

A Review of Approaches to Construct Social Discount Rate

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Abstract

There is increasing concern on how public projects are being evaluated especially for public projects that bring impacts towards the economic, social and environmental of the nation in the long-term, for example infrastructural, environmental protection, energy efficiency, healthcare, education expenditures and others. Thus, the federal government and state government recommend project assessors to adopt cost-benefit analysis for major infrastructure and social investment as well as for regulatory initiatives. Cost benefit analysis has been widely used as a tool to enable stakeholders to make a better decision for projects by systematically comparing the social costs and benefits with the emphasis on valuing them in monetary term. One of the most significant parameters for cost benefit analysis is the social discount rate. It is a rate that used to convert the future social costs and benefits into present value. However, there is a long-time debate on how to construct appropriate social discount rate. Literature reveals that there are various popular approaches to construct social discount rate, such as Social Time Preference (STP) approach, Social Opportunity Cost of Capital (SOC), and Shadow Price of Capital (SPC). The selection of approaches is a significant process to construct an appropriate social discount rate for the project. In this paper, author examines theoretical for each approach and procedures to construct social discount rate. A framework will be developed to guide the assessor in selecting the approaches to construct social discount rate. This paper intends to review social discount rate construction approaches and the pros and cons of each approach. The paper would provide insight to assessor in selecting the approach in construction social discount rate.

Keywords: Social discount rate, social time preference, social opportunity cost of capital and shadow price of capital.

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1.0 INTRODUCTION

Public projects are implemented at local, micro-regional, national and international level. Types of the public project consist of infrastructural, environmental protection, energy efficiency, healthcare, education expenditures and others. Public projects are encouraged to evaluate before launching by using economic assessment technique, such as Cost-Benefit Analysis (CBA). In developed countries, governments encourage project assessors to use CBA for evaluation purpose. For example, European Union (EU) required their project assessors to apply CBA to calculate the important budget consumption of a project (European Commission, 2001). In United State, they provide a guideline of public project appraisal in Circular A-94 and this guideline had highlighted the importance of CBA to analyze the government project and policies, whereas in the United Kingdom, there is a legislative requirement for project assessors to carry out CBA to evaluate the significant of projects (Pearce, et. al., 2006).

CBA has been defined as a project evaluation tool that is used to measure the value of all effects of a project to a society in monetary terms (Boardman, et. al., 2006). The scope of analysis is wide if it can be related to public decision that implication for the use of public resources. CBA can be used for several purposes, such as to analyze and to strengthen a wide range of government choices, for example undertake an infrastructure, pass a regulation, produce a public good, change a social welfare program or adjust a tax (Harrison, 2010). Further, CBA also useful in comparing the costs and benefits among the competing projects; to reveal the beneficiary and sufferers from the projects; to assess the wisdom of using natural resources of altering environmental conditions; to explain which projects can be adopted and what are the impacts from the projects; as well as to examine the potential actions to increase social welfare (Shively and Galopin, 2013). In summary, CBA is used to compare the social costs and benefits to select the optimal project that has largest benefits to the society and it also used to clarify and highlight the consequences of alternative projects for deciding which projects can be adopted.

In CBA, the core calculation part is discounting, which is a process to convert the expected flows of benefits and costs into the net present value (NPV). There are two types of discounting, which are social discounting and private discounting. Social discounting is discounting from the society point of view that is embodied in cost and benefit analysis. On the other hand, private discounting is based on the specific and limited perspective of private firms (U.S. Environmental Protection Agency, 2010). There are several purposes for doing this. The first purpose is to determine the worthwhile of project, that is to estimate whether the project has positive net present value or not. The basic decision rule is if the NPV is positive, then the project is accepted and vice versa. The second purpose is to compare the NPV of the projects with the same objectives but different timeframes (Young, 2002). The third purpose of discounting is because most of the people prefer to consume now rather than in the future and thus, discounting is used to estimate the opportunity cost (Boardman, et. al. 2006). During the discounting, the discount rate that used to convert the expected future cash flow into NPV should refer to the social discount rate (SDR). The social discount rate is a rate which used to convert the estimated future costs and benefits of public projects into the present value (Singh, 1994; Davidson, 2006). It is the most significant rate to CBA, especially to evaluate the project with high net costs in early years and high

