Social Discount Rates for Six Transition Countries

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Abstract

The key role of public sector investments in economic transformations makes the choice of social discount rate especially crucial for transition countries. The aim of this study is to estimate the social discount rates of six transition economies – Czech Republic, Estonia, Hungary, Latvia, Poland, Slovak Republic – by using two different approaches. We observe that the estimates produced by tax approach are concentrated in a band between 3.3% (Hungary) and 6.91% (Estonia). In comparison with tax approach estimations, the social discount rates obtained by food demand approach are lower for all selected countries: the lowest value is 1.94% (Czech Republic) and the highest is 3.5% (Latvia).

Keywords: *social discount rate, transition economies, project appraisal*

JEL Classification: H40, H43

Introduction

The role of the government in transition economies is particularly critical for a successful development strategy. A challenging issue facing the policymakers in the transformation from a centrally planned economy into market economies is the simultaneous need to accelerate growth and to increase the democratic level of the society. In this process of transition, the government has a dual, and a potentially conflicting responsibility: on one hand, encouraging private ownership and entrepreneurship for building a vibrant and tolerant society, on the other, making public investments to stimulate market competition, growth, and efficiency. The stimulating effect of public investments[1] is particularly crucial for transitioning economy; which needs to create the right conditions to form a free society, and to encourage increased productivity and higher levels of private investments simultaneously (Aschauer, 1989b; Afonso and St. Aubyn, 2009; Andrade and Duarte, 2016; Hatano, 2010; Hladká, Hyánek and Špalek, 2017).

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[1] This effect is known as the crowding-in effect.

The key to achieving the above-mentioned objectives in parallel with each other is to devise an efficient public sector project management strategy. However, this is not an easy and unambiguous task because of the technical aspects of the project appraisal. In order to assess the viability of the projects, it is necessary to consider several methodological issues, foremost of which is the performance evaluation (Kossova and Sheluntcova, 2014). An objective evaluation of performance in public sector projects is difficult to accomplish when it is compared with the standard evaluation mechanisms used in private investments. Cost-benefit analysis is probably the most comprehensive method of economic evaluation both for private and public projects (Robinson, 1993). On the other hand, the use of cost-benefit analysis in public sector is different than using it for private sector in terms of purpose, funding, project life, benefits, politics, measure of efficiency, etc. Therefore, it may well be that the same project can be described as success or failure depending on who is making the observations. This differentiation is mostly related to the various techniques used by public sector in order to determine the discount rates.

The discount rate is a vital element for cost-benefit analysis both in public and private sectors. Since it measures the opportunity cost of postponement of receipt of any benefit from an investment, the correct determination of this rate is crucial for maximizing the social welfare. Therefore, regardless of a capital's source (private or public), the use of an incorrect discount rate can lead to suboptimal welfare outcomes due to the very serious misallocations of resources (Baumol, 1968). However, it is mostly assumed that the welfare loss, caused by using an incorrect discount rate, is even a bigger problem for the public sector due to the crowding-in effect.[2] Since the use of an incorrect rate leads to miscalculating the cost-benefit streams, it is quite possible to misallocate the already scarce public funds.

According to Feldstein (1964), choosing between alternative time-streams of social benefits and costs, is one of the most difficult and most important problems in the evaluation of public investment projects. In order to reach the correct present value; one should first calculate the correct social discount rate, (henceforth, SDR) which makes it possible to compare the social benefits and costs extended over a period of time. While a high SDR may result in the rejection of desirable projects, a low SDR may cause undesirable projects to be approved (Harrison, 2010). The correct SDR is a significant parameter, which ensures an optimal allocation of funds to public sector projects (Evans and Sezer, 2002; Azar, 2007). However, it is harder to calculate the SDR in such a way than estimating

[2] Furthermore, as the size of the public sector increases, the volume of the welfare loss would likely become more important.

the private one. Most scholars agree that the SDR must be lower than the private discount rates since high rates discriminate future generations (Rambaud and Torrecillas, 2005).

As it is discussed above, the complex and special role of governments in the transition economies makes them most responsive to SDR. The purpose of this study is to estimate the SDRs of six transition economies (Czech Republic, Estonia, Hungary, Latvia, Poland, Slovak Republic). To this aim, we use two methods – personal taxation model and food demand approach – in order to check the legitimacy of our results. This study is a first attempt to estimate the SDRs by using two different methods for these countries. In this context, the paper aims to make an empirical and practical contribution to the literature by estimating alternative SDRs for the selected transition economies.[3] We hope to provide an opportunity to compare the results obtained by two different approaches.

The organization of the paper is as follows. The next section summarizes related literature. Section three provides a theoretical framework. Then, the methodology is described and regression analysis is presented. The final section presents some concluding remarks.

1. Literature Review

The transformation from a command to a market-based economy takes a long time to be completed. The countries of Central and Eastern Europe and the former Soviet Union have launched a set of structural reforms to reduce the size of the public sector during the transformation process. Despite these efforts, the public sector still has a relatively significant role in the economic development due to the crowding-in effect. A state in a transition economy has a distinctive task of stimulating the private market to accelerate the growth. Therefore, the degree of governmental involvement in market decisions and development projects is expected to be relatively more intense in transition economies than in developed market economies (Falke, 2002). Although the impact of public investment on growth and development is more crucial for transition countries; most previous studies on the estimation of SDR have dealt with already developed countries.

The following information have been compiled to show some previous estimates of SDR for developed countries: a) USA: 5.3% (Kula, 1984; 1987), 4% (Evans, 2005), 5.66% (Azar, 2007), 3.7% (Azar, 2009), 3.5% (Moore, Boardman and Vining, 2013) b) Canada: 5.2% (Kula, 1984), 5.4% (Kula, 1987), 3.5% (Boardman, Moore and Vining, 2010) c) UK: 2.6% (Kula, 1987), 2.4% (Pearce

[3] We purposefully select these countries, because the data needed for the preferred procedures are only available for the subject states.

and Ulph, 1999), 4% (Evans and Sezer, 2002), 3.8% (Evans, 2005) d) France: 3.8% (Evans, 2004), 3.7% (Evans, 2005) e) Germany: 4% (Evans, 2005), 3% (Schad and John, 2012) f) Italy: 3.7 – 3.8% (Percoco, 2008) g) Japan: 4.4% (Evans, 2005) h) European Union: 3 – 5.5% (Evans and Sezer, 2005), 3% (Evans, 2006), 4 – 5% (Spackman, 2006), 3.5 – 5.5% (Florio, 2006), 1.13 – 6.52% (Florio, 2014).

