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V. V. Akberdina, A. V. Grebenkin

## OPPORTUNITIES OF ECONOMIC DEVELOPMENT OF THE SVERDLOVSK REGION IN THE LIGHT OF TECHNOLOGICAL MULTISTRUCTURE<sup>1</sup>

*In the article on the basis of the statistical data it is shown that the problem of inadequate structure of technological ways remains one of the main problems of Sverdlovsk region development, a barrier to sustainable growth, the inertial trap threatening by serious structural crisis in intermediate term prospect. Possibilities of occurrence of the sixth technological way sprouts as a way of nanotechnological projects and conditions of the bearing branches transformation taking into account innovations in the field of molecular researches and workings out are designated.*

Economic and empirical studies [1, 2, 4] showed that the technological structure of the economy can be distinguished by groups of technology clusters associated with each other by the same type of technological chains and form reproducing integrity — the technological way. Each of these patterns represents a holistic and sustainable education, within which a closed cycle, including mining and primary resources receipt, all stages of their processing and production of a set of end products that meet the appropriate type of public consumption. The life cycle of the technological way covers nearly a century, the period of its dominance in the economy varies from 40 to 60 years (with the acceleration of STP and reducing the duration of research and production cycles, this period is gradually reduced).

Complex of basic technologies of related industries form the core of the technological way. Technological innovation involved into creating the core of the technological way, is known as a «key factor». Industries, intensively consuming the key factor and playing a leading role in the dissemination of new technological ways, are its bearing branches. By the beginning of the XXI century in the global techno-economic development (beginning with the Industrial Revolution in England) there are life cycles of the five successive technological ways, including the information technology way, which is

dominant structure of modern economy. Currently in the world economy began a transition to the sixth technology way.

Technology multistructure that exists within the world economy, has an impact on the economy development by creating its new type, changing the behavior of economic agents, forcing them to develop new strategies and tactics work in modern conditions. In the international division of labor today countries with technical and innovative capabilities, which are the first to master new types of products of modern technological way, assigning intellectual rents, benefit.

A study of the technological level of development of the Sverdlovsk region shows that technological multistructure of the production is now one of the main problems of the region. It must be noted that the very multistructure is normal, provided that the lowest way correlate with the way higher and are gradually replaced. In the Sverdlovsk region, however, along with emerging technologies the production of obsolete technology ways continues existing; the third and fourth ways have been marginalized from the market of developed countries long ago and are not the carriers of economic growth (fig. 1). Typically, they are unprofitable and artificially supported by local authorities and their continued reproduction reduces the effectiveness of economy as a whole and makes it difficult to further develop the region's economy.

While the second technological way shares less than 1%, the third way is dominant in the output of industrial production (fig. 1). The third technological way of the Sverdlovsk region is represented with mining, production of foodstuffs, including beverages and tobacco, wood processing and production of wood, pulp and paper production, publishing and printing activities, part of metallurgical production, as well as production and distribution of electricity, gas and water. The grouping of economic activities for the technological ways was produced by [2, 6, 13].

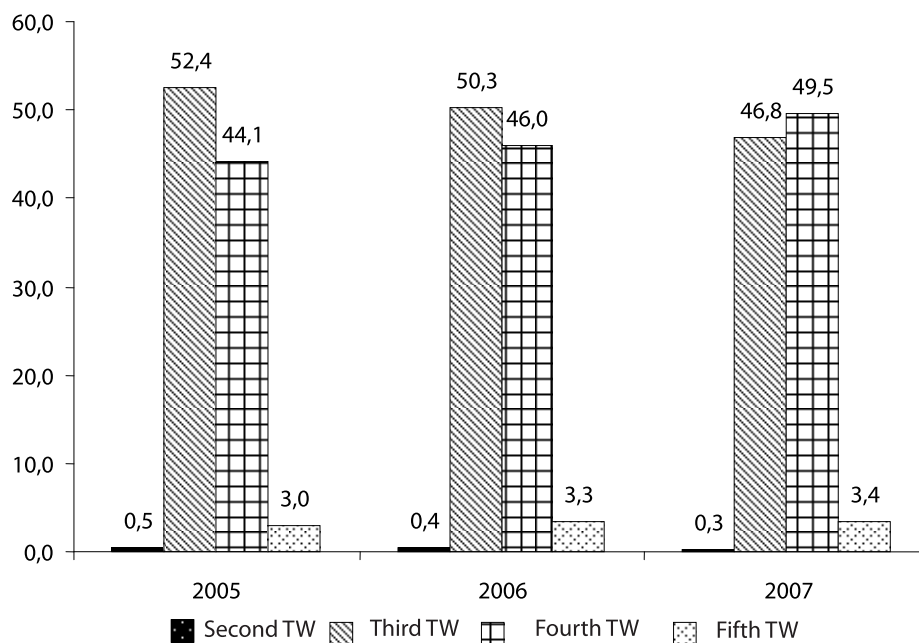
The share of the third technological way to the year 2007 accounted for more than half of the shipped products in the industry. Since 2007 there has been a positive change in the technological structure of industrial production — the percentage

