Daneshmand et al. Economic Structures (2018) 7:29
https://doi.org/10.1186/s40008-018-0127-x

Journal of Economic Structures

RESEARCH

Open Access

A time preference measure of the social discount rate for Iran

Arian Daneshmand[1*], Esfandiar Jahangard[2] and Mahnoush Abdollah-Milani[2]

*Correspondence: daneshmand@atu.ac.ir
[1] Economic Research Institute, Allameh Tabataba'i University, Shahid Beheshti Ave., Tehran 15136-15411, Iran
Full list of author information is available at the end of the article

Abstract

Public sector projects in Iran are inefficiently carried out for reasons of mismanagement and poor prioritization. This problem may arise from the lack of a generally accepted social discount rate for project appraisal. The value of the social discount rate can have implications for resource allocations. The aim of this paper is to estimate the appropriate value of a social discount rate for Iran using the social time preference rate approach. The overall result indicates that the social discount rate for Iran is 5.8%.

Keywords: Social discount rate, Social time preference rate, Project appraisal, ARDL, Iran

JEL Classification: C32, H43

1 Introduction

Iran is a semi-industrialized country that adopted the industrialization policy for development in the 1960s and expanded its manufacturing activities such as steel and car manufacturing, petrochemical and refineries during the oil boom in the 1970s. In the aftermath of Iran–Iraq war, the government of Iran found itself with a substantial disruption of supplied chains caused by the freezing of the country's foreign assets, the destructive 8-year war with Iraq (1980–1988) and economic sanctions (Pesaran 1995; Amuzegar 2000; Valadkhani 2001). In the face of such intense challenges, the government was forced to spend billions of dollars to compensate for the destruction of production capacity and infrastructure. The result of these policies, as argued by Pesaran (2000), 'had been an economy in a state of acute disequilibrium with highly distorted price signals'. These economic conditions together with the absence of a strong private sector may help explain the government's role in the economy.

After the 1979 revolution, the government began the nationalization process.[1] The result of this policy was the formation of a high degree of government ownership and its associated institutional incentives which prohibited the private sector from participating

[1] According to the Article 44 of the Iranian Constitution, '[...]. The state sector includes all the national industries, foreign trade, major mines, banking, insurance, energy sources, dams and large water irrigation networks, radio and television, post, telegraph and telephone, aviation, navigation, roads, railroads, and others which are publicly owned and under the state's control'. It is important to notice that the law on implementation of the general policies of the Article 44 was declared in 2006 in a bid to build up the share of cooperative and private sectors in the national economy and cut down government's financial and management burden on economic activities.

in the financing, construction, operation and maintenance of public infrastructure. Since then, the government has actively involved in a variety of investment projects aimed at meeting the country's identified needs such as education, electricity and water utilities, medical care, transportation and waste disposal. As a resource-rich country, Iran's economic performance has been largely driven by oil and gas revenues. The windfall income from natural resources creates fertile ground for rent-seeking activities (Farhadi et al. 2015). It is worth noting that the share of oil revenue in GDP declined from 9% in 1990 to 6% in 2015, while the share of tax revenue in GDP marginally increased from 4.5% in 1990 to 6% in 2015. Thus, it is reasonable to believe that the decline in oil revenue may tie the government's hands to some extent. We therefore expect the government to make viable investment decisions and to become more accountable to the public.

It is important to emphasize at this point that, in the case of Iran, the government participation in investment projects is most likely to be prone to X-inefficiency. According to the monitoring report of the Iranian Planning and Budget Organization for 2014, the expected life of a new public project is around 2.8 years, while the weighted average of a completed project is 12.7 years.[2] This gap is associated with a mass of unfinished projects which has weakened the financial ability of the Iranian government to meet its objectives efficiently. Given the increasing importance of cost–benefit analysis for public investment decisions, the choice of a proper social discount rate is a crucial issue. The social discount rate is an established measure of a society's preference for present consumption versus future consumption. In other words, it reflects the extent to which a society is willing to give up a unit of consumption now in return for more consumption later. Zhuang et al. (2007) argue that when dealing with very long-lived projects, the choice of the social discount rate should not only consider economic efficiency, but also intergenerational equity. Itoh (2016) points out that implementation of cost–benefit analysis has significant implications for the financial evaluation of economic sectors. This is particularly important for policymakers in the government decision-making process to ensure significant and long-term benefits for the country.

