Social Discount Rates and Welfare Weights for Public Investment Decisions in Turkey

By

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Thesis submitted to Oxford Brookes University in partial fulfilment

of the requirements of the award of Doctor of Philosophy

March 2011

ACKNOWLEDGEMENT

I would like to thank my Director of Studies Dr David Evans for his guidance, assistance and patience.

I would also like to thank my supervisor Professor Erhun Kula for his help and encouragement.

ABSTRACT

This study is concerned with the measurement of the social discount rate (*SDR*) to be used in the evaluation of public sector projects and the application of regional welfare weights (*RWW*) to facilitate the implementation of regional development policy in Turkey. The issue of an appropriate *SDR* and a set of *RWW* is particularly important for Turkey since the country has acquired candidate status for membership of the EU and therefore is eligible for EU funds such as the Instrument for Pre-Accession Assistance. However, the EU regulations stipulate that all major investment projects to be considered for a share of the EU funds must be supported by a cost benefit analysis which requires the application of a discount rate. Moreover, Chapter 21 of the *acquis communautaire* sets out regional development as one of the most important policy concerns for the EU. Thus, it is crucially important for Turkey to develop coherent and viable regional policies in the context of its negotiations for full membership of the EU. However, Turkey currently has neither a consistent and explicit policy regarding the application of a social discount rate in the appraisal of its public projects, nor a set of coherent and viable policies with respect to regional development. There is also a gap in the literature regarding these issues. Therefore, the twin objectives of this study are the estimation of an SDR for Turkey and the calculation and application of welfare weights in regional policy.

ACRONYMS AND ABBREVIATIONS

ACF	Autocorrelation function
ADF	Augmented Dicky-Fuller test
AIDS	Almost Ideal Demand System
AIC	The Akaike Information criterion
ARDL	Autoregressive Distributed Lag model
ARUR	Annual rate of equity-adjusted return on capital
AREAR	Annual rate of unadjusted return on capital
B/C	Benefit-cost ratio
B-S	Bergson-Samuelson model
CAPM	Capital asset pricing model
CEM	Constant Elasticity Model
CF	Cohesion Fund
CPED	Compensated cross-price elasticity of demand
CBA	Cost-benefit analysis
DAP	Eastern Anatolia Plan
DF	Dicky-Fuller test
DOKAP	Eastern Black Sea Project
DPT	Devlet Planlama Teskilati (State Planning Organisation in Turkish)
DWP	Department of Work and Pensions
EC	European Commission
ECM	Error Correction Model
EIS	Elasticity of intertemporal substitution
EMH	Efficient Market Hypothesis
ERDF	European Regional Development Fund
ESA	European System of Accounts
ESF	European Social Fund
ESSC	Employees' social security contributions
EU	European Union
F-F-F	Demand-for-food model
GDP	Gross Domestic Product
HQC	The Hannan-Quinn criterion
İBBS	İstatistiki Bölge Birimleri Sınıflandırması (NUTS in Turkish)
IED	Income elasticity of demand
IEW	Index of economic welfare
IMF	International Monetary Fund
IPA	Instrument for Pre-Accession Assistance

IPARD	Instrument for Pre-Accession Assistance for Rural Development
IRR	Internal rate of return
ITC	Information technology and communication
KOP	Konya Plain Project
LES	Linear expenditure system
MEW	Measure of economic welfare
MRS	Marginal rate of substitution
MU	Marginal utility
NGO	Non-governmental organisation
NIC	Newly Industrialised Country
NPV	Net present value
NUTS	Nomenclature of Territorial Units for Statistics
OECD	The Organisation of Economic Co-operation and Development
OLS	Ordinary Least Squares method of regression
OXERA	The Oxford Economic Research Associates Ltd
PED	Compensated own price elasticity of demand
PNDP	Preliminary National Development Plan
PDR	Priority Development Region
PPP	Purchasing Power Parity standard
QUAIDS	Quadratic Extension of Almost Ideal Demand System
QLI	Quality of life index
R&D	Research and development
RDA	Regional Development Agencies
RWW	Regional Welfare Weights
GAP	Southern Anatolian Project
SBC	The Schwarz Bayesian criterion
SDR	Social Discount Rate
SEE	State Economic Enterprises
SF	Structural Fund
SOC	Social opportunity cost rate of discount
SPO	State Planning Organisation (DPT: Devlet Planlama Teskilatı in Turkish)
STP	Social time preference
STPR	Social time preference rate
SWF	Social welfare function
SWW	Social welfare weights
TSI	Turkish Statistical Institute
TürkStat	Internet portal of Turkish Statistical Institute
VAR	Vector autoregressive regression

CONTENTS

Chapter 1 Introduction

1.1 Chapter overview

Improvement in economic welfare depends on economic growth and development, and these in turn depend on investment. Thus, investment decisions are at the heart of any growth and development strategy. They also involve weighing benefits against costs, a process which is referred to by economists as cost-benefit analysis (CBA). However, individuals who benefit from an investment project will not necessarily be the same individuals who bear the cost of the project. They will in fact be separated both spatially and sometimes generationally. This implies that any investment decision will necessarily involve not only the issue of efficiency but also that of equity, i.e. the distribution of benefits and costs between different groups of people in the same time period as well as between generations. The former involves distributional weights and the latter the discount rate. Distributional issues and an appropriate discount rate for public projects have been a part of welfare economics in general and of CBA in particular across generations (Arrow 1995, Ekstein 1958, Harberger 1978 and 1984, Musgrave 1969, Sen 1961, Stern 1977 and 2007). More recently, several European governments have explicitly stated social discount rates for long term public projects and made references to social welfare weights (see Section 1.2).

This study is concerned with measurement of the social discount rate (*SDR*) to be used in the evaluation of public sector projects and the regional welfare weights (*RWW*) to facilitate the implementation of regional development policy in Turkey. The issue of an appropriate *SDR* and *RWW* is particularly important for Turkey in the context of Turkish candidacy for the membership of the EU.

The Cohesion Policy regulations of the EU stipulate that all major investment projects applying for a share of the Cohesion Funds must contain a CBA (European Commission 2008). Additionally, Chapter 21 of the *acquis communautaire* on Regional Policy and the Co-ordination of Structural Instruments sets out regional development as one of the most important policy areas in the EU. For the period 2007-13, the planned expenditure on regional policy constitutes the second largest item in the EU budget with an allocation of €348 billion (Europa 2010a).

Turkey acquired a candidate country status at the Helsinki meeting of the European Council in 1999 and began negotiations in October 2005 for full membership of the EU. By

October 2010, 13 out of 35 chapters of the EU's *acquis communautaire* had been opened for discussion (European Commission 2010). Consequently, Turkey has been eligible for the EU funds and the EU annually finances many projects in Turkey from social services to regional development. For example, it was envisaged by the preliminary European Commission (EC) draft budget for 2007 that Turkey could get over €2 billion from the Instrument for Pre-Accession Assistance (IPA) and Instrument for Pre-Accession Assistance for Rural Development (IPARD) for the period 2007-2010 (Europa 2010b). However, it can be stated that there has been a relative lack of coherent and consistent policy regarding the formulation and the implementation of *SDR* with respect to the evaluation of long term projects in Turkey. The State Planning Organisation (SPO) is the institution which is charged with the formulation and implementation of public spending policies in general and public investment policies in particular in Turkey. Despite references in the five-year development plans and associated documents by the SPO to the necessity of subjecting public sector projects to financial, economic and social analysis, there has been no mention of a specific *SDR*, unlike the UK and other European countries (see, for example, European Commission 2008, HM Treasury 2003, and Rambaud and Torrecillas 2006), or even a discussion relating to *SDR*. In fact a 2004 study regarding environmental costing in Turkey makes an explicit reference to this issue. "*For a public investment project or a public investment programme, the appropriate discount rate (often called the social or economic discount rate) is ideally set by a central planning authority, such as DPT or Treasury. We understand that such a (social) discount rate for public investment projects has not been established and published by the Government of Turkey.*" (Envest 2004, p 11)

Turkey also faces serious problems regarding regional development since there are significant differences in the level of development between different regions in Turkey in terms of per capita income as well as other indicators of development such as unemployment levels, demographic indicators, education levels and provision of health services (see section 1.3.2). Regional inequalities are particularly challenging since relative poverty and underdevelopment of North-eastern, Middle-eastern and South-eastern Anatolia regions are regarded as the most urgent issues facing both Turkish and EU policy makers with respect to Turkey's integration in the EU (European Stability Initiative 2010). Moreover, while the EU and other developed countries approach the problem of regional development with policies that are relatively consistent and based on sound principles, Turkey appears to be relatively unsuccessful in the formulation, implementation and the consequences of regional policies (Pınar and Arıkan 2003). The relative lack of a coherent and consistent policy framework is not confined to the *SDR* but also applies to the development of viable regional policies. There are also inconsistencies between the Turkish and the European Regional policies in terms of both approach and implementation. The biggest problem has been the lack of a regionalist tradition in Turkey. This is due, at least in part, to the rather centralist tradition arising from historical reasons in governmental and administrative structures. Tentative attempts at introducing regionalisation have generally been unsuccessful for fear that they may undermine territorial integrity and encourage Kurdish separatism (Reeves 2005). However, Turkey is under obligation to undertake, during the accession negotiations, the infrastructural and institutional reforms as required by the EU regional policies. These reforms involve regional decentralisation and the establishment of democratised regional governance structures (Beleli 2005).

Consequently, the derivation of the *SDR* to be used in the evaluation of public sector projects and of the *RWW* to facilitate the implementation of regional development policy in Turkey appears to be highly relevant in the current economic and political climate. It is also likely to fill a gap in the literature since there is a lack of empirical studies devoted to the estimation of an appropriate *SDR* and a set of *RWW* for Turkey.

1.2 Academic context

Discounting costs and benefits over time at a given percentage per year is a long-established practice in CBA to estimate the present value of an outcome that is to occur in future, such as consumption, income or output. An *SDR* is the rate which renders society indifferent between current and future wellbeing. It reflects a society's relative valuation of the current welfare versus the future welfare. Thus, the determination of an appropriate social discount rate is crucially important for cost–benefit analysis (Zhuang *et al* 2007).

Although there are several approaches to what constitutes an appropriate *SDR*, the social time preference rate (*STPR*) is gaining increasing acceptance among academics as well as policy makers as the appropriate approach to discounting (see, for example, Evans 2007, Evans and Sezer 2005, Kula 2004, Percoco 2008, Rambaud and Torrecillas 2006, and Spackman 2008, as well as the European Commission 2008 and HM Treasury 2003). The *STPR* is the rate at which the society is prepared to substitute future consumption for present consumption. For that reason it is also called the consumption rate of interest. In a two-period analysis this rate relates to the marginal rate of substitution of future for current consumption at any point on a given societal indifference curve. The theoretical basis and derivation of the *STPR* are discussed in Chapter 2, Section 2.3.5, and empirical estimates in Chapter 4, Section 4.2.

The equation for the *STPR*, based on Ramsey (1928) is given by

(1.1) $STPR = \rho + \varepsilon . g$

where

ρ = the pure time preference rate or the utility discount rate

ε = elasticity of marginal utility of consumption

g = average growth of projected per capita real consumption

As can be seen the *STPR* consists of two elements. The utility discount rate *(ρ)* is the cause of much controversy among the economists, which is explored in Chapter 2, Section 2.3.5. The literature regarding estimates of this parameter is examined in Chapter 4, section 4.2. The utility discount rate reflects individuals' (society's) intertemporal preferences when the real per capita consumption is constant, i.e. the growth rate of consumption (g) is zero over the discounting period. If, however, g is positive then future consumption exceeds current consumption, which implies that the marginal utility of consumption is declining and the rate of decline is determined by the growth rate of consumption and the elasticity of diminishing marginal utility of consumption (Potts 2002). This is reflected in the term ($\varepsilon . g$), where ε is the absolute value of the elasticity of marginal utility with respect to consumption. This concept occupies an important place in the literature and plays a pivotal role in the estimation of both the *STPR* and social welfare weights. Therefore, the whole of Chapter 3 is devoted to the discussion of the theoretical and empirical issues surrounding the concept of the elasticity of marginal utility of consumption. As for the average growth rate of consumption, the theoretical issues regarding g are discussed in Chapter 2, Section 2.3.5 and empirical estimates of it in Chapter 4, Section 4.2.2.

In terms of economic policy and practice, several European countries have set an explicit discount rate based on the *STPR* approach. For example, the official *SDR* based on the declining (after 30 years) time preference approach for the UK is 3.5% (HM Treasury 2003). Similarly, the EU guide to CBA in the evaluation of investment projects stipulates that a rate of 5.5% for the Cohesion Countries and 3.5% for the non-Cohesion countries would be the appropriate *STPR* for the EU (European Commission 2008). Other countries have also stated explicitly what the *SDR* ought to be for public sector projects. For example, France applies an *STPR* of 4% (Evans 2007) and Spain applies multiple *STPRs* of 4% for water, 5% for environmental and 6% for transport projects (Spackman 2008). Italy's discount rate is 5% which is also based on *STPR* (Percoco 2008).

As for the distributional welfare weights, which are also known as the social welfare weights, they are devices that can be used in the allocation of funds to finance public spending projects among the different groups of a given population. It could be argued that the *SDR* implicitly deals with the intertemporal distribution of welfare and the *SWW* relate to the interspatial distribution of welfare. However, because the *SWW* explicitly introduce distributional issues into CBA, they are somewhat controversial. Some argue that CBA should only be concerned with efficiency issues not distributional ones (see, for example, Musgrave 1969). This line of argument assumes that the existing distribution of income is optimal. If it is not, then optimality should be achieved by some other way such as taxation and subsidy. Thus a social project should, it is argued, be judged according to efficiency criteria based on the Kaldor-Hicks principle. Harberger (1978 and 1984), on the other hand, argues that distributional weights might be acceptable as long as the extra benefits of such weights are at least as large as the cost in terms of efficiency loss. If distributional issues are to be explicitly incorporated into CBA, then the use of regional welfare weights (*RWW*) in cost-benefit analysis would be beneficial.

The analysis of welfare weights is based on the concept of a social welfare function which is rooted in the analysis of consumer behaviour. A commonly used social welfare function is of the Bergson-Samuelson (B-S) type. The properties of this function and the derivation of distributional welfare weights are discussed in Chapter 2, Section 2.2. It suffices to state here that the distributional weights involve the concept of diminishing marginal utility of income (consumption) and are based on welfare –as reflected by per capita income-differences between the socio-economic or regional groups concerned.

In terms of economic policy in practice, distributional welfare weights also seem to be an important consideration in the evaluation of social projects and policies where benefits accrue to –and costs are borne by- different groups of the society whose distinguishing characteristic seems to be the net income they receive (Weisbrod 1972). For example, the UK government makes explicit use of this concept in its expenditure policy in the latest Green Book (HM Treasury 2003). The recent EU Guide to CBA of investment projects also refers to the explicit use of welfare weights based on income differences (see European Commission 2008, Annex E).

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1.3 Background to the Turkish economy

The modern Turkish Republic was founded in 1923 through the leadership of a group of Young Turks (Mustafa Kemal –later Ataturk- and his friends) after a political and military struggle from the ruins of the Ottoman Empire. It first adopted a single-party system and in 1946 multi-party parliamentary democracy was established based on a constitutional regime similar to that of the UK and has continued until today albeit with some interruptions along the way (Index Mundi 2010).

1.3.1 The geography and geo-politics

Turkey is situated to straddle two continents, Europe and Asia, and constitutes an important part of the geography of the Middle-East. Its main religion is Islam (99% of its population) and it is the only secular –by Constitution- parliamentary democracy among the predominantly Islamic countries of the world. It occupies a geopolitically significant location since it borders Georgia, Armenia, Iran, Iraq and Syria in the east, Bulgaria and Greece in the northwest and is surrounded by the Black Sea in the north, the Aegean in the west and the Mediterranean in the south (see Figure 1.1).

Figure 1.1 Location of Turkey

Its surface area is 778 000 km^2 and it has a population of 72 561 312 people. Turkey is the second largest country in Europe and, according to the Turkish Statistical Institute (TSI), demographically the youngest with more than half of its population being under 29 years old (TSI 2010b).

Turkey is a founding member of the Council of Europe, a member of NATO and held a non-permanent seat on the UN Security Council during 2009-10. Turkey has also been an associate member of the European Union since 1963 (then the EEC) with the Treaty of Ankara and acquired, as has been mentioned above, a candidate country status at the Helsinki meeting of the European Council in 1999. Turkey has undergone a series of legal, administrative and constitutional reforms in recent years in order to comply with the *acquis communautaire* of the EU the most important of which is the constitutional reform of September 2010 (European Commission 2010).

1.3.2 The economy

Turkey is one of the Newly Industrialised Countries (NIC) and had, in 2009, a per capita GDP (PPS) of US$ 12,476 (IMF 2010). Its total GDP in PPS in 2009 was over US$ 880 billion which implies a share of world's total GDP of 1.25%; that makes the Turkish economy the 17th largest in the world.

The report points out the fact that between 1992 and 2009 Turkey's GDP increased by 263.1% while the same figure was 125.7% for Spain, 115.8% for the UK, 89.6% for France, 81.6% for Russia, 71.4% for Germany and 66.1% for Italy. Moreover, Turkey's share of Europe's economy increased from 3.4% in 1992 to 4.55% in 2009 and will, according to the IMF, be 4.99% by 2014.

The economic structure of Turkey based on the sectoral distribution of GDP is not very different from those of advanced economies with the shares of the services and industrial sectors being 70% and 23% respectively (See Table 1.1). However, the employment based economic structure presents a somewhat different picture.

Considering that more than one third of the population still lives in rural areas, it is not surprising that the share of agriculture in total employment is 24.7% which is to be compared with the agricultural share of 8.2% in total GDP. Similarly, the share of the service sector in total GDP is 69.1% while it is only 50% in employment.

Table 1.2 provides selected indicators for the Turkish economy between 2001 and 2009. It shows that private consumption as a proportion of GDP has been fairly stable over this period with a figure of around 75% while total investment shows fluctuations between 15.9% and 22.3% mainly as a result of the variation in private investment

Table 1.1 Percentage sectoral shares of GDP and employment

	GDP				*Employment*			
	2006	***2007***	***2008***	***2009***	***2006***	***2007***	***2008***	***2009***
Agriculture*	***8.2***	***7.6***	***7.6***	***8.2***	**24.0**	**23.5**	**23.7**	**24.7**
Industry	***24.9***	***24.8***	***24.5***	***22.7***	**26.8**	**26.7**	**26.8**	**25.3**
Mining and quarrying	1.2	1.2	1.4	1.5	—	—	—	—
Manufacturing	17.2	16.8	16.2	15.0	—	—	—	—
Electricity, gas and water supply	1.8	1.9	2.2	2.4	—	—	—	—
Construction	4.7	4.9	4.7	3.8	—	—	—	—
Services	***66.9***	***67.6***	***67.9***	***69.1***	**49.2**	**49.8**	**49.5**	**50.0**
Total	***100.0***	***100.0***	***100.0***	***100.0***	**100.0**	**100.0**	**100.0**	**100.0**

Source: TurkStat (2010)

*Agriculture, hunting, forestry and fishing

It also indicates that the general government gross debt has been fairly large, but much smaller than some of the European countries such as Greece, Spain and the UK, with over 40% of the GDP on average for the last five years. The trade figures indicate that Turkish economy is a fairly open economy for the size of the country with around one quarter of the GDP being traded which is not very different from countries such as the UK, France and Germany.