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of the fourth technological way made up for almost 50%. Primarily this happened due to technical re-equipment and transition to production with high added value in the steel industry. The structure of ferrous metallurgy in the recent years has improved due to the faster growth in production of final products, rolled and steel pipes, as compared to the production of steel, and a growth of steel production — with the growth of iron and iron, respectively — to the production of ore and coke. Non-ferrous metal enterprises also consistently implement programs aimed at developing the production of high-tech and competitive products.

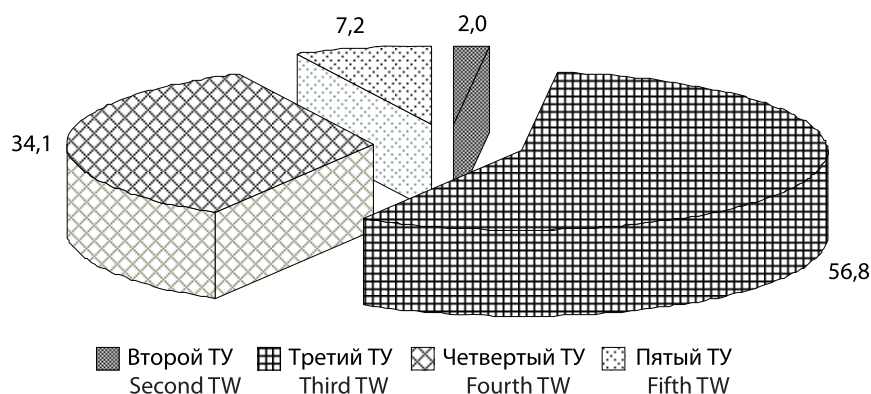
In addition to the part of metallurgical production, the activities of the fourth technological lifestyle includes production of coke and petroleum products, chemicals, rubber and plastic products, building materials, machinery and equipment, vehicles.

Catastrophically low proportion of the fifth technological way — about 3.5% in the structure of industrial production — is the principal barrier to further development of the economy of the Sverdlovsk region. The composition of the fifth way is composed of the production of electrical, electronic and optical equipment, medical equipment, aircraft and spacecraft. However, it should be noted that the fifth technological way is not only in manufacturing but also in the non-industrial sector. It allows increasing the proportion of the structures in the gross output of the Sverdlovsk region in general up to 7% (fig. 2). The output of the fifth technological way is supplemented with communication, activities associated with the use of computer technology and information technology, research and development. Compiled by: The central statistical database of Federal State Statistics Service, [www.gks.ru](http://www.gks.ru).



Compiled by: The central statistical database of Federal State Statistics Service, [www.gks.ru](http://www.gks.ru).

**Fig. 1.** The technological structure of industrial output in Sverdlovsk region



**Fig. 2.** The technological structure of the volume of shipped products for all types of economic activity in the Sverdlovsk region in 2008

As it is evident from the measurement results and available estimates at this stage of growth of the fifth technological way, reached the stage of maturity, its spread in the Sverdlovsk region occurs in the bearing industries, while technological core remains undeveloped. It follows that the fifth way enlargement process has a catching imitating nature. The rapid expansion of bearing branches of the fifth technological way is happening on the base of import technologies that prevents the chances for adequate development of key technologies of its core. This means drawing of the enterprises into the trap of unequal exchange with a foreign core of the technological way, which generates the bulk of intellectual rents [1].

It should be noted that the rate of growth of the fifth technological way industries starting with the 80-ies of the last century reached 25–30% per year in developed and newly industrialized countries, that is 3–4 times the growth rate of industrial production in general, [10] and their contribution to the growth of GDP reached 50% in the 80's 90's [9]. In the Sverdlovsk region for the period 2006–2008 average real growth rate of the fifth technological way did not exceed 5% per year (table 1).