To this end, the rest of the paper proceeds as follows. Section 2 will explain and justify the social time preference rate method. In Sect. 3, we will present the data and methodology. The empirical analysis and the derivation of the social discount rate will be displayed in Sect. 4. Section 5 will highlight our conclusions.

2 Theoretical model

The use of social time preference rate (STPR) approach as an appropriate measure of the social discount rate is well documented in the literature (Marglin 1963; Feldstein 1964; Kula 1984, 2004; Pearce and Ulph 1995; Evans and Sezer 2002, 2005; Percoco 2008; Schad and John 2012; Halicioglu and Karatas 2013; Moore et al. 2013). Kossova and Sheluntcova (2016) convincingly argue that in the absence of competition for resources between public and private projects due to a lower rate of return on investment, the STPR approach is recommended. As a starting point, consider the following model

[2] https://www.mporg.ir.

where the representative infinitely lived agent maximizes inter-temporal utility subject to the flow budget constraint:

$$\max_{c_t} W = \int_0^\infty U(c_t)\mathrm{e}^{-\rho t}\mathrm{d}t, \tag{1}$$

$$\text{s.t.} \quad \dot{k}_t = f(k_t) - c_t, \tag{2}$$

where $U(.)$ represents a time-invariant iso-elastic utility function, $U(c_t) = \frac{c_t^{1-\eta}}{1-\eta}$ with the following properties: $U'(.) > 0, U''(.) \leq 0$; $\mathrm{e}^{-\rho t}$ is the discount factor for utility of consumption; $\dot{k}_t$ is the rate of change of the capital stock (net investment); and $f(.)$ represents a production function owned by the agent according to an AK technology. The Euler equation corresponding to this maximization problem requires that:

$$U'(c_t)f'(k_t) + U''(c_t)\dot{c}_t - \rho U'(c_t) = 0 \tag{3}$$

After some simplification, the resulting equation is known as the 'Ramsey equation' and is shown in Eq. (4):

$$r = \eta g + \rho, \tag{4}$$

where r is the marginal return on investment, g is the growth rate of per capita real consumption (with mean μ and variance σ^2), η is the elasticity of marginal utility of consumption and ρ is the pure rate of time preference describing impatience. The parameter, ρ, could be determined as the instantaneous probability of death (Boardman et al. 2010). Eventually, we extend the Ramsey formula to encompass uncertainty in the rate of growth in consumption, adapting a formulation suggested by Mankiw (1981) as follows:

$$\text{STPR} = \eta\bar{g} + \rho - 0.5\eta(\eta + 1)\sigma^2, \tag{5}$$

where $\bar{g}$ is expected growth rate of consumption (Gollier 2012).[3] The last term in Eq. (5) is uncertainty about the rate of growth in consumption known as the 'precautionary saving effect' and is the product of three factors: relative risk aversion η, relative prudence $\eta+1$ and the variance of the growth rate of consumption σ^2 (Gollier 2012). This extension of the Ramsey rule is consistent with the uncertainty attached to the Iranian economy as a whole.

There are basically four alternative methodologies to estimate the elasticity of marginal utility of consumption (Groom and Maddison 2018): the equal-sacrifice income tax approach, relative risk aversion in insurance markets, the Euler-equation approach and the Frisch additive-preferences approach. Each of the four methods has its advocates and critics (for a survey, see Lopez 2008; Percoco 2008; Evans and Kula 2011; Moore et al. 2013; Groom and Maddison 2018; Freeman et al. 2018). On the basis of previous reviews, Groom and Maddison (2018), among others, argue that in the case of some developing countries, the Frisch additive-preferences approach might be the only feasible means of estimating the elasticity of the marginal utility of consumption,

[3] That is: $\bar{g} = E\exp(\tilde{x}) = \mu + 0.5\sigma^2$, where x is the lognormal growth rate of expected consumption.

