

# Use of a discrete choice method to assess the willingness of the population to pay for high-tech medical care

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## ABSTRACT

As part of the current study, an attempt to assess the willingness to incur additional costs that ensure increased access to advanced medical technologies was made by using the discrete choice methodology on a representative sample of the urban Russian population. The results of the study carried out indicate that there are preconditions to attract significant financial resources to pay for medical services related to the increased use of advanced medical technologies, at the expense of the population funds and budgetary sources. In the future, this solution will enable Russia to overcome historical lagging behind medium- and high-income countries in terms of health care costs.

**Keywords:** high-tech medical, health care, VMI, health insurance, medical services.

## Introduction

Technological and organizational changes taking place in the medical area are reflected in the new terms that appeared - smart medicine and fourth-generation medicine.

Smart medicine combines the following set of characteristics formulated by Deloitte<sup>[1]</sup>:

- Appropriate treatment shall be provided in due time, place, and to a due patient;
- Physicians use technology to diagnose and treat diseases more accurately;

- All healthcare ecosystem members communicate effectively and efficiently, and use information;
- Patient data are collected in a single, easily accessible place;
- Staff do the job corresponding to their competencies (e.g. nurses take care of the patient and do not deal with administrative issues);
- Patients are informed and actively involved in treatment plans;
- Lower costs lead to new models that expand medical coverage to new areas and populations, where many medical services were not provided previously;
- Efficiency increases, meaningless costs decrease.

A new trend is the use of patient genetic information, which can radically change the healthcare model shortly<sup>[2-4]</sup>.

Continuous monitoring of individual features of a human body can become the key element of a new model, which determines the features of disease development and course. Fourth-generation medicine is not limited to the use of genetic data only, but it is the human genome decoding that is becoming a

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turning point in predictive and personalized medicine development, providing physicians access to the most extensive array of personal information. In clinical practice, expected regular use of genetic data is often seen as a transition to a new healthcare delivery model - genetic medicine or genetic healthcare<sup>[5]</sup>. In the best-case scenario, developed countries can move to a genetic healthcare model in the next five to ten years.<sup>[6-8]</sup>

It is also predicted that there in the future medicine will show a transition from disease treatment to their prevention by maintaining a healthy lifestyle and carrying out preventive examinations.

Currently, total public health funding in Russia provides severely limited access for patients to treatment based on advanced medical technologies. In the framework of this study, by using the discrete choice methodology, an attempt to assess the willingness of the Russian population to incur additional costs that ensure increased access to advanced medical technologies was made. As part of the work, possibilities to use four additional sources to fund additional programs for the health care and expensive care sectors were considered:

1. Additional voluntary contributions from the working population, using behavioral incentives to expand coverage.
2. A reverse mortgage for senior citizens - homeowners.
3. Government budget co-funding to motivate engagement, attract low-income citizens, and limit excessive risks to financial service providers.
4. Establishment of a trust fund for public assets, including public companies, land, and real estate, trading, and commercial service income of which will be used to co-fund medical care.

At the same time, an additional health insurance system should get the best out of incentives to enhance engagement of the people insured, based on behavioral effects, which provides:

- automatic inclusion in the system;
- automatic contribution escalation (low contribution rate upon accession and its automatic gradual increase to the maximum level as the nominal wage of the insured person increases);
- income tax and insurance premium transfer to the VMI system (voluntary medical insurance) benefiting insured persons, the amount is calculated based on contributions of the VMI-insured person, which gives an increase in the number of contributions by almost one and a half times compared to taxable wage contributions;
- full or partial minimum payment from the budget benefiting insured persons over the periods of insured persons' reduced income below the minimum wage.

The marginal VMI contribution rate can reach 4%, which, regarding the transferred income tax and insurance premiums to

the VMI benefiting insured persons, is equivalent to contributions of about 6%. If the payer requests to extend insurance coverage contributions to his/her parents, the contribution rate can be increased up to 6%, which is equivalent to roughly 9%, taking into account supplemental payments within the accrued income tax and insurance premiums.