Table 1

**The real growth rate of shipment of products on the technological ways of the Sverdlovsk region in the period 2006–2008**

	2006	2007	2008	Average for the period 2006–2008
Fifth TW	109,9	93,9	110,3	104,7
Fourth TW	121,8	117,9	111,8	117,1
Third TW	125,2	118,0	89,5	110,9

Compiled by: The central statistical database of Federal State Statistics Service, [www.gks.ru](http://www.gks.ru).

Thus, structural and technological shifts in the economy of the Sverdlovsk region are largely carried out spontaneously under the influence of current market changes, resulting in a critical situation in the technological structure of production. As a result, there was a serious shift to the dominance of low-, energy- and environmentally exceptionable technology industries of the third way. In addition, the simultaneous expanded reproduction of the three production ways due to the overall resource constraints led to a decline in growth rates of each of them, including the fifth (table 1), as well as to slow the progressive structural changes.

As noted by S. Glaziev, the current world crisis is nothing but a process of substitution of the fifth technological way by the sixth. And although the process is somewhat obscured by layers of specific

processes such as financial pyramid bond issuer's global currency and financial derivatives, the overall picture of the global crisis fits into the overall picture of the long waves of economic conditions and the replacement of their technological ways which make its base.[1].

«The economic miracles» of last century show that the period of replacement of the technological ways creates for countries lagging behind the window of opportunity for technological breakthrough. However, considering the economic and technological reality in the Sverdlovsk region, it should be recognized that the possibility of technological breakthrough and «saddling» of the new economic wave looms very weak. Being burdened by the surplus capacity of the obsolete technological way, Sverdlovsk region is more vulnerable to structural crisis, and will face massive devaluation of capital in the medium term. However, there are certain prerequisites that allow us to talk about establishing a foundation for the formation of a small niche in the sixth way core with the technological modernization of the mass of bearing branches. This is possible along with the formation of a tight regional industrial policy, including both encouraging the development of new technologies and production of competitive materials, and targeted formation of the regional innovative infrastructure, including the promotion of scientific development at the molecular level (known as nanotechnology).

At the forefront come economic problems of the nanotechnology development, which can be divided into endogenous, related to economic factors of the actual molecular technology, and exogenous, determining the institutional conditions for the development of industries based on the achievements of molecular sciences. Endogenous factors determine a number of types of economic opportunities, the assessment of which may become the basis for determining the impact of the implementation of specific technologies [14].

The first type of the opportunities is increased profit earning by reducing the cost of traditional products (less weight, lower cost of labor, materials and energy per unit of useful properties, etc.). The second type of opportunity is associated with the emergence of clearly defined competitive advantage: the modern firms «prefer using unexpected scientific developments rather than adapt to the situation in the market demand. This is greatly related to optics, biotechnology, medical equipment, measuring equipment and many other industries where nanotechnological approaches have already demonstrated their effectiveness and can play a

crucial role in the competition on the markets of new products» [12, с. 133].

The third type of possibilities is associated with the emergence of commercial third-generation nanoproducts, «which are characterized by the usage of three-dimensional structures, synthesized by various methods, including biological methods of hierarchical self-organization, which resemble the structure of the developing mikrorobots possessing their own and changing behavior» [11, с. 293]. The third type of economic opportunities of nanotechnology is still difficult to assess, but it also opens up space for the modeling of social, environmental and ethical implications of nanotechnological revolution. The fourth type of opportunities associated with the concept of convergent technologies such as NBIC (nano-, bio-, info- and cognitive) should be mentioned. In the convergent technologies there is strong synergistic effect, which can be called the transgressive effect (by analogy with the genetic concept of transgression: strengthening (or weakening) manifestation of a genetic trait of the offspring compared to parental individuals), resulting from the joint effects of not only molecular sciences (physics, chemistry, biology), but closely interacting with information technology and cognitive sciences. It is believed that changes in the anthropogenic environment associated with the development of convergent technologies, «lead to serious changes not only on ethical perceptions in the future... but also to fundamental changes in the principles of human behavior at all» [11, с. 304].

One aspect of this choice of technological development priorities of the sixth technological

way can be nanotechnological Foresight. In the present study it is developed a technique of nano-Foresight for an expert survey of stakeholders in the Sverdlovsk region: public authorities, regional science and business, industrial enterprises, public organizations, small innovative business. The result will be the identification of research priorities for nanotechnology, defining long-term development of the science of Sverdlovsk region, the wording of the initiatives to invest in researches, development of recommendations for the later support of growing nanotechnology industry by the state of regional governance.