η. The calculation of parameter η is based on an adopted version of the Fellner demand model (see Fellner 1967) extended by Kula (1984). To obtain the parameter η from the Fellner demand model, an important assumption has to be satisfied: the 'Frisch elasticities' formula has to be assumed to be based on the principle of the presumed existence of additive preferences since food is deemed to be a 'want-independent' or 'preference-independent' good (Schad and John 2012; Groom and Maddison 2018).

According to this, the elasticity of marginal utility of consumption can be approximated by the ratio of the income elasticity to the compensated price elasticity of demand for food. So:

$$\eta = \frac{\eta_1}{\hat{\eta}_2}, \tag{6}$$

where η_1 is income elasticity of the food demand function and $\hat{\eta}_2$ is the compensated price elasticity of food after elimination of the income effect. Following the empirical literature, we specify our model of food demand in log-linear form. Therefore, our long-run food demand takes the following form:

$$\ln F_t = \alpha_0 + \eta_1 \ln Y_t + \eta_2 \ln \left({}^{P}\!/_{P^*} \right)_t + \varepsilon_t, \tag{7}$$

where F_t is the (per capita) real consumption of food, Y_t is the (per capita) real income, P and P^* are price indices for food and non-food, respectively. ε_t is error term which has normal distribution with zero mean and constant variance. A number of authors (Stone 1954; Fellner 1967; Kula 1984, 2004; Evans and Sezer 2002) have estimated $\hat{\eta}_2$ by using $\left|\hat{\eta}_2\right| = |\eta_2| - \omega\eta_1$, where ω is the share of food in consumers' budget.

From a theoretical point of view, earlier works on inter-temporal choice behaviour have proposed the use of survival (or mortality) probabilities as rational bases for discounting in inter-temporal consumption decisions. In an attempt to explore how survival uncertainty may affect individual behaviour, Bommier (2006) has shown that time discounting is directly related to preferences over length of life and inter-temporal choice. This makes sense given the fact that individuals would discount their future utility by the probability of being alive at that date. For this purpose, following Kula (1984) the pure rate of time preference is assumed to be equal the average death rate in the population as a whole.

3 Methodology and data collection

Given the relatively small sample size in the present study, we use the ARDL bounds testing approach developed by Pesaran et al. (2001) to test the presence of cointegration within the variables and also to estimate the long-run and short-run coefficients of the variables. The ARDL cointegration approach has numerous advantages in comparison with the conventional cointegration methods such as Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990) procedures. One of the main advantages of this technique is that the underlying regressors are not restrictive irrespective of whether the variables are $I(0)$, $I(1)$ or fractionally cointegrated (Pesaran and Pesaran 2009). Also, as noted by Harris and Sollis (2003), the ARDL technique provides unbiased estimates of the long-run model and valid t-statistics even when some of the regressors are endogenous. The unrestricted error correction model (UECM) version of the ARDL model of Eq. (3) can be written as follows:

$$\begin{aligned}\Delta \ln F_t = {} & \beta_0 + \beta_1 \mathrm{Dum}_t + \sum_{i=1}^{a1} \delta_{1i} \Delta \ln F_{t-i} \\ & + \sum_{j=0}^{b1} \theta_{1j} \Delta \ln Y_{t-j} + \sum_{p=0}^{c1} \phi_{1p} \Delta \ln \left({}^{P}\!/_{P^*} \right)_{t-p} \\ & + \lambda_1 \ln F_{t-1} + \lambda_2 \ln Y_{t-1} + \lambda_3 \ln \left({}^{P}\!/_{P^*} \right)_{t-1} + \varepsilon_t \end{aligned} \tag{8}$$