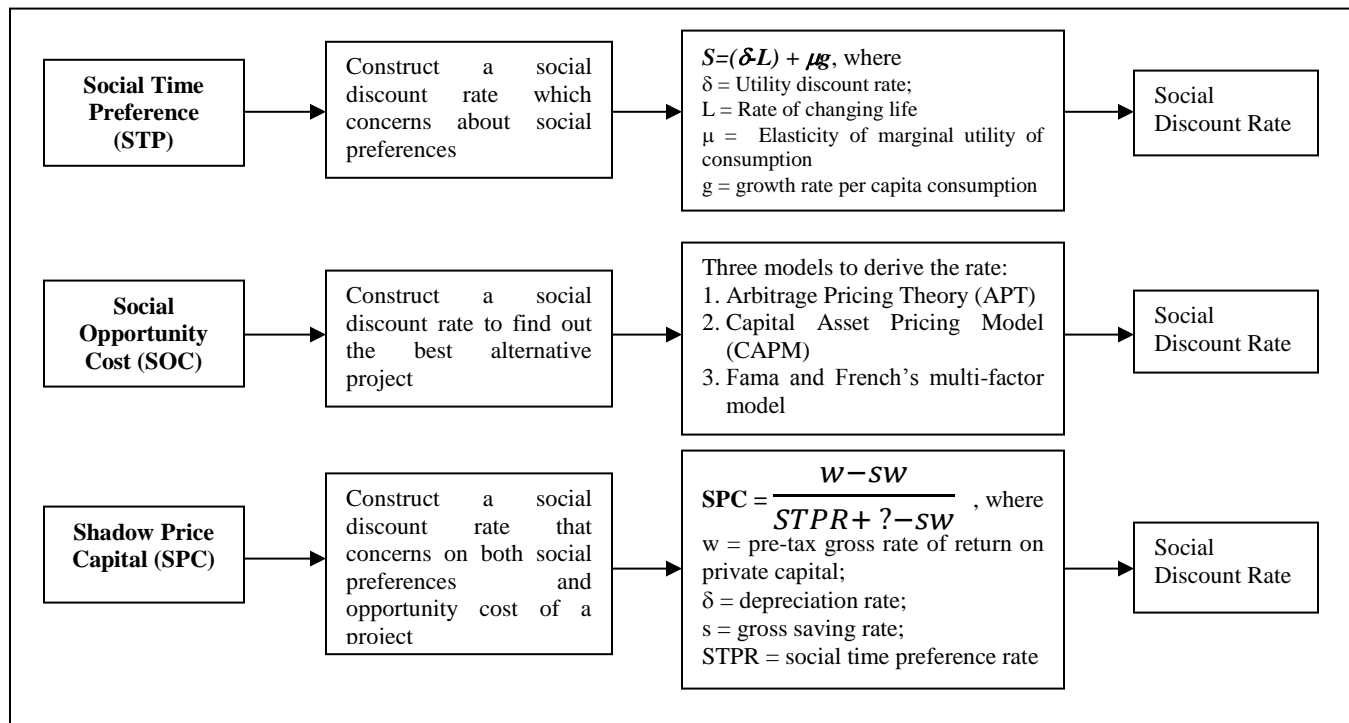
net benefits in later years (Moore, et. al., 2013, Burgess and Zerbe, 2011). Historically, the social discount rate has been discussed in 19th century by Von Thunen (1826), Faustman (1849), Jevons (1871) and Bohm Bawerk (1884) (Sheluntsova (2009) and Kula (2004)). Social discount rate is continued to study widely in 20th century. Among of economists who have worked in this sphere are Ramsey (1928), Marglin (1963), Baumol (1968), Feldstein (1972), Bradford (1975), Jenkins (1980), Kula (1985), Price and Nair (1985), Zerbe and Dively (1990), Spackman (1991), Harvey (1994), Pearce (1995), Boardman (1996), Henderson and Langford (1998) etc. (Sheluntsova, 2009). And now, it is widely applicable for CBA in evaluation of public projects.