## Materials and Methods

### 1. Methodological approaches to assessing willingness to pay in the healthcare sector: discrete choice experiments

Discrete choice experiments are a tool to measure individual preferences regarding economic benefits, indicated as benefit attributes as well. In contrast to the classical theory of identified preferences, development of which dates back to Samuelson's work<sup>[9]</sup>, discrete choice experiments enable individuals to express preferences regarding non-market and hypothetical goods. During the discrete choice experiment, several times, respondents compare several hypothetical alternatives, determined by their attributes, i.e. various characteristics, including the price of a product under consideration. Different product alternatives are generated by changing attribute levels. It is assumed that a rational individual will always prefer an alternative with the highest utility level. Observing the choice made by the respondent, the researcher can identify the utility level gained by the respondent from each attribute. This approach, based on the "new demand theory" ideas suggested by Lancaster<sup>[10]</sup>, is also known as conjoint analysis in the terminology of Hensher et al.<sup>[11]</sup>.

The most famous alternative to discrete choice experiments is the contingent valuation method. A certain situation or product is described in detail and respondents are asked to indicate their highest level of willingness to pay for this fixed product. In this case, only the item price attribute, not its characteristics, varies. On the contrary, in discrete choice experiments, all attributes change simultaneously, which enables the evaluation of the significance of the entire set of attributes. Although discrete choice experiments describe the product under consideration in less detail than a standard conditional evaluation study, Louvière et al.<sup>[12]</sup> indicate that this helps analyse the overall range of goods by changing the levels of significant attributes. Probable choice out of multiple goods attributes can be directly considered, which enables statistically evaluate the values of willingness to pay for each of the attributes individually. Moreover, the respondents are less likely to behave strategically in comparison to a contingent valuation focused solely to consider the price of a product that produces a negative impact on the indirect consumer utility. Finally, in contingent evaluation, respondents directly answer questions about their willingness to pay, which often leads to a biased estimation; on the contrary, according to Ryan's study, biasing is less frequent in discrete choice experiments<sup>[13]</sup>.

In the context of the current study, a particular advantage of discrete choice experiments is that the experiment includes both the attributes describing the services provided within the proposed alternative and their characteristics and the price attribute as a monthly service co-funding by the patient. Thus, the decision to choose from two or more alternatives is made in a scenario closely approximate to the market, where a consumer considers both the characteristics of the economic good and his budget constraints simultaneously. During the discrete choice experiment, respondents are faced to make a simultaneous choice on the co-funding amount and the services received, which enables the researcher to assess the relative significance of each of the attributes and the individual willingness to pay for changed attribute levels, as well as for the product in whole.

When developing reforms to the public health insurance system, quantitative results on the willingness to co-fund services enable answering the question of whether supplementing to insurance coverage is justified and under what conditions they should be included. In particular, in case a risk compulsory medical insurance model is introduced, it is required to assess a change in consumer welfare as a result of insurance coverage growth and an increase in insurance premiums.

## 2. Empiric base

### 2.1. A discrete choice experiment design to assess the willingness of citizens to pay for medical and longitudinal care services

The choice of attributes and their levels to be applied in the discrete choice experiment was based on the literature study, as well as focus group discussions consisting of citizens with different peculiarities (age, sex, health status, and experience in co-funding treatment). Seven attributes and their levels were selected, as shown in Table 1.

**Table 1 – Attributes of a discrete choice experiment and their possible values**

Attribute	Values (levels)
Outpatient services in private and institutionalized clinics	Yes/no
Hospital service in private and institutionalized clinics	Yes/no
Payment for medicines at outpatient servicing	Yes/no
Access to advanced technologies to restore and improve lost body functions	Yes/no
Treating chronic diseases with the respondent and their children in private and institutionalized clinics	Yes/no
Treating chronic diseases with the respondents' parents in private and institutionalized clinics and longitudinal care of the respondent's parents	Yes/no
Cost of free-of-charge public investment fund to pay for treating the respondent, his parents and children as a monthly income percentage	0%, 3%, 5%, 7%, 10%, 20%, 50%
Cost of the VMI policy per month as a monthly income percentage	0%, 1%, 2%, 3%, 4%, 6%

It is clear enough that all attribute type combinations and combinations of their levels account for the total number of possible scenarios that cannot be implemented during experiment  $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 7 \cdot 6 = 2^6 \cdot 7 \cdot 6 = 2688$ . To reduce their number, restrictions on possible attribute value combinations are introduced to most accurately reflect a set of potentially implemented scenarios, which, however, does not significantly reduce the number of alternatives. Additionally, design optimization methods are used, which, along with the restrictions imposed, enabled limiting the number of alternatives under the current study, except for the status quo, down to 14. The remaining 14 alternative scenarios are divided into two groups of seven alternatives, each group including one alternative in each set twice to test the consistency of the respondent's decisions. As a result, two sets of alternatives are formed, each of which having eight binary choice scenarios for each respondent. Examples of cards describing discrete choice scenarios are presented in the following section.