Table 1.2: Selected economic indicators

	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009
GDP p c	USD in current PPS	8 615	8 667	8 789	10 164	11 391	12 585	13 362	13 952	13 115
Real GDP p c growth	Annual, %	-7.0	4.8	3.9	8.0	7.1	5.6	3.4	-0.5	-5.8
Private final consumption	% of GDP	74.9	74.0	76.0	75.8	75.6	74.5	74.6	73.2	75.1
GFCF	% of GDP	15.9	16.7	17.0	20.3	21.0	22.3	21.4	19.9	16.9
Private GFCF	*% of GDP*	*11.7*	*12.4*	*13.6*	*17.4*	*17.7*	*18.9*	*18.0*	*16.0*	*13.2*
Public GFCF	*% of GDP*	*4.2*	*4.3*	*3.4*	*2.9*	*3.3*	*3.4*	*3.4*	*3.9*	*3.7*
Central government total revenue	% of GDP	-	-	-	-	23.5	22.9	22.6	22.1	22.5
Central government total spending	% of GDP	-	-	-	-	24.6	23.5	24.2	23.9	28.0
General government gross debt (EU definition)	% of GDP	-	-	-	-	52.3	46.1	39.4	39.5	45.4
Average real interest rate on public debt	%	-	-	-	-	4.3	3.5	7.5	2.4	7.9
Gross Interest expenditure	% of GDP	-	-	-	-	7.0	6.1	5.8	5.3	5.6
Unemployment rate	%	8.6	10.6	10.8	11.1	10.9	10.5	10.5	11.1	14.3
Exports	% of GDP	27.4	25.2	23.0	23.6	21.9	22.7	22.3	23.9	23.2
Imports	% of GDP	23.3	23.6	24.0	26.2	25.4	27.6	27.5	28.3	24.4
Inflation rate: all items	Annual growth %	54.4	45.0	21.6	8.6	8.2	9.6	8.8	10.4	6.3
Exchange rates	TRY per USD	1.2	1.5	1.5	1.4	1.3	1.4	1.3	1.3	1.5

Source: TurkStat (2010a); (OECD 2010c); IMF (2010)

Notes:

GDP pc: Gross Domestic Product *per capita*

GFCF: Gross fixed capital formation

TRY: Turkish lira

1.3.3 Income distribution and welfare

It would be fair to state that the figures presented above and in Table 1.2 point to an economy whose performance is fairly erratic in the short run but rather promising in the long run. However, these figures are average indicators and thus hide persistent regional differences that characterise the Turkish economy with respect to welfare considerations (Kılıçaslan and Özatağan 2007). An analysis of the distribution of household incomes and of economic activity among the different parts of the country shows that there is a clear east-west divide and considerable discrepancies of welfare exist among different households as well as different regions of the country. The *Income and Living Conditions Survey* for 2008 (TSI 2010a) shows that the ratio of the incomes of the richest 20% to those of the poorest 20% of society is 8:1, which implies that Turkey has the second worst distribution of income after Mexico among the OECD countries. The ratio of the top quintile to the bottom one is 17:1 to be compared with the OECD average of 9:1. There are also considerable income differences among the different regions of the country.

Figure 1.2: Geographical Regions of Turkey

Turkey is traditionally divided into seven broad geographical regions containing eighty one provinces (see Figure 1.2). However, as part of the reforms to comply with the EU regulations, Turkey has adopted the European system of Nomenclature of Territorial Units for Statistics (NUTS) in order to achieve consistency in gathering and presenting regional statistical data.

Figure 1.3: NUTS Level-1 regions of Turkey

Guide

Akdeniz	Mediterranean
Anadolu	Anatolia
Batı	West
Doğu	East
Ege	Aegean
Güney	South
Karadeniz	Black Sea
Kuzey	North
Orta	Middle

Thus, by a law passed in 2002, 81 provinces were grouped into 26 regions at NUTS Level-2 Statistical Units, and these were further grouped into 12 main regions NUTS Level-1 Statistical Units (see Figure 1.3 and Table 1.3). For estimation purposes, however, the Level-1 regions have been further aggregated into six main regions by combining the neighbouring regions of Level-2 classification (see Table 1.3 and also Chapter 6, Section 6.3.1).

There are sharp regional differences in welfare levels in Turkey indicated by the differences in the average income levels of the regions. For example, the average income

Table 1.3 Regions of Turkey: NUTS Level-1, Level-2 and Level-3

	Rank	*Level-1*	*Level-2*		*Level-3*
Marmara Region	1	İstanbul	TR10	İstanbul sub-region	İstanbul
	5	Western Marmara	TR21	Tekirdag sub-region	Tekirdağ, Edirne, Kırklareli
			TR22	Balikesir sub-region	Balıkesir, Çanakkale
	3	Eastern Marmara	TR41	Bursa sub-region	Bursa, Eskişehir, Bilecik
			TR42	Kocaeli sub-region	Kocaeli, Sakarya, Düzce, Bolu, Yalova
Aegian Region	4	Ege (Aegian)	TR31	Izmir sub-region	İzmir
			TR32	Aydin sub-region	Aydın, Denizli, Muğla
			TR33	Manisa sub-region	Manisa, Afyon, Kütahya, Uşak
Mediterranean Region	6	Akdeniz (Mediterranean)	TR61	Antalya sub-region	Antalya, Isparta, Burdur
			TR62	Adana sub -egion	Adana, Mersin
			TR63	Hatay sub-region	Hatay, Kahramanmaraş, Osmaniye
Black Sea Region	7	Western Black Sea	TR81	Zonguldaksub region	Zonguldak, Karabük, Bartın
			TR82	Kastamonu sub-region	Kastamonu, Çankırı, Sinop
			TR83	Samsun sub-region	Samsun, Tokat, Çorum, Amasya
	9	Eastern Black Sea	TR90	Trabzon sub-region	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
Central Anatolian Region	2	Western Anatolia	TR51	Ankara sub-region	Ankara
			TR52	Konya sub-region	Konya, Karaman
	8	Middle Anatolia	TR71	Kirikkale sub-region	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir
			TR72	Kayseri sub-region	Kayseri, Sivas, Yozgat
Eastern Anatolian Region	12	North-eastern Anatolia	TRA1	Erzurum sub-region	Erzurum, Erzincan, Bayburt
			TRA2	Agri sub-region	Ağrı, Kars, Iğdır, Ardahan
			TRB1	Malatya sub-region	Malatya, Elazığ, Bingöl, Tunceli
	11	Middle-eastern Anatolia	TRB2	Van sub-region	Van, Muş, Bitlis, Hakkari
			TRC1	Gaziantep sub-region	Gaziantep, Adıyaman, Kilis
	10	South-eastern Anatolia	TRC2	Şanlıurfa sub-region	Şanlıurfa, Diyarbakır
			TRC3	Mardin sub-region	Mardin, Batman, Şırnak, Siirt

Source: Own compilation

Note: Ranking is based on average income levels

Table 1.4 Poverty Rates

	Regional threshold (TL)	National threshold (TL)	Poverty rate, % (regional basis)	Poverty rate, % (national basis)
İstanbul	*4 574*	3 146	*9.9*	3.2
West Marmara	*3 369*	3 146	*12.9*	11.6
Aegean	*3 540*	3 146	*15.7*	11.4
East Marmara	*3 992*	3 146	*9.5*	4.9
West Anatolia	*3 596*	3 146	*12.7*	9.0
Mediterranean	*2 597*	3 146	*10.0*	16.6
Central Anatolia	*2 867*	3 146	*12.7*	16.3
West Black Sea	*2 795*	3 146	*11.9*	16.8
East Black Sea	*3 318*	3 146	*13.7*	11.6
North East Anatolia	*2 189*	3 146	*17.7*	34.0
Central East Anatolia	*1 838*	3 146	*9.3*	36.8
South East Anatolia	*1 550*	3 146	*12.7*	47.9

Source: TSI (2010a)

Notes: Poverty thresholds are calculated as 50% of the median value of equivalised household disposable income

of the Marmara Region, as a proportion of the per capita GDP in Turkey as a whole, is equal to 1.44 while the same figure for the Eastern Anatolian Region is 0.46. More specifically, the same figures for the western sub-regions of TR10 (Istanbul), TR21 (Edirne, Tekirdag and Kirklareli) and TR31 (Izmir) are 1.55, 1.30 and 1.26 respectively , while the corresponding figures for the eastern sub-regions of TRA2 (Ağrı, Kars, Iğdır, Ardahan), TRB2 (Van, Muş, Bitlis, Hakkari) and TRC2 (Şanlıurfa, Diyarbakır) are 0.40, 0.35 and 0.43 respectively (See Chapter 6, Table 6.5)

The regional welfare differences in Turkey are also indicated in the figures provided by the above-mentioned *Income and Living Conditions Survey* (TSI 2010a). Table 1.4 provides information on regional poverty levels in Turkey based on both the national and the regional poverty thresholds. The figures indicate that there is a substantial gap between the western and the eastern parts of the country. In fact the three sub-regions with the highest poverty rates happen to be in Eastern Anatolia with Southeast Anatolia (Güneydogu Anadolu) having the highest poverty rate of 47.9% based on the national poverty threshold. This is in contrast with the west of the country where the Marmara, including Istanbul, the Aegean and the West Anatolia regions have much lower poverty rates with Istanbul having the lowest poverty rate only 3.2%.

Other welfare indicators, such as educational levels and health care, also show sharp differences between the eastern and the western regions of the country. For example, for the 2009/10 academic year the net secondary schooling ratio for western provinces such as Bilecik, Bursa, Edirne and Izmir was 89%, 75%, 79%, 75% respectively. The same ratio for eastern provinces such as Agri, Bitlis, Diyarbakir, Sirnak, Urfa, Van was 27%, 34%, 45%, 34%, 32% and 33% respectively.

Similarly, while in the western cities, for example, of Aydin, Edirne, Istanbul and Izmir there are 1.53, 2.51, 2.03 and 2.47 doctors per thousand of population, respectively, the same figure for eastern provinces such as Agri, Muş, Urfa and Şırnak are 0.83, 0.73, 0.75, 0.68 respectively (TSI 2009).

1.3.4 Migration

Given that welfare differences among the different regions in Turkey have a long history, migration has been an important fact of life in Turkey. In line with the general characteristic of migration all over the world, internal migration in Turkey is closely related to the socio-economic developments in the country and therefore its direction has generally been from the less developed eastern and south-eastern provinces to the more developed western provinces (Bülbül and Köse 2010). Thus, this section is a background to regional welfare weights to be estimated in Chapter 6.

As an economic phenomenon, migration is influenced by demand and supply factors. Supply factors are those associated with the source region such as the desire to improve one's standard of living, enhancement of educational and other opportunities for one's children, and the attraction of better professional facilities in the case of skilled migrants. Demand factors are those associated with the host region such as ageing home population, lack of skilled labour, or simply the shortage of labour per se. In a simple economic model of two regions with similar skill levels, if one region has plenty of labour and thus low wages and the other region has a labour shortage and therefore high wages, then migration will occur from the low-wage region to the high-wage one (Borjas 2000). This simple model can explain, at least partially, internal migration in Turkey in that the more industrialised western regions with a higher standard of living have attracted migrants from less developed eastern and south-eastern regions with a lower standard of living.

However, migration is often a complex issue with political, sociological and cultural dimensions, and Turkish migration is no exception. Interregional migration in Turkey started in the 1950s, accelerated after the 1980s and is continuing even today. At the beginning the nature of this migration was from rural areas to urban centres in parallel with the process of industrialisation, but today it is more of the urban-to-urban type. Recently, urban to rural migration has also gained importance (Bülbül and Köse 2010).

Turkey experienced different rates of internal migration over the years. The net rural-to-urban migration was around 214 000 people in the period of 1945-50 and it jumped to 904 000 in the period of 1950-55. It then stabilised until 1965 when it began increasing again. For example, the ratio of urban population to total population increased from 41.8% in 1975 to 53% in 1985 and again to 64.9% in 2000. Internal migration, particularly from the rural areas of eastern regions to the urban areas of western regions, gained considerable momentum after 1985 until the early years of the present century. Over the period 1995-2000 internal migration into big cities has reached 6 662 263 people which corresponds to more than 10 percent of the total population of Turkey (Kırdar and Saracoğlu 2006). 23 provinces were net receivers of migrants while 58 provinces were net providers of migrants. Most of the 23 provinces were in the Marmara, Aegean and Mediterranean regions while most of the 58 provinces were in the East and South-East Anatolian regions (Bülbül and Köse 2010). It can be said that, in addition to the socio-economic factors mentioned above, the problem of terrorism and the state policies regarding such terrorism also played an important role in such large scale displacement of population, since the regions with highest negative rate of migration are also the regions that are most affected by terror and its repercussions. Therefore part of the migration figures is forced migration.

Table 1.5 provides details of the net migration rate by region. It can be seen that the western regions such as Marmara, Istanbul and the Aegean have positive migration rates while the eastern Anatolian regions have negative migration rates. However, it would appear that internal migration has slowed down in recent years compared with the year 2000 since there has been a reduction in both the positive migration rates of the western regions and the negative rates of the eastern regions. This is partly due to the reduction in the incidence of terrorism.

Table 1.5: Net migration rate by region

		Rate of net migration		
	Region (NUTS Level 1)	**2000**	**2008**	**2009**
TR1	İstanbul	46.1	2,10	3,06
TR2	Western Marmara	26.1	9,73	4,03
TR3	Aegean	22.9	3,70	1,74
TR4	Eastern Marmara	15.9	12,57	6,37
TR5	Western Anatolia	15.9	2,98	4,60
TR6	Mediterranean	0.4	2,15	0,52
TR7	Central Anatolia	-24.9	-9,00	-4,99
TR8	Western Black Sea	-50.3	-4,35	-2,40
TR9	Eastern Black Sea	-26.1	-2,24	0,63
TRA	North-eastern Anatolia	-49.8	-26,12	-14,72
TRB	Central-eastern Anatolia	-33.4	-10,89	-9,09
TRC	South-eastern Anatolia	-36.2	-7,56	-7,12

Source: TurkStat (2010d)

Note: Rate of net migration is the number of net migrants per thousand population of the region

At the beginning, migration from rural areas to urban centres was not regarded as a problem; in fact it was positively encouraged. However, in later years, social and economic problems experienced by big cities such as Istanbul, Izmir and Ankara as a result of migration caused the rural-to-urban migration to be conceived as a problem to be dealt with. For example, in the three urban centres mentioned above the unemployment rate has increased due to migration since the demand for extra labour is far short of what is needed to absorb the number of migrant workers. Thus, migration, far from providing even a partial solution to the problem of chronic unemployment, aggravates it (Bahar and Bingöl 2010). In fact, the mushrooming of shanty towns at the outskirts of big cities, the inability of the infrastructure to cope with increased demand and the pressure on the municipal services such as transport, energy distribution and amenities are common complaints among the dwellers of these cities even today and are the main reasons for the increase in the rate of urban-to rural migration in Turkey.

Consequently, various plans and projects at national and regional levels have been prepared to deal with this problem (Güreşci 2010). One of these projects is 'Returning to the Village' which has only recently started. It is designed to encourage those who migrated (many forcefully) from the eastern provinces to the western ones to return to their homelands. In this context, it is proposed not only that measures must be taken to slow down the high rate of population increase, but also that regional resources must be mobilised to increase economic activity locally. The responsibility of achieving this has, however, been put on the shoulders of the private sector and thus lacks concrete and effective mechanisms to achieve the desired outcome. Moreover, this project is the only one designed to reduce migration from the east to the west. Most of the other projects proposed by the State Planning Organisation (SPO) aims either to improve the infrastructure such as roads, sewage facilities and water distribution networks, housing and the environment in the regions receiving migrants, or to make educational, health and cultural institutions more effective to facilitate the adjustment of the migrant population to their new environment (SPO 2001a).

In the light of above discussion, it would appear that there is a lack of appropriate policies designed to encourage potential migrants to remain in their regions by making these regions sufficiently attractive economically, socially and culturally. What Turkey needs is coherent and viable policies to reduce regional differences in terms of social and economic development if large scale migration is to be curtailed. Long term investment projects, particularly those which would create enduring employment opportunities and therefore 'take work to the workers', are part of such a strategy. Thus, the development of coherent and consistent policies regarding the social discount rate and implementation of appropriate regional welfare weights are important instruments of such a strategy.

The next section will briefly explore the existing policies regarding the *SDR* and *RWW* in Turkey. More detailed evaluation of these policies will be provided in Chapter 7.

1.4 Policies regarding the social discount rate and regional development in Turkey

The institution in charge of the formulation and implementation of public spending policies in general and public investment policies in particular in Turkey is the State Planning Organisation (SPO) known as the DPT (short for Devlet Planlama Teskilati in Turkish) which is accountable directly to the Office of the Prime Minister. The responsibilities of the SPO cover the evaluation of the projects submitted by public bodies and the allocation of public funds to these projects according to a set of priorities. These priorities are set out in successive five-year plans. Although the general principles and targets regarding public spending and public investment are set out in the five-year plans, specific policies and incentive structures are determined by government directives, guides and announcements published either by the SPO on behalf of the government or directly by the relevant Ministry. There are also special temporary or permanent commissions established and charged with the responsibility of gathering information, undertaking research and developing appropriate policies (SPO 2001b). These commissions are set up to guide the SPO in the implementation of five-year plans, facilitate maximum contribution from different sections of society to the success of the plans, and to evaluate the actual and potential economic resources of the country.

Until 1975, the benefit/cost (B/C) ratio was the main method used in the allocation of funds to public sector projects. The calculation of labour cost and the exchange rate was based on shadow prices and the discount rate was based on the shadow interest rate. After 1975 this method was abandoned in favour of a market rates approach due to lack of reliable data. In evaluating public projects, factors such as value-added creation, contribution to employment, and the impact on the balance of payments were taken into account. However, in actual calculations, market prices instead of shadow prices were used on the assumption that market prices reflect actual benefits and costs accurately (Gökgöz and Çinar 2010). This approach became even more entrenched after 1980 when interventionist economic policies were replaced by a more market oriented approach. As a result of Turkey starting negotiations for membership of the EU in 2005, the last two five-year plans and the associated directives and guides have been prepared with a view of compliance with the *acquis communautaire* of the EU.