Although social discount rate has been studied in few decades, the issue of constructing social discount rate has not reached consensus among economists. An essential question always appears in the study: What approach should be applied in determining social discount rate? The reason for this issue appears is no consistent approach to construct social discount rate (Moore, et. al., 2013, Kazlauskieno, 2015). Without a consistent and appropriate approach, there is a potential to construct an over-value rate which directly affects the result of CBA. Hence, it is important to reach an agreement towards the approach of constructing social discount rate. In this paper, approaches to construct social discount rate will be examined and reviewed. Later, all advantages and disadvantages of each approach will be discussed to provide a guideline to assessors in selecting the approach.

2.0 APPROACHES TO CONSTRUCT SOCIAL DISCOUNT RATE

Literature search (Boscolo, et. al. (1998); Morrison (1998); Young (2002); Moore, et. al. (2004); Azar (2009); Halicioglu and Karatas (2013)) reveals that there are various approaches to construct social discount rate (SDR), for example, Social Time Preference (STP) approach, specifying a benchmark financial rate approach, trade-offs in financial markets approach, Social Opportunity Cost of Capital (SOC), weighted average approach, Shadow Price of Capital (SPC), and others. Among these, the most popular approaches that adopted by researchers (Sheluntsova, 2009; Schad and John, 2012, Boscolo et. al., 1998) are Social Time Preference (STP) approach, Social Opportunity Cost (SOC) approach, and Shadow Price of Capital (SPC) which is shown in Figure 1. Figure 1 shows that each of the approaches has its functions and procedures to construct an appropriate rate for the different circumstances. For example, Social Time Preference (STP) approach is selected if the decision makers concerns on the social preference, whereas Social Opportunity Cost (SOC) develops a rate to find out the best alternative investments. Further, Shadow Price Capital (SPC) is more advanced and preferred than the both approaches. Hence, the selection of approaches is a significant process to estimate an appropriate social discount rate for a particular purpose.

Figure 1 Summary of three popular approaches to construct social discount rate



3.0 SOCIAL TIME PREFERENCE (STP) APPROACH

This approach is used to construct social time preference rate (STPR). This is a rate to reflect society that is willing to give up a unit of current consumption in exchange for more in future consumption. This rate can be used as a social discount rate (SDR) (Sen, 1961; Marglin, 1963a and b; Diamond, 1968; and Kay, 1972).

STPR is difference as individual time preference. The reason is individual time preference rate reveals from the market decisions, such as lending and borrowing rate. People lend or borrow the money based on the current real interest rate. For an individual as a whole, individual time preference rate is equal to the real interest rate on lending and borrowing. However, for society, the decision of society's willingness to

trade off the consumption now or later is not solely based on the market; it is also based on other factors. Further, the period of the society's consumption is longer than individual's consumption. Therefore, STPR is not equivalent with individual time preference.

There are two alternative methods to derive STPR. One of the methods is using after-tax rate of return on government bonds or other low-risk marketable securities. This method is more direct, yet, the main weakness of this method is individuals may not voice out all their preferences concerning the future in the marketplace, and, even they do, their preferences voiced out as individuals may be different from their preferences voiced out when they see themselves as part of a society (Dasgupta and Pearce, 1972).

