Management of technological modernization of production as the most important factor of labor productivity growth in the industry of the Arctic regions

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Abstract. It is shown that technological modernization should have a significant impact on the growth of labor productivity but this process must be effectively managed for the maximum use of available production resources. For this purpose, it is proposed to follow a new direction of economic analysis of the production system activity, namely, the investment-and-innovation analysis which allows determining the economic necessity and possibility of technological renewal for any production enterprise or industry. It was found that over previous years the intensity of technological renewal of industrial production in the Arctic regions was insufficient. As a result, the growth of labor productivity was provided mainly extensively due to the increase in the level of fixed capital per worker. Accordingly, a significant increase in capital productivity, and hence labor productivity, while reducing the material intensity of products, which allows the volume of toxic waste emissions into the environment to be diminished, can only be achieved due to the introduction of intensive technological innovations of intensive type. At the same time, the effectiveness of practical implementation of such solutions is largely influenced by the quality of the human capital used by the industry. It is shown that the successful implementation of technological modernization largely depends on the regulatory role of the state.

1. Introduction

The level of labor productivity in the Russian economy is several times lower than that in developed countries [1], thus the study of opportunities for increasing labor productivity is an urgent task [2], [3]. This finding is of particular importance for the regions of the Russian Arctic, where labor productivity in industry is much lower than that in the Northern regions of the Scandinavian countries [4]. The fact is that, on the one hand, severe climatic conditions make it necessary for enterprises to provide employees with an increased level of wages, which reduces their profits compared to the enterprises operating under more favorable conditions. On the other hand, in many Arctic regions there is a tendency to decrease the number of permanent residents, mainly due to the outflow of young people - the most promising labor resources.

Digitalization of the economy should bring a new impetus to the growth of labor productivity, but the growth rates will vary in different sectors of the economy [5]. In the production sectors of the Russian economy, technological modernization should have a significant impact on labor productivity growth, but this process must be managed effectively for the maximum use of available production resources [6].

Labor productivity in production systems is known to be determined by multiplication of the value of fixed capital per worker by the value of capital productivity, where the former is the extensive factor of economic development and the latter is an intensive one. It is obvious that under modern conditions the
economic growth should be determined to a greater extend by the influence of intensive factors. This means that the growth of labor productivity in the production sectors of the Russian economy primarily depends on the growth of capital productivity which should provide the technological renewal of production.

Unfortunately, over the previous decade capital productivity in industry declined rather than increased. We have shown that between 2005 and 2015, its value decreased from 1.32 to 1.10 rubles/RUB. As a result, fixed capital per worker increased 5.1 times over these years, with labor productivity increasing only 4.3 times (in current prices), i.e. 80 per cent less. In our opinion, the reasons for this situation are as follows. On the one hand, in practice the implementation of cost-effective investment projects for technological innovations at existing enterprises does not always lead to an increase in the level of its capital productivity. On the other hand, companies often do not set the goal of increasing the level of capital productivity, since it, other things being equal, reduces the share of depreciation in production cost and therefore cuts the amount of their own financial resources which are not subject to taxation in contrast to profit. Thus, the purpose of the work is to determine the main directions of increasing labor productivity in the Russian industry on the example of the Arctic regions.

2. Materials and methods
The first situation arises because when an investment project is implemented at an existing enterprise, the project level of capital productivity may be less than its level at this enterprise. Unfortunately, this fact is not taken into account in the current (second) edition of the officially approved Methodological Recommendations for Evaluating the Effectiveness of Investment Projects [7], and even in its subsequent amended version from 2004 (the third edition), which has not been officially approved yet.

The second situation can be resolved by using the new direction of economic analysis of production systems’ activity that we are developing - the investment- and-innovation analysis [8], [9], [10], which allows one to determine the economic necessity and possibility of technological renewal for any production enterprise or industry. As a result, it is possible to significantly increase both the level of capital productivity, and hence labor productivity, and reduce the material intensity of products, that is, increase the profit and the share of added value in the cost of these products and, accordingly, the contribution of the production system to the growth of the country's GDP. In addition, reducing material intensity will decrease the toxic waste emissions into the Arctic environment, with its assimilation capacity being significantly lower than that of other Russian regions [11], [12], [13], [14].

