0.726 |
| CP                   | 2.971 | 2.590 | 2.707 | 2.273 | 2.667 | 3.027 | 2.896 |
| k                    | 0.62  | **0.71** | **0.60** | **0.70** | **0.58** | **0.48** | **0.48** |
| N                    | 3     | 4-2   | 3     | 4-2   | 3     | 3     | 4-2   |
| Production of        |        |       |       |       |       |       |       |       |
| electricity, gas and |        |       |       |       |       |       |       |       |
| water                |        |       |       |       |       |       |       |       |
| Mining               | MI     | 0.329 | 0.308 | 0.305 | 0.318 | 0.295 | 0.264 | 0.283 |
|                      | CP     | 0.255 | 36.68 | 0.301 | 0.325 | 0.318 | 0.330 | 0.288 |
|                      | k      | 11.92 | **0.09** | **10.89** | **9.69** | **10.69** | **11.48** | **12.27** |
|                      | N      | 4-2   | 1-2   | 2     | 3     | 2     | 1     | 4-2   |
| Processing           | MI     | 0.857 | 0.891 | 0.876 | 0.848 | 0.856 | 0.877 | 0.889 |
|                      | CP     | 2.515 | 1.388 | 2.584 | 3.189 | 0.905 | 6.248 | 8.111 |
|                      | k      | 0.46  | **0.81** | **0.44** | **0.38** | **1.29** | **0.18** | **0.14** |
|                      | N      | 4-2   | 4-2   | 1-2   | 1-2   | 4-2   | 3     | 3     |
| Production of        |        |       |       |       |       |       |       |       |
| electricity, gas and |        |       |       |       |       |       |       |       |
| water                |        |       |       |       |       |       |       |       |
| The Republic Of      |        |       |       |       |       |       |       |       |
| Sakha (Yakutia)      | Mining | MI     | 0.276 | 0.261 | 0.269 | 0.278 | 0.278 | 0.279 | 0.274 |
|                      | CP     | 1.099 | 0.928 | 0.976 | 0.914 | 0.960 | 0.923 | 1.036 |
|                      | k      | 3.33  | **4.14** | **3.80** | **3.94** | **3.74** | **3.89** | **3.52** |
|                      | N      | 1     | 2     | 3     | 4-2   | 1-2   | 4-2   | 1-2   |
| Processing           | MI     | 0.669 | 0.652 | 0.614 | 0.652 | 0.686 | 0.700 | 0.698 |
|                      | CP     | 1.711 | 1.879 | 1.888 | 1.983 | 2.282 | 2.175 | 2.220 |
|                      | k      | 0.87  | **0.82** | **0.86** | **0.77** | **0.64** | **0.66** | **0.65** |
|                      | N      | 3     | 1-2   | 1     | 3     | 3     | 4-2   | 1-2   |

Yamalo-Nenets
Autonomous district

| Mining               | MI     | 0.329 | 0.308 | 0.305 | 0.318 | 0.295 | 0.264 | 0.283 |
|                      | CP     | 0.255 | 36.68 | 0.301 | 0.325 | 0.318 | 0.330 | 0.288 |
|                      | k      | 11.92 | **0.09** | **10.89** | **9.69** | **10.69** | **11.48** | **12.27** |
|                      | N      | 4-2   | 1-2   | 2     | 3     | 2     | 1     | 4-2   |
| Processing           | MI     | 0.857 | 0.891 | 0.876 | 0.848 | 0.856 | 0.877 | 0.889 |
|                      | CP     | 2.515 | 1.388 | 2.584 | 3.189 | 0.905 | 6.248 | 8.111 |
|                      | k      | 0.46  | **0.81** | **0.44** | **0.38** | **1.29** | **0.18** | **0.14** |
|                      | N      | 4-2   | 4-2   | 1-2   | 1-2   | 4-2   | 3     | 3     |
| Production of        |        |       |       |       |       |       |       |       |
| electricity, gas and |        |       |       |       |       |       |       |       |
| water                |        |       |       |       |       |       |       |       |

The Republic Of
Sakha (Yakutia)
Minning
Production of electricity, gas and water

| MI | 0.572 | 0.557 | 0.551 | 0.568 | 0.534 | 0.484 | 0.453 |
| CP | 0.446 | 0.468 | 0.455 | 0.369 | 0.352 | 0.367 | 0.383 |
| k  | 3.92  | 3.83  | 3.99  | 4.78  | 5.32  | 5.63  | 5.77  |
| N  | 1     | 1-2   | 2     | 4-2   | 2     | 1     | 1     |

Chukotka Autonomous district

Mining

| MI | 0.581 | 0.517 | 0.494 | 0.576 | 0.620 | 0.612 |
| CP | 2.217 | 2.207 | 1.680 | 1.096 | 1.675 | 2.023 |
| k  | 0.78  | 0.88  | 1.20  | 1.58  | 0.96  | 0.81  |
| N  | 1     | 2     | 2     | 4-2   | 3     | 1-2   |

Processing

| MI | 0.414 | 0.639 | 0.849 | 0.867 | 0.826 | 0.649 |
| CP | 0.541 | 0.670 | 0.541 | 0.585 | 0.959 | 0.799 |
| k  | 4.46  | 2.33  | 2.18  | 1.97  | 1.26  | 1.93  |
| N  | 2     | 3     | 4-1   | 3     | 1-2   | 2     |

Production of electricity, gas and water

| MI | 0.209 | 0.150 | 0.296 | 0.385 | 0.262 | 0.299 |
| CP | 0.527 | 0.384 | 0.526 | 0.497 | 0.402 | 0.411 |
| k  | 9.06  | 17.33 | 6.42  | 5.22  | 9.49  | 8.14  |
| N  | 1     | 2     | 3     | 4-2   | 2     | 3     |

Production of electricity, gas and water

| MI | 0.609 |
| CP | 0.671 |

Production of electricity, gas and water

| MI | 0.227 |
| CP | 0.388 |

4. Conclusions

1. From the point of view of the theory of endogenous economic growth, the change in the value of the coefficient of technological effectiveness level of production determines the rate of technological progress, since it depends on the degree of renewal of the active part of fixed assets, with its absolute value in the country's economy being calculated in the same way at micro, meso and macro levels on the basis of statistical data. Accordingly, the values of this coefficient at the best enterprises of industries can be used by enterprises as target values in technological innovations.

2. The target values of the coefficient of technological effectiveness level of production and material intensity determine the target value of the capital productivity of enterprises as well, and hence their labor productivity. Thus, there is a possibility of calculating the reachability of goals on the basis of available financial capacity of enterprises, including the use of "quasi-self-financing".

3. The methodological approach considered should first be used to assess the possibility of innovation activation and increase the productivity of Arctic enterprises operating under difficult climatic conditions.

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