### 2.2. Conducting a representative sociological study

Data were collected on-line using Yandex.Form platform. The choice of a platform is justified by several factors. Firstly, the ability to publish images with the required resolution to subsequently read the text. Secondly, the ability to create questions in the format required (single or multiple-choice, scale questions), the ability to insert text blocks, the convenient format for study result extraction.

The designer enables distributing the survey form in the format of a link to the questionnaire, which facilitates the invitation of participants to participate in the survey. People who took part in the past waves of this study were invited to participate in it once again, as well as those who took part in other studies and gave consent to take part in the research later.

Invitations to complete the questionnaire were sent by e-mail or via social networks. The letter involved a short explanatory note on the study objectives and organizations that initiated it, as well as a questionnaire link to fill out. Invitations were sent to both participants of past waves of the study devoted to this issue and other study participants. In total, approximately 6,000 letters were sent. For the target audience of Moscow and St. Petersburg, questionnaires were completed easier.

The target audience is represented by two groups of study participants aged between 18 and 55: residents of Moscow, residents of St. Petersburg, and residents of other cities with a population of over 500 thousand people.

The sample size was 700 people represented by sex and age, regarding the number of residents in cities. For Moscow and St. Petersburg, the sample size accounted for 350 people, while the second half of the sample was representative of other large cities. Respondents were represented by sets of scenarios for discrete choice decision making. In addition to the discrete choice between the "status quo" scenario and the proposed set of

alternatives, respondents were asked to answer several general sociological questions during the survey. To ensure the validity of the results, which assumes that the decisions made are based on homogeneous information and are taken in a coordinated way, respondents were asked to describe the attributes and their possible values. Data were collected based on the results of the survey and experiment, while the survey was conducted following a questionnaire that enables gaining information on a significant number of socio-economic, demographic, and behavioral peculiarities of respondents.

In part 1 of the questionnaire, the respondent had to answer 24 questions about their demographic, socioeconomic and medical peculiarities: region of residence, city population, age, sex, self-reported health status, current chronic diseases in the respondent, current chronic diseases in respondent's relatives, employment type and form, marital status, educational background, trust in public health institutions, trust in private health facilities, VMI availability, number of soughts to health facilities over the past 12 months using a compulsory health insurance, whether the respondent paid for additional medical services and what the amount was, the number of visits to private health facilities over the past 12 months and the amount of services paid for, the amount of total respondent's expenditures on medicine over the past 12 months, getting to know potentials for advanced technologies to restore or improve health, experience in using advanced technologies to restore or improve health over the past 5 years, the need to provide financial assistance to parents of pre-retirement or retirement age in order to pay for treatment or purchase medicines, Total cost to help parents treat or buy drugs over the past 12 months.

In part 2 of the questionnaire, the respondent compared a standard VMI with an alternative one. At the same time, all respondents in each target group were randomly divided into two subgroups, each of which had one of the two prepared alternatives. This was followed by 8 cards with several VMI options offered to compare. In each pair, the respondent had to choose a more preferable option base on his opinion. In each card, a standard VMI was offered as the first pair, which provides outpatient and inpatient services in private and institutionalized clinics, payment for medicines at outpatient servicing, and access to advanced technologies to restore and improve lost body functions in the event of their loss or significant failure, as well as a free-of-charge public investment fund in the amount of 10% of monthly income to pay for treating the respondent, his parents, and children. A standard VMI cost is 3% of monthly income.

Table 2 shows an example of a card of the first No. A1-A8 alternative scenario set. Similarly, cards of the second No. B1-B8 alternative scenario set was drawn up, each of which was distributed to respondents randomly.