Nevertheless, it would be fair to say that there has been a lack of coherent and consistent policy regarding the formulation and implementation of *SDR* with respect to the evaluation of long term projects in Turkey. The *SDR* would sometimes be based on the market rate of interest and at other times on the success of similar projects. Political considerations would, however, always play a role in the allocation of funds to investment projects. The inconsistencies and lack of coherence were also present in the application of the discount rate. In the ranking of new public sector projects for funding, the *SDR* differs according to the type of analysis implemented. Financial analysis requires that market rates of interest be used whilst economic and social analysis necessitates a different *SDR* on the assumption that social time preference is different from private time preference. However, the *SDR* applied in Turkey would also differ according to the way the project was financed. If, for example, the source of finance for the project combines public funds, domestic commercial credit and international capital in different proportions, the relevant discount rate would be a weighted average of the long term government bond rate, the market rate of interest for borrowing and the international rate of interest, the weights being the shares of the three source of finance (see Chapter 2, Section 2.3).

Most importantly, there has been, unlike the UK and other European countries, no mention of a specific *SDR*, as explained in Section 1.1. Thus, there appears to be an urgent need for the formulation of appropriate policies regarding the determination and implementation of the *SDR* in the evaluation of long term projects in Turkey.

As for regional development, it is clear from the discussion in Sections 1.3.3 and .1.3.4 that Turkey faces serious regional problems despite several attempts to introduce regional development policies. These policies have largely been unsuccessful either because they have not been implemented properly or because they were inappropriate policies (see, for example, Doğruel 2006, Elvan et al 2005, Filiztekin 2008, and Pınar and Arıkan 2003). A detailed discussion on regional development policies in Turkey is provided in Chapter 7. It suffices to state here that there are two main reasons for the failure of regional development policies in Turkey. One is that maximisation of national income and thus sectoral considerations have always had priority over regional considerations, and the other is that the Turkish political and administrative structure and hence policy-making and implementation process is highly centralised. Thus there is a distinct lack of essential infrastructure for regionalisation with no local institutions to acquire the ownership of or the power to supervise any policy initiative at the regional level (Elvan *et al* 2005 and Ertugal 2005a).

This centralist character of the Turkish political and administrative structure is the main difference and inconsistency between the Turkish and the EU approaches to regional development. However, as a candidate country Turkey has undertaken to implement certain reforms as part of its regional policy. These reforms have included the introduction of the Preliminary National Development Plan (PNDP) aimed to draw up the guidelines of economic and social cohesion policy for 2004-2006, and the establishment of Regional Development Agencies (RDA) for 26 new regions in 2005. However, as was stated above, these measures have proved to be inadequate partly because they have not been implemented properly, e.g. RDAs, and partly because there has been a lack of political will regarding the policy of decentralisation.

1.5 The objectives, the method and the structure of the study

The discussion above indicates that there is a pressing need in Turkey to develop clear guidelines and coherent and consistent policies both for the implementation of a social discount rate for government projects and for the formulation and application of viable regional development policies. Consequently, this study aims to provide both an analytical framework and technical indicators that should be helpful in the formulation and implementation of such policies.

1.5.1 The objectives

There are two main objectives of the study. One is to provide guidelines for the social discount rate by estimating the *STPR* for Turkey and the other is to calculate regional welfare weights which might be useful in the formulation and implementation of regional policies with respect to government projects.

In the process of achieving these objectives, the study will explore and critically evaluate the literature regarding both the social discount rate -in particular the *STPR*- and the social welfare weights. The literature review will cover not only the theoretical issues but also the empirical studies regarding these two measures. Moreover, since the concept of the elasticity of marginal utility of income (ε) plays a pivotal role both in the estimation of the *STPR* and that of social welfare weights, a whole chapter, i.e. Chapter 3, is devoted to the theoretical and empirical issues surrounding this concept.

1.5.2 The method

Regarding the estimation procedures, a combination of mathematical and econometric models is employed in the calculations. In the estimation of the all important variable, namely the elasticity of marginal utility of income (ε) for Turkey, this study will use two different approaches. The first one is based on a demand model in which the income and compensated-price elasticities for a want-independent composite commodity, namely food, are estimated in order to calculate the value of ε. Secondly, an income-tax model combined with a government social valuation function based on the principle of equal absolute sacrifice of utility will be employed using the Turkish progressive income tax system to provide an alternative estimate of for ε. After comparing and contrasting the results obtained from these models, an appropriate value for the elasticity of marginal utility of income (consumption) will be selected to be used in the calculation of the *STPR* and the *RWW* for Turkey.

The Fellner-Fisher-Frisch (FFF) approach

The demand model developed by Fellner (1967), Fisher (1927) and Frisch (1932) is known as the FFF approach. The theoretical construction and development of this model is provided in Chapter 3, Section 3.2.2. This approach is based on the demand for want-independent consumer goods, i.e. food. In this method an approximate estimate of ε is provided by the ratio of the estimated income elasticity of demand for food, η, to the compensated own-price elasticity (absolute), γ, (Fellner 1967).

Using the FFF approach two contrasting demand models are used to estimate the income and compensated price elasticities of demand for food. One is the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980b) involving the estimation of complete demand systems (see, for example, Blundell *at al* 1993, Blundell 1988, Evans 2004b, and Percoco 2008); and the other is called the Constant Elasticity Model (CEM) (see, for example, Evans 2005, 2004a, Evans and Sezer 2002, Kula 1984 and 1985 and Percoco 2008). Full details of these models are given in Chapter 5, Section 5.2.

The statistical time series data used in these models, which are presented in Appendix A, are taken from national income accounts published by the Turkish Statistical Institute and can be obtained on line (TurkStat 2010a). However, before such data can be used in these models, their time series properties must first be investigated. More precisely, whether the time series is stationary or non-stationary must be established first. This is done by subjecting the data to standard tests, including the Dicky-Fuller (DF) and Augmented Dicky-Fuller (ADF) tests, which are discussed in Chapter 5, Section 5.3. The results of these unit root tests indicate that the time series variables are a combination of order I(0) and I(1). However, the risk of spurious correlation is removed since the error correction model (ECM) indicates that a long-run equilibrium relationship exists between the variables. This means that co-integration analysis is appropriate for estimating the long run elasticities.

The income tax approach

An alternative approach to the estimation of the elasticity of marginal utility of income (ε) makes use of the concept of revealed social values of governments. A common method relates to government's aversion to income inequality as revealed by the progressivity of income tax (see, for example, Cowell & Gardiner 1999, Evans 2004b and 2008, Evans and Sezer 2005, Percoco 2008 and Stern 1977). It is based on the assumption of equal absolute sacrifice which means that the income tax taken from individuals involves the same sacrifice of utility for all tax payers regardless of income levels. This assumption and the derivation of the model are discussed in detail in Chapter 3, Section 3.2.3. The model uses the marginal and average tax rates to estimate the value of ε. In order to estimate the value of ε for Turkey according to this model, data on personal income taxation have been used (see OECD 2010a).

The comparison and evaluation of the two alternative approaches to estimating ε are provided in Chapter 3, Section 3.2 and 3.3. The results for Turkey obtained from the two models are discussed in Chapter 5. It suffices to state here that the ε value obtained from the tax model is regarded as more appropriate in the estimation of the regional welfare weights since the aversion to income inequality by the government (on behalf of society) is more relevant than consumer behaviour in this context.

1.5.3 The structure

The study is structured as seven chapters including the Introduction. Chapter 2 deals with the concepts of distributional welfare weights (in particular of regional welfare weights) and social discount rate. It will first explore the properties of an iso-elastic social welfare function and then discuss the theoretical basis for deriving welfare weights examining the relationship between per capita income (consumption) and diminishing marginal utility (MU). It will establish that regional welfare weights depend not only on per capita income (consumption), but also on the value of the elasticity of marginal utility of income (ε). It will then discuss the issues of the suitability of per capita income to represent welfare and the choice of the relevant concept of income when comparing the welfare of different groups. The second part of Chapter 2 will first discuss the theoretical basis for a social discount rate and then critically evaluate the different approaches to its measurement including the market rate, social opportunity cost of capital and the *STPR*. The discussion of this last measure will include its theoretical derivation and the exploration of its components, namely the utility discount rate and the growth rate of consumption. The chapter will end with a special reference to the importance of the concept of the elasticity of marginal utility of income and thus the necessity of covering it in a separate chapter.

Chapter 3 is, following from the reference at the end of Chapter 2, entirely devoted to the concept of the elasticity of marginal utility of income (ε). It begins with the examination of the relationship of the elasticity of marginal utility of income first to aversion to inequality and then to aversion to risk. It then moves on to the critical evaluation of the different methods of measuring ε. This involves a discussion of first survey methods, then the behavioural approach including life-time consumption behaviour and models based on demand-for-food analysis, and finally the revealed social values approach which includes the income-tax method. The chapter evaluates not only the theoretical aspects of these different models but also the empirical studies that use these different models to estimate the value of ε.

Chapter 4 is devoted to the exploration of the literature regarding empirical evidence on social discount rates and social welfare weights. It presents a critical evaluation of the studies that provide estimates of the different components of the *STPR* such as the utility discount rate and the growth of consumption and, of course, of the *STPR* itself for various countries. It also provides a discussion on the use of different income measures, such as equally-distributed equivalent income (*EDEI*) and equivalised income, as well as a critical evaluation of studies that produce empirical estimates of social welfare weights.

Chapters 5 and 6 are where the actual values of ε, the *STPR* and the *RWW* are estimated for Turkey. In Chapter 5 a value for ε is estimated by using two alternative approaches as explained in Section 1.5.2 above. Chapter 6 will provide estimates of the utility discount rate and the growth of per capita consumption by using data obtained from World Bank

(WB 2010), OECD (2010b) and Turkish Statistical Institute (TurkStat 2010a). The projected growth rate for consumption here is the required growth rate if convergence with the EU countries is to be achieved. Thus, it will depend on the rate of convergence as well as with which countries convergence is sought. Then, combining these estimates with the estimate of ε obtained in Chapter 5, an *STPR* for Turkey will be calculated which will be evaluated in the context of similar calculations for selected European countries. Chapter 6 will also provide estimates of the *RWW* based on both regional per capita income and equally-distributed equivalent income (*EDEI*). The rationale behind using the latter is that regional per capita income takes into account interregional welfare differences but ignores intraregional differences in welfare, and *EDEI* reflects both (see Chapter 4, Section 3). There will also be a sensitivity analysis of the *RWW* with respect to different values of ε.

Finally, in Chapter 7 a summary of findings on *STPR* and *RWW* will be presented. Then the *SDR* policies in Turkey will be explored and critically evaluated. Similarly, the framework for Turkish regional policy will be outlined, and it will then be subjected to critical evaluation in the context of the EU regional policies. This will be followed by a consideration of the practical application of both the *SDR* and *RWW* in Turkey. The practical application of the *RWW* will use the twin concepts of equity-adjusted net present value and equity-adjusted internal rate of return. Finally, Chapter 7 will end with a Conclusion section providing a brief evaluation of the aims and objectives of this study and how it goes about achieving them.

Chapter 2 Regional Welfare Weights and Discount Rate Measures: Theory

This chapter will focus on the concepts of distributional welfare weights (in particular regional welfare weights) and social discount rate which are crucial in public sector spending decisions. Once funds are allocated to a particular region, then most socially/economically desirable projects must be ranked, say, by using net present value (*NPV*), for which we need a discount rate. The chapter will firstly discuss the theoretical basis for deriving welfare weights exploring the relationship between per capita income/consumption and diminishing marginal utility (*MU*) and the properties of iso-elastic utility functions. It will then move on to a discussion on the theoretical issues surrounding the derivation of the social discount rate. The exploration of the different welfare measures and the empirical literature relating to both the regional welfare weights and the social discount rate will be examined in Chapter 4.

2.1 An overview of distributional issues

Distributional welfare weights, which are sometimes also referred to in the literature as social welfare weights (*SWW*), are devices used in the allocation of public funds among the different groups of a given population. Distributional issues across generations are normally handled through the social discount rate and the method of discounting. They have been part of welfare economics, and in particular, cost-benefit analysis (CBA) literature for some time. However, distributional welfare weights explicitly introduce distributional issues into CBA and therefore are somewhat controversial. Some economists (for example, Musgrave 1969) object to them arguing that CBA should only be concerned with efficiency issues not distributional ones (see Chapter 1, Section 1.2 for details). The counter-argument is that CBA is about making choices regarding maximisation of welfare. Thus, distributional (equity) issues are very much part of cost-benefit analysis and therefore should be considered alongside the efficiency issues in evaluating projects and social policies. Some argue that the twin objectives of equity and efficiency can be achieved by specific use of welfare weights (Kula 2002, Prest & Turvey 1965, Seton 1972 and Stern 1977). Moreover, even if one holds that the equity issues are better dealt with by way of taxation or subsidy, welfare weights will still be a useful tool in judging to what extent public spending meets given social objectives (Layard and Glaister 1994). Finally, there is the view held by some economists that the orthodox economic thinking has by and large focused exclusively on the issue of efficiency and ignored the issue of equity far too long. It is time that economic analysis gave greater prominence to equity issues (Blue and Tweeten 1997 and Potts 1999).

However, even if one accepts that distributional issues should be incorporataed into CBA, there is a large debate regarding how this should be done. Social welfare weights are one of the methods of dealing with the spatial (interpersonal) equity issues of project evaluation and shadow prices are another. Shadow pricing as part of the social opportunity cost of capital approach to the determination of the social discount rate is discussed in Section 2.3.4, but here we briefly mention shadow prices as an alternative method to social welfare weights in project evaluation. Shadow prices are commonly used in the valuation of benefits and costs as part of CBA of investment projects where market prices fail to reflect the true costs and benefits of a projects. Such a failure is due to a variety of reasons such as public goods and externalities, economies of scale, multiplier effects due to unemployment, and market imperfections, e.g. monopolioes, or simply the lack of a market, e.g. defence. However, the derivation of shadow prices are somewhat difficult and arbitrary and thus some economist and practitioners shy away from using them (Dasgupta and Pearce 1978).

The alternative to shadow prices is social welfare weights. In a regional context, the regional welfare weights are estimated and incorporated into the CBA in the evaluation of public projects, with higher weights being applied to projects in poorer regions. The practical application of the regional welfare weights are discussed in Chapter 7, Section 7.5.2. The theoretical aspects of distributional weights in general will be discussed in the next section.

2.2 Distributional issues and welfare weights

As popinted out in the previous chapter, social welfare weights seem to be an important consideration in the evaluation of social projects and policies where net benefits accrue to different groups of the society whose distinguishing characteristic seems to be the net income they receive. For example, the UK government makes explicit use of this concept in its expenditure policy in the latest Green Book (HM Treasury 2003). The recent EU Guide to CBA of investment projects also refer to the explicit use of the welfare weights based on income differences (see European Commission 2008, Annex E).

The use of social welfare weights (*SWW*) in evaluating the distribution of benefits and costs from a project or expenditure policy in general requires the determination of the distributional criteria. In the literature relating to the application of *SWW* a number of possible criteria have been identified such as, gender, religion, age, region, etc. (see for example Weisbrod 1972 and HM Treasury 2003). As long as the groups concerned can be differentiated on the basis of real income *per capita* received, *SWW* can be applied to any type of social grouping in a given population.

At the heart of the analysis of welfare weights lies the concept of the social welfare function. The *SWF* may be viewed as expressing the planners' social valuation of income (see, for example, Creedy and Guest 2008). A commonly used social welfare function is of the Bergson-Samuelson (B-S) type. The B-S social welfare function can be defined as

(2.1) $$SWF = \sum_i U_i(Y_i)$$

where

SWF = social welfare function

U_i = utility of ith individual

Y_i = income of ith individual

Thus

(2.2) $$\Delta SWF = \sum_i U_i(\Delta Y_i)$$

where the utility of the ith individual is expressed as a function of income. Issues relating to the definition of income are discussed below.

It is assumed that

(2.3) $$U_1(Y_1) = U_2(Y_2) = U_3(Y_3) = \ldots = U_n(Y_n)$$

That is, individuals are assumed to have the same utility functions. It is also assumed that interpersonal comparisons are possible, i.e. $Y_i = Y_j$ for all i and j. From a government's point of view, interpersonal comparisons are not a problem for social valuation. Normally, the demand theory is based on ordinal utility, i.e. ranking of individual preferences and therefore the measurement of the intensity of preferences is not relevant. However, the social welfare function refers to *society's preferences* and thus the aggregation of individual preferences would be necessary and somewhat problematic (see, for example, Dasgupta and Pearce). Fortunately, it is possible to view the *SWF* in equations (2.1) and (2.2) as a function perceived by the social planner (government) as opposed to a simple aggregation of individual utility functions (Creedy and Guest 2008), which enables us to make the assumption that interpersonal comparisons are possible.

Differentiation of (2.1) gives

$$(2.4) \quad \frac{d(SWF)}{dY_i} = \Sigma MU_i$$

where MU_i is the first derivative of $U_i(Y)_i$ which is equal to the marginal utility of income for the i^{th} individual which would be declining as income increases.

It is appropriate to discuss several issues related to the social welfare function before we progress further.

2.2.1 The properties of the social welfare function

Let us assume that the society to which the *SWF* applies consists of n individuals with n different utility levels. Then

a) *The SWF is non-decreasing*: This implies that in comparing the welfare levels in two different states, W^A and W^B, , if $U_1^A \geq U_1^B$ then $SWF^A \geq SWF^B$ which implies that the social welfare in state A is at least as good as it is in state B.

b) *The SWF is additive*: This implies that if individual utility is a function of income only, then we can write

$$SWF = \Sigma U_i(Y_i)$$

This additive separability is based on the assumption that individual utilities are independent of each other, i.e. intra-regional externalities, greed, altruism and envy are assumed away. [Cov $(U_1, U_2, \ldots U_n) = 0$]. (The issue of additive separability is discussed in detail in Cahpter 3, Section 3.5.2b).

c) *The SWF is symmetric:* This, also referred to as *impartiality* principle (Cowell and Gardiner 1999), means that the level of welfare is neutral between individuals, i.e. exchanging a given level of income between two individuals with identical income –and hence utility- levels does not alter the total utility of the society.

2.2.2 The shape of the SWF

Given the general characteristic and properties of the SWF, it is possible to simplify the underlying assumptions of the function.

a) *The SWF is strictly concave.* This is implied by the diminishing marginal utility. In conjunction with the additivity property it produces an important result since it means that redistributing a given amount of income from a high income individual to a low income individual would increase total welfare. In other words, from a viewpoint of distributional policies high incomes are associated with low weights and *vice versa.*

b) *The SWF is iso-elastic.* This is based on the argument that, given the property of concavity, a restriction of constant elasticity of utility implies that the rate of change in utility for a given percentage change in income (consumption) remains constant for all income levels. However, the iso-elasticity property may be seen as too restrictive where incomes diverge by a large margin, but this is an empirical matter (see below).

An iso-elastic utility function is given by

(2.5) $$U = \frac{1}{1-\varepsilon} Y^{(1-\varepsilon)}$$

which has the following properties.

U increases with Y,
MU declines with Y
ε is, of course, the elasticity of marginal utility with respect to income (consumption).

If $\varepsilon > 1$, *U* is negative but becomes smaller in absolute value as Y increases, if $\varepsilon < 1$, U is positive.