However, the investment- and innovation analysis shows that the simultaneous growth of capital and material productivity is possible only if the production system operates at one of the six possible stages of the technological development life cycle [10]. This provides the most significant increase in the coefficient of technological effectiveness level, which, in our opinion, reflects the impact of technological progress on the development of production systems. Thus, if the technological development of the production system corresponds to other stages, it reduces the efficiency of using production resources - material, labor and fixed capital. For example, capital productivity at enterprises can also grow in cases when the company increases output of products with a technology being in use for a long time, in which the equipment has a significant level of physical wear, hence the material intensity of products is no longer reduced, but begins to grow. Accordingly, if the technological renewal of production is not performed on time, at the next stage of the life cycle of technological development of production systems, along with the growth of material intensity, the capital productivity will simultaneously decrease, which will ultimately lead to a sharp decrease in enterprise’s profits and cause its financial insolvency with the subsequent possibility of bankruptcy.

3. Results
Unfortunately, over previous years, the intensity of technological renewal of industrial production in the Arctic regions was highly insufficient. The economic results of industrial development by type of industrial activity in the four regions that are in the Arctic zone of the Russian Federation within 2005 to 2015 (five-years results) presented in Table 1 show that, on the one hand, the growth of labor productivity in the industry of the Arctic regions is mainly provided extensively by increasing the level of fixed capital per worker. On the other hand, it is clear that a significant increase in capital productivity and hence labor productivity, while reducing the material intensity of products, can only be achieved due to the introduction
of technological innovations of intensive type, i.e. updating the active part of fixed assets of industrial enterprises on a new technological basis.

This circumstance is determined by the fact that in all Arctic regions the development of industrial production did not correspond to the best stage of the life cycle of technological development of production systems, although the values of the coefficient of technological effectiveness level of production tend to increase. Accordingly, it becomes possible to manage the innovative and effective development of the industry in the Arctic regions-subjects of the Russian Federation, which is basically what the regional industrial policy should be aimed at.

Of course, the effectiveness and implementation of such solutions largely depends on the quality of management activities at all levels of industry management and, in general, on the quality of human capital used by enterprises [15], [16], [17], [18]. Accordingly, on the one hand, the internal investment –and-innovation analysis allows enterprises to develop necessary requirements for knowledge, skills and practical experience of the labor force used and, on the other hand, to formulate prospective requirements for the education system at all levels to ensure the necessary quality of workers and specialists.

It should be noted that the successful technological modernization depends largely on the regulatory role of the state. In some cases, the authorities of the state and regions-subjects of the Federation can provide financial support to enterprises introducing actively technological innovations on the terms of private-public partnership, for example, in the form of the "quasi-self-financing" mechanism proposed by us. In addition, if such enterprises reduce the costs of production and sales of their products by increasing material, capital, and labor productivity, they could be allowed to use the accelerated depreciation mechanism within the limits that ensure that the profit tax they paid before the introduction of technological innovations is not reduced.

**Table 1.** Indicators of labor productivity (in thousands of rubles per person), fixed capital per worker and capital productivity in the Arctic regions by types of industrial activity (by five-year period)a,b