Unfortunately, the literature for developing and transition economies is currently limited than for developed.[4] Sharma, McGregor and Blyth (1991) and Kula (2004) estimate the SDR (2% and 5.2%, respectively) in India for the evaluation of investment projects. Lopez (2008) presents estimates of the SDRs (3 – 4%) for nine Latin American countries. Valentim and Prado (2008) provide a ready-to-use framework for computing the SDR and they calculate the SDR as 4.7% for Brazil. Jalil (2010) suggests the SDR between 9 – 11% for Bangladesh. Halicioglu and Karatas (2013), and Kaplan (2014) estimate the SDR of 5.06% and 9.56% for Turkey, respectively. Kossova and Sheluntcova (2016) suggest two SDR values of 3.2% and 3.9% for Russia.

Kazlauskiene and Stundziene (2016) calculate the SDR, which varies between 3.5% and 4.3%, for Lithuania. Foltyn-Zarychta (2014) uses a survey to estimate an SDR for Poland. She proposes a rate of 5%. Additionally, Florio and Sirtori (2013) estimate the SDR of 4.43% for Poland. Plus, Evans and Sezer (2005) calculate the SDRs for European Union member states, which includes Poland (6.1%), Czech Republic (3.1%), Hungary (3.5%) and Slovak Republic (6.65%). Florio and Sirtori (2013) provide values of SDR for Slovenia (3.25%), Hungary (3.67%), Poland (4.43%), Czech Republic (4.75%) and Estonia (6.53%). European Commission (EC, 2008) estimates the SDRs for cohesion fund countries; Poland (5.3%), Czech Republic (5.7%), Hungary (8.1%) and Slovak Republic (7.7%). Additionally, Florio (2006) suggests the SDR of 5.5% for the convergence regions in European Union.[5,6]

2. Theoretical Framework

Although there is still no consensus about the calculations, existing literature on the SDR suggests that, there are two main methods that are utilized to measure the value:

[4] The literature reviewed here is presented regardless of the estimation method and period.

[5] This result is compatible with the standard benchmark suggested by European Commission guidelines. For the 2007 – 2013 period, the European Commission suggested SDR benchmark values to be 5.5% for the cohesion countries, and 3.5% for the others (EC, 2008).

[6] Government agencies usually use an SDR between 3% and 7% in developed countries, and between 8% and 15% in developing countries (Medalla, 2014). See Zhuang et al. (2007), Harrison (2010), Spackman (2013) and Medalla (2014) for the detailed information.

(i) *Trade-off approach* assumes private investments as the opportunity cost of public investments under perfect markets assumption,

(ii) *Social time preference rate (STPR) approach* measures SDR as an opportunity cost of consumption.

Most of the research in the literature (e.g., Kula, 1984; 1985; Evans and Sezer, 2002; Evans, 2004; Evans and Sezer, 2004; Kula, 2004; Evans, 2005; Evans and Sezer, 2005; Evans, 2006; Percoco, 2008; Nestico, De Mare and Conte, 2015) are based on the STPR approach because of its advantage in allowing real life market distortions. On the contrary, the number of scholars (e.g., Florio, 2006; Azar, 2007; 2009) who have used the trade-offs approach, is limited due to its assumption of perfect market.[7] Most researchers consider this assumption to be unrealistic due to the wedge between the consumption and investment rate of interest (Harrison, 2010). Since the capital market is distorted by taxes in reality,[8] most scholars suggest the STPR as an appropriate measure of the SDR (e.g., Young, 2002; HM Treasury, 2003; Spackman, 2004, Nestico, De Mare and Conte, 2015). In a similar way, we use the STPR approach in this study because of its more realistic assumptions.

Although the pioneer studies in the field have used a different version of STPR approach,[9] a large majority of the recent studies benefit from a linear formula that is generated by Ramsey (1928). According to this formula, STPR, that indicates the community's marginal weight on consumption at different points in time (Kula, 1984), can be calculated by the following equation:

$$stpr = p + eg \tag{1}$$

where

(p) – utility discount rate,

(e) – the elasticity of marginal utility of consumption,

(g) – the growth rate of per capita reel consumption.

2.1. The Utility Discount Rate *(p)*

The utility discount rate measures the inter-temporal opportunity cost which that is used by a given generation to incur for delaying consumption (Percoco, 2008). In a similar way, Moore et al. (2004) define the utility discount rate as an indicator which measures the rate at which society discounts the well-being of its future per capita consumption.

[7] See Marglin (1963) for detailed information.

[8] In other words, the consumption rate of interest is no longer equal to the investment rate.

[9] See Kula (1984), and Kula (1985) for two pioneer studies. These studies have adopted STPR approach by using variables such as; pure time preferences, probability to survive, per capita consumption growth rate, and the elasticity of marginal utility of consumption.

Pearce and Ulph (1999) suggest that the utility discount rate consists of two components: pure time preference (*d*) and life chances (*L*). According to Lowry and Peterson's (2011, p. 490) definition „pure time preference is a preference for something to come at one point in time rather than another merely because of when it occurs in time". Time preferences show the relative importance of the utility of the current generation with respect to the future generations (Nestico, De Mare and Conte, 2015). If one handles pure time preferences in a normative approach, the value of the rate can be changed according to value judgments. Since pure time preference is a point of interest for philosophers, the calculation of pure time preference rate is influenced by value judgements.

The other component seems to be relatively easier to calculate than pure time preference. Life chance indicates the survival probability of a person and is usually calculated by benefiting from death rates. Halicioglu and Karatas (2013) suggest that the survival probability of a person can be calculated as $L = 1 - death\,rate$. Since this data is easily accessible, the calculation of life chance does not constitute difficulty.

2.2. The Elasticity of Marginal Utility of Consumption *(e)*

There are two main approaches in the calculation of the elasticity of marginal utility of consumption, one based on the analysis of personal taxation while the other based on food demand.