Thus, we re-write (2.5) as

$$(2.6) \quad U = \frac{Y^{(1-\varepsilon)} - 1}{1-\varepsilon}$$

so that U would be positive whatever the value of ε except where $\varepsilon = 1$

Differentiating (2.5) with respect to Y we obtain

$$(2.7) \quad MU = Y^{-\varepsilon}$$

Equation (2.7) implies that MU declines as Y increases.

However, if $\varepsilon = 1$, then equation (2.5) changes to

$$(2.8) \quad U = LnY$$

which would mean that

$$(2.9) \quad MU = Y^{-1}$$

The rationale for the restriction of iso-elasticity, i.e. the constancy of ε, and hence the justification for equation (2.5) are provided by the Atkinson Inequality Index in which ε is a parameter representing the societal weight attached to the inequality of income distribution, a high value of ε indicating a greater weight attached to inequality (Atkinson 1983).

It is now easier to see why ε is also called the inequality aversion parameter. It indicates the societal attitude to inequality. The Libertarians would assume that $\varepsilon = 0$, so the distributional issues would be ignored. The Rawlsian position, where the society is only concerned with the poorest group, would imply that $\varepsilon = \infty$.

The iso-elastic property of the *SWF* also reduces the necessity to rely on the cardinal concept of utility (Fellner 1967) since what matters in equation (2.5) is the level of average income and the rate at which marginal utility varies when income level is altered. Thus a constant ε implies that the rate at which marginal utility increases remains the same whether we shift a given percentage of income from the very rich to the not so rich or from the fairly well off to a poor person. Thus, all we need (and measure) then is a kind of cardinal index as opposed to the levels of utility.

However, the assumption of iso-elasticity is more than just a mathematical convenience since there is also empirical support for the constancy of ε (Blue and Tweeten 1997 and Evans 2005).

A more detailed discussion on the concept of ε involving the methods of estimation and the associated empirical evidence will be considered in Chapter 3.

2.2.3 Regional welfare weights

The economic rationale for attaching a greater weight to poor regions is based on the idea of diminishing marginal utility of income, which is one of the oldest theories in economics. Stigler (1972) argued that this concept has been seriously under-utilised despite its great potential in economic analysis.

Let us assume 2 regions, A and B. From (2.7) above we have

(2.10) $MU_A = Y_A^{-\varepsilon}$ and $MU_B = Y_B^{-\varepsilon}$

where
Y_A = per capita income or consumption in A, and
Y_B = per capita income (consumption) in B.

Then the welfare weights for the two regions are

(2.11) $W_A = \dfrac{MU_A}{MU_B} = \dfrac{Y_A^{-\varepsilon}}{Y_B^{-\varepsilon}} = \left(\dfrac{Y_B}{Y_A}\right)^{\varepsilon}$

where
Y = *GDP per capita* or per capita consumption

Equation (2.11) implies that the social welfare weight for a region depends not only on per capita income (consumption), but also on the value of ε.

It should be noted that there is the issue of intra-regional income distribution, which is assumed to be similar among the different regions. The validity of this assumption is a question of empirical verification, which would need to be investigated separately and we do so in Chapter 4, Section 4.3. It suffices to state here that intra-regional income differentials can be taken into account by using the concept of equally-distributed equivalent income (*EDEI*). This concept was introduced in Chapter 1, Section 1.5.3 and will be further developed theoretically in Chapter 4, Section 3 and empirically in Chapter 6, Section 6.3.2.

There are two further issues which need to be addressed here.

The first one concerns the suitability of income to represent the wellbeing of an individual. For example, some economists argue that per capita income is an inadequate measure of welfare and hence cannot be relied upon as reflecting welfare fully. There is a wide range of literature already developed discussing this issue which could be brought under the umbrella term of economics of happiness (See, for example, Boarini *et al* 2006, Deaton 2008, Easterlin 1974, Easterlin 2003 and Layard 2005). The economics of happiness approach does not necessarily replace per capita income as an indicator of welfare but rather complements it with other factors such as social cohesion, inequality, health, job satisfaction, environmental harmony, etc. Studies indicate that people do get happier as their income level rises but only up to a point, and that there does not seem to be a one-to-one relationship between average income and average happiness even in the poor countries (Graham 2006). However, the earlier Easterlin (1974) study exposed a conundrum referred to as Easterlin paradox that is still to be resolved. The paradox is that within countries wealthier people are, on average, happier than the poorer ones but that this relationship does not seem to hold across countries or over time. Another point is that according to some people it is not the level of income but its distribution that matters. They argue that more equal societies are happier (see, for example, Wilkinson and Pickett 2010). This is not surprising when considering the fact that many people would not feel very happy if they are surrounded by poverty even if themselves are well–off. This is also borne out by empirical studies regarding the value of the parameter of aversion to income inequality (see Section 3.3, Chapter 3).

Nevertheless much research finds that income is still the most important factor determining happiness/utility. For example, Deaton (2008) refers to the findings of the

Gallup/World Poll of people in 150 countries which display a strong relationship between GDP *per capita* and several different measures of well-being. Similarly, Blue and Tweeten (1997) employ 28 single indicator variables to construct a quality of life index (QLI) to be used as a proxy for utility and then regress this QLI variable on a group of independent variables including income, health, age and education. They find that income, age and health have the greatest impact on the QLI. Interestingly, they found that QLI increases as income increases but at a decreasing rate, which is consistent with the principle of diminishing marginal utility of income.

The second issue is the choice of relevant concept of income when comparing the welfare of different groups. Comparing incomes across different family or household types is made possible by use of an equivalence scale. There are several different equivalence scales employed in literature (DWP 2006) such as OECD Equivalence Scale also known as Oxford Scale (OECD 1982), OECD-modified scale (Hagenaars *et al* 1994), and Square Root Scale (OECD 2008). The process of adjusting the total household income for the size or some other attribute of the household is called 'equivalisation' and the adjusted income is called equivalised income. The latter reflects the fact that, for example, a household of four members would require higher income than a household of two, and hence enables us to make meaningful comparisons of welfare across households that vary in size and composition. The basic assumption here is that all members of the household derive equal benefits from the total equivalised income (Cowell & Gardiner 1999 and HM Treasury 2003).

2.3 The social discount rate: alternative approaches to its measurement

In this section we will discuss the theoretical issues relating to the SDR and different approaches to its measurement.

2.3.1 An overview

A social discount rate (*SDR*) is the rate which renders the society indifferent between its current and future wellbeing. It reflects a society's relative valuation of the current welfare versus the future welfare. Thus, the determination of an appropriate social discount rate is crucially important for cost–benefit analysis. It also has significant implications for resource allocation. If the *SDR* is too high, it could exclude the consideration of many socially desirable public projects, and if it is too low, it will allow for the possibility of financing economically inefficient investments (Zhuang *et al* 2007).

Moreover, a relatively high *SDR* favours projects and policies with short-run benefits and long-run costs, e.g. nuclear power, and discriminates against projects with short-run costs and long-run benefits, such as policies regarding climatic change. In short, it favours the current generation at the expense of future generations. However, the extent of this bias in favour of the current generation is a matter of ethical value judgment (OXERA 2002). Thus, the *SDR* has an ethical as well as an economic dimension.

The *SDR* is an important concept in CBA and is gaining increasing importance in the context of the evaluation of social projects. It has assumed particular importance recently in the distribution of Structural Funds and the Cohesion Fund among the countries of the EU. Also several European countries have set an explicit discount rate based on the *STPR* approach such as France, Italy, Spain and the UK, (see Chapter 1, Sections 1.1 and 1.2).

As for Turkey, there appears to be a relative lack of coherent policy regarding the application of *SDR* in the evaluation of long term projects. The *SDR* normally varies according to the nature of the analysis regarding the project. For example, if the project is subject to 'commercial and financial analysis' the *SDR* would reflect the market interest rates despite their inadequacies in this context. On the other hand if, economic and social analysis is applied in the evaluation of the project, the *SDR* would be higher reflecting the arguments discussed in 2.3.2 below. However, *SDR* applied in Turkey would sometimes be based on the market rate of interest on time-deposits and at other times on the success of similar projects. It would also be varying according to the different cost components in the financing of the project (Ayanoğlu, *et al* 1996). Let us assume that a public project is, for example, financed from three different sources, and that 40% comes from the consolidated budget, 20% from commercial credit and 40% the international capital market. Further assume that the rate of interest paid to the long term government bonds is 4%, the rate of interest for commercial borrowing is 10%, and the international rate of interest is 8%. The relevant SDR would be calculated as the sum of the weighted average of these three different cost elements. In this case, as the following calculation shows, the *SDR* is 6.8%.

$$SDR = (0.4 \times 0.04) + (0.2 \times 0.10) + (0.4 \times 0.08) = 6.8\%$$

2.3.2 The theory on the social discount rate

It is a long-established practice to discount costs and benefits over time at a given percentage per year. Discounting is a procedure used in CBA to estimate the present value of an outcome that is expected to occur in the future, such as the present value of a given level of consumption, output, or income that is to accrue in a given future period. Why the present values of these magnitudes should be different from their values expected to occur in future, i.e. the presence of a positive discount rate, is a somewhat philosophical but a highly controversial issue in economics which will be taken up in Section 2.3.5 where we examine the social time preference rate (*STPR*). We are mainly concerned here with the fact that investment projects involve future benefits and costs the present values of which involve discounting.

For the private sector the discount rate is conventionally based on the cost of capital for the project in question. Apart from the minor controversies regarding the calculation of the cost of capital it has been a relatively uncontroversial area. However, the same could not be stated for the public sector. Controversies surrounding the theoretical basis for discounting public sector projects have been around for some time and given to much heated debate (Kula 1997).

The problem of choosing an appropriate discount rate involves two separate questions. One is a conceptual question: what is the appropriate discount rate for public sector projects. The other is a practical one: how do we derive such a rate? The answers to the second question will be explored and evaluated Chapter 4, Section 4.2. Here we will concentrate on the issue of selecting a suitable *SDR*.

The role of the *SDR* relates to the nature of the issue of discounting. Discounting can be considered from two different angles, one from the viewpoint of the consumer (saver) and the other from that of the producer (investor). The first one is that consumers prefer a given amount of consumption now to the same consumption level in the future; and there are two reasons for it. One is that consumers appear to have a positive pure time preference (which is discussed in Section 2.3.5 under utility discount rate), either because they have 'impatience' (or 'myopia') or because the future is uncertain, i.e. the risk of not surviving. The other reason why consumers prefer current consumption to future consumption is that incomes (consumption levels) are expected to be higher and hence the marginal utility to be lower in the future. Thus one unit of consumption now will be equal to more than one unit of consumption in the future (Zhuang *et al* 2007). Put differently, the consumer needs to be paid more than one unit in the future for the act of sacrificing one unit of current consumption (saving). Consequently, the *SDR* looked at from the consumers' point of view will be equal to the marginal social time preference rate (*STPR*), which is also called the consumption rate of interest. In other words, the social time preference discount factor is the marginal rate of substitution between current and future consumption.

The second consideration is that of the producer or investor. It is argued that since capital funds are not unlimited, there is an opportunity cost involved in each public investment in terms of foregone private investment (Dasgupta and Pearce 1972). Therefore, a public investment project should bring a return which is at least equal to the return which would be brought by the foregone private project (Baumol 1968). This return is the marginal social rate of return on private investment and is referred to as the social opportunity cost of capital (SOC) rate which is also called the investment rate of interest.

If markets are perfect and Pareto optimality conditions prevail, these two rates will, of course, be the same. In fact, the prevailing rate would be equal to the market rate of interest which would be equal to the rate of return to savers [the private rate of substitution between consumption and savings] and the rate of return to investors [the rate of transformation for investment] (Young 2002). Thus, the *SDR* will act as an indicator of the social time preference rate, *STPR*, on the one hand and social opportunity cost (SOC) rate of discount on the other.

However, imperfections, externalities, other market failures and government intervention such as a corporation tax, drive a wedge between these two rates. For example, if the reason for the imperfection is the presence of monopoly (or the corporation tax), the rate of return to the investment would include the economic rent earned by the monopolist (or the corporation tax to be paid by the investor), and thus the discount rate reflecting this would be different from the one that reflects the optimal choice of consumers between the current and future consumption. Under these circumstances it becomes necessary to decide which rate is the appropriate discount rate to evaluate the investment decision; a choice must be made between the *STPR* and the SOC. Most economists today would agree that in a world of mixed economy, market imperfections and multiple interest rates, looking for a single *SDR* as a measure of both the *STPR* and the SOC would be futile. According to Dasgupta and Pearce (1978), there is almost a consensus that the STPR will generally be lower than the SOC rate]; and yet a substantial amount of the CBA analysis is devoted to the search of a single *SDR*.

In the light of the preceding discussion one could state that there are at least three main approaches to public sector discounting. One is the market rates approach based on the assumption that markets are efficient and thus market outcomes are optimum, therefore the appropriate discount rate to be applied to public sector projects is the market rate of interest. There are two versions of this approach: one is the efficient market hypothesis and the other is the government borrowing rates. These are discussed in Section 2.3.3 below. The other two approaches arise out of the discussion above and are based on the observation that market outcomes are not necessarily optimum outcomes; financial and other markets are riddled with externalities, failures and other forms of imperfection such as inadequate information, monopolies, and government interventions. Thus, the market rate of interest would be an inappropriate discount rate to be used for social projects and therefore an alternative discount rate must be calculated. One alternative to the market rate approach is the social opportunity cost of capital (SOC) approach of which there are two versions (see Section 2.3.4) and the other is the social time preference rate (*STPR*). We explore and contrast all three approaches below.

2.3.3 The market rate approach

The basis of this approach is that public sector capital projects involve, like any other project, foregoing current consumption (saving and subsequently investment) to finance them in order to have a higher level of future consumption. Thus, the interest rate determined in the capital market is the appropriate discount rate (Kula 1997). There are, however, two versions of this approach. One is the efficient market hypothesis (EMH) and the other government borrowing rate.

a) The efficient market hypothesis

Many argue that the appropriate discount rate for government investment projects is the market rate of interest. In particular, the Efficient Market Hypothesis (EMH) school argues that financial markets provide the correct discount rate even for government projects; an argument which is based on the analysis of a model in financial economics widely known as the capital asset pricing model (CAPM). According to this model the cost of capital for an asset comprises of two elements: a risk-free rate of return, e.g. the rate on government bonds, and a risk premium. The latter is equal to the difference between the expected market rate of return and the risk-free rate of return multiplied by a factor known as beta, β. (Note that β is simply the ratio of covariance between the asset and the expected market returns to the variance of the expected market returns, that is, it reflects asset-specific sensitivity to non-diversifiable, i.e. market, risk). According to the model, any portfolio (consisting of different assets) is subject to two types of risk: the systematic or market risk which applies to all assets and which cannot be diversified; and the specific or diversifiable risk which is associated with individual assets in the portfolio (Howells and Bain 2007).

The argument of the EMH school is that a government-financed project is the equivalent of a privately own asset, and the 'market risk' associated with this 'asset' is the variability of GDP fluctuations in an economy. Thus, the risk premium described above provides a measure for the social cost of the systematic risk of any government project (Spackman 2004 and 2007). The argument of the EMH approach has, however, been criticised on several grounds. First of all, the several of the assumptions on which the CAPM is based, such as that asset returns are normally distributed random variables; that financial markets make efficient use of all the available information and therefore reflect true cost of financing projects; and that all investors have access to the same information and agree about the risk and expected return of all assets (homogeneous expectations assumption) are strongly challenged. For example, large swings do occur in the financial markets so as to violate the assumption of normally distributed returns (Russell and Torbey 2000). Moreover, financial markets crash every now and then followed by instability and chaos before normality is restored. For example, the financial crisis of 2007/08 may have caused doubts regarding the hypothesis that all participants have appropriate information and they value asset prices correctly.

b) Government borrowing rate

Some of those who go for the market rate argue that the appropriate discount rate for government projects is the government bond rate (see, for example, HM Treasury 1973 and Lind 1990). One reason for this is the fact that public sector projects are, it is argued, virtually risk free and therefore what is needed is a risk-free interest rate. It is true that some of these projects would have returns less than anticipated and some might even fail altogether, but others might exceed expectations and thus on average these projects will be 'successful'. Besides, even the not-so-successful projects might be 'saved' by rescue packages.

However, this argument is subject to several criticisms. One issue here is: which government bond rate, the long-term bond rate or the short-term one? Moreover, government bonds are also subject to the capricious behaviour of the capital markets and hence are not entirely risk-free (Kula 1997). The counter-argument to this criticism is that, from the point of view of the government, it is risk free in the sense that it just pays the rate of interest, and that is the end of it. What happens to the bond is not relevant.

A rationale for using the government-bond rate is that it represents the cost of capital used in financing the public sector projects (Somers 1971). The objection to this argument is that not all public sector projects are financed by borrowing; some would be financed out of taxation.

Another criticism of using the government bond rate as the discount rate is that it is also subject to market imperfections. In fact, as a significant borrower, the government itself would distort the market rate of interest when it borrows substantial quantities as suggested by the loanable funds theory.

Despite the criticisms above the government bond rate has been used in the evaluation of government projects in the US in the past and Germany has, in recent times, used the average real long term bond rate as its official social discount rate (see Kula 1997, Preez 2004 and Spackman 2008)

c) Criticism of the market rate approach

A more general criticism of the argument that the private rate of return should be used to evaluate public sector projects is that private cost ignores externalities such as pollution and congestion and also that the private rate of return may be artificially high due to imperfections in the market such as monopolies and oligopolies (Kula 2006).

Moreover, even if it were possible to find the private rate of return arising out of perfect market interaction, it would only be measuring the private productivity of the investment schedule, whereas what is needed is a rate that would measure the social productivity of capital. Investment increases the productivity of all factors of production including labour and hence raises the return to it, i.e. wages. This is an increase in costs to the private investor who estimates her rate of return net of payments to other factors, but from the society's point of view an increase in factor incomes should be regarded as a gain. Therefore, the social rate of return on an investment project, that is to say, the reciprocal of the marginal capital-output ratio is likely to be much greater than the private marginal productivity of capital (Feldstein 1964b). In fact, in countries with chronic unemployment such as a typical developing economy, the opportunity cost of labour will be zero, particularly of the unskilled labour. Thus, the only cost associated with any increase in output as a result of public sector investment would be that of capital. This would make the capital-output ratio appropriate for public investment much lower.

Furthermore, even if markets were perfect, one might wish, for public sector investment, to replace the evaluation of future consumption based on market-determined criteria by a politically determined social time preference function. Additionally, it has been shown that individuals are likely to express a different time preference rate in the context of collective saving-consumption decisions from the rate that they would choose in the context of unilateral decisions (See, for example, Feldstein 1964a, Marglin 1963a and Sen 1961 and 1967). This phenomenon is known in the literature as the 'isolation paradox'. That is, individuals' saving rates might be higher than the saving rate that they would choose in isolation, if they knew that other members of the society would also save for future generations. This means that a government can, based on such an argument, justify the use of a *SDR* that is lower than the long-term market rate of interest on retail savings.

