Original Paper
doi 10.15826/recon.2025.11.4.027
JEL R1, O16, D31
UDC 338

The problem of definition and calculation of the social discount rate for government financing of social projects at the regional level

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ABSTRACT
Relevance. The study's relevance stems from the need to resolve a fundamental contradiction in spatially distributed state financing to prevent inefficient resource allocation and reduce inequality.
Research Objective. The study seeks to examine specialized theories and present a practical approach to estimating the social discount rate for the effective implementation of state social policy and public financing.
Data and Methods. The study relies on mathematical modeling in combination with comparative and statistical analysis of empirical data, while theoretical and interpretive approaches provide the basis for justifying the chosen calculation model (intertemporal preferences) and critically evaluating the results. This integrated approach was used to calculate and assess the social discount rate for 85 Russian regions.
Results. The study highlights the theoretical and heuristic differences among approaches to estimating the social discount rate, explaining why the intertemporal preference method is most appropriate and distinguishing between stationary and non-stationary economic assessments. It provides an objective interpretation of the Ramsey formula parameters, grounded in primary sources and mathematical constructs. Social discount rate values were calculated for Russian regions, revealing spatial variation and a notable discrepancy between the calculated mean rate (4.26 %) and the Central Bank's key rate (18 %).
Conclusions. The proposed methodology for calculating a differentiated social discount rate for each Russian region enables a shift from a uniform approach to a targeted evaluation of social investment effectiveness. In other words, it provides a practical tool to support more informed and equitable budget policy decisions under present economic conditions.

KEYWORDS
spatial economy, social time preferences, elasticity of marginal utility, social financing, opportunity cost of capital, consumption utility, savings, income

FOR CITATION
Khairulin, V. A., Alekseev, P. V., Chuvakhina, L. G. (2025). The problem of definition and calculation of the social discount rate for government financing of social projects at the regional level. *R-Economy*, 11(4), 503–519. doi: 10.15826/recon.2025.11.4.027

Проблема определения и расчёта социальной ставки дисконтирования для государственного финансирования социальных проектов на региональном уровне

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АННОТАЦИЯ
Актуальность. Актуальность исследования обусловлена насущной необходимостью решения фундаментального противоречия в государственном финансировании проектов по пространственному признаку, во избежание неэффективного распределения ресурсов и минимизации неравенства.
Цель исследования. Рассмотреть специальные теории и представить наглядную практику оценки социальной ставки дисконтирования для це-

КЛЮЧЕВЫЕ СЛОВА
пространственная экономика, социальные межвременные предпочтения, эластичность предельной полезности,

Online ISSN 2412-0731

лей эффективной реализации социальной политики государства и государственного финансирования.
Данные и методы. В исследовании применен метод математического моделирования в сочетании со сравнительным и статистическим анализом эмпирических данных. Теоретические и интерпретационные методы служат основой для обоснования выбранной модели расчёта (межвременные предпочтения) и критического осмысления результатов. Проведён расчёт и оценка социальной ставки дисконтирования по 85 регионам России.
Результаты. Представлен теоретико-эвристическое различие подходов к оценке социальной ставке дисконтирования. Объяснено, почему приоритетным подходом к оценке социальной ставки дисконтирования является подход межвременных предпочтений, а также разница между стационарной и нестационарной экономической оценкой. Продемонстрирована объективная, основанная на первоисточниках и математических конструктивных выражениях интерпретация показателей формулы Рамсея. Произведен расчет социальной ставки дисконтирования по регионам России. Объяснена вариация значений социальной ставки дисконтирования по пространственному признаку. Выявлено расхождение между рассчитанной средней ставкой дисконтирования (4,26 %) и ключевой ставкой ЦБ (18 %).
Выводы. Расчет дифференцированной социальной ставки дисконтирования для каждого региона России позволяет перейти от унифицированного подхода к адресному оцениванию эффективности социальных инвестиций, то есть представляет практический инструмент для повышения обоснованности и справедливости бюджетной политики в текущих экономических условиях хозяйствования.

социальное финансирование, альтернативная стоимость капитала, полезность по потреблению, сбережение, доход

ДЛЯ ЦИТИРОВАНИЯ
Khairulin, V. A., Alekseev, P. V., Chuvakhina, L. G. (2025). The problem of definition and calculation of the social discount rate for government financing of social projects at the regional level. *R-Economy*, 11(4), 503–519. doi: 10.15826/recon.2025.11.4.027

区域层面社会项目国家融资的社会贴现率的确定和计算问题

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摘要
现实性：本研究的现实意义在于，亟需解决基于地域特征的国家项目融资中存在的根本性矛盾，以避免资源配置失效并最大限度地减少不平等现象。
研究目标：探讨特殊理论，并提出评估社会贴现率的明确方法，以便有效实施国家社会政策和公共融资。
数据与方法：本研究采用数学建模方法，并结合实证数据的比较和统计分析。理论和解释方法为所选计算模型（跨期偏好）的论证和结果的批判性评估奠定了基础。本研究计算并评估了俄罗斯85个地区的社会贴现率。
研究结果：本文阐述了社会贴现率评估方法的理论与启发式差异。文中解释了为何跨期偏好法应作为评估社会贴现率的优先方法，并区分了稳态与非稳态经济评估之间的区别。同时，基于原始文献与数学推导表达式，文章对拉姆齐公式的指标进行了客观阐释。研究计算了俄罗斯各地区的社会贴现率，并解释了社会贴现率在空间分布上的差异。结果发现，计算得出的平均贴现率（4.26 %）与中央银行的基准利率（18 %）之间存在显著偏差。
结论：针对俄罗斯各区域计算差异化的社会贴现率，有助于从统一方法转向精准评估社会投资效益，从而为在当前经济运营条件下提升预算政策的合理性与公平性提供实用工具。

关键词
空间经济学、社会时间偏好、边际效用弹性、社会融资、资本替代成本、消费效用、储蓄、收入

供引用
Khairulin, V. A., Alekseev, P. V., Chuvakhina, L. G. (2025). The problem of definition and calculation of the social discount rate for government financing of social projects at the regional level. *R-Economy*, 11(4), 503–519. doi: 10.15826/recon.2025.11.4.027

Online ISSN 2412-0731

Introduction

The social discount rate (SDR) has remained a controversial indicator since its inception, both in terms of value interpretation and assessment. The challenge of evaluating social discount rates is especially relevant today, as the effectiveness of public funding for social projects has become a critical factor for the sustainable development of regional and national economies. Standard discount rate practices do not reflect the substantial differences in the socioeconomic conditions of regional development, resulting in suboptimal and inefficient resource allocation and contributing to greater spatial inequality.