where Δ represents the first difference operator; ε_t is the random error term; δ_{1i}, θ_{1j} and ϕ_{1p} are short-run coefficients; and λ_1, λ_2 and λ_3 denote the long-run coefficients. Here, β_0 and β_1 are deterministic variables in an augmented ARDL model.[4] The ARDL bounds testing procedure involves two steps. In the first step, the presence of cointegration between the variables is investigated by an *F*-test for the joint significance of the coefficients of the lagged levels of the variables. In this set-up, the null hypothesis of no cointegration $H_0 : \lambda_1 = \lambda_2 = \lambda_3 = 0$ was tested against the alternative hypothesis of $H_1 : \lambda_1 \neq 0, \lambda_2 \neq 0, \lambda_3 \neq 0$. Here, the *F*-test has a non-standard distribution. To overcome this problem, Pesaran et al. (2001) and Pesaran and Pesaran (2009) compute two sets of critical values for a given significance level. One set assumes that all variables are *I*(0), and the other set assumes they are all *I*(1). If the calculated *F*-statistic lies above the upper level of the bound, the null hypothesis of no cointegration is rejected. If the calculated *F*-statistic is below the lower critical value of the bound, the null hypothesis cannot be rejected. Finally, if it lies between the bounds, the result is inconclusive.

In the second step, the lag orders of the variables are chosen using Schwarz Bayesian Criterion (SBC), as many studies show that SBC yields more parsimonious lag order. Thus, the selected ARDL model determined by SBC is used to estimate the short- and long-run models. Once a long-run relationship has been established, we use estimates of $\lambda_1 - \lambda_3$ to form the error correction term, ECT_{t-1}. The error correction term shows how quickly variables converge to equilibrium and it should have statistically significant coefficient with a negative sign. As stated by Fuinhas and Marques (2012), the absence of shift dummies to control for outliers and structural breaks could lead to the misinterpretation of elasticities and cointegration between variables. This approach is supported by Pesaran et al. (2001), who argue that the asymptotic theory developed for the bounds test procedure is not affected by the inclusion of 'one-off' dummy variables. Therefore, a dummy variable, Dum_t, that takes the value one in 2012 and zero in all other years has been included in the estimation in order to capture the second phase of subsidy reform in Iran.

Annual time-series data, which cover the period 1990–2015, are utilized in this study. Data are collected from the Household Income and Expenditure (HIE) Surveys conducted by Statistical Centre of Iran (www.amar.org.ir). Relevant series for food model are shown in Table 1 in the case of Iran.

[4] See Pesaran and Pesaran (2009) for more details.

Table 1 Time series data for food demand function in Iran

Year	Per capita real consumption of food (F)	Per capita real income (Y)	Price of food relative to non-food $\left({}^{P}/_{P*}\right)$
1990	6421.87	22,809.52	1.478126
1991	6421.87	24,169.21	1.394015
1992	6683.99	25,269.09	1.363308
1993	6683.99	25,986.16	1.386108
1994	6550.31	24,363.08	1.485096
1995	6563.43	22,069.46	1.597143
1996	6823.24	24,696.16	1.359061
1997	6895.06	25,364.73	1.288508
1998	6938.89	25,557.73	1.374384
1999	6880.58	25,002.28	1.299975
2000	7245.92	27,190.87	1.197012
2001	7326.97	27,371.12	1.04888
2002	7426.65	28,488.73	1.038808
2003	7443.53	28,847.85	1.07039
2004	7634.39	28,405.48	1.052254
2005	8047.06	29,545.75	0.967086
2006	8229.03	32,465.15	0.889833
2007	8462.93	32,903.55	0.880643
2008	8551.32	32,446.88	0.894882
2009	8664.43	33,131.96	0.895927
2010	8875.75	33,586.69	0.912224
2011	8948.51	35,601.49	1
2012	9072.45	22,665.2	1.136373
2013	9411.36	37,871.46	1.110577
2014	9465.76	39,411.13	1.003812
2015	9465.76	40,765.57	0.95292

Data are in constant local currency (1000 Rials)