| Regions                  | Indicators | 2005  | 2010  | 2010/2005 | 2015  | 2015/ 2010 | 2015/2005 |
|--------------------------|------------|-------|-------|-----------|-------|------------|-----------|
| **Nenets Autonomous district** Mining | LP         | 8729  | 25595 | 2,932     | 26417 | 1,032      | 3,026     |
|                          | FCW        | 8853  | 43381 | 4,900     | 63199 | 1,457      | 7,139     |
|                          | CP         | 0,986 | 0,590 | 0,598     | 0,418 | 0,708      | 0,424     |
| **Processing**           | LP         | 863   | 1643  | 1,904     | 17737 | 10,795     | 20,553    |
|                          | FCW        | 325   | 390   | 1,200     | 0,897 | 0,002      | 0,003     |
|                          | CP         | 2,654 | 4,212 | 1,587     | 19771 | 4741,453   | 7449,5    |
| **Production of electricity, gas and water** | LP         | 833   | 940   | 1,128     | 1523  | 1,620      | 1,828     |
|                          | FCW        | 656   | 1123  | 1,712     | 1901  | 1,693      | 2,898     |
|                          | CP         | 1,269 | 0,837 | 0,660     | 0,801 | 0,957      | 0,631     |
|          | LP  | FCW | CP    |
|----------|-----|-----|-------|
|           | 1181| 3199| 2,709 |
| Production| 2,753| 7593| 2,374 |
|           | 6,430|     |       |
| Processing| 863 | 1943| 2,251 |
|           | 3262| 1,679| 3,902 |
|           | 1,437| 1078| 2,368 |
|           |     | 1,648|       |
|           |     | 2,082|       |
|           |     | 3,841|       |
|          | 1,895| 2,971| 0,950 |
| Production of| 0,950| 3,027| 1,019 |
| electricity, gas and|       |       |       |
| water        | 1,597|       |       |
|          | 1108| 2159| 1,949 |
| Yamalo-Nenets| 2,747| 1,272| 2,479 |
| Autonomous district|       |       |       |
| Mining     | 4226| 7522| 1,780 |
|           | 18870| 2,509| 4,465 |
|           |     | 1,385|       |
|           |     | 2,356|       |
| Processing| 562 | 2978| 5,299 |
|           | 3300| 1,108| 5,872 |
|           | 6,248| 2,484| 1,609 |
|           | 0,397| 0,292| 0,760 |
| Production of| 0,222|       |       |
| electricity, gas and|       |       |       |
| water        | 0,559|       |       |
| Chukotka | 941 | 1610| 1,711 |
| Autonomous district| 2,230| 1,385| 2,370 |
| Mining     | 2370| 5514| 2,327 |
|           | 10045| 1,822| 4,238 |
|           | 0,397| 0,292| 0,760 |
|           | 0,760|       |       |
|           | 0,559|       |       |
|          | 616 | 5916| 9,604 |
|           | 13940| 2,356| 22,630|
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| Processing   | LP  | 1054  | 1198  | 1,137 | 2427 | 2,026 | 2,303 |
|--------------|-----|-------|-------|-------|------|-------|-------|
|              | FCW | 26    | 2214  | 85,154| 3038 | 1,372 | 116,829|
|              | CP  | 40,143| 0,541 | 0,013 | 0,799| 1,477 | 0,020 |

| Production of electricity, gas and water | LP  | 752   | 1337  | 1,778 | 2477 | 1,853 | 3,294 |
|----------------------------------------|-----|-------|-------|-------|------|-------|-------|
|                                        | FCW | 1519  | 2537  | 1,670 | 6027 | 2,376 | 3,968 |
|                                        | CP  | 0,495 | 0,527 | 1,065 | 0,411| 0,780 | 0,830 |

a LP is labor productivity, FCW is fixed capital per worker, CP is capital productivity.
b Calculated according to the statistical collection "Regions of Russia. Socio-economic indicators".

4. Conclusion
It is shown that under conditions of digitalization of the Russian economy, a significant increase in labor productivity in the industry of the Arctic regions can only be achieved due to effective management of the process of technological modernization. To do this, it is proposed to use a mechanism for performing a new direction of economic analysis of production systems - the investment- and innovation analysis.

It was revealed that over previous years the intensity of technological renewal of industrial production in the Arctic regions was highly insufficient. As a result, the growth of labor productivity was provided mainly extensively due to the increase in the level of fixed capital per worker. Accordingly, a significant increase in capital productivity, and hence labor productivity, while reducing the material intensity of products, which allows the volume of toxic waste emissions into the environment to be diminished, can only be achieved due to the introduction of technological innovations of intensive type.

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