2.3.4 The social opportunity cost (SOC) approach:

As stated above, ther are are two versions of the SOC approach to the social discount rate for public sector projects. One is to take the weighted average of SOC and *STPR* and apply this as the *SDR*. The other is a more sophisticated version of using the *STPR* but applying shadow prices to public investment (Eckstein 1958 and 1961, Feldstein 1964b, Marglin 1963b and Spackman 2007 and 2008). We will first explore and evaluate these two versions of SOC approach to discounting before we consider the *STPR* approach.

a) SOC/STPR weighted discount rate

A simpler version of the SOC approach uses either a social opportunity cost discount rate or a weighted average of SOC rate and *STPR*. Several economists, including, among others, Baumol (1968), Diamond and Mirrlees (1971), Feldstein (1964b), Marglin (1963a), and Mishan (1967), have suggested the use of the marginal social opportunity cost of capital as the *SDR*. The underlying principle governing the SOC approach is that resources in any economy are scarce, therefore any public investment has an opportunity cost in terms of the returns which would be earned by the private investment it replaces. Thus the discount rate should reflect the economic (social) opportunity cost of capital.

Marglin (1963b), for example, argues that the appropriate basis for comparisons between public and private investment that compete for scarce resources is the present value of their net benefits to society discounted at the marginal social rate of discount since it reflects the community's marginal weight on consumption at different times. According to Dasgupta and Pearce (1978), even if there was no direct competition between public and private projects it is still possible to regard the government to compete with the private sector in the capital market for funds in which case the public investment must yield as least the same return as that of its alternative in the private sector. Similarly, Potts (2002) states that the SOC approach is based on the implicit assumption that the use of investment funds for any one project removes the possibility of using these funds for any other project. However, he argues that the economic opportunity cost of capital should be based on shadow prices and suggests that it can be obtained in four different ways. One way is to consider the successful projects in the recent past and obtain a range of economic internal rate of return values which would provide a reasonable indication of the possible range for future projects. Another is the estimation of the value added that can be attributed to capital by using macroeconomic data, which is discussed below. A third way is the use of the real cost of borrowing in the international capital markets as the opportunity cost of capital, provided that the country is able to borrow on commercial markets. Finally, it is possible to use the trial and error method by selecting an initial figure for the discount rate, e.g. 10%, and then adjusting this figure in the light of experience.

Assuming that public investment replaces private investment, then the SOC rate would be used as the *SDR* and the calculation of the SOC rate would be relatively easy since the appropriate discount rate would be equal to the marginal internal rate of return to the foregone investment (Dasgupta and Pearce 1978). It is also suggested that the SOC rate could be based on the marginal rate of return on riskless private investments before tax; and this could be approximated by the real pre-tax rate on top-rated corporate bonds (Zhuang 2007)

However, we cannot *a priori* assume that public sector projects replace only private sector projects. It is possible that public sector investment is wholly or partly funded by a reduction in private sector consumption rather than private sector investment (Eckstein 1961, Marglin 1963b and Feldstein 1964a). If it is the former, then the source of finance for public investment is taxation in which case the appropriate discount rate would be the *STPR*. However, if public investment is funded partly by a reduction in private consumption and partly by a reduction in private investment, then a weighted average of the *STPR* and the SOC rate would be used as the *SDR*. In that case the SOC rate will, according to some, be equal to the weighted average of pre-tax return to reflect the cost of displaced investment; post-tax return to reflect the opportunity cost of foregone consumption; and the marginal cost of foreign borrowing on the international capital markets to reflect the cost of external financing (see, for example, Burgess and Zerbe 2011, Harberger 1969, Sandmo and Dreze 1971, Sjaastad and Wisecarver 1977). The weights would be the proportions of these three elements, namely the displaced private investment, postponed private consumption and the relative importance of foreign finance in the total cost of the project. Similarly, Marglin (1963b) expresses the SOC of public investment as a function of the displaced private investment, reinvestment and yield rates; and Feldstein (1964b) argues that the SOC of any public investment must reflect both the direct and indirect effects and thus states that the SOC is equal to the discounted (at the social time preference rate) value of the consumption stream that is foregone.

The common element of these suggestions is the possibility of reinvestment. The idea here is that the private investment that is displaced would have generated an income stream which would have been partly consumed and partly invested. This new investment would also been partly consumed and partly invested, and so on. The end-result of this process would have been an aggregated consumption stream over time. Therefore, any measurement of the SOC of any public investment should include the present value of the consumption stream that would have been generated by the private investment it displaces. However, distinguishing between foregone investment and foregone consumption is regarded as slightly odd by some since the foregone consumption could have been invested which would have change the calculation of the SOC (see, for example, Mishan 1967 and Dasgupta and Pearce 1978).

Ignoring the reinvestment issue would lead to overdiscounting of project benefits which will get worse the further in the future the benefits occur. Thus, the weighted average approach could be biased against projects with long-term benefits (Zhuang 2007). Another criticism of the weighted average approach is that the SOC approach is based on rather restrictive assumptions. Dasgupta, Marglin, and Sen (1972) note that the argument for using SOC as the social discount rate is based on a two-period model where the total amount of capital available for investment is fixed independently of project choice in the public sector. In this case, the public investment crowds out private investment and the marginal rate of return on private investment (inclusive of taxes) provides an adequate measure of SOC. But when either assumption (two-period model or fixed amount of capital) is dropped, the argument would not hold anymore. If capital needed for financing public projects is partially satisfied by consumers postponing their current consumption, the return required by consumers usually is less than the marginal rate of return on private investment; hence, the social discount rate should be lower than SOC.

There are also empirical difficulties involved in the estimation of the weighted average of the SOC rate. Not only the rates of return from each source of finance must be estimated but also the relative importance of each source of funding must be determined. The opportunity cost of displaced investment could be approximated, as was suggested above, by the pre-tax rate of return to private capital and this could be obtained from National Accounts data as the ratio of the total income accruing to capital divided by the stock of capital. One advantage of this would be low level of volatility compared with financial rates of return (Burgess and Zerbe 2011). However, using macroeconomic data also has its problems since the estimates for the opportunity cost of capital would tend to be overestimates and hence would be highly unreliable (Potts 2002). For example, the return to capital would need to be estimated as the residual value added after the value added for labour and other inputs is estimated by use of shadow prices. In this method all technical progress is assigned as a return to capital and therefore tends to exaggerate the return to capital. Also any estimate obtained this way would be an average figure and thus higher than the opportunity cost of capital since the latter is a marginal concept. Finally, historic cost data on the value of the capital stock understate its value and thus the return to it would be overestimated.

b) Shadow pricing

A more sophisticated version of the SOC approach involves shadow pricing. The need for shadow–pricing public investment is that private investment is 'crowded out' by public investment but the opportunity cost of public investment cannot be measured by the market price. Shadow prices are prices that reflect the opportunity cost of resources and thus they measure the economic cost or benefit of inputs and outputs (Potts 2002). They are sometimes called economic prices and sometimes accounting prices. Feldstein argues that shadow pricing is necessitated by the fact that markets are not perfect and consequently it is not possible to apply a single rate of interest that would fully reflect the SOC of public funds. "The S.O.C. depends on the source of particular funds *and must also itself reflect the S.T.P. function.* It is best therefore to allow for the S.O.C. of funds directly by placing a 'shadow price' on the funds used in the project and to make all intertemporal comparisons with an S.T.P. rate or function" (Feldstein 1964a, p 362,). [For the development of this idea see Feldstein 1963b, Eckstein 1958 and 1961, and Marglin 1963a]. According to this version, the relevant discount rate for long term public projects is the *STPR* but an appropriate shadow price must be attached to public investment. Thus, the shadow price would be equal to the *STPR*-discounted present value of the benefits arising from a unit of private investment (Spackman 2007 and Felstein 1965).

Two of the most discussed methods of estimating the shadow price of benefits and costs that enter the calculation of the net present value are UNIDO (1972 and 1980) Guidelines and the OECD Manual (see Little and Mirrlees 1969 and 1974). Both methods involve industrial projects in a developing country whose main national objective is the maximisation of aggregate consumption benefits. Both methods recommend the use of shadow prices to calculate the net present value on the assumption that the saving rate is sub-optimal and that the optimal rate of savings cannot be achieved by fiscal measures and therefore must be addressed at the project level. However, the UNIDO Guidelines uses consumption as the unit of measurement discounted by the social rate of discount whereas the OECD Manual uses investment (expressed in free foreign exchange units) as the unit of measurement and thus applies the accounting rate of interest for discounting. Thus, the Guidelines revalues investment in terms of consumption using a shadow price for investment, whereas the Manual revalues consumption (by unskilled labour) in terms of investment using a shadow price for consumption. In other words, the UNIDO approach discounts aggregate net benefits in terms of consumption while the OECD approach discounts net benefits expressed in terms of investible resources.

The UNIDO approach divides the components of a project into three broad categories, namely direct present benefits (consumer goods, producer goods and foreign exchange), direct present costs (producer goods and foreign exchange) and indirect future benefits and costs, e.g. unskilled labour. All items are valued in terms of present aggregate consumption measured at shadow prices. Some of these shadow prices, e.g. unskilled labour, foreign exchange and investment, are given by the government. For a given project the algebraic sum of the present values of the direct and indirect benefits and costs for the years of its lifetime yields the present value of the net aggregate consumption benefits. If it is positive, the project is accepted, if it is negative, the project is rejected.

A particularly interesting point here is the valuation of indirect benefits and costs. Due to the assumption of sub-optimal aggreagate national savings, the shadow price of investment exceeds unity, i.e. the social rate of discount is judged to be less than the social rate of return to investment. This implies that, if there is an increase in saving (investment) by one unit at the expense of a decrease in consumption by one unit, the society gains. Therefore, the higher the proportion of the net benefits (of a project) that are reinvested, the higher the value of that project to the society.

The OECD approach also divides the components of a project into three broad categories, i.e. the traded goods and services, non-traded goods and services and unskilled labour. The shadow prices for the first category take into account the full impact of exports and imports in terms of foreign exchange. That is, they are valued at world prices. The shadow prices for the category of non-traded goods are estimated by calculating the marginal social cost of these goods by using the shadow prices of the inputs involved in the production of these goods and then treating these marginal social costs as the shadow prices of these goods. That is, they are valued in terms of their contribution to earning or saving foreign exchange. The shadow price of unskilled labour depends on labour's opportunity cost (the shadow price of the agricultural output forgone), the industrial wage rate, and the shadow price of investment. [Incidently, the shadow price of unskilled labour in the UNIDO approach is calculated in exactly the same way]. For a given project the algebraic sum of the social value of the inputs and outputs for the years of its lifetime is the total social profit (or loss) of that project. If a project yields social profit, it is recommended, and if it yields social loss, it is rejected.

It should, however, be noted that reinvestment is also an important aspect of the OECD approach. Since projects concerned are in the public sector, all social profit is assumed to be reinvested. In fact, any part of the social profits that is consumed is treated as a cost.

Although the two approaches use different procedures and apply different rates for discounting and therefore might come up with different recommendations with respect to projects, they do, in fact, converge in terms of the issue of reinvestment. The UNIDO approach penalises projects to the extent that a project uses resources which would otherwise have been invested and credits projects to the extent of the reinvestment of net benefits. Similarly, the OECD approach uses investment as unit of measurement and penalises a project to the extent that it commits the economy to consumption. Both approaches, however, penalise project that encourage employment and hence consumption due to the way the shadow price of unskilled labour is estimated.

c) The criticism of the SOC approach

Whichever version of the SOC approach is considered, there are some difficult issues surrounding this approach. Firstly, there is a degree of arbitrariness involved in the calculation of shadow prices since the quantification of externalities and merit and demerit goods is far from being precise. The same applies to the quantification of some inputs such as skilled labour and capital. Also, shadow pricing presents difficulty at the practical level. While discounting has long been routinely accepted in the public sector, an investment shadow price is regarded as an extra *unfamiliar complication*. (Spackman 2004). In the application of the SOC approach, the implicit assumption is that the SOC rate, which is taken to be above the *STPR*, could be compounded indefinitely into the future. However, indefinite compounding is not possible at a rate that is above the growth rate of the economy, and the economy's growth rate is normally less than the currently acceptable *STPR* for the UK and the EU. Moreover, the crowding out argument does not hold in a world of international capital mobility since public and private projects would not be competing with each other for limited funds. An additional criticism relates to the application of the concept of risk premium in the estimation of the social opportunity cost. Opportunity cost is the cost of the next best alternative and thus is applied to benefits. However, the risk premium in private investment returns is a cost not a benefit and foregoing of a cost does not incur a positive opportunity cost (Arrow and Lind 1970). Nevertheless, the risk premium is usually treated as an opportunity cost in the public sector discount rate literature. A possible rationale for this could be the assumption that public investment is subject to the same risk of variability as equity financing. Under such an assumption, it would be correct to take into account the risk factor but the cost would not be an opportunity cost (Spackman 2004, Appendix B).

Despite all these criticisms, the SOC approach has an intuitive appeal especially for the public sector bureaucrats. It was influential in the determination of the *SDR* in the UK until the late 1980s and is still influential in several countries and international institutions. For example the US Ofice of Management and Budget (OMB) applies a kind of SOC approach. The OMB issues discount rates for federal programmes in Circular A-94, Appedix C. These rates are based on cost effectiveness rate equal to Federal borrowing rate. Until recently this rate was 7% but has been reduced to 2.3% for programmes with duration longer than 30 years by a revision to Circular A-94 Appendix C in December 2010. In Australia, most State government Treasury departments publish a prescribed real discount rate based on the cost of capital rate to reflect true opportunity cost of capital and to ensure an efficient use of resources in project/proposal evaluation. The New South Wales Treasury currently directs that a 7% real discount rate be used in CBA while the Victorian Government advises the use of a 6% real rate (NSW Treasury 2007). The Office of Best Practice Regulation (OBPR) in its publication, the Best Practice Regulation Handbook, suggests the use of an annual real discount rate of 7% (Australia Government 2007). The New Zealand government formally applies 10% as a standard rate based on private sector comparators although it accepts *STPR* 'in principle'. Canada uses 10% rate based on the SOC approach. Some Asian countries such as India (12%), Pakistan (12%)

and Philippines (15%) also use SOC-based discount rates (Zhuang *et al* 2007). The World Bank's approach to discounting, however, is based on the weighted average method (Belli *et al* 1998), while the UN suggests that the rate be based on the SOC approach (Spackman 2007). The approach adopted by the Asian Development Bank (1997) also follows the World Bank approach of a weighted average of the SOC and *STPR*.

2.3.5 The social time preference rate (*STPR*)

The *STPR* is the rate at which the society is prepared to substitute future consumption for present consumption. For that reason it is also called the consumption rate of interest. In a two-period analysis this rate is equal to the marginal rate of substitution of consumption at any point on a given societal indifference curve.

1) The derivation of the *STPR*

The equation for the *STPR*, based on Ramsey (1928) is given by

(2.12) $$r = \rho + \varepsilon . g$$

where

r = *STPR*
ρ = the utility discount rate
ε = elasticity of marginal utility of consumption
g = average growth of per capita real consumption

It is possible to demonstrate that in a two-period model this rate is equal, as stated above, to the marginal rate of substitution of consumption at any point on a given societal indifference curve relating to the time periods t and $t+1$.

The assumptions of the model are as follows.

a) The society aims to maximise utility from consumption over the two periods, C_0 and C_1, subject to current income Y_0 and expected future income Y_1.

b) In each time period, consumption is subject to diminishing marginal utility and therefore the marginal rate of substitution between C_0 and C_1 changes as the combination of possible consumption levels in the two periods, consistent with a given level of utility, changes. So, the inter-temporal consumption indifference curves are convex to the origin, just like ordinary a-temporal indifference curves. If the utility discount rate were zero, i.e. $\rho = 0$, then

(2.13) $MRS = \frac{dC_1}{dC_0} = -\frac{MU_{C0}}{MU_{C1}}$ $\quad$ $\mathrm{MRS} = -1$ where $\mathrm{C}_0 = \mathrm{C}_1$

c) The society can save or borrow, subject only to income capacity, at the same proportional real rate of interest (r) in order to achieve its optimal consumption levels for the two time periods. Income is assumed to be the only resource available for consumption. The maximum possible consumption in period 0 is

(2.14) $Y_0 + \frac{Y_1}{1+r}$

and the maximum possible consumption in period 1 is

(2.15) $Y_1 + Y_0(1+r)$

Joining these two points on an indifference curve diagram gives the relevant budget constraint with the slope of the budget line equal to *-(1+r)*.

Mathematically, the budget constraint can be expressed in terms of the present value of expected lifetime income, Y_L. In our simple two-period model this constraint is

(2.16) $Y_L = Y_0 + \frac{Y_1}{1+r}$

So, the society will aim to maximise utility with a present value consumption combination C_L that matches Y_L. This can be expressed as

(2.17) $C_L = C_0 + \frac{C_1}{1+r}$

A suitably simple inter-temporal consumption-utility function can be written as follows:

$$(2.18) \quad U = \frac{C_0^{1-\varepsilon}}{1-\varepsilon} + \frac{C_1^{1-\varepsilon}}{(1-\varepsilon)(1+\rho)}$$

where

U = the total utility obtained from total consumption over the two periods
C_0 = current consumption
C_1 = future consumption
and ρ and ε as defined above.

Equation (2.18) directly follows from equations (2.5) and (2.6) whose properties were discussed in sections 2.2.1 and 2.2.2.

