A social discount rate for Turkey

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2011

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Abstract

Social Discount Rate (SDR) is a very crucial policy parameter in public project appraisals due to its resource allocation impacts. This study estimates an SDR for Turkey using the Social Time Preference Rate (STPR) approach. The elasticity of the marginal utility consumption, which is the most important component of the STPR, is estimated econometrically from a demand for food approach during the period of 1980-2008. The overall result indicates that the SDR for Turkey is 5.06%. The European Union requires evaluation of the publicly supported commercial projects in terms of the SDR; hence the findings from this study can be used as a useful policy measurement for a full EU member candidate country, Turkey.

Keywords: social discount rate; social time preference; project appraisal; ARDL; Turkey.

JEL Classifications: H20; C22.

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1 Introduction

Public projects and regulations have impacts that occur over time. For instance, infrastructure projects, such as motorways, bridges or dams, have effects that occur over decades. The Social Discount Rate (SDR) measures the rate at which a society is willing to trade present for future consumption. Thus, the SDR is a very crucial parameter in public project appraisals as it could considerably alter the resource allocation and efficiency. If this rate is too high, future generations will face excess financial burden since distant cash flows will become negligible. If this rate is too low, ineffective projects are chosen creating an inefficient allocation of resources.

There is a consensus amongst the public policy makers that future impacts should be discounted at the SDR. At this rate, society discounts future costs and benefit and converts them into present values. There is, however, less agreement over what this rate should be and how to determine it.

The existing literature on the SDR suggests that there are three main methods that are utilized to measure the value: *i*) Social Time Preference Rate (STPR) approach which is based on classical Ramsey (1928) model of saving and growth. A number of studies such as Kula (1984 and 2004), Evans and Sezer (2002), Evans (2005), and Percoco (2008) have adopted this approach; *ii*) Specifying a benchmark financial rate approach which is based on the long-term treasury interest rates. This method is adopted by the US Office of Management and Budget. The financial discount rate for 30 year projects is 2.8% based on 1979-2008 average. Florio (2006) provides a fruitful discussion on this approach; *iii*) Trade-offs in financial markets approach which measures the SDR as the opportunity cost of private investment instead of consumption under perfect markets assumption; see for example, Azar (2007).

According to Spackman (2004), the STPR is an appropriate measure of the SDR. The primary concern of this paper is to estimate Turkey's social discount rate for long-term social projects using the demand for food approach of the STPR. As far as this paper is concerned, no previous study has been carried out to estimate the SDR based on the STPR for Turkey using the demand for food approach. Therefore we aim to fill this gap in the literature. Regarding this fact the European Union requires evaluation of the publicly supported commercial projects in terms of the SDR; hence the findings from this study can be used as a useful policy measurement for a full EU member candidate country, Turkey.

2 Explanation of the STPR components

Marglin (1963) and Feldstein (1965) provide the theoretical derivation of the STPR formula which is expressed as follows:

$$STPR = (1+g)^{e}(1/\pi)-1 \qquad (1)$$

where g is the growth rate of per capita real consumption (income), e is the absolute value of the elasticity of the marginal utility of consumption (income), and π is the average probability of survival of an individual: a measuer that may be used for pure time discount rate.

Elasticity of the marginal utility of consumption (e)

For the purpose of estimating appropriate SDR, the measurement of e plays a crucial policy concern. Cowell and Gardiner (1999) provides a comprehensive study of the various approaches to the measurement of e and the problems involved. There are basically two most common approaches to estimate it: a) the personal taxation model, which elicits the value of e by observing the structure of the personal income tax (Stern, 1977). Spackman (2006) argues that this approach has serious limitations. Therefore, estimates will be biased downwards; b) demand for food models which is proposed by Fellner (1967) assuming that e is a function of consumer preferences as revealed by the demand for food since food is deemed to be a preference independent good.

In this study, estimates of e are derived similar to the study of Kula (1984). According to Kula (1984), e is measured by the ratio of income elasticity to compensated price elasticity of the food demand function; expressed as follows:

$$e = e_1 / \hat{e}_2 \qquad (2)$$

where e_1 is income elasticity of the food demand function and $\hat{e}_2$ is the compensated price elasticity that is obtained by eliminating the income effect from the uncompensated price elasticity, e_2.

In order to estimate income and price elasticities, the following econometric food demand equation is formed for Turkey in natural logarithm as follows:

$$f_t = a + e_1 y_t + e_2 (p / q)_t + \varepsilon_t \qquad (3)$$

where, a is the constant term, f is the per capita real consumption of food expenditures, y is the per capita real income, p and q are price indices for food and non-food, respectively, ε is the stochastic error term, and t is the time subscript.

The compensated price elasticity is obtained as follows:

$$\hat{e}_2 = e_2 - (\alpha(e_1)) \tag{4}$$

where (α) is the share of food in a consumer's budget. Eq.(4) also refers to the standard Slutsky equation for the relation of compensated responses to price changes written in elasticity form. As we calculate the value of $\hat{e}_2$, e_2 is considered in absolute value too.