The Personal Taxation Model (PTM): Under PTM, the elasticity of marginal utility of consumption is calculated by the approach suggested by Stern (1977), and Cowell and Gardiner (1999). In this approach, elasticity of marginal utility of consumption represents the government's aversion to income inequality and is measured by the progressivity of tax rates (Nestico, De Mare and Conte, 2015).

The model depends on two main assumptions, which are expressed as the following equations (Evans, 2005):

$$U(Y) - U(Y - T(Y)) = k \tag{2}$$

$$U(Y) = (Y^{1-e} - 1) / (1 - e) \tag{3}$$

where *Y* and *T*(*Y*) represent taxable income and income tax function, respectively. Equation 2 shows that the tax structure is assumed to be based on the principle of „equal absolute sacrifice of satisfaction". Equation 3 refers to the iso-elastic utility functions.[10] Equation 2 and 3 together indicate that the extent

[10] See Blue and Tweeten (1997) for an empirical support in favor of the use of iso-elastic utility functions.

of progressiveness income tax rates is closely related with the government's degree of aversion to income inequality (Evans, 2005).

Substituting Equation 3 into Equation 2 gives:

$$(Y^{1-e}-1)/(1-e)-\left[\left(Y-T\left(Y\right)\right)^{1-e}-1\right]/(1-e)=k \qquad (4)$$

Taking the total differential of Equation 4, we obtain:

$$Y^{-e}-\left[Y-T\left(Y\right)\right]^{-e}\left(1-t\right)=0 \qquad (5)$$

where t indicates marginal tax rate. By rearranging Equation 5 we get:

$$\left(1-t\right)=(1-T\left(Y\right)/Y)^{e} \qquad (6)$$

Taking the logarithms of both sides gives:

$$\log\left(1-t\right)=elog(1-T\left(Y\right)/Y) \qquad (7)$$

Then, the elasticity of marginal utility of substitution is expressed as follows:

$$e=\log\left(1-t\right)/\log(1-T\left(Y\right)/Y) \qquad (8)$$

Equation 8 implies that if marginal and average tax rate[11] are known, it is possible to calculate the elasticity of marginal utility of consumption.[12]

The Demand for Food Model: This approach which is proposed by Fellner (1967), is based on the pioneer ideas of Fisher (1927), and Frisch (1932). In this model, the elasticity of marginal utility of consumption (*e*), is approximately calculated by using the income elasticity (*b*), the compensated price elasticity (*c*) and the budget share (*w*) for preference independent goods:

$$e=b(1-wb)/\left|c\right| \qquad (9)$$

According to this model, preference dependence (want dependence) criterion implies the absence of important specific complementary intergroup relationships (Evans and Sezer, 2002). In other words, preference independence indicates that the „marginal utility of good *i* is independent of the consumption of *j*, $i\neq j$, (Selvanathan and Selvanathan, 1993, p. 1250).[13]

[11] $T\left(Y\right)/Y$.

[12] Evans (2004), Evans (2005), Evans and Sezer (2004), Evans and Sezer (2005), Percoco (2008), and Nestico, De Mare and Conte, (2015) use this methodology to estimate elasticity of marginal utility of consumption.

[13] Selvanathan and Selvanathan (1993) suggest that preference independence is plausible for broad product groups such as food production. Since food production group does not have a serious complementary relationship with the other production groups, it is commonly preferred by researchers. Evans and Sezer (2002), Evans (2004), and Percoco (2008) use food demand estimation method to determine relevant elasticity values.

Two model specifications are generally used to estimate the elasticity of marginal utility of consumption; the constant elasticities model (CEM) and the almost ideal demand system (AIDS).[14]

2.3. The Growth Rate of Per Capita Reel Consumption *(g)*

The growth rate of per capita reel consumption is usually calculated by regression analysis with time series data (e.g., Evans, 2004; Evans and Sezer, 2005; Halicioglu and Karatas, 2013). However, a limited number of studies use the growth rate of income as a proxy for the growth rate of per capita reel consumption (e.g., Percoco, 2008; Nestico, De Mare and Conte, 2015).

3. Methodology and Estimation

In this section, we estimate SDRs for six transition countries (Czech Republic, Estonia, Hungary, Latvia, Poland, Slovak Republic) by using the Ramsey formula. To this aim, we first calculate the values for the elasticity of marginal utility of consumption (*e*), the utility discount rate (*p*) and the growth rate of per capita reel consumption (*g*), respectively.

3.1. The Elasticity of Marginal Utility of Consumption (*e*): Alternative Approaches

We employ two different approaches in order to estimate the elasticity of marginal utility of consumption.

Personal Taxation Model (PTM): We calculate the values of *e* for each of the countries by using the formula in Equation 8.

T a b l e 1

Calculation of *e* through the Income Taxation Model at the Average Wage (AW)

Countries	t		T/Y		$\log(1-t)$		$\log(1-T/Y)$		e	
	2000	2015	2000	2015	2000	2015	2000	2015	2000	2015
Czech Rep.	0.300	0.311	0.225	0.233	–0.155	–0.162	–0.111	–0.115	1.399	1.404
Estonia	0.260	0.213	0.219	0.184	–0.131	–0.104	–0.107	–0.088	1.218	1.178
Hungary	0.685	0.345	0.357	0.345	–0.502	–0.184	–0.192	–0.184	2.615	1.000
Latvia	0.318	0.311	0.279	0.289	–0.166	–0.162	–0.142	–0.148	1.170	1.092
Poland	0.305	0.267	0.278	0.249	–0.158	–0.135	–0.141	–0.124	1.117	1.085
Slovak Rep.	0.296	0.299	0.198	0.231	–0.152	–0.154	–0.096	–0.114	1.591	1.353

Notes: The „all-in tax“ rate is used for calculations. The „all-in” tax rate includes central and sub-central government income tax, plus employee social security contribution (as a percentage of gross wage earnings). The AW is based on a single person at 100% of average earnings, no child.

Source: <https://stats.oecd.org/index.aspx?DataSetCode=TABLE_I4>;
<https://stats.oecd.org/index.aspx?DataSetCode=TABLE_I5>.

[14] See Appendix A in Evans (2004) for detailed information about CEM and AIDS.