For the first time in complete form and with a specific mathematical description, the social discount rate appeared in Frank Plumpton Ramsey's well-known 1928 work *A Mathematical Theory of Saving*. From the moment this piece was published, which, as will later be shown, serves as a factual supplement to and a logical continuation of Evgenii Slutsky's (also known as Eugene, Eugen, or Yevgeni Slutsky) 1915 work *On the Theory of the Budget of the Consumer* (Slutsky, 2010), there has consistently been a real difficulty in interpreting and evaluating this indicator. As already noted, there are numerous interpretations of both the calculation formula and the evaluation of the SDR. There are two reasons for this:

The first reason is the actual complexity of the mathematical apparatus in the work, primarily in Slutsky's contributions that informed Ramsey's assessments in 1928. In 1963, V. A. Volkonsky and A. A. Konyus criticized Slutsky's article for presenting the main calculations in a cumbersome and unclear manner (Slutsky, 2016). This criticism, however, is not entirely justified. It is true that Ramsey presented his calculations in a more elegant and accessible form. However, Slutsky's 1915 work *On the Theory of the Budget of the Consumer* serves as a factual supplement to his earlier piece, one of the foundational works in the entire field of macroeconomics, *The Theory of Marginal Utility*, published in 1910. In that work, Slutsky developed argumentation and proofs while frequently omitting detailed explanations. This approach was understandable given the nearly 400-page volume of the text and the assumption that a thoughtful reader would be capable of analyzing causal relationships as well as performing logical and heuristic analysis. As subsequent development of the subject field demonstrated, this assumption proved correct, which is confirmed by Ramsey's 1928 work. The same applies to J. R. Hicks's 1939 book *Value and Capital*, where he discusses Slutsky's 1915 work across three chapters, and indeed the entire book reflects theory belonging to the subject field introduced by Slutsky: "The present work represents the first systematic investigation of the 'territory' first opened by Slutsky" (Hicks, 1988). Even so, the complexity of the mathematical apparatus continues to make it difficult to compare this theory with real-world phenomena, especially for economists with a predominantly humanitarian orientation.

The second reason arises directly from the first. The complexity of the mathematical expressions in Ramsey's work prompted numerous studies that offered varying interpretations, some of which diverge significantly from the original meaning of his contribution.

The objective of the study is to examine specialized theories and present a demonstrable practice for estimating the social discount rate for the effective implementation of state social policy and public financing. To accomplish this, the study pursues the following tasks:

1. To conduct a comparative analysis of theoretical approaches to determining the social discount rate and, on objective grounds, assign priority to the intertemporal preference (STP) approach;
2. To examine the methodological aspects of economic assessment related to stationary and non-stationary models and provide a clear interpretation of the Ramsey formula parameters;
3. To implement a practical procedure for calculating social discount rate values for Russian regions;
4. To analyze and explain the spatial variation in the calculated values of social discount rates.

All stated tasks were successfully completed. The first task involved a theoretical and heuristic analysis, confirming the suitability of the STP approach. The second task established a methodological foundation and an applied framework for calculating the social discount rate. Completion of the third task produced an empirical set of social discount rate values for each oblast. Finally, the fourth task revealed a key pattern: significant spatial variation in the social discount rate, reflecting differences in the socio-economic development of Russia's regions.

Online ISSN 2412-0731

Theoretical Framework

The discussion concerning the definition of the social discount rate begins with the differences in how it is understood. While standard evaluation practice typically distinguishes between two approaches, a closer historical examination reveals three:

1. *The social time preferences approach (STP).* This direction includes the contributions of E. E. Slutsky, F. Ramsey, A. C. Pigou, J. R. Hicks, J. von Neumann, O. Morgenstern, J. Broome, W. Baumol, N. Stern, M. F. G. Scott, M. Spackman, D. Ackland, A. Matthew, and others.

2. *The social opportunity cost approach (SOC).* Related terms include social opportunity cost, social alternative cost, and the marginal productivity of capital (SMP). This approach is associated with J. Hirshleifer, K. J. Arrow, R. C. Lind, D. W. Milliman, R. H. Strotz, J. A. Stockfisch, M. Eden, H. Gravelle, T. Sterner, and others.

3. The third approach combines political and economic judgments, or the views of society as a whole, to define the social discount rate. Its main representatives are S. A. Marglin and A. K. Sen, but it has not gained wide adoption.

The fundamental methodological problem in all three approaches lies in the assumption that government financing of public and social activities arises from insufficient development of markets and private capital. Practically all foundational work in this subject field was written under the influence of economic liberalism, Friedman's monetarism, and related ideas. The dominance of concepts associated with J. Locke (1632–1704), A. Smith (1723–1790), J.-B. Say[1] (1767–1832), and others remains characteristic of modern Western economic thought. However, it was during the early and mid-twentieth century that these ideas reached their peak.

For example, Hollis B. Chenery in his 1953 work[2] observes "the gap between theory and practice in the analysis of investments in underdeveloped regions". O. Eckstein's 1957 study, authored by one of the leading theorists of the STP approach, states that "criteria are necessary for project selection, considering certain specific market imperfections characteristic of underdeveloped countries". The central idea behind applying the SDR was its intended use for financing projects in "underdeveloped" countries, in line with the prevailing belief that the market serves as the primary solution to economic problems.

A notable exception is the 1970 work by K. J. Arrow and R. C. Lind, *Uncertainty and the Evaluation of Public Investment Decisions*. This study is one of the few that, following the contributions of Slutsky and Ramsey, can also be regarded as genuinely fundamental in this subject area.

The Social Time Preferences Approach

The essence of this approach lies in the idea that market or commercial interest rates reflect private interests and individual preferences regarding income, risk-taking, and related factors. In contrast, in society or a social group, collective preferences in consumption, income distribution, and similar matters become important. As a result, individual preferences expressed through market or commercial interest rates may conflict with collective preferences concerning consumption, income distribution, and risk-taking at different points in time. This distinction becomes especially important in government policy-making for financing public and social projects, activities in the budget sector, and state social programs. A practical example is the system of national projects in Russia, which are financed at preferential rates that differ from commercial or market rates.

There is a deeper issue concerning temporal preference. The commercial sector seeks to obtain benefits as quickly as possible, while the state is expected to think long-term and consider the interests of future generations. Given the finite nature of natural resources, an intertemporal consumption problem emerges: whether to consume more in the current generation or to restrain current consumption in light of future needs. Until the 1970s, the prevailing view held that the government financing rate should include a premium over the market interest rate. K. J. Arrow and R. C. Lind, particularly Lind, challenged this position by raising the issue of the fundamental distinction between market or commercial interest rates and social interest rates. These authors can be regarded as the principal theorists of the social opportunity cost (SOC) approach.