Growth of per capita real consumption (g)

This parameter is usually proxied by average performance of over past time series data; see for example, Evans (2004) and Evans and Sezer (2005). Some researchers also use the growth rate of the economy as a substitute measurement; see for example, Percoco (2008). In this study, we will adopt the first approach.

Calculation of the mortality based pure time discount rate (π)

The estimation of appropriate value of the pure time preference is a long-standing debate in the economics literature, since choosing a value for this parameter requires inferring how much today's society cares for future societies. Therefore, empirical studies on this issue rely on different values for it. Some researchers derive it from the individual risk of death (e.g. Kula 2004 and Lopez 2008).

This approach assumes that each member of a country discounts their future by the probability of not being alive over a period of time. Therefore, for example, a two-period analysis of average death rate in a country will provide the annual average survival probability for a typical person. Thus, a similar approach is adopted in this study.

3 Estimations and Results

Recent advances in econometric literature dictate that the long-run relation in Eq.(3) should incorporate the short-run dynamic adjustment process. It is possible to achieve this aim by expressing Eq.(3) in an error-correction model (ECM) as suggested by Engle-Granger (1987). Then, the equation becomes as follows:

$$\Delta f_t = b_0 + \sum_{i=1}^{m1} b_1 \Delta f_{t-i} + \sum_{i=0}^{m2} b_2 \Delta y_{t-i} + \sum_{i=0}^{m3} b_3 \Delta (p/q)_{t-i} + \gamma \varepsilon_{t-1} + \mu_t \qquad (5)$$

where Δ represents change, γ is the speed of adjustment parameter and ε_{t-1} is the one period lagged error correction term, which is estimated from the residuals of Eq. (3). The Engle-Granger method requires that all variables in Eq.(5) are integrated of order one, $I(1)$ and the error term is integrated order of zero, $I(0)$ for establishing a cointegration relationship. If some variables in Eq.(3) are non-stationary, we may use a new cointegration method proposed by Pesaran *et al*. (2001). This approach is also known as autoregressive-distributed lag (ARDL) that combines Engle-Granger

(1987) two steps into one by replacing ε_{t-1} in Eq.(5) with its equivalent from Eq.(3). ε_{t-1} is substituted by linear combination of the lagged variables as in Eq.(6):

$$\Delta f_t = c_0 + \sum_{i=1}^{n1} c_{1i}\Delta f_{t-i} + \sum_{i=0}^{n2} c_2 \Delta y_{t-i} + \sum_{i=0}^{n3} c_3 \Delta(p/q)_{t-i} + c_4 f_{t-1} + c_5 y_{t-1} + c_6 (p/q)_{t-1} + v_t \quad (6)$$

The bounds testing procedure is based on a Wald (W) or Fischer (F) type statistics and this is the first step of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration under the null hypothesis, (H_0: $c_4 = c_5 = c_6 = 0$), against the alternative hypothesis, (H_1: at least one of c_4 to $c_6 \neq 0$) should be performed for Eq. (6). The critical values that are tabulated of an upper bound on the assumption that all variables are $I(1)$ and a lower bound on the assumption that all variables are $I(0)$. For cointegration, the calculated F or W statistics must be greater than the upper bound.

Once a long-run relationship has been established, Eq.(6) is estimated using an appropriate lag selection criterion. At the second step of the ARDL cointegration procedure, it is also possible to obtain the ARDL representation of the error correction model. To estimate the speed with which the dependent variable adjusts to independent variables within the bounds testing approach, following Pesaran *et al.* (2001) the lagged level variables in Eq.(6) are replaced by EC_{t-1} as in Eq.(7):

$$\Delta f_t = \alpha_0 + \sum_{i=1}^{k1} \alpha_1 \Delta d_{t-i} + \sum_{i=0}^{k2} \alpha_2 \Delta y_{t-i,} + \sum_{i=0}^{k3} \alpha_3 \Delta(p/q)_{t-i} + \lambda EC_{t-1} + \mu_t \quad (7)$$

A negative and statistically significant estimation of λ not only represents the speed of adjustment but also provides an alternative means of supporting cointegration between the variables. Pesaran *et al.* (2001) cointegration approach has some methodological advantages in comparison to other single cointegration procedures. Reasons for the ARDL are: i) endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger (1987) method are avoided; ii) the long and short-run coefficients of the model in question are estimated simultaneously; iii) the ARDL approach to testing for the existence of a long-run relationship between the variables in levels is applicable irrespective of whether the underlying regressors are purely stationary $I(0)$, purely non-stationary $I(1)$, or mutually cointegrated; iv) the small sample properties of the bounds testing approach are far superior to that of multivariate cointegration, as argued in Narayan (2005).

Time series data between 1980 and 2008 is used to estimate Eq.(3) with the ARDL procedure. Data is collected from House Hold Budget Surveys of Turkish Institute of Statistics (www.turkstat.gov.tr), European Marketing Data and Statistics (www.euromonitor.com), and Istanbul Chamber of Commerce (www.ito.org.tr). Three tests were used to test unit roots in the variables: Augmented Dickey-Fuller (1981), Phillips-Perron (1988), and Elliott-Rothenberg-Stock (1996). Unit root tests results are displayed in Table 1 warrant for applying the ARDL approach to cointegration since all variables included in the model are $I(1)$. Visual inspections of the variables in logarithm show no structural breaks.