Relevant marginal and average tax rate data is obtained from OECD tax database. In order to evaluate the results over time, we calculate *e* first for 2000. The year 2000 is the earliest date at which reliable data could be obtained. Then, we calculate *e*, for the year 2015 so as to satisfy compatibility with the results of second approach. The results can be seen in Table 1.

Table 1 shows that *e* values decrease over time for all selected countries, except Czech Republic. The elasticity of marginal utility of consumption values vary between the range of 1 to 2.6 for 2000; and 1 to 1.4 for 2015.

Food Demand Model: We use AIDS approach to calculate the elasticity of marginal utility of consumption. AIDS approach is developed by Deaton and Muellbauer (1980) in order to study demand for broad classification of products. The advantages of this approach are the followings (Deaton and Muellbauer, 1980, p. 312): „(i) it gives an arbitrary first-order approximation to any demand system, (ii) it satisfies the axioms of choice exactly, (iii) it aggregates perfectly over consumers without invoking parallel linear Engel curves, (iv) it has a functional form which is consistent with known household-budget data, (v) it is simple to estimate, (vi) it largely avoids the need for non-linear estimation, (vii) it can be used to test the restriction of homogeneity and symmetry through linear restrictions on fixed parameters“.

Additionally, AIDS approach let to avoid the constant elasticity assumption of log-linear demand models and allows elasticity to vary with changes in quantities and prices.[15]

Following Evans (2004), and Percoco (2008), we constitute the regression equation as:

$$W_{it} = \alpha + \beta \log(conspc)_{it} + \gamma log(fp / nfp)_{it} + \delta log(nfp)_{it} + u_{it} \qquad (10)$$

$$i = 1, 2, \ldots, N$$

$$t = 1, 2, \ldots, T$$

where $conspc$ is the per capita household consumption expenditures, fp is the price index of the food, nfp is the price index for nonfood, W is budget share of food with respect to total consumption, and u_{it} is an error term which is assumed to be normally distributed such that $u_{it} \sim N(0, \sigma^2)$ .The subscript *i* represents countries, while the subscript *t* represents time dimension.

[15] We also estimated income and price elasticities by CEM. We observed that the signs of the coefficients are meaningless, and for this reason we didn't share the results. In the literature, some disadvantages of CEM approach are discussed by scholars. For example, Hosken et al. (2002) remark that the CEM can not guarantee the parameters have the "right" signs. Additionally, Crooke et al. (1999) indicate that CEM also does not guarantee the post-merger equilibrium depending on the elasticity values taken.

In Equation 10, the income elasticity and the compensated own-price elasticity are defined as $b = 1 + \beta / w$ and $c = (\gamma / w) - (1 - w)$, respectively.

To estimate Equation 10, we employ annual dataset for six transition countries for the period 1996 – 2015.[16] Table 2 shows the description and sources of the data.

Table 2

Data Description and Sources

Variable	Data	Source
w	The share of expenditures on food and nonalcoholic beverages in total household budget	OECD Stat, Authors' own calculations
conspc	Per capita household final consumption expenditures (constant 2010 USD)	World Bank, Authors' own calculations
fp	Harmonized Index of Consumer Prices for food and nonalcoholic beverages	EUROSTAT
nfp	Harmonized Index of Consumer Prices for overall goods excluding food and nonalcoholic beverages	EUROSTAT

Source: Table is constructed by authors.

We consider three models depending on different assumptions about the constant term. First, in pooled model (P), we assume that constant term a is constant. Therefore, it is affected neither by cross section nor by time dimension. Since the constant term in Equation 10 has no subscript; this model can be said to represent pooled regression. Despite its simplicity, there is a major drawback of the pooled regression. It may not reflect the exact relationship between budget share of food consumption and the regressors. In order to deal with this problem, we determine a new model which considers the individual level effects. Then, Equation 10 becomes

$$W_{it} = a_i + b\log(conspc)_{it} + clog(fp / nfp)_{it} + dlog(nfp)_{it} + u_{it} \qquad (11)$$

$$i = 1, 2, \ldots, N$$

$$t = 1, 2, \ldots, T$$

The second model (fixed effects model (FE)) is represented by Equation 11. In FE model, we assume that a changes according to cross section dimension, while the slope estimates are constant across units. In the third model (random effects model (RE)), we assume that the distribution of a is not determined by cross-section.[17] Table 3 summarizes the results.

In order to decide whether individual level effects are significant, we first employ F-test and compare the pooled model against the fixed effects model by

[16] We use the most recent data available at the time of our study. It contains 120 observations.

[17] We assume random distribution.

testing the null hypothesis that the constant term is the same for all countries. Since the calculated F-statistics (21.94) is greater than the critical value of (3.21) in the 1% significance level, we conclude that the constant term is affected by the cross-section units and prefer the fixed effects model to the pooled model.

T a b l e 3

Estimation Results for Pooled, Fixed Effects and Random Effects Model

Dependent Variable: *W*	**(P)**	**(FE)**	**(RE)**
a	1.9726*** (20.59)	1.8336*** (19.51)	1.8410*** (19.85)
log(conspc)	–0.2049*** (–12.70)	–0.1761*** (–11.09)	–0.1775*** (–11.41)
log(fp / nfp)	0.1070*** (3.01)	0.1150*** (3.89)	0.1145*** (3.92)
log(nfp)	0.0184 (1.15)	–0.0085 (–0.60)	–0.0073 (–0.53)
R squared	0.7846	0.8483	0.8483
F/Wald statistic	140.83	206.85	636.09
Prob(F-statistic)	0.0000	0.0000	0.0000

Notes: Figures in parenthesis are t statistics; *** p < %1, ** p < %5, *p < %10.

Source: Authors' own calculations by using Stata 13.0 Software.

In the next step, we employ a formal test of Hausman (1978) in order to decide which one of the individual-level effects models to use.[18] The test indicates that we cannot reject the null hypothesis, and therefore we prefer RE model over FE model.

Additionally, we employ the approaches of Levene (1960), and Brown and Forsythe (1974)[19] for assessing whether RE model is correctly specified. These approaches are designed to check the equality of variances between the cross-section units. Although the goal is common to all approaches, Brown test and Forsythe test replace the mean in Levene's formula with alternative location estimators. The results are given in Table 4.