Another method is using a formula which formed by an economist Frank P. Ramsey. The standard formula of Ramsey equation (Ramsey, 1928) shown as below:

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

where ρ is rate of time preference; μ is the elasticity of marginal utility of income (or consumption) schedule; and g is the projected rate of growth of per-capita real consumption. The origin of this equation is from the models of individual savings behavior; in which individual maximize utility (or welfare) over time. The rate of social time preference (s) will be equated to the interest rate (r) if one uses it to allocate his incomes between saving and consumption.

Later, Pearce and Ulph (1995) provide an overview empirical estimate of individual components. They further decompose the equation into as follow:-

$$s = (\delta - L) + \mu g \quad (2)$$

where δ is the "true" utility discount rate; while L is the rate of change in life chance. The decomposed focus on the rate of time preference, which looking at two perceptives: individual's utility (such as impatience or myopia) and changing in life chance of a population. If the rate of life chance is smaller, then the rate of utility discount rate will become larger.

In the literature, some authors only consider the first component (i.e. "true" utility discount rate) in deriving the pure rate of time preference. Still, most of the authors prefer to use the formula (2) decomposed by Pearce and Ulph (1995). Hence, in this study, researcher will apply the Pearce and Ulph's formula (2). Below explains each of the components in details.

Pure Rate of Time Preference, ρ

Utility discount rate, δ

Many of previous researchers, for example, Kula (1984, 1987, 2004); Cline (1992); Stern (2006) and others set the value of this component (δ) to zero because of ethical ground. However, setting this component in zero rate may produce some contradictory results. This issue has been argued by some of the researchers (such as Ramsey 1928, Pigou 1932, Harrod 1948, Solow 1974). They defended that positive utility discount rate is more favorable as it suggests the value of utility in present generation to be higher than the future generation. However, other researchers claimed that all generations should be treated alike; therefore, zero utility discount rate is preferable. Yet, the value of δ is difficult to be determined through empirical study due to limited information. Thus, most of the researchers determine this rate based on previous literature. Since there are different rates of utility discount rate applied in literature, this leads to various pure time preference rates exist in literature as well.

Changing of life chance, L

There is a controversy on how to measure the uncertainty of survival chance in the future. From literature findings, previous studies suggested death rate statistics as the individual's survival probability and risk of death (Kula 1984, 1987, 2004). Thus, the rate of life of chances (L) is determined based on the death rate over population rate. The formula to estimate is as below:-

$$\text{Changes of Life } (L) = \frac{\text{Total Death Rate}}{\text{Total Population Rate}} \quad (3)$$

Overall, based on previous researchers findings (Pearce and Ulph, 1995; Arrow, 1995; OXERA, 2002; Evans and Sezer, 2004; Kula, 2004, Evans, 2006; Stern, 2006 and others), the determined empirical estimates are within the range of 0.1% to 3%. These empirical estimates are derived by applying utility discount rate and rate of changing life chance.

Elasticity of Marginal Utility of Consumption, μ

Based on the literature, there are three approaches can be used to estimate this component, including direct survey methods, indirect behavioral evidence and revealed social values. Direct survey methods focus on measuring risk and inequality aversion through a specially designed questionnaire.

For indirect behavioral evidence approach, it refers to consumer demand models in order to estimate the value of μ . Several models can be used as consumer demand models, for example Constant Elasticities Model (CEM), Almost Ideal Demand System (AIDS) and Quadratic Almost Ideal Demand System (QUAIDS). These models have to determine at the same time to find out which model provides significance and plausibility of results of μ (Evans, 2004a).

For the third approach, it is to reveal government behavior through spending and tax policies. Cowell and Gardiner (1999) applied the saving behavior and they look at UK tax schedules. In result, they are having the value of 1.2-1.4 as the value of μ .

Overall, the range value for this component is fall in between 1 to 2% except for a few outliers (see Table 1). The results of this component are differences due to model specifications, the level of aggregation in the data, choice of estimators, sample size and the length of sample periods (Zhuang, et. al., 2007).