Table 1 Unit root results

Variables	ADF	PP	ERS
f_t	1.65	2.11	1.38
y_t	1.73	2.04	1.88
$(p/q)_t$	2.27	2.54	1.74
Δf_t	3.20*	7.17*	3.23*
Δy_t	3.54*	6.19*	3.41*
$\Delta (p/q)_t$	4.26*	8.00*	3.94*

Notes: The sample level unit root regressions include a constant and a trend. The differenced level unit root regressions are with a constant and without a trend. All test statistics are expressed in absolute terms for convenience. Rejection of unit root hypothesis is indicated with an asterisk. Δ stands for first difference.

Table 2 displays the cointegration tests. According to Table 2, there exists a long-run relationship amongst the variables of Eq.(3).

Table 2 The results of F and W tests for cointegration

The assumed long-run relationship; $(f \mid y,(p/q))$				
F-statistic	95% LB	95% UB	90% LB	90% UB
8.85	4.24	5.40	3.44	4.46
W-statistic				
26.57	12.73	16.20	10.32	13.38

If the test statistic lies between the bounds, the test is inconclusive. If it is above the upper bound (UB), the null hypothesis of no level effect is rejected. If it is the below the lower bound (LB), the null hypothesis of no level effect cannot be rejected.

The summary ARDL results with some diagnostic tests are presented in Table 3. The overall empirical results appear to be rather satisfactory. The lag selection procure suggests the optimal lag length as 3.

Table 3 ARDL cointegration results

Panel A. Estimated long-run coefficients: ARDL (1,3,3) selected based on the Akaike Information Criterion.
Dependent variable f_t

Regressor	Coefficient	Standard error	T-ratio
y_t	0.870*	0.175	4.964
$(p/q)_t$	-0.727*	0.110	6.563
Constant	-0.927***	0.499	1.857

Panel B. Error-correction representation results.
Dependent variable Δf_t

Regressor	Coefficient	Standard error	T-ratio
Δy_t	0.823*	0.161	5.111
Δy_{t-1}	0.311**	0.173	1.798
Δy_{t-2}	-0.298***	0.177	1.677
$\Delta(p/q)_t$	-0.035	0.110	0.318
$\Delta(p/q)_{t-1}$	0.161***	0.085	1.880
$\Delta(p/q)_{t-2}$	0.220*	0.085	2.590
EC_{t-1}	-0.623*	0.127	4.884

Diagnostic tests

$\overline{R}^2$	0.75	F-statistic	13.7*	$\chi^2_{SC}(1)$	2.01	$\chi^2_{FF}(1)$	0.24
RSS	0.03	DW-statistic	2.39	$\chi^2_{N}(2)$	0.34	$\chi^2_{H}(1)$	0.06

*, **, and, *** indicate, 1%, 5%, and 10% significance levels respectively. RSS stands for residual sum of squares. T-ratios are in absolute values. χ^2_{SC}, χ^2_{FF}, χ^2_{N}, and χ^2_{H} are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. The critical values for $\chi^2(1) = 3.84$ and $\chi^2(2) = 5.99$ are at 5% significance level.

On the basis of the coefficients obtained from Panel A of Table 3 and with a budget share of food in Turkey 24.5% during the estimation period, Eq.(4) reveals that

$$\hat{e}_2 = 0.727 - (0.245)(0.830) = 0.516$$

As we substitute $\hat{e}_2$ in Eq.(2) along with the absolute estimate value of e_1, we compute the value of e as follows:

$$e = 0.870 / 0.516 = 1.686$$

The average growth rate of per capita real consumption for the period of 1980-2008 is calculated as 2.60%. According to the Turkish Institute Statistics, average crude death rate is 6.1 per 1000 or 0.61% during 1980-2008. Therefore, survival probabibility of a person is computed as $\pi = 1 - 0.0061 = 0.9939$, which is also considered to represent the mortatility based time discount rate in Turkey.

Subsituting all the estimates of component parameters of the STPR in Eq.(1), we obtain the following result for Turkey:

$STPR = (1 + 0.026)^{1.686}(1/0.9939) - 1 = 0.0506$ or 5.06%.

4 Concluding Remarks

This study reveals that the SDR for Turkey based on the STPR is 5.06% and it is appropriate for application in social project appraisals. This rate is very close to the 5% discount rate proposed by the European Commission (2002) but it is not based on any empirical analysis. Considering Turkey is on the way to become a full member of the EU, this paper recommends application of 5.06% for different investment decisions in the public sector of Turkey. We also draw attention to the fact that we suggest this rate because it is very close to other empirical estimates derived for developing countries and there exists no other STPR as being estimated for Turkey as far as this research is concerned.

Acknowledgement

The authors would like to thank Professor Erhun Kula of Bahcesehir University for providing insightful and valuable comments on an earlier draft of this paper. The usual disclaimer applies.

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