Optimisation of 'lifetime' consumption behaviour would require the maximisation of U in equation (2.18) subject to the present value budget constraint expressed in equation (2.19) below:

$$(2.19) \qquad Y_0 + \frac{Y_1}{1+r} = C_0 + \frac{C_1}{1+r}$$

Equations (2.18) and (2.19) can be combined into a single Lagrangian function U^* for the purpose of using a relatively simple mathematical approach to determine the optimal consumption conditions. The derived equations for optimal 'lifetime' consumption behaviour can then be used to calculate C_0 and C_1 for different income levels, Y, different rates of pure time preference, ρ, and different values of r. Thus

$$(2.20) \quad U^* = \frac{C_0^{1-\varepsilon}}{1-\varepsilon} + \frac{C_1^{1-\varepsilon}}{(1-\varepsilon)(1+\rho)} + \lambda\left[\left(Y_0 + \frac{Y_1}{1+r}\right) - \left(C_0 + \frac{C_1}{1+r}\right)\right]$$

Differentiating U^* with respect to C_0, C_1 and λ and setting each of the partial derivatives to zero we can determine the utility-maximising conditions:

$$(2.21) \quad \frac{dU^*}{dC_0} = C_0^{-\varepsilon} - \lambda = 0$$

$$(2.22) \quad \frac{dU^*}{dC_1} = \frac{C_1^{-\varepsilon}}{1+\rho} - \frac{\lambda}{1+r} = 0$$

(2.23) $$\frac{dU^*}{d\lambda}=\left(Y_0+\frac{Y_1}{1+r}\right)-\left(C_0+\frac{C_1}{1+r}\right)=0$$

From equations (2.21) and (2.22) we have the following optimisation conditions for inter-temporal consumption:

(2.24) $$\frac{MU_{C0}}{MU_{C1}}=\frac{P_{C0}}{P_{C1}},$$

That is, dividing equation (2.21) by equation (2.22)

(2.25) $$\frac{dU^*/dC_0}{dU^*/dC_1}=\frac{C_0^{-\varepsilon}}{\left(\frac{C_1^{-\varepsilon}}{1+\rho}\right)}=(1+r)$$

It is more convenient to express equation (2.25) as follows:

(2.26) $$\left(\frac{C_1}{C_0}\right)^{\varepsilon}=\frac{1+r}{1+\rho}$$

By definition, $C_1 = C_0\,(1+g)$ and therefore (C_1/C_0) in equation (2.26) can be replaced by the term (1+g). In our model, this gives the following relationship between r, ρ and g:

(2.27) $$(1+g)^{\varepsilon}=\frac{1+r}{1+\rho}$$

Therefore,

(2.28) $$(1+r)=(1+\rho)(1+g)^{\varepsilon}$$

Taking natural logs we have,

(2.29) $$Ln(1+r)=Ln(1+\rho)+\varepsilon.Ln(1+g)$$

By making use of the approximation rule Ln (1 + X) = X where X is a small number, we obtain

(2.30) $r = \rho + \varepsilon.g$

where r is the *STPR*, which gives the same equation as in (2.12)

2) Components of the social times preference rate (*STPR*)

As can be seen from equation (2.30), the *STPR* consists of three elements. The utility discount rate, ρ, reflects individuals' (society's) inter-temporal preferences when the real per capita consumption is constant, i.e. the growth rate of consumption, (g) is zero, over the discounting period. If, however, g is positive, then future consumption exceeds current consumption, which implies that the marginal utility of consumption is declining. This is reflected in the term ($\varepsilon.g$), where ε is the absolute value of the elasticity of marginal utility with respect to consumption.

In the following sections we will explore the issues related to the use of the *STPR* as the discount rate for public sector projects.

a) The utility discount rate (ρ)

The term ρ in equation (2.30) is supposed to reflect a preference of what is available now over what is promised in future. It measures the rate at which society discounts future (marginal) utility, thus it indicates the extent to which society prefers current to future utility (Spackman 2007). Time preference has, however, caused much controversy among economists (see for example, Arrow 1995, Evans 2004, Harrod 1948, Kula 1984 and 1985, OXERA 2002, Pearce and Ulph 1999, Potts 2002, and Ramsey 1928) mainly because there are no empirical studies to inform us what it might be due to its subjective nature (Spackman 2004). It has also been a source of confusion in the literature since it is not always absolutely clear whether ρ refers to the pure time preference rate or the catastrophe rate (see below).

Discounting the future has an ethical dimension since it involves the present generation making decisions affecting future generations. Thus, there is a wide ranging debate on this which is explored below. However, first we will clarify the relevant concepts in order to avoid possible confusion.

The term ρ in equation (2.30) is called the utility discount rate which itself consists of two elements. One is the pure time preference rate, δ and the other is the rate of decrease in *life chances*, *L*. Thus we have

(2.31) $\rho = \delta + L$

Then equation (2.30) becomes

(2.32) $r = (\delta + L) + \varepsilon.g$

Confusingly, the term 'the pure time discount rate' is sometimes used to represent only δ and at other times both δ and *L*! Thus, sometimes we are not sure which one of these two possibilities is being discussed.

Before exploring the arguments for and against discounting the future, we must first say something about *L* representing 'life chances'.

'Life chances', L

Several studies accept the argument for a zero pure time preference rate, δ, but still derive a positive rate for ρ on the basis of individual risk of death (see, for example, Azar 2008, Evans 2007, Evans and Sezer 2002, Kula 2004, Lopez 2008 and Percoco 2008). Mortality-based measures of *L*, using average death rates, have been estimated for various countries (see Chapter 4, Section 4.2.1). However, the rationale for mortality based estimates of *L* has been criticised by Spackman (2004) arguing that the assumption of 100% altruism on the part of people would render individual mortality irrelevant while the assumption of zero altruism is plainly unrealistic since people do care, to some extent, about future generations. There is also the issue of individual versus societal life chances (*catastrophe risk*). The term 'life chances' makes sense in the case of an individual: it reflects the risk of death whatever the method of measurement. It is not, however, all that easy to define life chances for a whole society. If one assumes that society is nothing but the sum of its individuals, then the average death rate (the number of deaths divided by the population figure) may represent life chances of an average person; or alternatively, this would reflect, over a longer period, the average annual survival probability. However, societies are not mortal in the sense that individuals are, and therefore life chances for a society would be different from the simple aggregation of the risk of death for its individuals.

A more relevant concept of life chances relates to the concept of *catastrophe risk*. It can be defined as the risk that future generations may not be able to enjoy the returns of the intended investment due to natural or man-made disasters such as a war, a nuclear disaster, a major and devastating earthquake, etc. However, a distinction must be made between a local disaster such as an earthquake which would result in the destruction of local capital and a global disaster such as a nuclear war which might eliminate the human race. In the former case the catastrophe risk would be much higher. Although some studies attempt to quantify the catastrophe risk and use it to represent life chances (see Chapter 4, Section 4.2.1) it must be stated that all the figures relating to catastrophe rate are rather arbitrary since it is not possible to determine the value of the catastrophe rate from actual observations. However, since catastrophe risk is an additional risk over and above normal loss of human life and relates to the probability of the destruction of capital which can be considered as non-insurable risk, it should be regarded as a wider measure than life chances based on mortality rates.

The pure time preference rate, δ

The other element of the utility discount rate (ρ) is the pure time preference rate, δ, (see equation 2.31). However, utility discount rate (the time preference rate), ρ, and the pure time preference rate, δ, are sometimes confusingly used interchangeably. This is due to the fact that some studies (see, for example, Azar 2008, Evans 2007, Evans and Sezer 2002, Kula 2004, Lopez 2008 and Percoco 2008) ignore life chances in which case the two terms in question become synonymous, that is, in equation (2.31) ρ becomes equal to δ. Thus, some of the arguments for or against discounting the future are made with reference to ρ meaning δ. It should also be stated that much of the controversy regarding the pure time preference rate (δ) revolves around the issue of intergenerational equity. In this context, if it is considered ethically indefensible to weight the welfare of different generations unequally, then ρ = 0. However, allowing for catastrophe risk, then discounting the future is still justified.

Arguments for zero time preference (utility discount) rate (ρ)

One of the oldest arguments for zero-time preference rate is that a positive time preference rate is not rational, nor is it ethical for a government to discount the future on the basis of present marginal utility of individuals. What is argued here is that the pure time preference rate (δ) is zero by stating that it might be perfectly rational for an individual to discount her future utility but it is not legitimate to discount across generations since it means discounting someone else's utility (Broome 1992, Harrod 1948, O'Neill 1993, Parfit 1984, Pigou 1932, Price 1989 and 1993, and Ramsey 1928). In other words, intra-generational discounting is allowed but intergenerational discounting is not.

This type of objection to positive discounting finds its expression in the 'no waiting' argument. Although an individual might prefer a bar of chocolate now to a bar of chocolate at some future date, an individual born in the future would have no such problem. In other words individuals have no time preference before they are born since they do not have to wait before they receive the benefit. A variation on this theme is the 'impartiality' argument which states that the utilitarian approach to discounting requires 'impartiality' which means that there should be no discrimination not only between different commodities but also between different time periods (Broome 1992).

Another argument against a positive time preference rate arises out of the consideration that the intergenerational discount rate is not an exogenous variable. That is, a discount rate that optimises the distribution of consumption between generations is a function of the intergenerational resource allocation. Therefore the interest rate which is supposed to optimise intergenerational consumption patterns under Pareto conditions is itself determined by the intergenerational allocation patterns (Norgaard and Howarth 1991). The argument certainly has some validity in the sense that it points out to the erroneous assumption that well-functioning markets will achieve both an efficient and optimal outcome. The efficiency might be achieved by perfectly competitive markets but there would be an optimal outcome (discount rate) for each given resource allocation. However, the social time preference rate of discount is not so much about optimal market outcomes as it is about providing the social planner with a criterion – and more desirably a set of alternative criteria- to be applied in the selection of long term social projects.

A further argument for zero discounting is that although it might be possible to discount commodities and hence utility, it is not possible to discount wellbeing, particularly if it remains constant over time (Broome 1992). The argument is that some natural resources, such as a fishery, can change their value over time by increasing in quantity (size), but others such as a rain forest or ocean view, do not change through time and therefore have a zero own interest rate. As a rule, if something generates constant wellbeing it should not be discounted. As a proponent of zero discounting Price (1993) states that the use of a uniform negative exponential function to discount future goods, resources, and experiences cannot be justified. He argues that increasing the quantity of one product or a resource does not necessarily mean an improvement in all aspects of wellbeing and therefore trade-offs between products cannot be made at constant marginal rate of substitution or transformation. He also states that the most frequent used argument for discounting is the concept of diminishing marginal utility of income. He concedes that this is a very important concept in economics but argues that diminishing marginal utility is only an argument for marginal effects, whereas most important effects are intra-marginal. In fact, Price (*ibid*) is firmly against discounting future arguing that discounting is based on mistaken premises and its underlying logic is misconceived. He concedes that discounting is a practical reality but urges us to be rational and altruistic so that we can pass all the good thing we have today to future generations. However, in a later publication (Price 2008) he argues that there should be a separate discount rate applied for environmental projects (see the section on dual discounting below).

Arguments for a positive time preference (utility discount) rate (ρ)

There are many economists who argue that there is nothing irrational or unethical about a positive time preference rate (see, for example, Arrow 1995, Bohm-Bawerk 1888, Eckstein 1961, Fisher 1930, Koopmans 1960, Kula 1985, Nordhaus 2007, Parfit 1971 and Stern 1977). For example, Bohm-Bawerk (1888, V.1.16) argues that *"As a rule present goods have a higher subjective value than future goods of like kind and number."* This implies that there is diminishing marginal utility to consumption in an intertemporal context. He further argues that we feel less concerned about future joy or sorrow than about the present joy or sorrow and that our concern diminishes with the remoteness of that future. This in turn implies a positive rate of pure time preference. Similarly, Arrow (1995) argues that a generation will maximise, in line with agent-relative ethics, the sum of its own utility and the sum of utilities of all future generations but weighting the former more heavily than the latter. However, each generation is its own agent and thus successive generations will do the same. This implies that the pure time preference rate in an intergenerational context will be positive. Parfit (1971) argues that even if we put ourselves in place of future generations we would still consider our future selves less importantly than our present selves, which implies a positive pure time preference rate.

Moreover, objecting to discounting the future amounts to ignoring the main function of a positive time preference rate. Let us assume that the future generation, A, has the same utility function for a given level of income as the current generation, B, but is richer due to technical progress which also reduces prices. Thus, B is poorer but faces a higher set of prices so that an addition of £1 to its income would create less extra utility (since it would buy fewer goods) than it would if it were added to A's income. In this situation the utilitarian approach would dictate that the extra income be given to A rather than B, so that the total utility would be maximised. This, however, would be clearly against any equity considerations since it would involve shifting resources from the poorer current generation to the richer future generation. The principle of inequality aversion would require some sort of correction which is arguably provided by time preference discounting (OXERA 2002).

A somewhat pragmatic but compelling argument against the zero-time preference rate is that it has an absurd implication regarding saving and investment behaviour (see Arrow 1995, Hayek 1936, Koopmans 1960, Ramsey 1928). The higher the discount rate, the less future consumption matters. Thus lowering of the discount rate implies that each future generation matters more than the one preceding it, which implies that more and more saving and investment should be undertaken by the current generation. The logical extension of this is that current generation should keep its consumption at the subsistence level and save and invest as much as possible (Lopez 2008 and Olsen and Bailey 1981). Moreover, this would apply to each successive generation, thus leading to the impoverishment of successive generations! However, it should be borne in mind that positive discounting also allows for an absurd possibility of future generations being worse off than the current one (see, for example, Olsen and Bailey 1981, OXERA 2002, Spackman 2004, Evans 2008).

Finally, one could argue that zero discount rate does not realistically reflect the preferences of the present generation which might have genuine concern for the future. Both Eckstein (1957) and Marglin (1963a) make this point arguing that a social welfare function determined by a democratically elected government would reflect people's tastes including their intertemporal preferences.

Discounting for the very long term

This study is primarily concerned with the evaluation long term public projects which would normally have a time horizon of 20-30 years. Thus, issues relating to discounting for the very long term are outside the domain of this study. However, it is felt that a brief discussion on the subject would complement and shed further light on the arguments presented in the previous section.

The mechanistic way of applying a social discount rate to government projects is to multiply future values (benefits and costs) by a discount factor that is derived from a given social time preference rate (see, for example, Treasury 2003). The relationship between the two is given by

$$(2.33)\quad DF_t = \frac{1}{(1+r)^t} = (1+r)^{-t}$$

Alternatively,

(2.34) $DF_t = e^{-rt}$, if the discounting is applied instantaneously

where

DF = the discount factor
r = *STPR*
t = time period

The application of a single discount factor –derived from a single discount rate (*STPR*)- does not pose much of a problem for medium and long term projects, but is problematic for very long-term projects. It can be shown that even a modest discount rate, say 4%, would render future costs (and benefits) almost zero over several hundred years. Since some government projects involve time horizons well beyond a given generation in excess of 50, 100 or even 500 years such as forestry investment, nuclear power and projects involving climatic change, some argue that the ordinary or the time-constant (exponential) discount rate is inappropriate in the evaluation of such long term projects. For example, Pearce *et al* (1990) criticise the conventional method of discounting as being a discriminatory practice against future generations. They state that discounting is a biased tool which should be constrained since the process of discounting works against intergenerational justice and that the burden of defending the interests of future generations should not fall on the discount rate.

Kula (1981 and 1997) also argues that the use of traditional exponential discount rate discriminates against future generations since it is based on the implicit assumption that individuals live forever. He instead allows individuals to discount within their own lifetimes but not discount utility accruing to future generations. Individuals are divided into cohorts according to their age, one year apart. As time passes, the older cohorts die off and are replaced by new cohorts, for whom the ongoing benefits and costs of the project are discounted to their respective birth dates. The aggregate discount factor for any year is the average of all cohorts then living. Eventually the older cohorts disappear completely and the conventional discount factor gives way altogether to one which is no longer influenced by the historical Year Zero of the project. The result is much higher discount factors in a period of life expectancy (80 years) than the conventional method. An important characteristic of Kula's modified discount method is that in the early years the discount factors are similar to those in the conventional method and the high discount factors only kick in after a certain number of years. This is criticised by Price (1993) by arguing that present generation gets away with small sacrifices expecting the next generation to make much bigger one; however, this applies to each generation and thus the sacrifice would never get to be made.

Others argue that a declining (hyperbolic) discount rate would be a more appropriate method for evaluating such projects rather than the conventional (exponential) discount rate (OXERA 2002). For example, the UK government in its Green Book recommends that, for projects whose benefits and costs accrue within 30 years, appraisers should use a discount rate of 3.5%. However, for projects involving time periods exceeding 30 years, it suggests declining discount rates (HM Treasury 2003, Annex 6). Following the procedure outlined in OXERA (2002) based on the Weitzman (1998 and 2001) approach, it uses the step schedule of discount rates which produces the discount factors given by equation (2.33). It considers five different discount rates to be applied for five separate time periods. More specifically, for a period of 31-75 years the discount rate would be 3%, for 76-125 years 2.5%, for 126-200 years 2%, for 2001-300 years 1.5%, and finally beyond 300 years it would be 1%. However, although the Treasury followed the recommendations of OXERA (2002), it has applied the Weitzman approach inappropriately in its calculation of relevant discount factors. Thus, the decline in the discount rate is too gradual compared to standard exponential discounting to make any real difference to the discount factors applied. In fact the discount factors beyond 200 years become negligible (HM Treasury 2003, Annex 6, p 100) which have the implication, for very long term investment such as nuclear energy, that the costs (e.g. the risk regarding nuclear waste) are discounted away.

Arguments providing a rationale for the time declining (hyperbolic) discount rates can be divided into three groups. *The first group* is based on empirical observations of how individuals actually discount the future (OXERA 2002). There is a growing body of evidence that individuals discount values in the near future at a higher rate than values in the distant future (Heal 1997). For example, Percoco and Nijkamp (2006) argue that the intertemporal preferences of individuals present some anomalies and one of these anomalies is that individuals display behaviour indicative of time-decreasing discount rates. Recent experiments over the last couple of decades also suggest that humans employ a declining discount rate in making intertemporal choices. For example, some of these studies (Newell and Pizer 2000 and Weitzman 2001) employing the survey method, ask the subjects to make a choice between delayed rewards such as durable goods or reduced pollution levels. The resulting discount function indicates that people discount the current consumption trade-offs more heavily than the future ones displaying a hyperbolic discounting pattern (Hepburn & Koundouri 2007 and Weitzman 2001). Thus, the society would also have, on the assumption that individual preferences are additive-separable, a hyperbolic discounting pattern. Moreover, Gollier and Zeckhauser (2005) show that even if all individuals have exponential time preferences, providing that they have decreasing absolute risk aversion, then the representative individual would have a hyperbolic time preference. Therefore, a government, acting on behalf of the representative individual, uses declining discount rates. Furthermore, Hubern and Runkelnn (2008) argue that the median voter has a hyperbolic time preference. Consequently, governments would tend to use hyperbolic discounting.

An additional point is that a time-constant discount rate arising from a constant positive utility (pure time preference) discount rate implies certain axiomatic conditions regarding the intertemporal welfare function. Koopman (1960) shows that the relevant welfare function must be continuous and stationary over time and must comply with the condition of period independence. The latter implies that intertemporal preferences for benefits and costs are independent of each other. However, it is unlikely that future preferences would be independent of past decisions (Groom *et al* 2005).

The second group involves the role of uncertainty in the discount rate. As we go further into the future, uncertainty about everything increases. As Weitzman (1998) argued, relative to the near future, the far distant future involves much higher uncertainties regarding technical progress, the speed of capital accumulation and environmental factors, and therefore the pure time preference rate as well as the growth rate. Consequently, there is a wide range of possible discount rates from which a probability distribution for the associated discount factors can be constructed. The result would be a hyperbolic path for the discount factor and thus a certainty-equivalent discount rate which will be declining over time (Hepburn & Koundouri 2007). This occurs because the marginal discount rate relating to the hyperbolic path for the discount factor, continuously declines through time towards its lowest possible value . For example, Weitzman (2007) and Spackman (2004) provide numerical examples to demonstrate how a certainty-equivalent discount rate would follow a hyperbolic path. There are also theoretical and empirical studies that aim to quantify the nature of this decline (Newell & Pizer 2000, Gollier 2002, and Weitzman 2001).