As can be seen in Table 4, Brown test and Forsythe test indicate no heteroscedasticity at 5% significance level. However, there is a heteroscedasticity problem when Levene approach is employed. Therefore, robust re-estimation seems to be valuable.

[18] Both models have some drawbacks of their own: a) FE model causes a loss in the degrees of freedom due to the use of the dummy variable; b) RE model assumes no correlation between unit effects and explanatory variables as random effects model assumes (Greene, 2002). Baum (2006, p. 230) suggests that "if the regressors are uncorrelated with the u_i, the FE estimator is consistent but the RE estimator is not consistent. If the regressors are uncorrelated with the u_i, the FE estimator is still consistent, albeit inefficient, whereas the RE estimator is consistent and efficient".

[19] Two different approaches are presented in the paper.

Table 4

Heteroscedasticity and Autocorrelation Tests for Random Effects Model

	Test Statistics	Degrees of Freedom	Pr > F
Levene (W0)	2.4615**	(5, 114)	0.0371
Brown (W50)	1.6886	(5, 114)	0.1434
Forsythe (W10)	2.0961*	(5, 114)	0.0709
	Test Statistics	**Degrees of Freedom**	**Pr > χ^2**
LM	88.12***	1	0.0000
ALM	23.39***	1	0.0000

Note: *** p < %1, ** p < %5, *p < %10.

Source: Authors' own calculations by using Stata 13.0 Software.

In the next step, we employ Lagrange Multiplier (LM) test and Adjusted Lagrange Multiplier (ALM) test in order to detect the existence of autocorrelation for RE model. Both tests reject the null hypothesis[20] at the 5% level of significance. Hence, we conclude that the estimated RE model has an autocorrelation problem.

In order to eliminate heteroscedasticity and autocorrelation problems, we re--estimate the model with the estimator of Arellano (1987), Froot (1989), and Rogers (1993). All estimated coefficients except for the price index of non-food are statistically significant. Since we don't use the price index of non-food to calculate the income and price elasticities, the exception does not appear to be a problem.

Table 5 shows the results of the estimation of the elasticity of the marginal utility of consumption which is estimated as 0.483[21] by using Equation 9.

Table 5

Computation of the Elasticity of the Marginal Utility of Consumption

Income Elasticity (*b*)	Compensated Price Elasticity (*c*)	Budget Share of Food (*w*)	*e*
0.1125	–0.2275	0.20	0.483

Notes: w is calculated as the average rate of the budget share of food values of the sample.

Source: Authors' own calculations by using Stata 13.0 Software.

3.2. The Utility Discount Rate *(p)*

Ramsey defines the pure time preference discounting as „a practice which is ethically indefensible and arises merely from weakness of the imagination" (Feldstein, 1964, p. 366). Many of the studies in the literature support the view

[20] The autocorrelation coefficient is equal to zero.

[21] The difference between the results of the two methods may be due to the different data structures used.

of Ramsey. In line with the previous studies (e.g. Ramsey, 1928; Pigou, 1932; Price, 1989; Broome and Ulph, 1992; Evans and Sezer, 2005), we assume pure time preference (*d*) as zero for the sake of simplicity.[22]

In order to calculate the life chance (the second component of the utility discount rate), we use the formula $L = 1 - deathrate$ suggested by Halicioglu and Karatas (2013).[23]

3.3. The Growth Rate of Per Capita Reel Consumption *(g)*

To obtain a more precise estimation, we use the measure of the growth rate of per capita reel consumption, in a similar way to the studies of Evans (2004), Evans and Sezer (2005), and Halicioglu and Karatas (2013). We calculate the average growth rate of per capita reel consumption for the selected countries during the period 1996 – 2015.[24]

Using all the estimated parameters of the STPR in Equation 1, we obtain the following results. Table 6 summarizes the results.

Table 6

Social Discount Rates for Selected Transition Economies

	p	***g* (%)**	***e* from PTM**	***e* from AIDS**	***stpr* (%) from PTM**	***stpr* (%) from AIDS**
Czech Rep.	0.9895	1.9633	1.404	0.4830	3.75	1.94
Estonia	0.9873	5.0317	1.178	0.4830	6.91	3.42
Hungary	0.9868	2.3159	1.000	0.4830	3.30	2.11
Latvia	0.9858	5.2010	1.092	0.4830	6.67	3.50
Poland	0.9902	3.6430	1.085	0.4830	4.94	2.75
Slovak Rep.	0.9902	3.1980	1.353	0.4830	5.32	2.53

Source: Authors' own calculations

Concluding Remarks

The choice of an SDR is one of the most controversial points in public project appraisal. A low SDR allows public sector agencies to allocate a larger share of tax revenues to the long-term intergenerational projects (Bazerlon and Smetters, 1999). On the other hand, this may be a threat to the development of the market economy due to the crowding-out effect (Aschauer, 1989a; Narayan, 2004). Therefore, the estimation of the optimal SDR plays a critical role on economic growth, particularly in transition economies.

[22] This assumption means that society discounts the utility of its future per capita consumption with a zero rate.

[23] We obtain the data from World Development Indicators (WB, 2017).

[24] We obtain the data from World Development Indicators (WB, 2017).

To this aim, we estimate the SDRs of six transition countries (Czech Republic, Estonia, Hungary, Latvia, Poland, Slovak Republic) by using two different approaches. To our knowledge, this is the first attempt to estimate the SDRs of the selected transition economies by two approaches simultaneously. We observe that the estimates produced by PTM are concentrated in a band between 3.3% (Hungary) and 6.91% (Estonia). In comparison with PTM estimations; the SDRs obtained by AIDS method are lower for all selected countries: the lowest value is 1.94% (Czech Republic) and the highest is 3.5% (Latvia).

We believe that the estimation differences between the two approaches employed are due mainly to the methodology of data processing. However, there is not a clear-cut answer to the question as to which approach is most appropriate to estimate SDR. Since each economy has its own unique structure and institutional settings; the best option may be different for each country. Nevertheless, it is possible to say that the food demand approach could be a better way to estimate an SDR for a transition economy. Evans (2005, p. 206) indicates that when serious tax evasion is a matter of concern, the results of demand for food model are more reliable than those obtained from personal taxation model. Therefore, we may conclude the food demand approach seems to be a more suitable option for transition economies due to the large share of the shadow economy. However, this may not be the case for advanced European economies, which have a relatively smaller shadow economy.[25] The vast structural differences among various countries make it impossible to estimate an „one-size-fits-all" SDR. The use of one same rate for all economies leads to an incorrect evaluation of the public projects. We hope that our country-specific analysis could provide useful information both for the researchers and the government agencies in selected transition countries.