**Table 2 – Example of Discrete Choice Experiment Card (No. A1 Card)**

Service	Standard VMI	Alternative VMI
Outpatient services in private and institutionalized clinics	Yes	No
Hospital service in private and institutionalized clinics	Yes	No
Payment for medicines at outpatient servicing	Yes	No
Access to advanced technologies to restore and improve lost body functions	Yes	No
Treating chronic diseases with the respondent and their children in private and institutionalized clinics	No	No
Treating chronic diseases with the respondents' parents in private and institutionalized clinics and longitudinal care of the respondent's parents	No	No
Cost of a free-of-charge public investment fund to pay for treating the respondent, his parents, and children as a monthly income percentage	10%	0%
Cost of the VMI policy per month as a monthly income percentage	3%	0%
Choice of a Responder	<input type="checkbox"/>	<input type="checkbox"/>

Finally, after the discrete choice experiment had been conducted (part 2), the respondent was asked a series of questions from part 3 regarding their income level and risk aversion: income self-assessment, a hypothetical lottery to identify the risk aversion degree, willingness to pay for survival, willingness to pay for access to advanced technologies, the willingness of the respondent to pay a certain fraction of income monthly for gaining access to advanced medical technologies that enable to recover or improve health in the event of its substantial deterioration, willingness to pay for personal manager services, willingness to pay for individual access to expensive treatment, willingness to pay for parents' access to expensive treatment and longitudinal care.

## Results and Discussion

### 1. Data analysis results of a discrete choice experiment using a probit regression method

Evaluation of the results obtained from the respondents selected was carried out by the probit regression method. The econometric model is based on the random utility model:

$$\begin{aligned}
 V_{ij} = & \alpha_i + \beta_1AMBUL_j + \beta_2STAT_j + \beta_3MED_j \\
 & + \beta_4AUGMENT_j \\
 & + \beta_5CHRON_j + \beta_6PARENTS_j + \beta_7INVEST_j \\
 & + \beta_pPRICE_j + \varepsilon_{ij}
 \end{aligned}$$

The assessment of willingness to pay for one of the attributes is calculated as the ratio of the attribute coefficient (its marginal utility) to the price coefficient (marginal income utility). For example, the willingness to pay for an increase of the state investment fund to pay for respondent's, respondent's parents, and children treatment per 1% of the monthly income are:

$$MWTP(INVEST) = -\frac{\beta_7}{\beta_p}$$

Model evaluation findings obtained from the respondents of Moscow and St. Petersburg are presented in Table 3.

**Table 3. Evaluated findings for data obtained from Moscow and St. Petersburg**

Variable (model attribute, VMI service)	A variable named in the regression model	Coefficient estimate (standard error is indicated in parentheses)	Willingness to pay, % of monthly income
Outpatient services in private and institutionalized clinics	<i>AMBUL<sub>j</sub></i>	-0,371 (0,115)	-2,202***
Hospital service in private and institutionalized clinics	<i>STAT<sub>j</sub></i>	0,391 (0,134)	2,319***
Payment for medicines	<i>MED<sub>j</sub></i>	0,245 (0,165)	1,452
Access to advanced technologies	<i>AUGMENT<sub>j</sub></i>	0,101 (0,127)	0,596
Treating chronic diseases with the respondent and their children	<i>CHRON<sub>j</sub></i>	0,047 (0,190)	0,277
Treating chronic diseases with the respondents' parents and longitudinal care of them	<i>PARENTS<sub>j</sub></i>	0,182 (0,380)	1,078
Cost of free-of-charge public investment fund	<i>INVEST<sub>j</sub></i>	-0,021 (0,013)	-0,123
Insurance cost	<i>PRICE<sub>j</sub></i>	0,169 (0,13)	-

\*\*\* - statistical significance rate 1%

According to Table 3, the willingness to pay for the majority of additional services accounts for a significant share of respondents' income on average. The negative value is achieved only for outpatient services and in terms of willingness to use co-funding from the state property fund (where the result was statistically not significant).

The results of the model assessment for respondents from other cities with a population of more than 500 thousand people are presented in Table 4.

According to Table 4, the willingness of residents of other large cities to pay for the majority of additional services also accounts for a significant share of respondents' income on average. However, unlike residents of Moscow and St. Petersburg showing a statistically significant demand for access to advanced technologies, residents of other large cities show a specific demand for an additional service to pay for medicines. At the same time, outside Moscow and St. Petersburg, the willingness to pay for gaining access to advanced technologies is negative and statistically significant.