The third group of arguments is not based on empirical observations but on an ethical stand relating to the social choice approach (OXERA 2002). The recent concern over environmental problems in general and climate change in particular has resulted in renewed interest in long-term discounting. This group is led by the environmental and sustainable development economists, who argue that a time-constant (exponential) discount rate cannot solve the issue of intergenerational equity since it puts undue burden on the future generations. They also point out that the values of present value weights over very long periods are highly sensitive to the choice of the discount rate (Zhuang *et al* 2007). For example, Chichilnisky (1997) reiterates the argument that the time-constant discount rate establishes the 'tyranny' of the present generation over the future ones. This is because for a fixed discount rate the discount factor will approach zero in the very long term which means the interest of future generations are essentially disregarded. Similarly, Heal (1997) criticises the time-constant discount rate for being biased against environmental preservation and thus introduces a method of evaluating social projects which places more weight on long-run benefits. Li and Löfgren (2000) also criticise the conventional approach to discounting and suggest a model which introduces intergenerational equity explicitly. However, these models have themselves been criticised by, among others, Dasgupta (2001) for their lack of a proper criterion for choosing the relevant weights for the near and the distant future and thus their lack of relevance for the policy maker.

More recently, the Stern Review, commissioned by the UK government (Stern 2007), argued that the investment decision taken in the next decade or so will have a profound effect on the climate in this and the next century. More specifically, if no action is taken, the present levels of the emission of greenhouse gases would produce catastrophic results for future generations and therefore immediate action is required. Among its proposals is an *STPR* of 1.4% for discounting the damages of global warming based on the following values of the variables in equation (2.30): $\rho = 0.1\%$ (catastrophe rate), $\varepsilon = 1$, and $g = 1.3$. Thus, the Stern Review suggests a very low discount rate in order to tip the balance of intergenerational equity in favour of future generations. The Review created a great deal of heated debate and has been subject to much criticism. For example, Nordhaus (2007) claims that the Review is more in the nature of a political document rather than an economic one since it emphasises the studies supporting its policy recommendations and ignores those that oppose them and since it was not reviewed externally, which is a standard practice for scientific economic studies. He also criticises the Review for employing a very low discount rate (as a result of a near-zero utility discount rate based on ethical assumptions), which results in magnifying impacts in the distant future and justifying immediate deep cuts in carbon emissions. He also regards a unitary ε value as too small and the growth rate on the conservative side.

Dasgupta (2007) also criticises the Review for basing its recommendations on value judgement rather than economic facts. He argues that the strong immediate action the Review demands regarding a reduction in carbon emissions is based on the authors' view of intergenerational equity rather than climatic facts. Moreover, he points to a paradoxical stance on the part of the Review arguing that a near-zero utility discount rate the Review adopts indicates a highly egalitarian attitude regarding intergenerational equity but a unitary value for ε indicates a very inegalitarian attitude towards intragenerational equity.

Weitzman (2007) praises the Review for taking on board such a political and highly controversial issue as carbon emissions and making uncompromising recommendations and for popularising the idea that CBA can be a legitimate tool for evaluating the policies of mitigating global warming. However, he also makes the point that a near-zero value for the utility discount rate and a unitary value for the inequality aversion parameter are on the rather low side and do not compare with the empirical estimates of these parameters in the literature. He also criticises the Review for creating the impression that its highly radical conclusions and recommendations are the result of robust economic analysis rather than being based on controversial assumptions and unconventional discount rates.

The low discount rates suggested by the Review are also criticised by Gollier *et al* (2008) by arguing that the high estimates of climate change damages in the Review are driven by an arbitrarily chosen low constant discount rate. They employ a univariate model, which allows uncertainty in the behaviour of long term interest rates, to estimate a schedule of declining discount rates for nine representative countries. Then these schedules are aggregated into one schedule of declining discount rates to be used in the evaluation global climate change mitigation policy. They argue that the consideration of uncertainty makes the case for declining discount rates compelling and that their method of weighted declining discounting suggest much lower estimates of climate change damages than those derived in the Review.

However, one of the major problems regarding the time-varying (hyperbolic) discount rate is that it results in time-inconsistency which means decisions regarding future events made at a point in time are contradicted by a later action that revises that decision. Let us assume that the current generation, C, makes a decision involving future generations, F_1 and F_2, and then this decision is reversed by F_1. This would mean that C would be prevented from optimising its behaviour. However, Heal (1997) argues that time consistency in individual behaviour is not essential since social decisions need not be time-consistent. Therefore, the requirement of time-consistency, from the planners' point of view, is rather stringent. Others object to this by arguing that if the rules of time-consistency are not observed in government decisions, then private-sector agents will lose confidence in government policies (Zhuang et al 2007).

Hepburn (2003) also draws attention to the time-inconsistency aspect of hyperbolic discounting. He does not reject hyperbolic discounting as such but warns, by examining the resource collapses of the Peruvian anchovy and Atlantic cod, that if hyperbolic discounting is employed naively, problems of dynamic inconsistency might result in a renewable resource being completely exhausted. He also argues that further research into the issue of time-inconsistency is necessary and suggests that may be logarithmic discounting -a form of declining discount rate which is time-consistent- might provide a basis for long-term policymaking. In logarithmic discounting, time is measured in equal proportional increments as opposed to in equal absolute increments, which places much more weight on the distant future at a given discount rate (see Heal 1997 for detailed explanation).

The problem presented by the time-consistency principle for long-term discounting led to some suggesting that intergenerational equity should not be addressed by a lowering of the discount rate but by producing separate analysis for different scenarios as well as a sensitivity analysis with respect to different discount rates so as to provide choices and room to manoeuvre for the policy maker. The main idea is that if it is possible to separate certain consumption goods, such as environmental services, from private consumption, then there might be a case for adopting what is known as the dual discounting procedure.

For example, Cropper and Laibson (1998) argue that a lower discount rate for environmental projects is justified if three conditions apply. The first is the condition of separability in production. This implies that the production process of an environmental good, e.g. a forest, is a separate process from that of an ordinary private output. The second is the separability in consumption which implies that the environmental good and the private good are based on different utility functions. The final condition is that the government can control the rate of consumption of the environmental good. Price (2008) argues that hyperbolic discounting may lead to indefinite postponement of worthwhile investment and therefore different discount rates should be applied to different categories of projects. It might be possible to differentiate projects according to several criteria, such as, for different kinds of individuals, e.g., the 'aesthetes' and 'materialists', for different ethical views of time preference, for different products, etc., in which case different discount rates should be applied. For example, he shows that the application of the UK Treasury's discount schedule (HM treasury 2003) to landscape projects might result in the rejection of a worthwhile project due to the rate of decline in the discount rate not being sufficiently fast. Thus he argues that such projects should be evaluated separately, or indeed possibly not discounted at all. Kula and Evans (2011) also suggest projects with substantial environmental impact should be evaluated by using a different discount rate. They argue that the conventional parameters in the *STPR* based on the growth rate of income are not applicable to the environmental benefits of investment projects since they are actually undermined by economic growth. Thus the environmental benefits of a project should be treated separately. In fact, they distinguish between two approaches to dual discounting. One is to apply a separate and different discount rate to environmental projects and the other is to do the same to environmental impacts instead. They opt for the latter partly because it is easier, they argue, to identify environmental impacts than environmental projects and partly because discounting the impacts is more transparent and informs the decision maker better with respect to issues of sustainability and environment. Similarly, Henderson and Bateman (1995) state that a lower discount rate would, for at least some environmental projects, be a better approximation to the true social discount rate than exponential discounting. In fact, they argue that if project-specific discount rates are allowed, so must be multiple-discount rates. However, they do admit that there might be a problem with the practicality of multiple discount rates and suggest instead that the use of hyperbolic discounting might be advantageous in the case of intergenerational projects.

b) The growth rate of consumption

The rationale for including the growth rate of consumption in the discount rate is that ρ in equation (2.30) represents egalitarianism, i.e. one unit of consumption is traded off with one unit of future consumption. If, however, real incomes grow over time, future generations will be richer than the current generation and therefore one –for-one trade-off would not be appropriate. Moreover, since future consumption will be higher than current consumption, it will have lower marginal utility (Potts 2002). Thus the discount rate will depend upon the future growth rate and the elasticity of marginal utility of consumption (Lopez 2008). This effect is represented by the composite term of ($\varepsilon.g$) in equation (2.30), that is, the product of ε and the annual growth in per capita consumption, g.

The theoretical and empirical issues relating to ε are discussed in Chapter 3. In fact, all of Chapter 3 is devoted to these issues. The significance of the concept the elasticity of marginal utility of consumption is explained in Section 2.4. But first we will focus upon the issues surrounding the growth rate of consumption. The associated empirical evidence on g is presented and discussed in, Section 4.2.2 of Chapter 4.

It suffices to state here that the standard and conventional method of representing g is to generate the expected growth rates of consumption *per capita* over the next few decades based on the growth rates of consumption (Evans 2004, Evans and Sezer 2004 and 2005, Kula 2004, Lopez 2008 and Pearce and Ulph 1999) or the GDP (European Commission 2008, Evans 2007 and Percoco 2008) of the past few decades, and then take an annual average of these projected figures to represent g.

However, such representation is not free of problems. One of the problems is that the projected figure will be an overvaluation if there are social costs of consumption such as pollution, etc. during the projected period. Similarly the figure will be an under estimation if leisure is substituted for income (OXERA 2002). Pearce and Ulph (1999) argue that these problems may be overcome by using data covering a very long period but Spackman (2004) is sceptical of this stating that even if the scale and the timing of such deviations are known, they are not relevant to the time preference rate for marginal income.

Another problem is related to the issue of endogenisation of the growth rate. The *STPR* in equation (2.12) depends on the growth rate of per capita consumption (g), but g in turn will depend upon the distribution of investment over time, which will in turn be determined by the particular discount rate implemented (Dasgupta and Pearce 1978). Thus, it would appear that the growth rate of consumption can no longer be treated as an exogenous variable. However, this is not a serious problem as long as the projects in question are marginal in the sense that their contribution to the growth of the GDP of the country is relatively small and thus the impact on the growth of consumption is insignificant. However, for mega projects or large programmes containing a series of projects, this would be an important consideration.

There is a long standing debate, which goes back to J. S. Mill, over whether simple consumption (or GDP) levels adequately represent welfare. More recently, Nordhaus and Tobin (1972) constructed an index, called the measure of economic welfare, MEW, in order to measure human wellbeing more accurately than indicated by the GNP figures. The MEW uses the GNP figures but excludes from it certain items such as defence and security spending, sewage disposal, commuting, etc., while leisure time and housework are added on. This measure gives a lower growth rate for human welfare in the US between 1939 and 1965 than the ordinary GNP growth. Similarly, Daly and Cobb (1989) have constructed an index of economic welfare (IEW) which is still based on income figures but which makes allowances for the adverse effects of environmental damage and pollution. According to this measure economic welfare increased in the US in 1950-59, remained constant in the 1970s and has fallen in the 1980s and early 1990s. This finding can be contrasted with the GNP figures which grew steadily throughout the period (Kula 1994).

Thus, higher growth rates of consumption would indicate that future generations would be better off except that growth brings its own problems. This has particular importance for the social discount rate for very long term social projects since uncertainty increases as we go further into the future. Thus, we would face the types of problems similar to those discussed in the previous section regarding the impact of uncertainty upon g and hence on the *STPR* (Gollier 2002).

In the light of the debates that have been explored above, there appears to be a general agreement that a positive *STPR* should be used in discounting both intragenerational and intergenerational projects. This would be the case even if the utility discount rate (ρ) is assumed to be insignificant provided that incomes grow over time thus making ($\varepsilon.g$) and therefore *STPR* positive. However, there are also compelling reasons, as discussed in Section 2.3.5, for assuming that ρ is also positive. One is that a zero rate would imply strong altruism leading to subsistence level of consumption and unreasonably high saving and investment ratios on the part of the current generation, which is clearly highly unrealistic. Another is that, however small, catastrophe risk must exist which would give rise to a positive time preference rate. Finally, democratically elected governments must make decisions on the basis of the preferences of the current generation although they might moderate these decisions in the name of intergenerational equity.

However, the use of the *STPR* as the social discount rate is not free of criticism. The discussion regarding the *SDR* so far revolved around the intertemporal equity issues leaving the distributional impact of projects among different individuals or groups (interpersonal equity) aside. The distributional impact of a project or a series of projects can be dealt with in two different ways. One is to derive systematic and specific income distribution weights at the macro level and apply them to adjust the net present value (NPV) of projects (see Chapter 7, Section 7.5.2). This method is known as the social welfare weights (*SWW*) which has been discussed, at least at the theoretical level, in Section 2.2 and will be further discussed in chapters 4, 6 and 7. However, the application of the *SWW* requires the differentiation of the individuals or group of individuals, who are affected by the project, on the basis of per capita income. The other method involves the direct applicationof the CBA by use of shadow prices (Londero 1987, UNIDO 1972 and 1980 and Potts 1999). In this method the distributional impact of a project is assessed by identifying the major stakeholders and then estimating the direct income effects and the indirect effects of externalities that impact upon these stakeholders This procedure involves dividing the economic NPV of a project among the different recipients of benefits and then estimating the NPV associated with each recipient by placing a shadow price on the income flow going to each recipient (Potts 1999 and 2002). It should be noted this method still requires a discount rate, preferably an *STPR*, to calculate the NPV but shadow prices are used in the valuation of individual costs and benefits. The use of this method of project appraisal is not confined only to adjusting the project's impact on income distribution; it can also be used for adjusting the project's impact on saving and investment (see Section 2.3.4b), for obtaining the net benefit at economic (efficient) prices, or for the analysis of merit goods (Londero 1987 and UNIDO 1972). However, the application of this method requires comprehensive and disaggregated data at the micro level. For example, to estimate the distributional impact of a project would require the disaggregation of costs and benefits into primary factors on an annual basis, such as domestic resources, foreign exchange, skilled and unskilled labour, and so on. Then transfer payments would have to be categorised according to recepients, and finally a shadow price would be attached to each component (Potts 2002). In this method a different shadow price would be applied according to for which purpose the method is used, which would inevitably involve a degree of arbitrariness. This method also requires comprehensive disaggregated data which may not be readily available.

Another issue regarding the *STPR* relates to the capital rationing problem. It is generally accepted that the *STPR* would be lower than the market rate or the SOC rate (Dasgupta and Pearce 1978). Therefore, its application in the ranking of public projects would imply that more projects would be regarded as acceptable compared to other methods of discounting. This does not constitute a problem provided that there are no funding constraints. However, most governments work with a budget for public expenditure and therefore funds for financing public projects are not unlimited. This means that some projects will not be financed even if they are associated with a positive NPV. Under such budgetary constraint, the appropriate method of ranking projects would be the method of internal rate of return (IRR) rather than a positive NPV. Thus the projects would be ranked according to their IRR and the cut off point would be where the funds are exhausted.

2.4 Concluding comments

As a general comment one can state that it is rather difficult and would be highly presumptuous to pretend that one can provide a definitive resolution to technical problems and ethical issues that divide professional economists and philosophers alike. On the other hand, solutions to real-world problems cannot afford the luxury of waiting for academic consensus. What is important is that the policy-maker is aware of the issues and the trade-offs and has the necessary information to make informed decisions. In this respect, CBA can be viewed as a technique that provides such information and clarifies such trade-offs (Faber & Hemmersbaugh 1993).

Thus, due to the theoretical superiority of the *STPR* over the long-term government bond rate as a choice of social discount rate, we observe that various national governments and international bodies have issued explicit guides instructing the appraisers to use, to varying degrees, a positive *STPR* in their evaluation of social investment decisions such as the two Green Books by the UK government and the two CBA Guides of the EC (see HM Treasury 1997, HM Treasury 2003 and European Commission 2002 and 2008, Spackman 2004 and Evans 2007).

What is missing, however, from the discussion relating to the choice of the social discount rate above is the evaluation of the empirical studies that aim to estimate a particular value for the *STPR*. The empirical evidence and the various methods employed will be explored in Chapter 4.

Also missing from this chapter is a discussion of the third element of the Ramsey formula in equation (2.30), namely, the elasticity of marginal utility of income, ε. This concept plays a very significant role in the estimation of the social discount rate. Most people would expect positive growth rates and hence higher levels of income *per capita* in the future. This implies diminishing marginal utility of consumption (income) derived from net benefits over time. However, the extent of this decline depends on the elasticity of marginal utility of consumption, ε. Thus, high values of ε imply, given positive growth, a high value for the *SDR*. The issues relating to the empirical evidence on the *SDR* will be discussed in detail in chapter four. The importance of ε in the estimation of the *SDR* has been considerably enhanced by the UK Treasury's decision to focus entirely on the *STPR* (HM Treasury (2003) and the decision of the EU to adopt *STPR* as the basis of *SDR* for Europe (European Commission 2008).

ε also has a central role in the estimation of distributional welfare weights for application in the appraisal of social projects and policies impacting on different regions or socioeconomic groups. Since the size of ε determines the extent to which marginal social utility declines as income rises, the knowledge of its value permits a comparison of relative marginal utilities for regions with contrasting per-capita real incomes as can be observed from equation (2.9). Welfare weights could be used by governments in reaching decisions on the allocation of funds to social projects and policies on a regional basis or any other basis such as gender or ethnicity (Weisbrod 1972). The issues relating to the empirical evidence on the *RWW* will also be discussed in detail in Chapter 4.

Consequently, the appropriate measurements of ε are a crucial policy concern for the purpose of estimating values of both social discount rates and regional welfare weights for countries. There have been many attempts to estimate ε, employing several different approaches and often resulting in widely differing values.

Chapter 3 is devoted to the critical evaluation of the theoretical and empirical issues surrounding the concept of the elasticity of marginal utility of income since this welfare parameter is an important component of both discount rate and welfare weight measures.

Chapter 3 The Elasticity of the Marginal Utility of Income (ε): Theory and Evidence

3.1 Introduction

The third element of the Ramsey formula, i.e. equation (3.1) below, is the elasticity of the marginal utility of income (consumption) denoted by ε.

(3.1) $r = \rho + \varepsilon.g$

This chapter will explore the issues surrounding ε in detail and critically evaluate the different methods of measuring a value for this parameter. For the relationship between ε and the social welfare function to be maximised see Chapter 2, Section 2.2, and for the derivation of equation 3.1 above see Chapter 2, Section 2.3

As has already been pointed out, measurement of ε is a crucial policy concern for the purpose of estimating appropriate values of both social discount rates and social/regional welfare weights for countries. In fact, knowing how far the marginal utility of income declines as income increases is very important not only for CBA but also for the measurement of inequality and optimal taxation (Layard *et al* 2007). There have been several studies aiming to estimate a value for ε, employing different approaches. Cowell and Gardiner (1999), Evans (2005) and Stern (1977), cover a range of methods for estimating a value for ε in detail, with particular attention paid to the underlying theory and its deficiencies.

3.2 Marginal utility as a welfare weight

The different approaches to the estimation of ε relate to the different but interrelated perceptions regarding ε. In Chapter 2, it has been stated that estimation of the *SDR* and *SWW* involves the Bergson-Samuelson (B-S) type of social welfare function (*SWF*) which relates welfare to utility as a function income.