Table 2 DF-GLS unit root tests on variables

Log levels			First differences			Decision
Variable	SBC lag	DF-GLS stat	Variable	SBC lag	DF-GLS stat	
$\ln F$	1	− 1.732	$\Delta\ln F$	1	− 3.189*	$I(1)$
$\ln Y$	1	− 3.723**	$\Delta\ln Y$			$I(0)$
$\ln\left({}^{P}/_{P*}\right)$	1	− 2.334	$\Delta\ln\left({}^{P}/_{P*}\right)$	1	− 3.503**	$I(1)$

The optimal lag and bandwidth used are based on the Schwarz Bayesian Criterion (SBC)

*$P<0.1$; **$P<0.05$; ***$P<0.01$

4 Empirical results and analysis

Prior to implementing the ARDL model, Dickey–Fuller generalized least squares (DF-GLS) test is used to determine the integrating properties of the variables in our study. The DF-GLS test (Elliot et al. 1996) is a modification of the conventional ADF t test as it applies to GLS de-trending prior to testing for stationary. Compared with the ADF tests, the DF-GLS test has superior performance in terms of small sample size and power. The DF-GLS unit root tests results in Table 2 show that the variables have mixed orders of integration such as $\ln F$ and $\ln\left({}^{P}/_{P*}\right)$ being $I(1)$ and $\ln Y$ being $I(0)$.

Table 3 Results of bounds test: ARDL model (2, 1, 2)

Dep. var.|Indep. var.		*F*-stat		*W*-stat
$\ln F \mid \ln Y, \ln\left(^{P}/_{P*}\right)$		8.32		24.96
Critical bounds	**95% Lower bound**	**95% Upper bound**	**90% Lower bound**	**90% Upper bound**
F-stat.	4.40	5.57	3.49	4.52
W-stat.	13.20	16.72	10.47	13.57

Critical bounds and the respective *F*-stat and *W*-stat are computed using Microfit 5.01 (Pesaran and Pesaran 2009) with intercept and dummy

Table 4 Full information estimate of ARDL model (2, 1, 2)

Variable	Coefficient	Standard error	*T*-statistics
Panel A: Estimated long-run coefficients (Dep. var. $\ln F_t$*)*			
$\ln Y_t$	0.524	0.098	5.330 [0.000]
$\ln\left(^{P}/_{P*}\right)_t$	− 0.265	0.096	− 2.766 [0.013]
Dum	0.333	0.047	7.003 [0.000]
Constant	6.905	1.704	4.052 [0.001]
Panel B: Estimated short-run coefficients (Dep. var. $\Delta \ln F_t$*)*			
$\Delta \ln F_{t-1}$	− 0.291	0.175	− 1.662 [0.113]
$\Delta \ln Y_t$	0.298	0.084	3.524 [0.002]
$\Delta \ln (p/q)_t$	− 0.091	0.045	− 2.013 [0.058]
$\Delta \ln (p/q)_{t-1}$	0.073	0.031	2.314 [0.032]
Dum	0.151	0.042	3.545 [0.002]
ECT_{t-1}	− 0.453	0.122	− 3.701 [0.002]
Panel C: Diagnostic tests			
Serial correlation (χ^2)	0.029 [0.863]		
RESET (χ^2)	1.463 [0.226]		
Normality (χ^2)	0.227 [0.893]		
Heteroscedasticity (χ^2)	1.823 [0.177]		

The optimal lags of the ARDL model are selected based on SBC. Bracket represents probability values

According to Bahmani-Oskooee and Brooks (1999), the result of the *F*-test could be sensitive to the number of lags imposed on each first differenced variable. Given the small sample size of our data series, the maximum lag length is set at 2 to ensure sufficient degrees of freedom for econometric analysis. The results show that the computed *F*-statistic is 8.32, which is above the upper bound critical values at 5% significance level (Table 3). This shows that the null hypothesis of no cointegration between the variables is rejected. At this stage, the underlying ARDL model can be established to determine the short- and long-run relationships.

