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Estimation of Social Discount Rate for Lithuania

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Abstract

Purpose of the article: The paper seeks to analyse the problematics of estimation of the social discount rate (SDR). The SDR is the critical parameter of cost-benefit analysis, which allows calculating the present value of cost and the benefit of public sector investment projects. Incorrect choice of the SDR can lead to the realisation of ineffective public project or conversely, cost-effective project will be rejected. The relevance of this problem analysis is determined by discussions and different viewpoints of scientists on the choice of the most appropriate approach to determine the SDR and absence of methodically based the SDR on the national level of Lithuania.
Methodology/methods: The research is performed by the scientific and methodical literature analysis, systematization, time series and regression analysis.
Scientific aim: The aim of the article is to calculate the SDR based on the statistical data of Lithuania.
Findings: The analysis of methods of SDR determination, as well as the researches performed by foreign researchers, allows stating that the social rate of time preference (SRTP) approach is the most appropriate. The SDR, calculated by the SRTP approach, reflects the main purpose of public investment projects, *i.e.* to enhance social benefit for society, the best. The analyses of SDR determination practice of the foreign countries shows that the SDR level should not be universal for all states. Each country should calculate the SDR based on its own data and apply it for the assessment of public projects.
Conclusions: The calculated SDR for Lithuania using the SRTP approach varies between 3.5% and 4.3%. Although it is lower than 5% that is offered by European Commission, this rate is based on the statistical data of Lithuania and should be used for the assessment of the national public projects. Application of the reasonable SDR let get the more accurate and reliable cost-benefit analysis of the public projects.

Keywords: public investment projects, social discount rate, cost-benefit analysis, social rate of time preference, Ramsey model

JEL Classification: D61, H43

Introduction

Social discount rate (SDR) is the critical parameter that determines the social-economic value of the public investment projects (Zhuang *et al.*, 2007; Harrison, 2010; Hepburn, 2006). It is mostly important for the projects that have high net costs in the early years and high net benefits in later years (Moore *et al.*, 2013). Although the problematics of determination of SDR has been started to consider in scientific literature in the XX century, this question still has not been solved. Foreign researchers actively discuss about the suitability of various SDR determination methods (Scarborough, 2011; Moore *et al.*, 2013; Burgess, 2013; Burgess, Zerbe, 2013), calculate SDR for various countries (Evans, Sezer, 2002, 2005; Evans, 2004; Kula, 2004; Zhuang *et al.*, 2007; Shelunstsova, 2009; Florio, Sirtori, 2013; Halicioglu, Karatas, 2013) and compare them with official rates (Evans, 2004).

Lithuanian practice of assessment of public investment projects is noticeably shorter comparing with many foreign countries and the SDR researches performed on the data of Lithuania are missing. Lithuanian scientists fragmentarily analyse the problem of SDR determination. The certain issues of the cost-benefit analysis of the public investment projects and the application of SDR in the assessment of such projects has been analysed in the papers of Ginevičius and Bruzgė (2008), Baranauskienė (2013), Baranauskienė and Aleknevičienė (2014a, b). Kazlauskienė (2015) revealed the peculiarities of the application of SDR in the assessment of public projects. Although Lithuanian researchers recognizes the importance of SDR in the cost-benefit analysis of the public projects, there is a lack of deeper analysis of SDR, where the opportunities of application of various SDR determination methods are disclosed and the SDR based on the statistical data of Lithuania is calculated. The greater attention is paid only in methodical publications in Lithuania. However, they present instructions how to discount cost and benefit related with investments (Kazlauskienė, 2015). Though, frequently the five-percent SDR suggested by the European Commission is applied preparing the investment projects financed by the EU. This rate is of recommended and is not endorsed at national level. The Guide to Cost-Benefit Analysis of Investment Projects (2014) points out that it is possible to apply the SDR, based on calculations of the country, in the assessment of state investment projects; however, such rate has to be regulated by laws and legal acts. Currently the researches are not carried out and the SDR is not substantiated and regulated by laws and legal acts in Lithuania (Kazlauskienė, 2015). The need of SDR determination is evident from the results of many researches based on examples of EU countries (Netherlands, Germany, France, Slovakia, UK, Hungary and so on). The researchers showed that the SDR level fluctuates between 1.13 and 8.1 percent. Such diapason of the calculated SDR makes doubt about the validity of the recommendation to apply the uniform 5 percent SDR for all EU countries and raises the discussions of scientists.