Unfortunately, it is difficult to compare the results of this examination with past research because of the novel perspective of our study and the data constraints. Nevertheless, it is possible to consider our findings in line with the studies of Evans and Sezer (2005), and Florio and Sirtori (2013). Additionally, our recommendation regarding the use of food demand model indicates, that a lower rate than the suggested rate by the European Commission of 5.5% (EC, 2008), should be used for transition countries.

The data, which covers a relatively short time period, is the main limitation of this study. Therefore, prospective studies with a longer time frame could be useful for better estimation.

[25] The average size of shadow economy was estimated to be 22.1% and 14.1% of GDP in 2012, respectively for the six transition economies (Czech Republic, Estonia, Hungary, Latvia, Poland, Slovak Republic) and the six largest economies in Europe (Germany, United Kingdom, France, Italy, Spain, Netherlands) (Schneider, 2012).

Additionally, future research might be devoted to estimating different SDRs to different industries and investments. Further study is needed to examine the effects that changes the SDR in practice.

References

AFONSO, A. – ST. AUBYN, M. (2009): Macroeconomic Rates of Return of Public and Private Investment: Crowding-in and Crowding-out Effects. The Manchester School, *77*, s1, pp. 21 – 39. DOI: 10.1111/j.1467-9957.2009.02117.x.

ANDRADE, J. S. – DUARTE A. P. (2016): Crowding-in and Crowding-out Effects of Public Investments in the Portuguese Economy. International Review of Applied Economics, *30*, No. 4, pp. 488 – 506.

ARELLANO, M. (1987): Computing Robust Standard Errors for Within-Groups Estimators. Oxford Bulletin of Economics and Statistics, *49*, No. 4, pp. 431 – 434. DOI: 10.1111/j.1468-0084.1987.mp49004006.x.

ASCHAUER, D. A. (1989a): Does Public Capital Crowd Out Private Capital? Journal of Monetary Economics, *24*, No. 2, pp. 171 – 188. DOI: 10.1016/0304-3932(89)90002-0.

ASCHAUER, D. A. (1989b): Is Public Expenditure Productive? Journal of Monetary Economics *23*, No. 2, pp. 177 – 200. DOI: 10.1016/0304-3932(89)90047-0.

AZAR, S. A. (2007): Measuring the US Social Discount Rate. Applied Financial Economics Letters, *3*, No. 1, pp. 63 – 66. DOI: 10.1080/17446540600771068.

AZAR, S. A. (2009): A Social Discount Rate for the US. International Research Journal of Finance and Economics, *25*, No. 2009, pp. 203 – 208.

BAUM, C. F. (2006): An Introduction to Modern Econometrics Using Stata. Texas: StataPress.

BAUMOL, W. J. (1968): On the Social Rate of Discount. American Economic Review, *58*, No. 4, pp. 788 – 802.

BAZERLON, C. – SMETTERS, K. (1999): Discounting Inside the Washington DC Beltway. Journal of Economic Perspectives, *13*, pp. 213 – 228. DOI: 10.1257/jep.13.4.213.

BLUE, E. N. – TWEETEN, C. (1997): The Estimation of Marginal Utility of Income for Application to Agricultural Policy Analysis. Agricultural Economics, *16*, pp. 155 – 169.

BOARDMAN, A. E. – MOORE, M. A. – VINING, A. R. (2010): The Social Discount Rate for Canada Based on Future Growth in Consumption. Canadian Public Policy, *36*, No. 3, pp. 325 – 343. DOI: 10.3138/cpp.36.3.325.

BROOME, J. – ULPH, D. (1992): Counting the Cost of Global Warming. Cambridge: White Horse Press.

BROWN, M. B. – FORSYTHE, A. B. (1974): Robust Tests for Equality of Variances. Journal of the American Statistical Association, *69*, No. 346, pp. 364 – 367.

COWELL, F. A. – GARDINER, K. (1999): Welfare Weights. [STICERD Research Paper, No. 20.] London, UK: London School of Economics. Available at: <http://darp.lse.ac.uk/papersDB/Cowell-Gardiner_(OFT).pdf>.

CROOKE, P. – FROEB, L. – TSCHANTZ, S. – WERDEN, G. J. (1999): Effects of Assumed Demand Form on Simulated Postmerger Equilibria. Review of Industrial Organization, *15*, No. 3, pp. 205 – 217. DOI: 10.1023/A:1007730632277.

DEATON, A. – MUELLBAUER, J. (1980): An Almost Ideal Demand System. The American Economic Review, *7*, No. 3, pp. 312 – 326.

EC (2008): Guide to Cost-Benefit Analysis of Investment Project. Brussels: EC. Available at: <http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf>.

EVANS, D. J. (2004): A Social Discount Rate for France. Applied Economics Letters, *11*, No. 13, pp. 803 – 808. DOI: 0.1080/1350485042000254638.

EVANS, D. J. (2005): The Elasticity of Marginal Utility of Consumption: Estimates for 20 OECD Countries. Fiscal Studies, *26*, No. 2, pp. 197 – 224. DOI: 10.1111/j.1475-5890.2005.00010.x.

EVANS, D. J. (2006): Social Discount Rates for the European Union. [Working Paper, No. 20.] Milan: European Economic Workshop. Available at: <http://wp.demm.unimi.it/files/wp/2006/DEMM-2006_020wp.pdf>.

EVANS, D. J. – SEZER, H. (2002): A Time Preference Measure of the Social Discount rate for the UK. Applied Economics, *34*, No. 15, pp. 1925 – 1934. DOI: 10.1080/00036840210128753.

EVANS, D. – SEZER, H. (2004): Social Discount Rates for Six Major Countries. Applied Economics Letters, *11*, No. 9, pp. 557 – 560. DOI: 10.1080/135048504200028007.