Table 1 Summaries results of elasticity for marginal utility of consumption, μ based on different approaches

Authors / Years	Empirical Estimates	Sources of Data
A. Survey Method		
Barsky et. al. (1995)	Approximately 4.0	Survey on aversion risk in United State (US). Respondents: middle-aged of US residences
Amiel et. al. (1999)	0.2-0.8	Survey on inequality aversion of US residences Respondents: US students
B. Indirect Behavioral Evidence		
<i>a. Constant Elasticity Model (CEM)</i>		
Kula (1984)	1.56	Country: Canada Data timeframe: 1954-1976
Kula (1984)	1.89	Country: UK Data timeframe: 1954-1976
Evans and Sezer (2002)	1.64	Country: UK Data timeframe: 1967-1997
Evans (2004a)	1.6	Country: UK Data timeframe: 1965-2001
Kula (2004)	1.64	Country: India Data timeframe: 1965-1995
Evans et. al. (2005)	1.6	Country: UK Data timeframe: 1963-2002
Percoco (2006)	1.28	Country: Italy Data timeframe: 1980-2004
<i>b. Almost Ideal Demand System (AIDS)</i>		
Blundell (1988)	1.97	Country: UK Data timeframe: 1970-1984
Evans (2004b)	1.33	Country: France Data timeframe: 1970-2001
<i>c. Quadratic Almost Ideal Demand System (QUAIDS)</i>		
Blundell et. al. (1993)	1.06	Country: UK Data timeframe: 1970-1984 Aggregate model
	1.06 -1.37	Country: UK Data timeframe: 1970-1984 Micro models
Banks et. al. (1997)	1.07	Country: UK Data timeframe: 1970-1986
C. Revealed Social Values		
Cowell and Gardiner (1999)	1.28 – 1.41	Country: UK Data timeframe: 1999-2000
Evans and Sezer (2004)	1.5	Country: UK Data timeframe: 2001-2002
Evans (2005)	1.25 – 1.45	Country: Five major OECD countries (France, Germany, Japan, UK and US) Data timeframe: 2002-2003

(Sources: Evans, 2005 and Zhuang, et. al., 2007)

Growth Rate of Per-capita Consumption, g

Pearce and Ulph (1999) suggest using very long-term runs of per-capita consumption data to overcome the problems of using short-term of past data. Reasons are the value of g will be understated if there is a switch to leisure from consumption, and it will be overstated if there are social costs of consumption. Hence, the data of growth rate need to refer to long-term rather than short-term. As refer the report done by Oxera (2002), the period for data growth rate that referred by them is last 180 years. Longer period of data that referred by researcher will be more reliable. Besides, past growth rate represents the best information compares to the data of forecast growth rate.

4.0 SOCIAL OPPORTUNITY COST OF CAPITAL (SOC) APPROACH

The approach is proposed to derive the rate of marginal social opportunity cost of capital as the social discount rate. This approach has been recommended by Mishan (1967), Baumol (1968), Diamond and Mirrless (1971a and b) and Herberger (1972) and this approach has been further researched by Broadman, et. al. (2001), Nordhous (2007) etc (Zhuang, et. al., 2007). This approach is used when such situations arise, for example, government and private sector are competing for same resources, limited resources, or public investment supersede private investment.

This approach uses various models to derive the marginal rate of SOC, such as Arbitrage Pricing Theory (APT); Capital Asset Pricing Model (CAPM); and Fama and French's multi-factor model (1993). The purpose to work out these models is to forecast what is the market expects to receive from a particular project. Several considerations should be taking into consideration when deriving the marginal rate of SOC. First is to consider whether the project will receive subsidy from the government. This is because this factor would influence the rate rise. Second is to consider the factors of risk and externalities (refers social costs or benefits). If the rate is lower, it means that public project is replaced

by the private project due to negative externalities. In contrast, if the project of private sector able to deliver positive externalities to the society, then the rate will become higher (Young, 2002).