The aim of the article is to calculate the SDR based on the statistical data of Lithuania. This rate could be applied to the cost-benefit analysis of national public projects.

The research applies the scientific and methodical literature analysis, systematization, time series and regression analysis.

1. Theoretical basis of SDR determination

Four alternative approaches of SDR determination are presented in the scientific literature, *i.e.* social rate of time preference (SRTP), social opportunity cost of capital (SOC), weighted average approach and shadow price of capital (SPC). The SRTP approach is based on the idea that the fundamental goal in welfare economics is to maximize the utility of society (Moore *et al.*, 2013). The SRTP is the rate at which a society is willing to renounce a unit of current consumption in exchange for more future consumption (Zhuang *et al.*, 2007). This rate equals the current and deferred value of consumption for society. Different SRTP determination methods are presented in the literature. By the first method the SRTP is determined considering the interest rate of Government bonds or other low risk securities. The second and the most often mentioned approach of the SDR determination refers to the economic growth model of F. P. Ramsey, British economist. Referring to this model the SRTP is calculated by the formula:

$$SRTP = p + e \cdot g, \quad (1)$$

where:

p	utility discount rate,
e	elasticity of marginal utility of consumption,
g	he rate of growth of consumption (income) per capita.

Although the SDR calculation by the classical formula of Ramsey is not complicated in mathematical viewpoint, the main problems are related with

the determination of SRTP parameters. The utility discount rate (p) is the most discussed question, because choosing the value of this parameter requires interfering how much the present society cares for future societies (Halicioglu, Karatas, 2013). The utility discount rate is divided into two elements, *i.e.* the rate of pure time preference and life chances. There is no uniform opinion on the first element. Due to ethical ground this element is often equated to zero (Hepburn, 2006; Evans, Sezer, 2005). The second element of utility discount rate evaluates the annual level of death-rate in the country and most often it is calculated as the proportion of the number of deaths and the number of the population. As the performed researches on utility discount rate (Scarborough, 2011; Zhuang *et al.*, 2007; Evans, Sezer, 2005) show, this rate changes from 0.05% to 3%. Elasticity of marginal utility of consumption (e) captures the dynamics of consumption over time. Elasticity of marginal utility of consumption is the critical SRTP component in terms of calculations (Evans, Sezer, 2002) and it causes the most discussions of researchers. According to Arrow *et al.* (2014) e plays three roles in the Ramsey formula. First of all it is inversely related to the intertemporal elasticity of substitution between consumption today and consumption in the future. Secondly, it represents the coefficient of relative risk aversion. And thirdly it reflects an intergenerational inequality aversion. This complicates the estimation of e because researchers will obtain different values for e depending on which role is emphasized (Groom, Maddison, 2013). Elasticity of marginal utility of consumption can be calculated applying different approaches. The following models of e estimation are mentioned in the literature (Evans, 2004; Schad, John, 2012; Halicioglu, Karatas, 2013; Arrow *et al.*, 2014): the personal taxation model and demand for food model. The researchers argue which of these models is more suitable. As there is no consensus, e is usually calculated by both (Evans, 2004; Schad, John, 2012; Florio, Sirtori, 2013) or one of these models (Evans, Sezer, 2002; Kula, 2004; Sheluntsova, 2009; Halicioglu, Karatas, 2013).

The rate of growth of consumption (income) per capita (g) is dependent on the forecast of the growth of income in the economy (Scarborough, 2011). This component can be determined by evaluating the growth of consumption, GDP growth per capita, growth of personal income (Guide to Cost-Benefit Analysis of Investment Projects, 2014). Mostly g is determined as GDP growth in scientific publications (Scarborough, 2011; Schad, John, 2012; Florio, Sirtori, 2013) as least discussions arise about its determination. According to Kazlauskienė (2015) the main problem is related with too optimistic prognoses. It is particularly important to consider long-term period (over 30 years) by retrospective data when determining the rate of growth of consumption (income) per capita (Zhuang *et al.*, 2007).