However, today the analysis of patterns and trends of technological ways change is of great interest for understanding the problems of economic development of the Sverdlovsk region, the establishment of regional competitive advantage, studying trends in the development of science-intensive industries. Thus, the study of technological structure of the economy of Sverdlovsk region has identified the following patterns of technological ways change in the region.

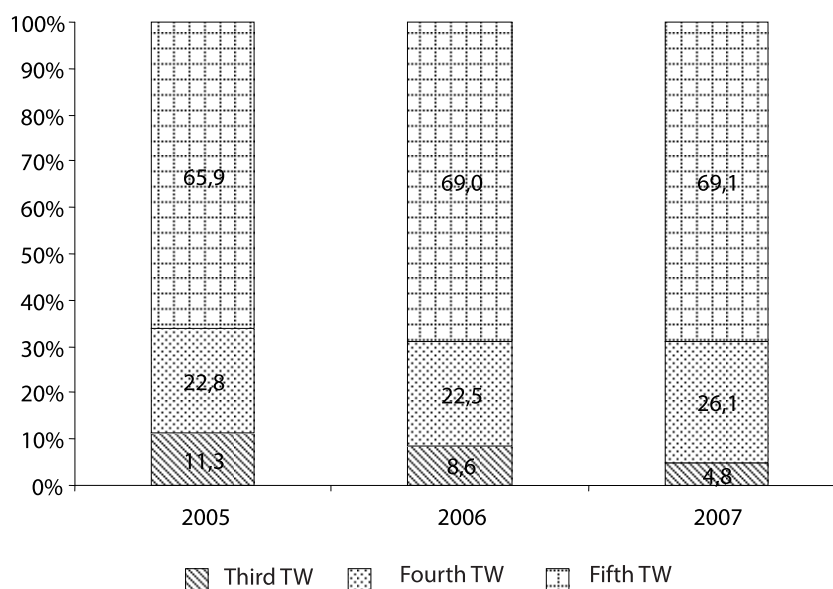
1. Changing of technological ways starts in the structure of research and development costs, and only after changing direction of innovation is changing the structure of output and GDP.

2. Potential and prospects of technology are reflecting the structure of the release of innovative products in the best way.

3. Cost-effectiveness of technological way can be measured through productivity.

#### The first pattern

Between dominating third and fourth and relatively new fifth technological ways there



Compiled by: The central statistical database of Federal State Statistics Service, [www.gks.ru](http://www.gks.ru).

Fig. 3. The technological structure of research and development costs of industrial enterprises in Sverdlovsk region

is certain continuity. The life cycle of new technological way begins during the previous domination, rooted in the industrial and institutional structures of power and spheres of social organization. During this period we can speak about the strong inertia of the industrial capital invested in tangible and intangible assets, organization, training, and relationships with suppliers, distributors and customers. Only a few entrepreneurs with enough own resources are prone to the radical innovations. In the Sverdlovsk region the inertia acquired pathological character.

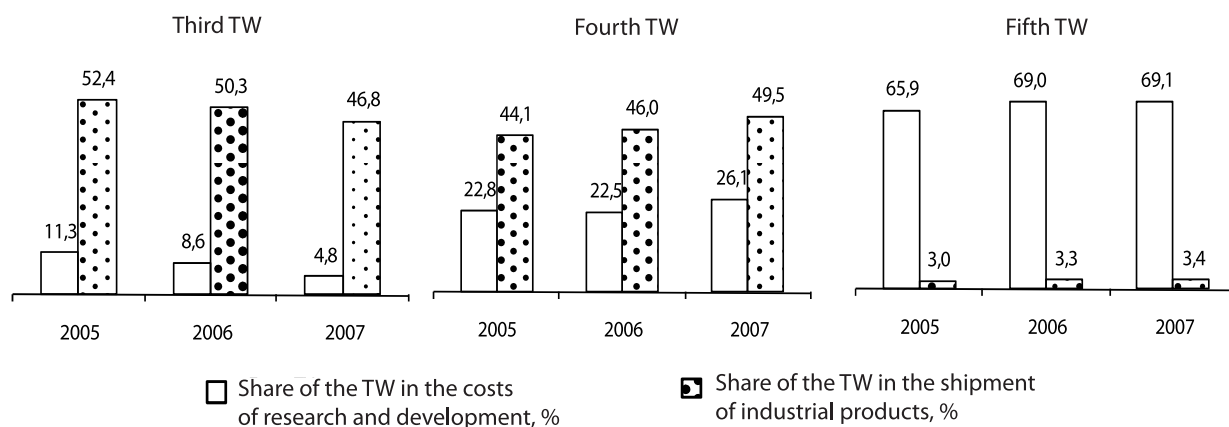
Despite the fact that the technological structure of industrial output looks rather frightening (fig. 1), the structure of research and development costs shows the prospects for further production growth of the fifth way in the near future (fig. 3). Thus the share of the fifth technological way accounts about 70% of the cost of innovation, while the dominant issue in the third way accounts only 5%.