As can be seen from Table 4, the food demand model yields satisfactory results in terms of both the short- and long-run estimated coefficients and the fitness of the model. Now, we can calculate $\hat{\eta}_2$ from Eq. (6) using the long-run estimated coefficients from Panel A of Table 4 along with the budget share of food with respect to total consumption in Iran 27%, ω, during the estimation period:

$$\left|\hat{\eta}_2\right| = |-0.265| - (0.27 * 0.524) = 0.124$$

Then, substituting the values of η_1 and $\hat{\eta}_2$ in Eq. (6) gives:

$$\eta = \frac{0.524}{0.124} = 4.226$$

The expected annualized consumption growth rate and the average death rate for the entire sample period are 1.3% and 0.53%, respectively. Finally, putting these values into the STPR formula in Eq. (5), we obtain:

$$\begin{aligned} \text{STPR} = {} & (4.226 * 0.01338) + 0.0053 \\ & - 0.5 * (4.226 * (4.226 + 1)) * 0.00043 = 0.0579 \end{aligned} \quad (9)$$

Hence, a 5.8% social discount rate is appropriate for application in public sector project appraisal in Iran. This estimate is consistent with previous estimates of STPR for selected Asian and Middle Eastern countries falling in a range of 4.5–7.8% (Zhuang et al. 2007; Halicioglu and Karatas 2013).

5 Conclusion

In the presence of market distortions, the market interest rate is unlikely to reflect the marginal social opportunity costs of public funds and hence, it is not the appropriate social discount rate for project appraisal. Social discounting plays a critical role in cost–benefit analysis and has important implications for resource allocations in the public sector. A relatively high social discount rate has a tendency to preclude socially valuable public investment projects from being undertaken. This could be due to the reason that a relatively high social discount rate normally favours projects with benefits occurring at near future. The vice versa is also feasible and possible.

This study estimates the social discount rate for Iran using the social rate of time preference method. The elasticity of marginal utility of consumption, an important component of the social discount rate, is estimated using the ARDL bounds testing approach from a demand for food model over the data period 1990–2015. The estimated model is found to be adequate in terms of the statistically valid empirical results. The overall result indicates that a 5.8% social discount rate is appropriate for discounting the benefits and costs of public projects. Despite of the importance of the social discount rate for many policy choices, to our knowledge, there is no official social discount rate proposed by the Iranian authorities. For this reason, our ability to compare our recommended value with that adopted by the government agencies is limited. In our view, further research should be devoted to estimating the social discount rate at the provincial level for the country.

Authors' contributions
All authors have equally contributed to designing of the research, the process of data collection and analysis as well as drafting and revision of the manuscript. All authors read and approved the final manuscript.

Author details
[1] Economic Research Institute, Allameh Tabataba'i University, Shahid Beheshti Ave., Tehran 15136-15411, Iran. [2] Faculty of Economics, Allameh Tabataba'i University, Tehran, Iran.

Acknowledgements
The authors would like to thank two anonymous referees for their useful comments. Any remaining errors are our own.

Competing interests
The authors declare that they have no competing interests.

Availability of data and materials
The data set used in the regression analysis is provided in the additional file.

Funding
Not applicable.

Publisher's Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 30 March 2018 Accepted: 8 November 2018
Published online: 13 November 2018