[1] Say's famous law states that supply creates its own demand, meaning that equilibrium is achieved automatically, without government intervention.

[2] Chenery introduced the indicator (within the SOC approach) of marginal productivity of capital (SMP).

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The Approach of Social Opportunity Cost (SOC)

According to this approach, a single generation can use available resources in different ways and with varying levels of benefit. The social discount rate therefore reflects the alternative uses of resources in government financing and expresses the effectiveness of those alternatives in generating public benefits.

The 1970 article by K. J. Arrow and R. C. Lind, *Uncertainty and the Evaluation of Public Investment Decisions*, became the starting point for the development of the entire SOC framework. In this work, they argue that it is necessary to distinguish not only between the benefits and costs accruing to society and those accruing to individuals, but also between individuals who experience net losses and those who experience net gains. They further argue that expected benefits should be discounted at a rate higher than the certainty rate, and costs at a rate lower than the certainty rate, even when social totals are already determined (Arrow, Lind, 1970).

At present, when the aim is to calculate the SDR with a level of credibility comparable to its explanatory value, the first approach is typically used, as it rests on a well-developed theoretical foundation and, importantly, provides a clearly articulated methodology for calculation and assessment (V. Pareto, E. E. Slutsky, F. Ramsey, J. von Neumann, O. Morgenstern, N. Stern, M. F. G. Scott, M. Spackman, D. Pearce, D. Ulph, and others). In the second approach, the theory is articulated, yet mathematical expressions with genuine explanatory power are lacking.

It should also be noted that the publications by K. J. Arrow and R. C. Lind sparked active debate and substantial criticism from supporters of economic liberalism. In fact, the subsequent influence of their work can be attributed largely to the considerable authority of these two scholars, particularly Arrow. Nevertheless, the theory of the second approach is formulated in a sufficiently complete manner, and it led to the formulation of the well-known Arrow–Lind principle (Arrow–Lind theorem): the social cost of risk tends toward zero as the population size approaches infinity (Arrow, Lind, 1970).

Arrow and Lind present equation number 23 on page 372:

$$\lim_{n\to\infty} nk(n) = 0,$$

and explain that as the number of taxpayers increases, the total cost required to cover risks approaches zero. In other words, the individual risks borne by taxpayers in connection with government investments are distributed across a very large population. Since the share of each taxpayer in the total population is extremely small ($n \to \infty$), the individual cost of covering individual risk tends toward zero as the number of participants rises, which corresponds to the scale of a national government project. This concerns primarily the individual risks associated with instability of social payments (social welfare, salaries of public employees, and other benefits), fluctuations in well-being due to reductions in government financing (social subsidies, grants, subventions), and unsystematic risks specific to a national project. The Arrow–Lind principle later found applications beyond this subject field.

The Approach to Defining the Social Discount Rate Through Consensus of Political and Economic Assessments (or of Society as a Whole)

The approach formulates a theoretical framework, but unlike the second approach, where at least some calculation procedures exist, this one offers none. Its core idea is that the social discount rate should reflect a rate emerging from the consensus of politicians, economists, and society as a whole. However, the heavy reliance on theory and the complete absence of applied assessment methods have prevented this approach from moving beyond a conceptual level.

S. A. Marglin illustrates one of the key difficulties, noting that the marginal time preference of individuals in the context of collective decisions on savings and consumption can differ markedly from their marginal time preference when they act independently (Marglin, 1968). The challenge here is that decisions about government financing are collective decisions made by those entrusted with state authority. Such decisions are not equivalent to collective decisions taken within a particular group of consumers. Marglin also observes that the rate of interest formed in an atomistic competitive market does not automatically acquire normative significance for planning collective investments (Marglin, 1963). Another problematic assumption lies in treating government financing of public and social sectors as identical to collective investment. Even within the logic of

Online ISSN 2412-0731

radical economic liberalism, such an identity appears doubtful.

To summarize, given the nature of the required assessments and the availability of established methods for practical evaluation, the most workable option is the social time preference (STP) approach. This view is widely shared; for example, M. Spackman (2004) notes that the standard STP rate is generally better suited for comparing government expenditures across time. In the practical section of this article, we likewise rely on the social time preference approach.

Method and Data

The Formula for Calculating SDR Within the STP Approach

The formula for calculating SDR, which is considered the main one (the so-called Ramsey formula or equation), usually looks like the following way (Ramsey, 1928):

$$s = \rho + \mu \cdot g. \quad (1)$$

Where s (STPR) is the social rate of intertemporal preferences (social discount rate, SDR), percent; ρ is the rate (norm) of temporal preference, percent; μ is the elasticity of marginal utility with respect to consumption, percent; g is the rate of growth of consumption per capita, percent.

Formula (1) represents a simplified special case. As noted earlier, Khairullin et al. (2021) argue that treating the parameters ρ and μ as constant is untenable in light of the empirical and theoretical evidence, a point that stems directly from Ramsey's own work. Despite this, the simplified formula continues to be widely used in applied evaluations.

When SDR is calculated dynamically, the formula's parameters must be understood as time-dependent. Moore and Vining (2018) acknowledge that ρ, g, and η may vary over time, yet they begin their analysis by treating them as constant. In the next section, we show how strongly this simplifying assumption can distort actual calculations.

A more general expression — one that better reflects real conditions — takes the following form (Khairullin et al., 2021; Khairullin, 2012):

$$STPR_t = \rho_t + t\Delta\rho_t + \mu_t g + \ln(C_t)\Delta\mu_t. \quad (2)$$

If consumption growth is treated as conditionally constant and the SDR is evaluated for a single time interval, then Formula (1) becomes equivalent to real conditions.

Stationary and Non-Stationary Model for Assessing SDR

The most important methodological issue in economic assessment lies in identifying the axiomatic assumptions that underlie any evaluation of economic events. This is crucial because many researchers, without reflecting on the nature of the initial model or assessment approach, such as Ramsey's model, apply it directly to specific projects. If the assessment model does not correspond to the actual conditions of project implementation, for example, if the model assumes stationarity while the project operates under non-stationary conditions, errors arise that can severely distort the empirical evaluation of the project's effectiveness.