■5.0 SHADOW PRICE OF CAPITAL (SPC) APPROACH

This approach is proposed by Eckstein (1958), Arrow (1966, 1970), Feldstein (1972), Bradford (1975) and Lind (1982), Dinwiddy (1985), Schereaga (1990), Cline (1992), Pearce (1995), Boscolo (1998), Broadman et. al. (2010) and others to reconcile the Social Time Preference (STP) approach with Social Opportunity Cost (SOC) approach (Zhuang, et. al., 2007).

The social discount rate can be calculated by using the formula (4). This formula has been applied by Lyon (1990), Cline (1992), Pearce and Ulph (1995), Boardman, et. al.(2010).

$$SPC = \frac{w - s\delta}{STPR + \delta - s\delta} \quad (4)$$

where, w is the pre-tax gross rate of return on private capital; δ is the depreciation rate, s is the gross saving rate and STPR is the social time preference rate.

The value of SPC is vary for each type of project because it depends on the value of STPR, SOC , depreciation rate, gross saving rate and pre-tax gross rate of return (Jenkins and Harberger, 1997). Thus, it is necessary to estimate all the parameters in appropriate way.

■6.0 GUIDELINE IN SELECTING AN APPROACH

There are advantages and disadvantages for the abovementioned approaches. Table 2 shows the summary of advantages and disadvantages for these three approaches, which are Social Time Preference (STP) approach, Social Opportunity Cost (SOC) approach and Shadow Price of Capital (SPC) approach.

For Social time preference (STP) approach, a major criticism on using social time preference rate (STPR) as the social discount rate is that the rate is purely concern about social preference towards public projects and ignores the fact that public projects could displace or crowd out private sector investment if they cause the market interest rate to rise (Baumol, 1968 and Harberger, 1972). Besides, public projects involve the cost of displacing the private investment; this cost would indicate what the replaced private investment contributes to the society. This cost could not be ignored when constructing social discount rate. Since, STP approach does not consider this significant cost as deriving STPR, another method could be applied to overcome the issue, which is Social Opportunity Cost of Capital (SOC) (Zhuang, et. al., 2007).

However, this approach is only considered in term of financing aspect than social preference, such as the cost of capital for public investment, public investment crowd out private investment dollar by dollar etc. For construction social discount rate, both aspects are significant to take into consideration. Without either one, the approach would not consider as an adequate approach. Hence, another approach (named Shadow Price of Capital, SPC) was proposed by researchers to balance out the advantages and disadvantages of STP and SOC approach.

Although Shadow Price of Capital (SPC) approach is more comprehensive than STP and SOC approach, this approach is less popular and less application by researchers. Reason is this approach consumes more time to calculate both social time preference rate (STPR) and marginal rate of social opportunity cost (SOC) before constructing a social discount rate.

Table 2 Comparisons among the approaches to construct social discount rate

Approaches	Pros	Cons
Social Time Preference (STP)	Derives a rate to reflect society's willingness to trade off consumption now or later	Purely concern on social preference
Social Opportunity Cost (SOC)	Derives a rate of marginal social opportunity cost of capital of a project	Only considers financing aspect rather than social preference
Shadow Price of Capital (SPC)	To reconcile the weaknesses between STP approach and SOC approach	Less popular than STP and SOC; taking more time to develop social discount rate

(Zhuang, et. al., 2007)

■7.0 CONCLUSION

Although STP and SOC approaches have their disadvantages, these approaches are still favorable among researchers. However, choice of approach is much dependent on the type of projects implemented. STP approach that measures the desirability of individuals towards the public project is most appropriate to apply for the new public project, whereas, SOC approach is suggested to apply only when the STP approach is unavailable or clearly unreliable (Young, 2002 and Lopez, 2009). SOC is social opportunity cost that determines next best use of the resources devoted to the project. Though most discussions in the literature argue that there is no approach appropriate to determine social discount rate (SDR), but practically, the popular approach is the STP approach (Young, 2002).

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