**Table 4. Data assessment from other cities with a population of more than 500 thousand people**

Variable (model attribute, VMI service)	A variable named in the regression model	Coefficient estimate (standard error is indicated in parentheses)	Willingness to pay, % of monthly income
Outpatient services in private and institutionalized clinics	<i>AMBUL<sub>j</sub></i>	0,011 (0,138)	0,092
Hospital service in private and institutionalized clinics	<i>STAT<sub>j</sub></i>	0,456 (0,133)	3,961***
Payment for medicines	<i>MED<sub>j</sub></i>	0,351 (0,154)	3,052**
Access to advanced technologies	<i>AUGMENT<sub>j</sub></i>	-0,196 (0,137)	-1,702
Treating chronic diseases with the respondent and their children	<i>CHRON<sub>j</sub></i>	-0,036 (0,169)	-0,311
Treating chronic diseases with the respondents' parents and longitudinal care of them	<i>PARENTS<sub>j</sub></i>	-0,015 (0,302)	-0,128
Cost of free-of-charge public investment fund	<i>INVEST<sub>j</sub></i>	0,006 (0,013)	0,052
Insurance cost	<i>PRICE<sub>j</sub></i>	0,115 (0,148)	-

\*\*\* - statistical significance rate 1%, \*\* - statistical significance rate 5%

The observed differences between the two capital cities and other large cities may be due to geographical differences in terms of high-tech medical service supply, which are much less accessible to consumers outside Moscow and St. Petersburg. As

a result, outside the capitals, high-tech medical care consuming experience is still limited, while the lack of it leads to a decrease in the willingness of consumers to pay for such health care.



At the same time, this supports a less mature model to consume medical services in cities outside Moscow and St. Petersburg. Within this model, patients prefer to seek medical care mainly in case of acute diseases. Hence, there is an increased willingness to pay for qualified hospital services. In other cases, including chronic disease treatment, patients neglect regular check-ups and visits to outpatient clinics, which is expressed in a low desire to co-fund high-quality outpatient care from personal income. Here, visiting a doctor is often replaced by self-medication, which, in turn, leads to an increased willingness to co-finance subsidized drug payment programs. At the same time, the total income share that residents of other cities are ready to co-finance for medical care and medicines is even higher than that of the residents living in the capitals.

Thus, an important condition to implement the program of additional medical care co-financing, which is based on advanced medical technologies, is the expansion of such service supply outside Moscow and St. Petersburg. This will accelerate the spread of a more mature pattern of high-tech medical care consumption throughout the rest of the country.

## **2. Assessment of additional resources that the health and expensive care system can attract through voluntary insurance contributions and reverse mortgages**

Taking into account the sociological results obtained, a preliminary assessment of potential additional costs of the population for medical and social services was conducted by processing the Russian Longitudinal Monitoring Survey of the National Research University Higher School of Economics (RLMS HSE) database. We assumed that the system of additional contributions to the medical insurance system will be formed gradually based on the principles of auto-recording and contribution escalation for young working citizens (starting from a minimum value, a gradual increase in the contribution rate as the nominal salary of the insured person increases). As part of this work, it is assumed that this system will cover older generations. Therefore, the maximum coverage of the working population making additional contributions to the health insurance system will be achieved as generations change. We conditionally assumed that additional health insurance premiums will be introduced in 2021 at a rate of 0.5% for employees aged 25-50, since this the age period when wages reach their highest value compared to the wages of employees belonging to other age groups, based on the wages distribution by age groups of workers. Starting in 2022, this rate will start to increase by 0.5% per year and will gradually reach 6%. Over time, the system of additional contributions will be applied to workers aged 50-55, 55-60, and 60-65.

For all age groups, 30 percent of employees are not expected to be covered by additional health insurance premium program. Also, workers with wages close to the subsistence rate valid for an able-bodied citizen do not make contributions to this system.

Rosstat data show that about a 2.9% account for those employees. As part of this assessment, these employees are assumed to be distributed as follows: 30% of employees under the age of 20, 10% of employees at the age of 20-24, in other age groups, workers with low wages are evenly distributed.