The second approach of SDR determination, *i.e.* the SOC approach is based on the fact that available resources are scare, and private and public projects compete with one another for funds. According to this approach, the return of public sector investments have to be not less than the return of private investments. The SOC can be determined as marginal pre-tax rate of return on riskless private investments (Zhuang *et al.*, 2007). In addition to the SDR determination approaches mentioned above, the other two approaches, *i.e.* weighted average approach and shadow price of capital approach are mentioned in the literature. They can be used for inter-temporal discounting, but they are rarely applied for evaluation of public investment projects (Guide to Cost-Benefit Analysis of Investment Projects, 2014).

The SRTP and SOC approaches are named as main and most suitable approaches to determine the SDR in the scientific publications, guides in cost-benefit analysis and methodological publications (Guide to Cost-Benefit Analysis of Investment Projects, 2014; Scarborough, 2011; Harrison, 2010). The SRTP is appropriate when the government is considering new government activities (Young, 2002). The SOC approach is suggested to be applied only when the estimation of SRTP is not available or clearly unreliable (Young, 2002). Although the uniform opinion about the most suitable SDR approach does not exist, the analysis of researches shows that the priority is given to the SRTP approach more and more often (Kazlauskienė, 2015). The SRTP approach is the most widely used in developed countries, especially in the EU (Florio, Sirtori, 2013).

The application of decreasing SDR in the cost-benefit analysis of public projects is another controversial aspect related to the SDR determination. The scientists that analyse questions of public projects cost-benefit analysis discuss about the need to apply the SDR that declines in time evaluating the long-term investments (more than 50 years) more often (Spackman, 2004; Moore *et al.*, 2013). Its outcomes are sensitive to the size of discount rate (Hepburn, 2006). The application of decreasing SDR for evaluation of the long-term investments is argued by changing interests and viewpoint of society (Moore *et al.,* 2013) as well as uncertainty of economic state in the future (Hepburn, 2006). Only

the opinion how the SDR of long-term investment projects should change is disclosed in the literature. Though it is recognized that SDR should not be the fixed measure during the entire period of the investment project (Spackman, 2004; Evans, Sezer, 2005), the constant SDR is applied in most practical researches.

2. SDR in assessment of the public projects in the foreign countries

The need to calculate the SDR for EU countries and apply it in practice arose when the public investment projects financed by the EU begun to develop. In 1990 the European Commission prepared the first version of the Guide to Cost-Benefit Analysis of Investment Projects, where the recommended SDR level was presented. The last and currently valid edition of the Guide to Cost-Benefit Analysis of Investment Projects was prepared in 2014. Despite the recommended uniform SDR, this rate varies in different countries. Table 1 presents the SDR calculated based on the data of different countries.

The SDR analysis applied in foreign countries showed that this rate fluctuates from 1 to 12 percent. The SDR level depends on the approach and the data that are used for calculations. Evans and Sezer (2005) calculated the SDR for the EU countries by the SRTP approach and it fluctuated from 2.3% (for Denmark) to 5.6% (for Ireland). Zhuang *et al.* (2007) showed that the SDR can fluctuate from 1% to 15% and the rates of developed countries are noticeably lower (2–3%) than the SDR of developing countries (10–15%). Florio and Sirtori (2013) calculated the SDR for 20 EU countries and showed that the rate fluctuates from 1.13% to 3.80% for non-Cohesion Fund countries and from 1.67% to 6.52% for Cohesion Fund countries. The results presented in the Table 1 shows that the SDR calculated by different authors varies even when the approach is the same. It is caused by the different data used in the research. For example, the SDR calculated for Italy by Zhuang *et al.* (2007) is equal to 8%, and it equals to 1.13% according to Florio and Sirtori (2013) calculations. The SRTP approach is mostly applied in developed countries, and the SOC approach is more popular in developing ones. The SOC approach is

Table 1. SDR of different countries.