But what do stationarity and non-stationarity mean? In economics, and more broadly in the analysis of time series, stationary and non-stationary models differ in the statistical properties of their indicators, specifically how the mean, variance, and covariance of a time series change over time. A model or time series is considered stationary if these statistical properties, including the mathematical expectation, variance, and covariance, do not depend on time. Importantly, this does not mean that the values are empirically constant; rather, they are conditionally constant within the model.

To make this clearer, let's consider a simple analogy. Imagine a person who visits a doctor once a year for a check-up. The examination itself involves certain controlled conditions, such as fasting before a blood test, and the person is in a rested state during the visit. The doctor's conclusions are valid at that specific moment, reflecting the accumulated "wear" on the body, but they do not account for future changes in lifestyle, exposure to new external factors, or shifts in emotional state. In this analogy, the doctor's assessment is stationary. If nothing significant changes, the conclusions and prognosis remain valid.

The problem, however, is that the world is not stationary. Both the environment and the individual's circumstances are constantly changing. To address this in practice, two general strategies are possible. First, the frequency of assessments can be increased, for example, from yearly to monthly. Second, conditions can be created to minimize the influence of external changes, such as through isolation. While a rough analogy, this example illustrates the fundamental distinction

Online ISSN 2412-0731

between stationary and non-stationary assessments and why recognizing it is critical in economic evaluation.

Let us return to economics. The overwhelming majority of existing economic and econometric models are stationary, which represents a significant empirical challenge for the discipline. As early as 1944, John von Neumann noted that the empirical foundation of economic science was largely unsatisfactory, arguing that mathematical interpretations of economic theory often provide assertions rather than proofs, offering little more than verbal reasoning (J. von Neumann, O. Morgenstern, 2013).

Ramsey's model (Formula 1) is stationary. F. P. Ramsey himself emphasized the need for simplifying assumptions, stating that society must be assumed to exist forever without changes in population, capacity for enjoyment, or aversion to labor, that enjoyments and sacrifices at different times are independent and additive, and that no new inventions or organizational improvements occur beyond those resulting from the accumulation of wealth (Ramsey, 1928).

E. E. Slutsky, who formalized the methodology for the entire subject field, distinguished between instantaneous and prolonged stationary systems, effectively creating the theory of prolonged systems. He explained that a stationary system can be defined as one in which activities repeat periodically at known intervals. While assuming absolute stationarity is a necessary theoretical abstraction, studying a prolonged stationary system is more complex than an instantaneous one. Observing actual behavior over consecutive moments shows that constancy of utility functions cannot be assumed, highlighting the limitations of instantaneous models (Slutsky, 2010).

This distinction has two important implications. First, Ramsey's model (Formula 1) represents an instantaneous stationary system, whereas Formula 2 corresponds to a prolonged stationary system, derived from Slutsky's demonstration that the equilibrium conditions of a prolonged system can be reduced to those of an instantaneous system. Second, Ramsey's model assumes the calculation of the real discount rate, a condition inherent to the model. However, if government investments are implemented under conditions of prolonged non-stationarity, the social discount rate should be recalculated for each project as frequently as possible.

In accordance with the Order of the Ministry of Economic Development of Russia No. 794 of December 24, 2021, when determining the discount rate, it is taken equal to the average for the preceding half-year. Therefore, the values of the social discount rate presented in Table 1 reflect real interest rates calculated for a half-year period, in line with Ramsey's instantaneous stationary model, Slutsky's methodological provisions, and Order No. 794 of the Russian Ministry of Economic Development.

Concerning the Problem of Interpreting the Calculation and Values of the ρ Indicator

The rate (or norm) of temporal preference, ρ, is a controversial indicator whose value is determined heuristically. In general, it reflects the subjective valuation of consumption within a society at a given point in time. If the current generation adheres to the principle that the next generation should consume at the same level as the present one, then $\rho = 0$. This zero value corresponds to the concept of impartiality, succinctly formulated by D. Broome: "Each reckons only with himself and no more than with himself" (Broome, 1992).

When ρ is greater than zero, it implies that future consumption is valued less than current consumption. The larger the value of ρ, the more weight is placed on present consumption relative to future benefits. Conversely, a negative ρ indicates that future consumption is considered more important than current consumption.

Concerning the Problem of Interpreting the Calculation and Values of the μ Indicator

The μ indicator is a key component in the SDR calculation formula. Its interpretation has been complicated by the large number of secondary publications discussing F. P. Ramsey's 1928 work, which itself represents a concise presentation and interpretation of E. E. Slutsky's 1915 research. The elasticity of marginal utility, as measured by the μ indicator, has been expressed through multiple calculation formulas and interpretations, some of which provide only a limited reflection of economic reality. In the following, we clarify the content and the step-by-step procedure for calculating this indicator, drawing on the foundational works of E. E. Slutsky and F. P. Ramsey.

In Slutsky's 1910 work *The Theory of Marginal Utility*, he writes: "For saturating goods (Fig. 3),

Online ISSN 2412-0731

$U'' \equiv \frac{d^2U}{dX^2} < 0$), and for non-saturating goods (Fig. 4) — $U'' \equiv \frac{d^2U}{dX^2} > 0$" (Slutsky, 2010), and "The limit of this ratio is evidently the derivative of specific utility, i. e., the second derivative of utility. We shall call this derivative the enjoyment of a given good… A concept analogous to acceleration and well known to mathematical economists. Large popularity it does not enjoy because the mathematical symbol $\frac{d^2U}{dX^2}$ is incomprehensible to many, and there is no special term for it. A case justifying, as it seems to me, even such an ugly neologism as 'enjoyment'" (Slutsky, 2010). Slutsky, using the phrase "incomprehensible to many," was optimistic, not anticipating that a century later, in Russian practice, interpretations would emerge that are not only difficult to understand but also bear little relation to reality. Therefore, we will attempt to explain the content of the μ indicator as simply as possible, using analogies from a high school physics course. To aid this explanation, let us turn to Figure 1.

Figure 1 presents two graphs: the marginal utility graph (red and concave) and the total utility graph (blue and convex). Consider two cases:

1) An airplane taking off (represented by the total utility graph);

2) An airplane landing (represented by the marginal utility graph).

What is the difference between these cases? In the first case, as the airplane takes off, it gains speed and acceleration — denoted in the figure by *a* — which is positive, though it can later become negative because, during takeoff, acceleration and speed are higher than during gliding. In the second case, as the airplane lands, its acceleration becomes negative (in Figure 1: $a < 0$).