EVANS, D. J. – SEZER, H. (2005): Social Discount Rates for Member Countries of the European Union. Journal of Economic Studies, *32*, No. 1, pp. 47 – 59. DOI: 10.1108/01443580510574832.

FALKE, M. (2002): Community Interests: An Insolvency Objective in Transition Economy? [Discussion Paper, No. 01.] Frankfurt: Frankfurter Institute fuer Transformationsstudien.

FELDSTEIN, M. S. (1964): The Social Time Preference Discount Rate in Cost Benefit Analysis. The Economic Journal, *74*, No. 294, pp. 360 – 379.

FELLNER, W. (1967): Operational Utility: The Theoretical Background and a Measurement. In: FELLNER, W. (ed.): Ten Economic Studies in the Tradition of Irving Fisher. New York: John Wiley and Sons, pp. 39 – 75.

FISHER, I. (1927): A Statistical Method for Measuring Marginal Utility and Testing the Justice of Progressive Income. London: Macmillan.

FLORIO, M. (2006): Cost-Benefit Analysis and the European Union Cohesion Fund: On the Social Cost of Capital and Labour. Regional Studies, *40*, No. 02, pp. 211 – 224. DOI: 10.1080/00343400600600579.

FLORIO, M. (2014): Applied Welfare Economics: Cost-Benefit Analysis of Projects and Policies Vol. 22. Oxford: Routledge.

FLORIO, M. – SIRTORI, E. (2013): The Social Cost of Capital: Recent Estimates for the EU Countries. [Working Paper, No. 03.] Milan: Centre for Industrial Studies. Available at: <http://www.csilmilano.com/docs/WP2013_03.pdf>.

FOLTYN-ZARYCHTA, M. (2014): Discounting in Intergenerational Investment Appraisal – Survey Results. Business Economic Horizons, *10*, No. 1, pp. 10 – 17. Available at: <http://dx.doi.org/10.15208/beh.2014.2>.

FRISCH, R. (1932): New Methods of Measuring Marginal Utility. Tübingen: Mohr.

FROOT, K. A. (1989): Consistent Covariance Matrix Estimation with Cross-Sectional Dependence and Heteroskedasticity in Financial Data. Journal of Financial and Quantitative Analysis *24*, No. 3, pp. 333 – 355.

GREENE, W. H. (2002): Econometric Analysis. 5th ed. New York: Prentice Hall.

GUJARATI, D. N. (2004): Basic Econometrics. 4th ed. New York: McGraw-Hill Companies.

HALICIOGLU, F. – KARATAS, C. (2013): A Social Discount Rate for Turkey. Quality & Quantity, *47*, No. 2, pp. 1085 – 1091. DOI:10.1007/s11135-011-9585-z.

HARRISON, M. (2010): Valuing the Future: The Social Discount Rate in Cost-Benefit Analysis. [Visiting Research Paper.] Canberra: Productivity Commission. Available at: <http://ssrn.com/abstract=1599963>.

HATANO, T. (2010): Crowding-in Effect of Public Investment on Private Investment. Public Policy Review, *6*, No. 1, pp. 105 – 120.

HAUSMAN, J. (1978): Specification Tests in Econometrics. Econometrica, *46*, No. 6, pp. 1251 – 1271.

HLADKÁ, M. – HYÁNEK, V. – ŠPALEK, J. (2017): The Relationship between Public Subsidies and Unearned Revenues for Non-profit Organizations: Testing the Crowding-Out and Crowding-In Positions in the Czech Republic. Ekonomický časopis/Journal of Economics, *65*, No. 3, pp. 263 – 281.

HM TREASURY (2003): Appraisal and Evaluation in Central Government. London: The Green Book. Available at: <HMSO.https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf>.

HOSKEN, D. – O'BRIEN, D. – SCHEFFMAN, D. – VITA, M. (2002): Demand System Estimation and its Application to Horizontal Merger Analysis. Washington, DC: Federal Trade Commission. Available at: <https://www.ftc.gov/sites/default/files/attachments/economics-best-practices/wp246.pdf>.

JALIL, M. M. (2010): Approaches to Measuring Social Discount Rate: A Bangladesh Perspective. SSRN Electronic Journal. Available at: <https://ssrn.com/abstract=1921987.> DOI: 10.2139/ssrn.1921987.

KAZLAUSKIENE, V. – STUNDZIENE, A. (2016): Estimation of Social Discount rate for Lithuania. Trendy Ekonomiky a Managementu, *10,* No. 26, pp. 39 – 47. DOI: 10.13164/trends.2016.26.39.

KAPLAN, Z. (2014): The Social Cost-Benefit Analysis of Investment Projects and Sample Application. [Master Thesis.] Ankara: Gazı University Institute of Social Sciences.

KOSSOVA, T. – SHELUNTCOVA, M. (2014): A Social Discount Rate for Appraisal of Regional Investments: Evidence from Russia. International Journal of Public Administration, *37*, No. 14, pp. 1024 – 1029. DOI: 10.1080/01900692.2014.928318.

KOSSOVA, T. – SHELUNTCOVA, M. (2016): Evaluating Performance of Public Sector Projects in Russia: The Choice of a Social Discount Rate. International Journal of Project Management, *34*, No. 3, pp. 403 – 411. DOI: 10.1016/j.ijproman.2015.11.005.

KULA, E. (1984): Derivation of Social Time Preference Rates for the United States and Canada. The Quarterly Journal of Economics, *99*, No. 4, pp. 873 – 882.

KULA, E. (1985): An Empirical Investigation on the Social Time Preference Rate for the UK. Environment and Planning, *17*, No. 2, pp. 199 – 217. DOI: 10.1068/a170199.

KULA, E. (1987): Social Interest Rate for Public Sector Appraisal in the United Kingdom, the United States and Canada. Project Appraisal, *2*, No. 3, pp. 169 – 174.

KULA, E. (2004): Estimation of a Social Rate of Interest for India. Journal of Agricultural Economics, *55*, No. 1, pp. 91 – 99. DOI: 10.1111/j.1477-9552.2004.tb00081.x.

LEVENE, H. (1960): Robust Tests for Equality of Variances. In: OLKIN, I. (ed.): Contributions to Probability and Statistics: Essays in Honor of Harold Hotelling, pp. 278 – 292. Stanford, CA: Stanford University Press.