Country	Approach	SDR (percent)	Source
EU countries			
Austria	SRTP	4.1	Palinko, Szabo (2012)
	SRTP	2.65	Florio, Sirtori (2013)
Germany	SRTP	4.3	Evans, Sezer (2005)
	SRTP	3	Hepburn (2006); Schad, John (2012)
France	SRTP	4	Zhuang *et al.* (2007)
	SRTP	1.74	Florio, Sirtori (2013)
Italy	SRTP	8	Hepburn (2006)
	SRTP	1.13	Zhuang *et al.* (2007)
United Kingdom	SRTP	5	Florio, Sirtori (2013)
	SRTP	3.5; different rates for long-term projects over 30 years	Zhuang *et al.* (2007)
Poland	SRTP	4	Moore *et al.* (2013)
	SRTP	2.61	Evans, Sezer (2002)
	SRTP	4.43	Florio, Sirtori (2013)
Non-EU countries			
USA	SRTP	3.5	Florio, Sirtori (2013)
	SOC	6–8	Burgess, Zerbe (2011)
Canada	SOC	10	Zhuang *et al.* (2007)
Turkey	SRTP	5.06	Halicioglu, Karatas (2013)
Norway	Government borrowing rate	3.5	Zhuang *et al.* (2007)
Australia	SOC	8 (annually reviewed)	Zhuang *et al.* (2007)
Mexico	SOC	10.4	Coppola *et al.* (2014)
India	SOC	12	Zhuang *et al.* (2007)
	SRTP	5.2	Kula (2004)
Russia	SRTP	11.5	Shelunstsova (2009)
Japan	SRTP	4.4	Evans (2005)

Source: Author's own study.

Table 2. Formulas used for the calculations of elasticity of marginal utility of consumption.

Source	*e* estimation formula	Explanation
Kula (2004)	$e = b \cdot y / p^*$ (2)	b – the average propensity to spend money on non-food, p^* – the relative price elasticity of food (relative to all other goods), y – the income elasticity of food.
Halicioglu, Karatas (2013)	$e = y / \hat{e}$ (3)	$\hat{e}$ – the compensated price elasticity that is obtained by eliminating the income effect from the uncompensated price elasticity p^*.
Evans (2004)	$e = y \cdot (1 - \alpha \cdot y) / p^*$ (4)	α – the share of food in a consumer's budget.

Source: Author's own study.

particularly popular in the USA as well (Shelunstsova, 2009; Spackman, 2004).

Some countries (Germany, United Kingdom, France, Norway, Australia and others) have the methodologies for SDR determination that analyse the models of SDR determination, its components, present detailed calculations of SDR. The countries where the SDR is confirmed by the legal documents change not only level of the rates, but also its determination approaches. For example, the SDR was calculated by the SOC approach in the United Kingdom from 1967 to 1980 and it fluctuated in the range of 5–8%. But when the SRPT approach was used since 1980, the SDR has changed and varied from 3.5% to 6%. Currently the countries rarely make the decision to change the approach of SDR determination and the SDR is recalculated every 3–5 years.

Although such countries as Germany, the United Kingdom and France have confirmed the SDR levels for the cost-benefit analysis of the public projects at the national level, they often differ from the SDR, calculated by various researchers. This shows the need to perform the more extensive researches that provide the justification of SDR level applied in the cost-benefit analysis of the public project.

The analysis of SDR determination practice in foreign countries provides evidence that the SDR level should not be universal for all states. According to Zhuang *et al.* (2007), the countries differ in economic structure, capital scarcity, stage of financial development, efficiency of financial intermediation, impediments faced in accessing the international capital market and social time preference. These factors must be taking into account when choosing the SDR.

The performed analysis has shown that the SDR determination approach makes significant influence on the SDR level. The analysis of SDR determination approaches as well as the researches performed by foreign researchers allows stating that the most appropriate approach is the SRTP approach. According to Kazlauskienė (2015) the SDR calculated by the SRTP approach best reflects the main purpose of public investment projects, *i.e.* to enhance social benefit for society. By the way it is usually applied in the countries where the time series of statistical data are short. These are also the determinants of the choice of approach for the SDR calculation for Lithuania

3. Methodology of research

The SDR for Lithuania will be calculated by the SRTP approach. Calculations will be done applying the classical Ramsey model, *i.e.* (1) formula. The logical sequence of the calculations of SRTP is as follows:

1. Calculation of elasticity of marginal utility of consumption (e);
2. Calculation of utility discount rate (p);
3. Calculation of the rate of growth of consumption (income) per capita (g).