This is precisely what Slutsky describes. He also explained the negative value of the first derivative (i. e., the speed of consumption), but we will not consider this here to avoid unnecessary complication. Ramsey summarizes more concisely: "This equation means that $u(x)$, the marginal utility of consumption, falls at a rate proportional to the rate of interest. Consequently, x is continually increasing until either df/dc or $u(x)$ disappears, and in this case it is easy to see that bliss is achieved" (Ramsey, 1928).

However, the phrase "incomprehensible to many" eventually led, for example, to the following formulae proposed by *D.* Pearce and *D.* Ulph in 1996: "$U''(C) = \frac{d^2U}{dX^2} < 0$. The elasticity of marginal utility of consumption μ measures the percentage by which marginal utility falls with each percentage increase in consumption. Formally: $\mu = \frac{CU''(C)}{-U'(C)}$" (Pearce et al. 1995).

M. Scasny and M. Opatrny (2022) defined it as:

$$\mu = -\frac{CU''(C)}{U'(C)} > 0,$$

where C denotes consumption, and μ — the curvature of utility, $U(C)$.

Given this definition, μ can be interpreted as a measure of Arrow-Pratt relative risk aversion (Scasny, Opatrny, 2022).

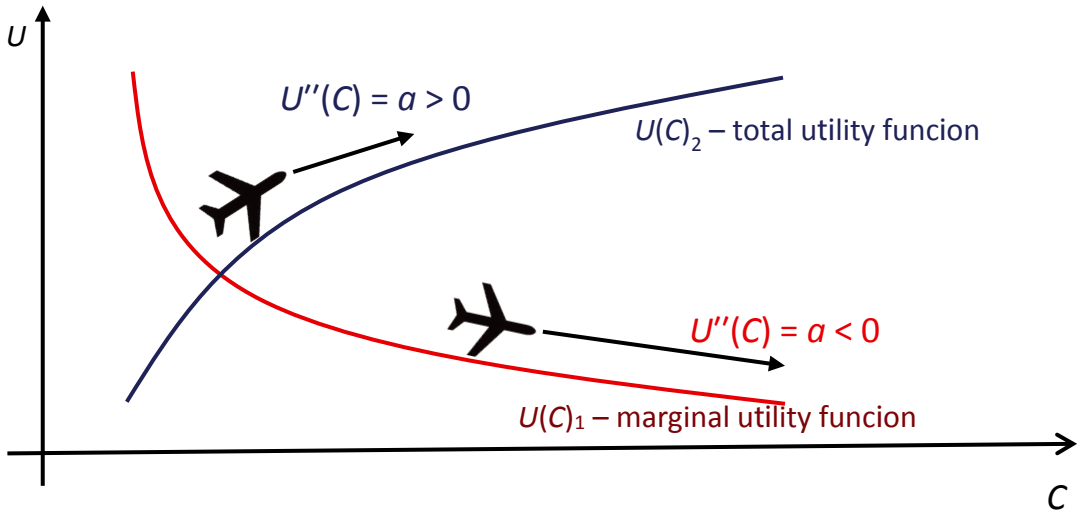

Figure 1. *View of marginal and total utility functions*

Source: developed by the authors

Online ISSN 2412-0731

The problem is that in Pearce and Ulph's formulation, a minus appears in the denominator of the fraction, which can mislead many researchers. In Scasny and Opatrny's version, a minus is placed in front of the fraction. Mathematically, this is equivalent to the minus in the denominator, but heuristically it can also cause confusion. Furthermore, labeling μ as a measure of Arrow-Pratt relative risk aversion can further distort understanding.

To clarify what the researchers were attempting to convey, let us return to Figure 1. The marginal utility graph, representing an airplane landing, slows down, and acceleration becomes negative. Consequently, the expression in formula (1): $\mu \cdot g < 0$ also becomes negative, as does the entire social discount rate. To avoid this, researchers introduce a minus in front of the fraction. In Pearce and Ulph's formulation, the minus in the denominator is mathematically correct, so that minus × minus = plus, ensuring that the social discount rate becomes positive.

The problem is that such calculations and reasoning are not immediately obvious to outside researchers. Returning to the primary source, Slutsky explains: "…at the point of saturation $dU/dX = 0$, and when satiation has occurred $dU/dX < 0$ …" (Slutsky, 2010).

Referring again to Figure 1, when an airplane lands, it is usually not acceleration that becomes negative, but speed — precisely what Slutsky highlighted. To clarify a methodological point, which is inherently complex, we present it as simply as possible: if position is described by function $U(C)$, then speed $V(U(C))$ — is the first derivative of $U(C)$ with respect to consumption: $V(U(C)) = dU(C)/dC$, then acceleration $a(U(C))$ — is the second derivative of $U(C)$ with respect to consumption: $a(U(C)) = d^2U(C)/dC$ or the first derivative of speed: $a(U(C)) = dV(C)/dC$.

For both speed and acceleration to be negative simultaneously, the function $U(C)$ must be decreasing (motion in the negative direction), and the rate of this decrease must be increasing (acceleration in the negative direction). In this case, the ratio $(-d^2U(C)/dC^2)/(-dU(C)/dC$ represents the rate of change of speed along the C-axis (or the projection of the derivative of consumption speed onto the C-axis), and similarly along the U-axis. This ratio is not a standard physical quantity with a commonly accepted name, but it describes how the speed changes along a given coordinate.

We believe that for researchers with primarily humanitarian backgrounds, such reasoning may not be entirely intuitive. Therefore, the key takeaway is simple: no minus signs should be added in front of the fraction. The universal formula for calculating the indicator μ is as follows (Scott, 1989):

$$\mu = \frac{C \cdot U''(C)}{U'(C)}, \quad (3)$$

where $U''(C)$ shows how marginal utility changes as consumption increases. Since $U''(C) < 0$, marginal utility decreases — hence the term diminishing marginal utility. That is, the slope of the tangent declines as C increases, meaning the curve becomes less steep (concave downward), reflecting a slowing increase in utility from additional consumption; $C \cdot U''(C)$ reflects the curvature of the marginal utility graph (Figure 1), weighted by the current level of consumption, i. e., a "weighted" curvature relative to the consumption level; $U'(C)$ represents the slope of the tangent to the marginal utility curve, i. e., the marginal utility itself — the negative rate of change of total utility as consumption changes.

The $(C \cdot U''(C))/U'(C)$ ratio indicates how the rate of change of the curvature of the function $U(C)$, relative to current consumption, correlates with the slope of the tangent itself (marginal utility).