References
Amuzegar J (2000) A perspective on Iran's post-revolution political economy. A lecture delivered at the Foundation for Iranian Studies, March, 24. http://www.fis-iran.org/amuzegar.htm
Bahmani-Oskooee M, Brooks TJ (1999) Bilateral J-curve between US and her trading partners. Weltwirtschaftliches Arch 135(1):156–165
Boardman AE, Moore MA, Vining AR (2010) The social discount rate for Canada based on future growth in consumption. Can Public Policy 36(3):325–343
Bommier A (2006) Uncertain lifetime and intertemporal choice: risk aversion as a rationale for time discounting. Int Econ Rev 47(4):1223–1246
Elliot G, Rothenberg T, Stock J (1996) Efficient tests for an autoregressive unit root. Econometrica 64:813–836
Engle RF, Granger CW (1987) Co-integration and error correction: representation, estimation, and testing. Econometrica 55:251–276
Evans DJ, Kula E (2011) Social discount rates and welfare weights for public investment decisions under budgetary restrictions: the case of Cyprus. Fiscal Stud 32(1):73–107
Evans D, Sezer H (2002) A time preference measure of the social discount rate for the UK. Appl Econ 34(15):1925–1934
Evans DJ, Sezer H (2005) Social discount rates for member countries of the European Union. J Econ Stud 32(1):47–59
Farhadi M, Islam MR, Moslehi S (2015) Economic freedom and productivity growth in resource-rich economies. World Dev 72:109–126
Feldstein MS (1964) The social time preference discount rate in cost benefit analysis. Econ J 74(294):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. Wiley, New York, pp 39–75
Freeman M, Groom B, Spackman M (2018) Social discount rates for cost–benefit analysis: a report for HM treasury
Fuinhas JA, Marques AC (2012) Energy consumption and economic growth nexus in Portugal, Italy, Greece, Spain and Turkey: an ARDL bounds test approach (1965–2009). Energy Econ 34(2):511–517
Gollier C (2012) Pricing the planet's future: the economics of discounting in an uncertain world. Princeton University Press, Princeton
Groom B, Maddison D (2018) New estimates of the elasticity of marginal utility for the UK. Environ Resour Econ. https://doi.org/10.1007/s10640-018-0242-z
Halicioglu F, Karatas C (2013) A social discount rate for Turkey. Qual Quant 47(2):1085–1091
Harris R, Sollis R (2003) Applied time series modelling and forecasting. Wiley, Chichester, UK
Itoh H (2016) Understanding of economic spillover mechanism by structural path analysis: a case study of interregional social accounting matrix focused on institutional sectors in Japan. J Econ Struct 5(1):22
Johansen S (1988) Statistical analysis of cointegration vectors. J Econ Dyn Control 12(2):231–254
Johansen S, Juselius K (1990) Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxf Bull Econ Stat 52(2):169–210
Kossova T, Sheluntcova M (2016) Evaluating performance of public sector projects in Russia: the choice of a social discount rate. Int J Proj Manag 34(3):403–411
Kula E (1984) Derivation of social time preference rates for the United States and Canada. Q J Econ 99(4):873–882
Kula E (2004) Estimation of a social rate of interest for India. J Agric Econ 55(1):91–99
Lopez H (2008) The social discount rate: estimates for nine Latin American countries. The World Bank, Washington
Mankiw NG (1981) The permanent income hypothesis and the real interest rate. Econ Lett 7(4):307–311
Marglin SA (1963) The social rate of discount and the optimal rate of investment. Q J Econ 77:95–111

Moore MA, Boardman AE, Vining AR (2013) More appropriate discounting: the rate of social time preference and the value of the social discount rate. J Benefit-Cost Anal 4(1):1–16
Pearce DW, Ulph D (1995) A social discount rate for the United Kingdom. CSERGE, Norwich, pp 1–22
Percoco M (2008) A social discount rate for Italy. Appl Econ Lett 15(1):73–77
Pesaran MH (1995) Planning and macroeconomic stabilization in Iran. In: Working paper series/Economic Research Forum; 9502. Economic Research Forum, Cairo, EG
Pesaran MH (2000) Economic trends and macroeconomic policies in post-revolutionary Iran. In: Alizadeh P (ed) The economy of Iran: dilemmas of an Islamic State. I.B. Tauris, London, pp 63–100
Pesaran B, Pesaran MH (2009) Microfit 5.0. Oxford University Press, Oxford
Pesaran MH, Shin Y, Smith RJ (2001) Bounds testing approaches to the analysis of level relationships. J Appl Econom 16(3):289–326
Schad M, John J (2012) Towards a social discount rate for the economic evaluation of health technologies in Germany: an exploratory analysis. Eur J Health Econ 13(2):127–144
Stone R (1954) Linear expenditure systems and demand analysis: an application to the pattern of British demand. Econ J 64(255):511–527
Valadkhani A (2001) An analysis of Iran's third five-year development plan in the post-revolution era (2000–2005). J Iran Res Anal 17(2):1–21
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. ERD working paper series no. 94, Asian Development Bank, Philippines