Elasticity of marginal utility of consumption (e) will be calculated by *Fellner demand for food model* that have several specifications. Three versions will be tested. The formulas used for the calculations of elasticity of marginal utility of consumption are presented in Table 2.

The compensated price elasticity () in the formula of Halicioglu and Karatas (2013) is obtained as follows:

$$\hat{e} = p^* - \alpha \cdot y \quad (5)$$

Calculated values of $\hat{e}$, p^* and y are considered in absolute values. The analysis of literature shows that e can range from 0 to 10, with a "concentration of estimates" around a value of 2 (OXERA, 2002).

The average propensity to spend money on non-food is calculated as the average share of expenditures for non-food relative to all expenditures. In order to estimate income and price elasticities (y and p^*), the following econometric food demand equation will be used (Kula, 2004):

$$D = A \cdot Y^{y} \cdot \left(P_1 / P_2\right)^{p^*} \quad (6)$$

where:

D	spending on food per capita,
A	constant,
Y	income per capita,
P_1	price of food,
P_2	price of non-food.

This equation can be written in double logarithmic form:

$$\ln(D) = \ln(A) + y \cdot \ln(Y) + p^* \cdot \ln(P_1 / P_2) \quad (7)$$

Meanwhile Schad, John (2012) used the budget share of food expenditure per capita relative to the consumption expenditures per capita (both at current prices) as the dependent variable and the consumption expenditure per capita in prices of the base year instead of income per capita (Y). This case will be also tested.

Utility discount rate (p), can be split into two components (OXERA, 2002): the pure time preference rate (d) and life chances (L). The social time preference rate is the least amenable to empirical analysis, but the literature suggests that the range is 0.0–0.5. The rate of 0 will be used in this analysis. Meanwhile life chances can be expressed by the death rate:

$$L = Total\ deaths/Population \quad (8)$$

The rate of growth of consumption (income) per capita (g) will be calculating as the growth of final consumption expenditure (at constant prices) per capita. As some researchers also use the growth rate of the economy as a substitute measurement, in addition the growth of GDP per capita will be calculated and compared with the growth of consumption per capita.

The data of the period 1996–2014 are used for the calculation of SRTP and related indicators. This is the longest time interval for which data are currently available on a consistent national accounting basis. The statistical data are obtained from the databases of the Organization for Economic Co-operation and Development (OECD) and Eurostat.

4. Results

At first the critical component of the classical Ramsey model, *i.e.* elasticity of marginal utility of consumption (e), is found. It is calculated by estimating the income and price elasticities (y and p^*) by the (7) formula using the indicators that were used by Schad and John (2012), *i.e.* D is the budget share of food expenditure per capita relative to the consumption expenditures per capita (both at current prices) and Y is the consumption expenditure per capita in prices of the base year.

At first Augmented Dickey-Fuller tests were conducted on the data in log-levels. Unit root test shows that all variables are stationary, *i.e.* I(0) at the significant level of 0.05. Logarithm of Y is stationary process with constant and trend (p-value is 0.0009706) while logarithms of D and P_1/P_2 are stationary processes with constant (p-value is equal 0.009811 and 1.785e-022 respectively).

Thus, the (7) equation can simply be estimated using an ordinary least-squares method. The results are shown in Table 3.

The results indicate that the relative price elasticity of food p^* is 0.7733 and the income elasticity of food y is -0.4504.

The analysis of the historical data of the share of expenditures for non-food relative to all expenditures shows that it varies during the period 1996–2014 and it has growing trend. The share of expenditures for non-food relative to all expenditures was 65% in 1996 while it accounted for about 79% in 2014. The average share of expenditures for non-food for the period is 73%. The projections of the future all expenditures and expenditures for food tend to the conclusion that the share of expenditures for non-food relative to all expenditures should be about 80%. So this estimate will be used as the average propensity to spend money on non-food (b).

Given the indicators calculated above, the Table 4 presents the results of the calculations of elasticity of marginal utility of consumption (e) using the formulas of Kula (2004), Halicioglu, Karatas (2013) and Evans (2004).

Table 3. The results of estimated model.

	Coefficient	Std. error	*t*-ratio	*p*-value
Const	2.47393	0.216460	11.43	$4.16e^{-09}$
ln(Y)	−0.450363	0.0253505	−17.77	$5.90e^{-012}$
ln(P_1/P_2)	0.773293	0.137610	5.619	$3.84e^{-05}$
Adjusted R-squared	0.946115			

Source: Author's calculations.