Thus, a quantitative shift of the technological ways can be traced using the assessment of the proportion of the way in the structure of the cost of innovation and production of final products (fig. 4). Obviously, the lower the technological way, the less is its share of research and development costs and the higher its share of shipments. The high proportion of shipments is due to significant funds invested in fixed assets, personnel and organizational decisions.

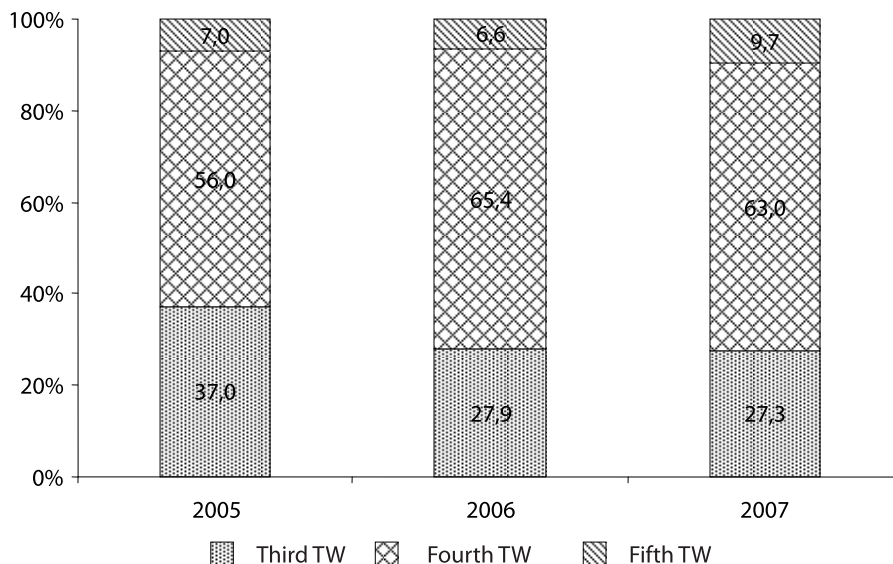
**The second pattern**

As noted in fig. 1, share of third technological way accounts nearly half of industrial output and this share declines. At the same time, a more meaningful indicator of the «long-term quality» of the way is an innovative product.

So we can conclude that in the Sverdlovsk region the fourth technological way is the dominant way which accounts more than 60% of innovative products. The share of the fifth way of accounting around 10% in the structure of innovative output,



Compiled by: The central statistical database of Federal State Statistics Service, www.gks.ru.  
**Fig. 4.** The role of technology ways in research and development costs and shipping of industrial products



Compiled by: The central statistical database of Federal State Statistics Service, www.gks.ru.  
**Fig. 5.** The technological innovation of the products shipment of industrial enterprises in Sverdlovsk region

which is slightly higher than its share of output (3%), but, nevertheless, it is not enough to talk about the competitiveness of the technological structure.

### The third pattern

Labor productivity of the technological way reflects the efficiency of working population and, consequently, the quality of employment in the economy. Industrialized countries have demonstrated high rates of formulation per worker in the fifth and sixth sectors of the technological ways. This fact is due to a high intellectual component in the production and the small number of employees. Many kinds of intellectual activity, making a significant contribution to the GDP growth does not require equipment. According to experts, today in the U.S. approximately 45 million people use as a means of production only to the intellect, backed by a personal computer [5].

In the Sverdlovsk region typical pattern for the world economic is observed. Analysis of the number of persons employed in the industrial sector has shown that half of employees work for the fourth technological way (fig. 6). In industries of the fifth way are employed only 7.6%, but in the recent years this figure has increased. Objectively share of employment in industries of the leaving third way is declining, but this proportion is still high (42%), which poses significant social risks.