Due to the complexity and the variety of interpretations of this indicator, its calculation formulas can differ significantly. We will not review all existing formulas, but it is important to note that the "classical" formula is considered to be the one proposed by *N*. Stern in 1977 (Robinson, 1990) and later modified by M. F. G. Scott in 1989, as shown in Formula (4):

$$\mu = \frac{r - \rho}{\frac{S}{Y} \cdot (r - \gamma) + \gamma}, \quad (4)$$

where ρ is the rate (norm) of temporal preference, share; r is the rate of return on investments, share; S/Y is the ratio of savings sums to income sum, share; γ is the expected rate of growth of income (wages), share.

Practice of Calculating the SDR

The following notes provide details on the calculation:

1. The source data and the calculation itself are submitted to the editorial office along with the manuscript.

Online ISSN 2412-0731

2. All values in Table 1 are taken from official sources of statistical data: Rosstat, Central Bank, RIA Rating.

3. The indicator ρ is taken as equal to zero (explained above).

4. The indicator *g* — the rate of growth of consumption per capita — is taken from the *Balance of Monetary Income, Expenditure, and Savings of the Population*, Line IV (sum of lines I + II + III), column Rate, % of previous year: 13.2 % (0.132).[3]

5. The r indicator represents the rate of return on investments. It is determined heuristically based on Central Bank[4] data as an average of coupon rates and yield to maturity, taken here as 10 % (0.1). It should be noted that this value is determined exclusively heuristically. One could choose a slightly higher value, for example, 12 % or 14 %. The authors selected the lower boundary because financial risks and instability in the economic and geopolitical environment increased by late 2024 and early 2025 (e. g., U. S. presidential elections). This choice also reflects consideration of potential risks that could reduce expected investment returns.

6. The indicator γ — the expected rate of income growth (wages) — is taken as 5.5 % (0.055) as of October 1, 2024. The wage indexation rate in 2024 was 5.1 %, in accordance with the Decree of the Government of the Russian Federation, No. 2189-r, dated August 15, 2024[5].

Results

Based on the obtained SDR values, several clarifications are necessary. The SDR values — particularly for the Russian Federation as a whole (4.26 %)— contradict the Central Bank of Russia refinancing rate (CRR) of 18 % as of July 2024. In principle, the SDR should be lower than the CRR, but in this case, the discrepancy for the Russian Federation (first row of the calculation) amounts to 4.23 times. This raises a practical contradiction: government financing uses the CRR as a base interest rate, including for lending to the public and social sectors, so a four-fold difference is notable.

Nevertheless, this discrepancy can be explained. The Central Bank's inflation targeting via an increased CRR is primarily aimed at countering inflationary pressures from sanctions and distortions in the USD/RUB exchange rate. These are examples of so-called externalities — a concept introduced by A. C. Pigou: "…implicit real factors acting 'from outside' on industries in which resources are invested" (Pigou, 1985). Since early 2023, the CRR has effectively been used to counter negative external effects rather than internal ones, creating an instrumental contradiction with the SDR, which is designed to address internal effects. Therefore, considering the change in the essential and instrumental bases of both CRR and SDR since 2023, the significant discrepancy in their values is understandable.

It should be noted that SDR values for the North Caucasus Federal District closely match the Central Bank's CRR. Some regions are highly subsidized and thus operate largely due to external effects relative to the region itself. In such cases, the SDR accurately reflects the excess of subsidy amounts compared with their average levels for the Russian Federation.

Applied Purpose of the SDR

The social discount rate has critical applied significance. The practice of applying the SDR can be broadly divided into two areas of social and public policy:

1) Interest rates for government financing of public and social projects. This is most clearly seen in preferential mortgage lending as part of government programs and national projects.

2) Discounting public and social benefits. Within social and public projects, benefits are discounted using the SDR; accordingly, the higher the SDR, the higher the requirements for current consumption of social and public goods.

Discussion

The philosophical dimensions of ethics and the choice of a consumption ideology are most fully represented, at present, by J. C. Robinson, who in 1990 published *Philosophical Origins of*

[3] BALANCE SHEET OF CASH INCOME, EXPENDITURE, AND SAVINGS OF THE POPULATION for 2023. -https://rosstat.gov.ru/folder/13397# (25.09.2025)

[4] ОФЗ-26222-ПД. Par value: 1,000 rubles, maturity date: October 16, 2024, rate: 7.1 % per annum, yield: 12.04 %.

ОФЗ 26227-ПД. Par value: 1,000 rubles, maturity date: July 17, 2024, coupon rate: 7.4 % per annum, yield to maturity: 12.35 %.

ОФЗ 26234-ПД. Par value: 1,000 rubles, maturity date: July 16, 2025, coupon rate: 4.5 % per annum, yield to maturity: 12.52 %.

[5] Order of the Government of the Russian Federation dated 15.08.2024 No. 2189-r Retrieved from: http://publication.pravo.gov.ru/document/0001202408160001?ysclid=m6euvapxb9138847170 (25.09.2025)