Table 4. Estimation of the elasticity of marginal utility of consumption.

Formula	Estimation	Result
$e = b \cdot y / p^*$	$e = 0.8 \cdot 0.4504 / 0.7733$	0.4660
$e = y / \hat{e}$	$e = 0.4504 / (0.7733 - 0.2 \cdot 0.4504)$	0.6593
$e = y \cdot (1 - \alpha \cdot y) / p^*$	$e = 0.4504 \cdot (1 - 0.2 \cdot 0.4504) / 0.7733$	0.5300

Source: Author's calculations.

The statistical data of Lithuania show that average death rate of the period 1996–2014 is 1.27%. However, the death rate increased during the last decade because of the decline of population and it is about 1.37% in recent years. As the projections of population don't show any significant changes in the tendency, the last estimate of the death rate is used for the calculation of SRTP.

The average growth of final consumption expenditure (at constant prices) per capita over the period 1996–2014 is 6.0% while the average growth of GDP per capita accounts for 5.6% in the country. However these values are greatly influenced by the rapid growth of both indicators before the crisis and such growth is hardly expected in the near future. The average growth of final consumption expenditure per capita of the last decade is 4.5% and it is close to the average growth of GDP per capita of the same period. Looking to the projections of the future growth of final consumption expenditure per capita the latter estimate is more realistic and therefore will be used for calculation of SRTP. However this value is higher than the estimate of *g* used for calculation of SRTP for many developed countries where it is about 2%.

Corresponding to the values of the elasticity of marginal utility of consumption, utility discount rate and the rate of growth of consumption per capita the SRTP is calculated by the (1) formula. The results are presented in Table 5.

Table 5. Estimates of SRTP for Lithuania.

p (%)	*e*	*g* (%)	SRTP (%)
1.37	0.4660	4.5	3.47
1.37	0.6593	4.5	4.34
1.37	0.5300	4.5	3.75

Source: Author's calculations.

The results show that SRTP for Lithuania depends on the calculations of elasticity of marginal utility of consumption and varies between 3.5% and 4.3% according to three versions of *Fellner demand for food model* that were analysed in this research.

Calculation of income and price elasticities (*y* and p^*) by the (7) formula where *D* is spending on food per capita and *Y* is income per capita is complicated as the data of income can be obtain only from 2005 year and this process is the second-order integrated, *i.e.* I(2), so the results of the calculations can be less reliable than the results got above and therefore are not presented in this paper.

5. Discussion and Conclusion

Social discount rate is an important indicator that determines the value of public projects. Its level depends on the approach of SDR determination, its parameters and data used for calculations. The analysis of SDR determination approaches as well as the researches performed by foreign researchers let state that the SRTP approach is the most appropriate. The SDR calculated by the SRTP approach best reflects the main purpose of public investment projects, *i.e.* to enhance social benefit for society.

The analysis of SDR determination practice applied in the foreign countries lead to the conclusion that there is no one universal SDR level suitable for all countries. Each country should calculate SDR based on its own statistical data and apply it for the assessment of its national public projects. Although various countries apply different approach of SDR determination, it causes different results of SDR level, that's why it is necessary to consider the possibility to apply the uniform methodology of SDR calculations. Despite the same methodology of the SDR determination, the results will vary among countries because of the differences in economic, social, demographic situation of the states.

The calculated social discount rate for Lithuania using SRTP approach is similar to those that were calculated for other developed countries. SDR for Lithuania depending on the calculations of elasticity of marginal utility of consumption varies between

3.5% and 4.3%. Although it is lower than 5% offered by EU, it is based on the statistical data of the country and should be used for assessment of national public projects.

Elasticity of marginal utility of consumption was calculated by demand for food model in this paper. It is the most popular model in the scientific literature. Nevertheless it is not the only model and the researches on SDR determination for Lithuania should be developed further analysing the other possible methods, comparing the results and determining the opportunities of application of each method. Furthermore, the SDR determination should be on-going and recurrent process as the time series of statistical data are constantly getting longer that let to increase the accuracy and reliability of the evaluation of SDR.

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