Despite the obvious positive, albeit rather slow structural shifts in employment, labor productivity analysis indicates a serious backlog of industries of the fifth way from the outmoded industries of the third and fourth ways (table 2). Labor productivity of the fifth way in the technological industry is 2.4 times lower than the productivity of the fourth order, and 2.1 times lower than the third. This is due partly

to the fact that in the production of the fifth way is used equipment which is not sufficiently advanced in comparison with world analogues. Using high-efficiency equipment allows countries which are the leaders of scientific and technological progress significantly reduce employment in those sectors of the economy.

Table 2

### Formulation per worker in the industries sector, Sverdlovsk region

rubles per person.

	2005	2006	2007
Third TW	1041,9	1389,4	1717,7
Fourth TW	1247,6	1559,4	1912,8
Fifth TW	413,3	555,6	809,2

Thus, a deep analysis of the technological structure showed a catastrophic backlog of Sverdlovsk region from the level of developed countries. However, the search and implementation of projects of the sixth technological way, especially in the field of nano- and biotechnology, would find a niche in the domestic and world market. Existing in the Sverdlovsk region nanotechnology development program [8, 7] reduced in the mid-2009 to 25 projects on scattered directions: from starting a research on photonics to the organization of serial production of light-emitting diodes. Unfortunately, this program is not linked to the regional innovation system (creation of business incubators and technology parks), and has individual declining funding because of the crisis. But the main thing is that the program does not aim to build a transitional zone from the production of traditional products in the leading sectors (metallurgy, machine building and metal processing) to production of materials with new properties that can be provided with the application

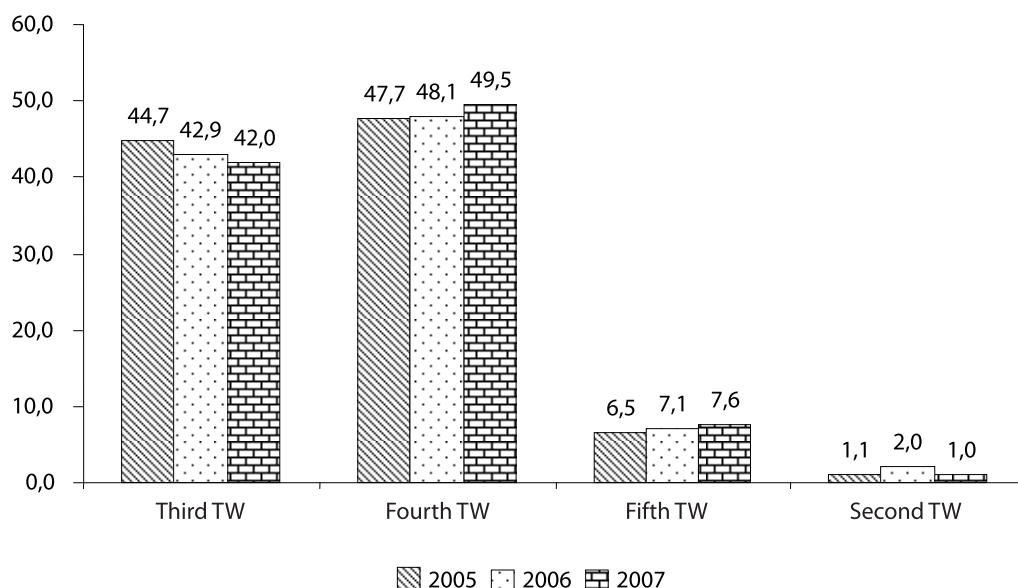


Fig. 6. The technological structure of employment in the industry in Sverdlovsk region

of molecular studies, i.e. what we call today the nanotechnological developments.

As the prospects of the «key factor» of the sixth technological way development (nanotechnology) may be required to build the script:

a) formation of clusters of nanotechnological «windows-translators» to the sixth TW;

b) formation of several (further — the entire network) closed regional chains «producer-consumer», in which nano-proposal is objectively embedded into a functional circuit of the needs of the businesses that are ready for innovative change;

c) creating conditions for innovative self-development: not to «introduce», nanotechnology, but to give «a golden key» to effective restructuring on the basis of convergent technologies [3];

d) integration of the entire range of nanotechnological developments in the regional innovation system.

Thus, the two main blocks of economic problems of nanotechnology development should be allocated: there are endogenous problem related to the assessment of the four types of economic opportunities in implementing the results of nanotechnological development; and the block external problems linking the anthropogenic environment with the economic space in the form of globalized network of regions. The implementation of the economic opportunities of nanotechnology within the new regional policy offers the chance to move to new economic and technological reality, a more advanced technological way and overcoming the consequences of instability in demand

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