According to our estimates, as a result of additional health insurance premium introduction and extension, financial resources are being created, the maximum value of which in annual GDP % value can be: in 2021 - 0.6%; in 2026 - 1.3%; in 2031 - 1.5%; in 2038 - 1.9%.

Regarding budgetary subsidies in the form of additional payments to the VMI accounts in the amount of personal income tax and insurance premiums accrued for payments of the people insured with VMI, as well as budgetary supplements to the accounts of the insured persons during the periods of a significant decrease in labor income, the amount of supplement to the VMI accounts in 2038 may reach about 2.8% of GDP. To assess the potential to attract financing using the reverse mortgage mechanism, the results of a sociological survey we conducted were used. According to the results, more than a third of elderly respondents owning property are willing to conclude reverse mortgage agreements to pay for expensive treatment and care. Another third of respondents justify their participation in a program by the increased confidence in financial institutions. At the same time, we proceeded from the assumption that the willingness to use the reverse mortgage mechanism will increase as confidence in this mechanism increases, which in our scenario is created with the state directly engaged in. Taking these parameters into account, we preliminary estimate that the peak financial resources of the reverse mortgage system created to provide the population with expensive treatment and care in the event of a serious disease can reach the GDP%: 71% in 2021, 79% in 2026, 87% in 2031 and 96% in 2038.

It should be borne in mind that the resulting estimate of the reverse mortgage potential cannot be realized immediately and that these amounts will be gradually used to finance medical care and expensive care services for several decades over the forecast period and beyond it, as property owners need to receive appropriate medical and social services. The average annual potential for attracting reverse mortgage resources to finance expensive treatment and care services can be roughly estimated at 3.5% of GDP based on the simplifying assumption of a 25-year cycle of home-related turnover as part of a reverse mortgage. Excluding interest payments, commissions, and other financial intermediation expenses under reverse mortgage contracts, the available resources will be about 2.4% of GDP.

The annual population resource volume that can be used to finance expensive treatment and care within the VMI contributions and reverse mortgages, taking into account additional budgetary subsidies, as well as less financial mediation interest and fees, will amount to about 5.2% of GDP in 2038.

Thus, by 2040, when Russia's GDP per capita will come close to the current GDP rate of the most world developed countries, the amount of spending on the health care sector may double and

exceed 10% of GDP due to the proposed mechanisms, which is typical for the most developed countries today.

## Conclusion

The results of the study carried out indicate that there are preconditions to attract significant financial resources to pay for medical services related to the increased use of advanced medical technologies, at the expense of the population funds and budgetary sources. In the future, this solution will enable Russia to overcome historical lagging behind medium- and high-income countries in terms of health care costs. However, the rapid growth of effective demand for health and social services may face supply constraints.

There are several key reasons for the rigidity the proposal shows under Russian conditions:

- 1) Predominant state and municipal institutions among service providers; are unable to respond flexibly to the growing demand by making investment decisions themselves.
- 2) Investments in fixed assets are made mainly from budget funds, and decisions are made within the framework of the budgetary process, which is not sufficiently sensitive to signals from effective demand for services and technologies.
- 3) Private sector engagement in the provision of high-tech services is purposefully restrained by artificial barriers that place it in an unequal competitive environment with government agencies and do not allow compensating investments inexpensive equipment and technologies.
- 4) The system of new medical technology entry to the market is underdeveloped, it has regulatory gaps, creates unreasonable barriers, and is generally weakly focused to support the rapid wide introduction of high-demand advanced technologies.
- 5) The system of medical personnel training is rigid and poorly sensitive to the pace of technological changes; given a huge gap between the beginning of specialist training to gain new qualifications and their mass entry into the market, the potential to use many advanced technologies will be constrained by a lack of personnel and competencies.

Supply fragmentation also leads to unreasonable use of the system's capabilities, creating imbalances like an insufficient supply of expensive resources and their shortage at the same time. This negatively affects health service availability and quality.

With the growth of effective demand for advanced medical technologies, the task will be not only to concentrate and centralize specialized and high-tech medical care but to increase the share of organizations capable to intensively use advanced medical technologies. Simultaneously, it will be required to solve the issues of geographical advanced technology

accessibility, ensuring a fairly even geographical distribution of organizations using them, taking into account the geography of effective demand in such a way that the widest possible availability of high-tech aid in demand is ensured.

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