LOPEZ, H. (2008): The Social Discount Rate: Estimates for Nine Latin American Countries. [Working Paper, No. 4639.] Washington, DC: The World Bank Policy Research. Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/6659/wps4639.pdf>.

LOWRY, R. – PETERSON, M. (2011): Pure Time Preference. Pacific Philosophical Quarterly, *92*, No. 4, pp. 490 – 508. DOI: 10.1111/j.1468-0114.2011.01408.x.

MARGLIN, S. A. (1963): The Social Rate of Discount and the Optimal Rate of Investments. The Quarterly Journal of Economics, *77*, No. 1, pp. 95 – 111.

MEDALLA, E. M. (2014): Using the Social Rate of Discount in Evaluating Public Investments in the Philippines. [Philippine Institute for Development Studies, No. 2014-02.] Pasig: National Economic Development Authority.

MOORE, M. A. – BOARDMAN, A. E. – VINING, A. R. – WEIMER, D. L. – GREENBERG, D. H. (2004): Just Give Me a Number! Practical Values for the Social Discount Rate. Journal of Policy Analysis and Management, *23*, No. 4, pp. 789 – 812. DOI: 10.1002/pam.20047.

MOORE, M. A. – BOARDMAN, A. E. – VINING, A. R. (2013): More Appropriate Discounting: The Rate of Social Time Preference and the Value of the Social Discount Rate. Journal of Benefit-Cost Analysis, *4*, No. 1, pp. 1 – 16. DOI: 10.1515/jbca-2012-0008.

NARAYAN, P. K. (2004): Do Public Investments Crowd Out Private Investments? Fresh Evidence from Fiji. Journal of Policy Modeling, *26*, No. 6, pp. 747 – 753. DOI: 10.1016/j.jpolmod.2004.06.002.

NESTICO, A. – DE MARE, G. – CONTE, A. (2015): Theoretical and Empirical Approaches to Estimating the Social Discount Rate: An Estimation for Italy through the Ramsey Formula. Journal Valori e Valutazioni, *14*, No. 2015, pp. 47 – 62.

PEARCE, D. – ULPH, D. (1999): A Social Discount Rate for the United Kingdom. In: PEARCE, D. W. (ed.): Economics and the Environment: Essays in Ecological Economics and Sustainable Development. Cheltenham: Edward Elgar, pp. 268 – 285.

PERCOCO, M. (2008): A Social Discount Rate for Italy. Applied Economics Letters, *15*, No. 1, pp. 73 – 77. DOI: 10.1080/13504850600706537.

PIGOU, A. C. (1932): The Economics of Welfare. London: Macmillan.

PRICE, C. (1989): The Theory and Applications of Forest Economics. Oxford: Basil Blackwell.

RAMBAUD, S. C. – TORRECILLAS, M. J. M. (2005): Some Considerations on the Social Discount Rate. Environmental Science & Policy, *8*, No. 4, pp. 343 – 355.

RAMSEY, F. P. (1928): A Mathematical Theory of Saving. Economic Journal, *38*, No. 152, pp. 543 – 559.

ROBINSON, R. (1993): Cost-Benefit Analysis. BMJ, *307*(6909), pp. 924 – 926. DOI: 10.1136/bmj.307.6909.924.

ROGERS, W. H. (1993): Regression Standard Errors in Clustered Samples. Stata Technical Bulletin, *3*, No. 13, pp. 19 – 23.

SCHAD, M. – JOHN, J. (2012): Towards a Social Discount Rate for the Economic Evaluation of Health Technologies in Germany: An Exploratory Analysis. The European Journal of Health Economics, *13*, No. 2, pp. 127 – 144. DOI: 10.1007/s10198-010-0292-9.

SCHNEIDER, F. (2012): Size and Development of the Shadow Economy of 31 European and 5 other OECD Countries from 2003 to 2012: Some New Facts. Available at: <http://pw.seipa.edu.pl/s/p/artykuly/93/931/Shadow%20Economy%20up%20to%202012.pdf>.

SELVANATHAN, S. – SELVANATHAN, E. A. (1993): A Cross-Country Analysis of Consumption Patterns. Applied Economics, *25*, No. 9, pp. 1245 – 1259. DOI: 10.1080/00036849300000186.

SHARMA, R. A. – MCGREGOR, M. J. – BLYTH, J. F. (1991): The Social Discount Rate for Land Use Projects in India. Journal of Agricultural Economics, *42*, No. 1, pp. 86 – 92. DOI: 10.1111/j.1477-9552.1991.tb00335.x.

SPACKMAN, M. (2004): Time Discounting and the Cost of Capital of Government. Fiscal Studies, *25*, No. 4, pp. 467 – 518. DOI: 10.1111/j.1475-5890.2004.tb00547.x.

SPACKMAN, M. (2006): Social Discount Rates for the European Union: An Overview. [Working Paper, No. 33.] Milan: European Economic Workshop.

SPACKMAN, M. (2013): Government Time Discounting and Required Rates of Return: UK History and Current Issues. Economic Affairs, *33*, No. 2, pp. 190 – 206. DOI: 10.1111/ecaf.12013.

STATA 13.0, StataCorp, Texas: USA.

STERN, H. N. (1977): Welfare Weights and the Elasticity of Marginal Utility of Income. In: ARTIS, M. and NORBAY, R. (eds): Proceedings of the Annual Conference of the Association of University Teachers of Economics. Oxford: Blackwell, pp. 209 – 257.

VALENTIM, J. – PRADO, J. M. (2008): Social Discount Rates. Lucca: IMT Lucca Institute for Advanced Studies. Available at: <https://www.researchgate.net/profile/Mauricio_Prado3/publication/228301251_Social_Discount_Rates/links/5404852c0cf2bba34c1c9429.pdf>.

WB (2017): World Development Indicators. Washington, DC: World Bank. Available at: <http://data.worldbank.org/data-catalog/world-development-indicators>.

YOUNG, L. (2002): Determining the Discount Rate for Government Projects. [Working Paper 02/21.] Wellington: New Zealand Treasury.

ZHUANG, J. – LIANG, Z. – LIN T. – DE GUZMAN, F. (2007): Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey. [Working Paper, No. 94.] Metro Manila: Asian Development Bank.