Online ISSN 2412-0731

Table 1

Table 1 Calculation of SSD indicators

Country/Regions	Income (*Y*)	Saving (*S*)	*S*/*Y*	μ (Скотт, 1989) ρ = 0 γ = 0,055	SSD in shares	SSD in %
Russian Federation	61,20	346,60	5,66	0,32	0,04	4,26
Central Federal District (median value of the SDD is 4.93 %)						
Belgorod Region	51,80	248,40	4,80	0,37	0,05	4,87
Bryansk Region	48,80	181,10	3,71	0,45	0,06	5,95
Vladimir Region	42,80	244,90	5,72	0,32	0,04	4,22
Voronezh Region	51,40	267,30	5,20	0,35	0,05	4,57
Ivanovo Region	43,80	230,90	5,27	0,34	0,05	4,52
Kaluga Region	46,70	235,80	5,05	0,35	0,05	4,68
Kostroma Region	46,40	223,90	4,83	0,37	0,05	4,85
Kursk Region	49,70	201,50	4,05	0,42	0,06	5,56
Lipetsk Region	52,00	205,50	3,95	0,43	0,06	5,67
Moscow Region	75,30	320,00	4,25	0,41	0,05	5,36
Oryol Region	58,80	209,60	3,56	0,46	0,06	6,13
Ryazan Region	48,50	257,80	5,32	0,34	0,04	4,49
Smolensk Region	48,60	208,00	4,28	0,40	0,05	5,33
Tambov Region	52,20	170,20	3,26	0,50	0,07	6,54
Tver Region	49,80	222,80	4,47	0,39	0,05	5,15
Tula Region	50,40	235,30	4,67	0,38	0,05	4,98
Yaroslavl Region	53,50	295,30	5,52	0,33	0,04	4,35
Moscow	136,60	1351,40	9,89	0,20	0,03	2,64
Northwestern Federal District (median value of the average daily income is 4.74 %)						
Republic of Karelia	68,10	277,90	4,08	0,42	0,06	5,53
Komi Republic	55,40	284,60	5,14	0,35	0,05	4,61
Arkhangelsk Region	61,30	298,00	4,86	0,37	0,05	4,82
Nenets Autonomous Region	171,80	648,10	3,77	0,44	0,06	5,87
Arkhangelsk Region (excluding the autonomous district)	56,40	298,00	5,28	0,34	0,05	4,51
Vologda Region	46,60	236,50	5,08	0,35	0,05	4,66
Kaliningrad Region	47,10	318,90	6,77	0,28	0,04	3,67
Leningrad Region	52,30	146,60	2,80	0,55	0,07	7,29
Murmansk Region	83,80	429,70	5,13	0,35	0,05	4,62
Novgorod Region	43,10	195,70	4,54	0,39	0,05	5,09
Pskov Region	46,70	193,80	4,15	0,41	0,05	5,46
Saint Petersburg	85,20	679,40	7,97	0,24	0,03	3,19
Southern Federal District (median value of the average daily income is 6.59 %)						
Republic of Adygea	57,70	95,00	1,65	0,77	0,10	10,23
Republic of Kalmykia	35,40	86,70	2,45	0,61	0,08	7,99
Republic of Crimea	42,10	119,20	2,83	0,55	0,07	7,24
Krasnodar Region	62,40	260,80	4,18	0,41	0,05	5,43
Astrakhan Region	41,00	167,50	4,09	0,42	0,06	5,53
Volgograd Region	41,80	185,20	4,43	0,39	0,05	5,19
Rostov Region	65,90	244,80	3,71	0,45	0,06	5,94
Sevastopol	48,40	121,90	2,52	0,59	0,08	7,84

Online ISSN 2412-0731

Country/Regions	Income (*Y*)	Saving (*S*)	*S*/*Y*	μ (Скотт, 1989) ρ = 0 γ = 0,055	SSD in shares	SSD in %
North Caucasus Federal District (median SDI value — 11.07 %)						
Republic of Dagestan	34,30	45,00	1,31	0,88	0,12	11,58
Republic of Ingushetia	25,00	22,10	0,88	1,06	0,14	13,93
Kabardino-Balkarian Republic	45,70	65,20	1,43	0,84	0,11	11,07
Karachay-Cherkess Republic	31,20	59,90	1,92	0,71	0,09	9,34
Republic of North Ossetia — Alania	39,60	119,90	3,03	0,52	0,07	6,90
Chechen Republic	42,90	27,60	0,64	1,19	0,16	15,72
Stavropol Region	38,10	160,90	4,22	0,41	0,05	5,39
Volga Federal District (median value of SDD — 4.88 %)						
Republic of Bashkortostan	44,60	172,20	3,86	0,44	0,06	5,77
Republic of Mari El	35,20	171,80	4,88	0,36	0,05	4,81
Republic of Mordovia	36,90	156,20	4,23	0,41	0,05	5,38
Republic of Tatarstan	56,80	260,70	4,59	0,38	0,05	5,05
Udmurt Republic	46,30	205,20	4,43	0,39	0,05	5,19
Chuvash Republic	38,30	231,70	6,05	0,31	0,04	4,03
Perm Region	49,00	232,20	4,74	0,37	0,05	4,92
Kirov Region	43,10	206,20	4,78	0,37	0,05	4,88
Nizhny Novgorod Region	60,00	297,60	4,96	0,36	0,05	4,74
Orenburg Region	40,30	178,70	4,43	0,39	0,05	5,19
Penza Region	43,50	209,50	4,82	0,37	0,05	4,86
Samara Region	49,60	293,60	5,92	0,31	0,04	4,11
Saratov Region	36,80	185,80	5,05	0,35	0,05	4,68
Ulyanovsk Region	40,70	194,90	4,79	0,37	0,05	4,88
Ural Federal District (median value of the average daily income is 5.19 %)						
Kurgan Region	40,20	145,50	3,62	0,46	0,06	6,06
Sverdlovsk Region	66,00	304,30	4,61	0,38	0,05	5,03
Tyumen Region	71,90	275,50	3,83	0,44	0,06	5,80
Khanty-Mansi Autonomous Region	74,10	405,70	5,48	0,33	0,04	4,38
Yamalo-Nenets Autonomous Region	139,00	473,60	3,41	0,48	0,06	6,34
Tyumen Region (excluding autonomous districts)	48,00	275,50	5,74	0,32	0,04	4,21
Chelyabinsk Region	48,50	214,80	4,43	0,39	0,05	5,19
Siberian Federal District (median value of the SFD is 5.50 %)						
Altai Republic	42,30	98,40	2,33	0,63	0,08	8,27
Tuva Republic	32,20	82,90	2,57	0,59	0,08	7,73
Khakassia Republic	40,70	156,10	3,84	0,44	0,06	5,80
Altai Region	40,20	165,30	4,11	0,42	0,05	5,50
Krasnoyarsk Region	55,50	216,90	3,91	0,43	0,06	5,72
Irkutsk Region	49,00	209,20	4,27	0,40	0,05	5,34
Kemerovo Region	46,40	195,40	4,21	0,41	0,05	5,40
Novosibirsk Region	58,10	291,10	5,01	0,36	0,05	4,71
Omsk Region	46,70	192,10	4,11	0,42	0,05	5,50
Tomsk Region	47,20	218,40	4,63	0,38	0,05	5,01
Far Eastern Federal District (median SDI value — 5.47 %)						
Republic of Buryatia	45,00	144,20	3,20	0,50	0,07	6,63

Online ISSN 2412-0731

Country/Regions	Income (*Y*)	Saving (*S*)	*S*/*Y*	μ (Скотт, 1989) ρ = 0 γ = 0,055	SSD in shares	SSD in %
Republic of Sakha (Yakutia)	75,50	212,40	2,81	0,55	0,07	7,27
Zabaykalsky Region	48,10	156,00	3,24	0,50	0,07	6,57
Kamchatka Region	96,10	445,20	4,63	0,38	0,05	5,01
Primorsky Region	63,20	360,10	5,70	0,32	0,04	4,24
Khabarovsk Region	61,80	316,50	5,12	0,35	0,05	4,62
Amur Region	61,00	256,10	4,20	0,41	0,05	5,41
Magadan Region	130,00	538,10	4,14	0,41	0,05	5,47
Sakhalin Region	102,00	425,20	4,17	0,41	0,05	5,44
Jewish Autonomous Region	51,60	182,50	3,54	0,47	0,06	6,16
Chukotka Autonomous Region	164,90	391,80	2,38	0,62	0,08	8,15

Source: developed by the authors: Line 2 — Rosstat (FSGS) data. — https://rosstat.gov.ru/folder/13397# (accessed: 09.25.2025) Line 3 — RIA Rating data.[6] — https://riarating.ru/infografika/20240205/630256997.html (09.25.2025).

the Social Rate of Discount in Cost-Benefit Analysis. This work deserves attention as it offers a relatively successful attempt to explain the essential nature of the SDR indicator.

Nevertheless, Robinson's research exhibits a significant limitation common to the entire field: it considers the subject exclusively through the lens of market theories and economic liberalism. Social and public goods are evaluated primarily in terms of consumption costs, monetary benefits, and expenditures, that is, as commodities or services in a market. This approach reflects the long-standing dominance of the idea of perfect competition in Western economic thought since the early 20th century. Within this ideology, perfect competition is seen as a hallmark of a developed country economy, whereas in underdeveloped or less developed countries, competition is considered imperfect. Notably, the classification of developed countries is influenced by political factors, so nations deemed "acceptable" economically are labeled developed, while all others are regarded as underdeveloped. For example, in England and the USA, markets with near-perfect competition have existed for most of the last century, and this position remains largely unchanged.

This perspective creates a serious practical problem in calculating and assessing the SDR, which highlights a fundamental challenge in government financing of public and social activities. Consider Table 1 as an example. At first glance, the indicators may seem non-contradictory. However, the SDR value for Moscow is 2.64 %, while for the Republic of Altai it is 8.27 %. That is, the requirement for public benefits for residents of Altai is 3.13 times higher than for residents of Moscow. At the same time, the income of Moscow residents is 3.22 times higher, and their savings are 13.7 times higher. Clearly, residents of Altai require more state support, yet for them, the social discount rate is higher, meaning the cost of social benefits relative to their needs is greater. In other words, wealthier people receive more social and public goods at lower relative costs than poorer populations. This creates a situation in which the rich become progressively wealthier, and the poor become progressively poorer — a consequence of the state acting as a market agent.

This outcome is justified within the ideology of markets and perfect competition that has dominated Western economic theory for more than a century. But what about social justice? This problem was highlighted by one of the truly significant economists of the 20th century, Joan Violet Robinson. In 1933, she published the seminal work *The Economics of Imperfect Competition* (Robinson, 1986), demonstrating that "perfect" competition does not exist. As one account notes, "In her own camp, Robinson was a 'heretic'…" (Robinson, 1986). Unfortunately, Robinson's works are largely ignored in modern economics textbooks,

[6] Prepared by experts from the RIA Rating Center for Economic Research, part of the *Rossiya Segodnya* media group, commissioned by RIA Novosti. Calculations were based on data from the Central Bank and Rosstat.

Online ISSN 2412-0731

as are Slutsky's contributions. Consequently, the research field, applied methods, and the practice of calculating and assessing SDR are significantly distorted by an artificially imposed ideological framework.

Conclusion

This study achieved its objectives, confirming the validity of the social time preference (STP) approach and enabling the development of a methodological tool for calculating the social discount rate (SDR) across Russian regions. A key finding was the substantial spatial variation in SDR values, reflecting differences in the socio-economic conditions of Russia's regions. These results may be of interest to policymakers, underpinning the improvement of public financing mechanisms and the effectiveness of state socioeconomic policy.

The research has enabled a comprehensive analysis of the theoretical foundations and practical application of the SDR, demonstrating its critical role as an instrument of government socio-economic policy. Using the STP approach, the SDR was calculated for Russia and its constituent entities, revealing substantial regional differentiation — from 2.64 % in Moscow to 15.72 % in the Chechen Republic. These results have practical value for substantiating financing rates for social and public projects and highlight the need for deep methodological and philosophical reconsideration of the SDR's role under modern conditions.

The main conclusion is that the simplified stationary Ramsey model (Formula 1), which assumes constant parameters, inadequately reflects actual economic dynamics. In contrast, calculations using the universal non-stationary model (Formula 2) align more closely with reality, requiring consideration of temporal changes in parameters such as the rate of time preference (ρ) and the elasticity of marginal utility (μ). This underscores the need to move away from simplified calculation practices toward more methodologically rigorous approaches rooted in Slutsky's work.

The significant discrepancy between the calculated average SDR for the Russian Federation (4.26 %) and the Central Bank key rate (18 %) is not a statistical error but reflects a fundamental difference in their nature. While the SDR serves as an instrument for assessing long-term social benefits and intertemporal resource distribution, the key rate currently functions primarily to counter external shocks and inflation arising from geopolitical instability. This discrepancy, therefore, highlights the distinction between long-term social planning and short-term monetary policy rather than a failure of SDR methodology.

A particularly acute problem, with both economic and ethical dimensions, emerges from the analysis of regional SDR differentiation. An inverse relationship between regional income levels and SDR values creates a paradox: poorer regions, such as the Republic of Altai (SDR = 8.27 %), must demonstrate much higher returns on social investments than wealthier regions, such as Moscow (SDR = 2.64 %), to receive equivalent government support. This means that efficiency requirements for social projects in needy regions are overstated, reinforcing existing inequalities. This phenomenon reflects the dominance in Western economic theory of the ideology of "perfect competition," which, as J. Robinson rightly noted, is an artificial construct that disregards the realities of imperfect markets and social justice.

Therefore, the research concludes that the role of SDR requires ideological and methodological reconsideration. Its application should not be reduced to mechanistic efficiency assessment based solely on market logic. Instead, the SDR should serve as an instrument for advancing social justice, consciously addressing market imbalances. This requires moving away from viewing government financing as equivalent to private investment and acknowledging the state's unique role in allocating resources to benefit future generations and disadvantaged populations.

The calculations and analysis presented provide a solid foundation for revising current practices in assessing public projects in Russia. Implementing regionally differentiated SDR values, calculated using dynamic models and employed as normative, rather than purely computational, instruments, can enhance both the justification and fairness of government socio-economic policy. Future research should focus on developing adaptive SDR models that integrate not only economic but also social and environmental dimensions of public welfare.

Online ISSN 2412-0731

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Online ISSN 2412-0731

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ARTICLE INFO: received May 05, 2025; accepted December 02, 2025

ИНФОРМАЦИЯ О СТАТЬЕ: дата поступления 05 мая 2025 г.; дата принятия к печати 2 декабря 2025

Online ISSN 2412-0731