(3.2) $SWF = \Sigma U_i(Y_i)$

It was established that the *SWF* is concave as well as additive in nature. The concavity of the *SWF* implies diminishing marginal utility, which in conjunction with the additivity property (see Chapter 2, Section 2.2.2), produces the result that redistributing a given amount of income from a high income individual to a low income individual would increase total welfare. In other words, from a viewpoint of distributional policies, high incomes are associated with low weights and *vice versa,* the weights being indicated by the marginal utility of income (Cowell and Gardiner 1999).

Moreover, the *SWF* is also iso-elastic implying that the rate of change in utility for changes in income (consumption) by a given percentage remains constant for all income levels. This can be demonstrated by assuming an iso-elastic utility function which is widely used in the literature (see, for example, Cowell and Gardiner 1999, Evans 2008 and 2005, Kula 2007 and 2004, OXERA 2002, Pearce and Ulph 1999, and Stern 1977).

$$(3.3) \quad U_i = \frac{1}{1-\varepsilon} Y_i^{1-\varepsilon}$$

The differentiation of (3.3) gives the marginal utility of income

$$(3.4) \quad MU_i = \frac{dU}{dY} = Y_i^{-\varepsilon}$$

Taking logs

$$(3.5) \quad LnMU_i = -\varepsilon . LnY_i$$

and differentiating with respect to LnY gives

$$(3.6) \quad \frac{d\left(LnMU_i\right)}{d\left(LnY_i\right)} = -\varepsilon$$

This implies that the elasticity of marginal utility with respect to income is constant. That is, a given percentage increase in income will result in the same percentage reduction in marginal utility whatever the income level.

The above analysis implies that marginal utilities associated with different individuals, groups or regions can be used as relative welfare weights regarding a redistribution of income. For example, if (i) represents an individual or a group of individuals or a region, we will, from (3.4), have,

(3.7) $MU_i = Y_i^{-\varepsilon}$ and $MU_{\overline{Y}} = \overline{Y}^{-\varepsilon}$

where

Y_i = i's income

$\overline{Y}$ = a *numeraire* such as the national income *per capita*

Then we have

(3.8) $\left(\frac{Y_i}{Y_{\overline{Y}}}\right)^{-\varepsilon} = \left(\frac{Y_{\overline{Y}}}{Y_i}\right)^{\varepsilon}$,

which represents the relative welfare weight for group/region i. Note that the magnitude of the weight depends on the ratio of the national income *per capita* to the average income of i^{th} group concerned, which is variable, and the value of ε, which is constant.

However, the above analysis is based on the implicit assumption that these weights are applied to projects which are marginal in the sense that the impact of the project is confined to the groups or regions with which they are associated. In other words, no spill-over effects are assumed. Some projects however, such as infra-structural and transport projects, will have impacts on more than one group or region. In the presence of such spill-over effects, welfare weights can still be applied in CBA but these spill overs would need to be explicitly taken into account. For example, if a project has cross-regional implications, then a weighted average of the relevant regional welfare weights can be applied on the basis of the relative importance of per capita benefits with respect to each region. If the project is financed from central government funds, then the cost implications are simple. However, if the regional government is bearing some or all of the costs, then the costs should also be distributed across the regions benefiting from the projects in accordance with the benefits received by each reagion. (See, the end of Section 7. 2 in Chapter 7).

Another point to bear in mind is the case where a project is located in one region but the benefits largely accrue to another region. In this case the relevant welfare weight would be the one associated with the region receiving benefits rather than the one where the project is located. What is important is the marginal utility of the beneficieries. Thus, if the project is not region-specific, then the regional welfare weights where the beneficiries are located should apply (Evans and Kula 2011)

3.3 Aversion to inequality

As we have seen, the *SWF* of equation (3.2) contains an inequality-regarding dimension, if we can assign to it the properties that have been discussed in 2.2 (Cowell and Gardiner). In the context of the classic utility approach, it is represented by the concept of the elasticity of marginal utility of income. When we consider utility under uncertainty (where income is the expected income), the relevant concept is the concept of aversion to inequality of income. The correspondence between the elasticity of marginal utility of income and the coefficient of aversion to inequality can easily be seen if we consider the Atkinson Inequality Index in which ε is a parameter representing the societal weight attached to the inequality of income distribution, a high value of ε indicating a greater weight attached to inequality (Atkinson 1983).

$$I = 1 - \left[\sum_{i=1}^{n} \left(\frac{Y_i}{\overline{Y}} \right)^{1-\varepsilon} f_i \right]^{\frac{1}{1-\varepsilon}}$$

where

i = 1, 2, 3,...., n

I = Atkinson Inequality Index

Y_i = the income of those in the ith income range

$\overline{Y}$ = the mean income

f_i = proportion of the population with incomes in the ith range

The functional form used to derive constant relative aversion in the context of the Atkinson Inequality Index is given by equations (3.9) and (3.10), [see Amiel *at al* 1999], noting that (3.9) is the same as (3.3) .

(3.9) $U(Y) = \frac{1}{1-\varepsilon} Y^{1-\varepsilon}$ for $\varepsilon > 0, \ \varepsilon \neq 1$

or

(3.10) $U(Y) = \log Y \qquad \text{for} \qquad \varepsilon = 1$

The parameter ε in equation (3.9) indicates the concavity of the total utility function *U*, i.e. the rate of change of the slope of the total utility curve. In other words, it shows how quickly marginal utility declines as income increases, which is the definition of the elasticity of the marginal utility of income. It also indicates the convexity of the indifference curves which show the combinations of (Y_i) and (Y_j) for persons *i* and *j* with identical welfare functions. The marginal rate of substitution between (Y_i) and (Y_j) is given by

(3.11) $$-\left.\frac{dY_i}{dY_j}\right|_W = \left(\frac{Y_i}{Y_j}\right)^{-\varepsilon}$$

The value of ε is determined by the so-called *leaky-bucket* experiment in which a scenario is created where there is a redistribution of income between two individuals, A and B. A has, for example, twice the income as B. One unit of income is taken away from A, and a proportion *x* of this is given to B, the rest (1-*x*) being lost (leaked!) in the process. Then the subject of the experiment is asked: At what level of *x* would the desirability of redistribution disappear (the overall welfare remain unchanged)? (Atkinson 1983).

The answer would determine the value of ε according to the formula

(3.12) $$\varepsilon = \frac{1}{2x}$$

For example, if the subject accepted 50% 'leakage' then the value of ε would be equal to 1, but if only 25% were deemed sufficient to make the redistribution worthwhile then the value of ε would be 2. That is, the higher the values of ε , the higher the aversion to inequality. It ranges from zero, which implies that the society is indifferent to equity, to infinity, which implies that the society is only concerned with the poorest section (Atkinson 1983).

A constant relative inequality aversion is considered to be reasonable in certain circumstances (Cowell and Gardiner 1999) and therefore the Atkinson Inequality Index also provides the rationale for the restriction of iso-elasticity and hence the justification for equation (3.3).

3.4 Aversion to risk

An alternative interpretation of ε would be as a coefficient of relative risk aversion. The social welfare function is based on the concept of social utility which is built on the structure of consumer preferences under certainty provided that certain restrictive conditions apply (see the discussion on the properties of *SWF* in Chapter 2, Section 2.2.1). However, it is possible to use an equivalent *SWF* even if the structure of consumer preferences faces uncertainty. Thus, the equivalent to equation (3.2) can be written as

$$(3.13)\quad SWF = \sum_{i=1}^{n} w_i U_i\left(Y_i\right)$$

where

$$w_i = \frac{1}{n} \qquad \text{and} \qquad i = 1, 2, \ldots, n$$

Under the condition of uncertainty, utility becomes 'expected' utility associated with expected incomes. That is to say that a representative individual is to expect to receive any one of the expected incomes, Y_1, Y_2,...,Y_n with equal likelihood.

In this approach social attitudes to inequality are obviously linked to the attitudes to risk. Thus risk aversion becomes the determining factor regarding aversion to inequality and thus measures of inequality can be regarded as being related to the risk associated with a given distribution of income (Cowell and Gardiner 1999).

3.5 Different methods of measuring ε

It is possible to group the approaches to the estimation of ε into 3 main types: survey methods, behavioural evidence and revealed social values via public policy decisions. Behavioural approaches can further be grouped into those based on lifetime consumption and the ones based on the market demand for want-independent goods. A critical examination of the theoretical and empirical issues regarding these approaches is presented below.

3.5.1 Survey methods

This approach is based on direct evidence and uses information obtained from surveys concerning risk or inequality aversion and involves measures of ε based on assessment of either the risk or inequality aversion of members of the public.

Barsky *et al* (1995) focus on a group of Americans aged between 51 and 61 years and use the questions from the Health and Retirement Survey to extract information about attitudes to risk. The questions mainly relate to gambling lifetime income in hypothetical situations. They define relative risk tolerance as the reciprocal of the coefficient of risk aversion and provide estimates of it for the persons in different quintiles in the income distribution. The arithmetic average of these estimates is 0.24, which means an implied estimate of the elasticity of marginal utility of income, ε is 4.2. This high value implies a considerable amount of aversion to risk which might be associated with the particular age group to which the survey applies. It is possible that for such an age group factors such as potential for regret would normally put an upward pressure on risk aversion (Spackman 2007). In any case a value of 4.2 for ε would imply an unrealistically high number, for example, for the UK social discount rate. Using equation (3.1) above and typically assuming a value of 1% for ρ, and 2% for g, a figure of more than 9% would be obtained for the *STPR*! Thus, the study is criticised for being based on a non-representative sample which would have an upward bias on the estimates as well as having unrealistic estimates (Evans 2005).

Amiel *et al* (1999) focus on a group of students, who are subjected to the *leaky-bucket* experiment described above, in order to estimate the coefficient of aversion to inequality, ε, which is a parameter that represents the weight attached by society to inequality in the income distribution.

They assume that the social welfare function takes the form

$$(3.14)\quad W = \frac{1}{N}\sum_{i=1}^{N} U\left(Y_i\right)$$

where

W =welfare

Y_i = person i's income

$U(Y_i)$ = the value attached to i's income.

N = the number of people

Using the theoretical structure set out in equations (3.9) – (3.12), their questionnaire is designed to elicit information regarding the value of x in equation (3.12) from which the values for ε can be discerned. In fact, their estimates of ε vary between 0.2 and – 0.8. Such low values might reflect the attitudes of the student group to inequality but cannot represent the society at large.

Survey methods are criticised for having high opportunity cost attached to them because they are time consuming and expensive and regular follow-ups are required to update the information obtained. Moreover, the estimates are sensitive to both the nature of the questions asked and the types of respondents targeted. Finally, they are also criticised for not being comprehensive enough in their coverage of a more representative cross-section of the general public in order to obtain appropriate ε values. Consequently, there appears to be a need for evidence from alternative approaches (Evans 2005).

3.5.2 Behavioural approach

This approach is based on indirect evidence obtained from household behaviour and the studies adopting this approach can be grouped under two categories.

a) Models of life-time consumption behaviour

This method of estimating ε is well-regarded theoretically and favoured by, Attanasio and Browning (1995), Besley and Meghir (1998), Blundell *at al.* (1994), Cowell and Gardiner (1999), OXERA (2002) and Pearce and Ulph (1999). In fact, Blundell *at al* (1994) has been highly influential on both government policy and the subsequent literature. The UK Treasury adopted a unitary value in its latest project appraisal guidance for the calculation of the social time preference rate *(STPR)* [see HM Treasury, (2003, Annex 6)]. This guidance drew on surveys of empirical evidence provided by the Cowell and Gardiner (1999), Pearce and Ulph (1999), and OXERA (2002), which themselves emphasised the study by Blundell *at al* (1994).

The approach is based on micro models of consumption behaviour over the life cycle in which an estimate of ε is provided by the inverse of the elasticity of inter-temporal substitution (*EIS*) of household consumption which is defined (Cowell and Gardiner 1999, Appendix A.3) as

$$(3.15)\quad EIS = \frac{\partial \ln C_0}{\partial \ln(1+r)}$$

where

EIS = elasticity of inter-temporal substitution

C_0 = consumption in period 0, and

r = the rate of interest in period 0

This interpretation of ε as a measure of relative risk aversion requires certain simplifying assumptions but avoids the controversy surrounding utility as an ordinal concept in the utility-under-certainty approach. The relevant theory and the underlying algebra are set out in Cowell and Gardiner (1999), Creedy (2006) and Pearce and Ulph (1999). Empirical estimates are provided by Attanasio and Browning (1995) Besley and Meghir (1998) and Blundell *et al* (1994).

Let us assume a standard inter-temporal choice model in which individuals try to maximise consumption over two periods, 0 and 1, based on an additive utility function given by

$$(3.16)\quad U_t = (1+\rho)^{-1} U(C_t)$$

where

U_t = utility at t

ρ = utility discount rate, and

C_t = consumption at t

Then the marginal rate of substitution (MRS) in the two periods is the absolute value of the slope of the indifference curve representing the trade-off between consumption levels in periods 0 and 1. This will be given by the ratio of the marginal utility of consumption in one period over the marginal utility of consumption in the other period (Creedy 2006).

(3.17) $$MRS_{C_0C_1} = \frac{\frac{\partial U_0}{\partial C_0}}{\frac{\partial U_1}{\partial C_1}} = \frac{MU_{C_0}}{MU_{C_1}}$$

However, if the utility function is of the usual iso-elastic type

(3.18) $$U(C_t) = (1-\varepsilon)^{-1} C_t^{1-\varepsilon}$$

Then the utility in period 0 will be equal to

(3.19) $$U(C_0) = (1-\varepsilon)^{-1} C_0^{1-\varepsilon}$$

and in period 1 to

(3.20) $$U_{C_1} = (1+\rho)^{-1} (1-\varepsilon)^{-1} C_1^{1-\varepsilon}$$

Therefore

(3.21) $$MRS_{C_0,C_1} = \frac{C_0^{-\varepsilon}}{(1+\rho)^{-1} C_1^{-\varepsilon}}$$

Rearranging we get

(3.22) $$MRS_{C_0,C_1} = \left(\frac{C_1}{C_0}\right)^{\varepsilon} (1+\rho)$$

However, the MRS is equal to the relative price regarding the two consumption levels, i.e. (1+r), which is given by the slope of the budget constraint (Creedy 2006)

Thus

$$(3.23)\quad MRS_{C_0,C_1} = \left(\frac{C_1}{C_0}\right)^{\varepsilon}(1+\rho) = (1+r)$$

Logging and rearranging

$$(3.24)\quad ln(1+r) = \varepsilon(lnC_1 - lnC_0) + ln(1+\rho)$$

Differentiating with respect to C_0

$$(3.25)\quad \frac{\partial ln(1+r)}{\partial lnC_0} = -\varepsilon$$

However, from (3.15) we have

$$(3.26)\quad EIS = \frac{\partial \ln C_0}{\partial \ln(1+r)}$$

Thus,

$$(3.27)\quad EIS = -\frac{1}{\varepsilon}$$

Empirical evidence (Table 3.1)

Pearce and Ulph (1999) criticise the official social discount rate for being too high and instead suggest a value of 0.88 for ε.

Besley and Meghir (1998) point to several studies which estimate values for *EIS* all of which are less than unity. Thus they argue that the value of ε must exceed unity. Attanasio and Browning (1995) in a similar study also suggest a value just over unity for ε.

The Blundell *et al* (1994) study uses two alternative models based on panel data obtained from large samples of Family Expenditure Survey data taken over many years. In the basic model, the estimates of ε range from 1.2 to 1.4 across the household income distribution expressed in terms of deciles. This very modest rise in ε with income level does appear to comply with the claim of approximate constancy of ε made in the literature (see, for example, Blue and Tweeten 1997, Evans 2004a and 2005 and Kula 2004). The second model used by the study provides much lower estimates of ε with a much wider range, namely, 0.35-1.05 displaying a much sharper rise with income. This contrast could be attributable to the use of dummy variables to adjust for high levels of the UK real interest rates in the 1980s.

The OXERA study suggests, after considering various studies that the most reasonable value would be within the range of 0.5-1.2.

Stern (1977), using a model in which a lifetime utility function is maximised subject to saving constraint, provides an estimate of 5 for ε. However, Scott (1989) criticised this figure as too high on the grounds of a misspecified equation and suggested that the correct figure would be 1.5.

The life-time consumption models are criticised on several grounds. They usually specify a single long-term government bond rate which is not very plausible since it ignores the fact that there are significant differences between the rates of interest on bank loans and those applied to saving deposits. The Blundell *et al* (1999) study comes under specific criticism not only because of the single interest rate issue mentioned above but also the fact that its data period of 1970-86 is very different from the current economic and financial environment. The data period was subject to several external shocks such as the oil price hike in the 1970s, the breakdown of the Bretton Woods arrangement and the EU membership of the UK. The period was also characterised by high inflation rates and highly regulated and thus less competitive financial markets (Evans 2005 and 2007).

b) Models based on demand analysis

An evaluation

The second behavioural method of estimating ε is based on demand analysis. This method, which was developed by Fellner (1967), Fisher (1927) and Frisch (1932) and thus is also known as the FFF model, has a long history and is based on the demand for preference-independent consumer goods, e.g. food. Although the assumption of preference-independence is present in all the models using the behavioural approach, it is a subject of contention. Preference-independence, also known as additive separability, is often assumed to simplify the analysis of consumer behaviour (Fleissig and Whitney

2007). In single-period utility functions, for example, consumption and leisure are commonly assumed to be additively separable.

If separability of preferences holds then the goods can be partitioned into groups so that intra-group preferences would be independent of the inter-group quantities. That is, the intra-group marginal rate of substitution between any pair of goods is independent of the quantity consumed of other goods (Fleissig and Whitney 2007 and Pollak 1971). More specifically, let us assume that there are six consumer goods, namely, groceries (x_1), non-groceries (x_2), textiles (x_3), shoes (x_4), TV (x_5) and watching sport (x_6) and that they are divided into three separable groups, namely, food, clothing and entertainment. The assumption of separability in general terms can be expressed as follows.

(3.27a) $U = v(x_1, x_2, x_3, x_4, x_5, x_6) = f[v_F(x_1, x_2), v_C(x_3, x_4), v_E(x_5 x_6)$

where f is an increasing function of the sub-utility functions v_F, v_C and v_E.

Equation (3.27a) implies that the preferences of a consumer regarding, for example, food would be independent of the quantities she consumes of clothing and entertainment. That is, the marginal rate of substitution between groceries and non-groceries would be independent of quantities consumed of textiles, shoes, TV and sport. The quantity demanded of food, for example, would be a function of spending on and the price of groceries and non-groceries only. Thus, a change in the price of say shoes or TV would only have an indirect effect on demand for food via its impact on the expenditure on food (Deaton and Muellbauer 1980a). This is a form of two-stage budgeting: the consumer first decides how much to spend on each category of goods, i.e. on food, clothing and entertainment, and then allocates the expenditure between goods within a category, i.e. on groceries and non-groceries.

However, equation (3.27a) relates to what is known as *weak separability* which means that quantities demanded are a function of group utility and intra-group prices. Another form of separability is *implicit separability* or *quasi separability* which means that intra-group budget shares are a function of total utility and intra-group prices. This implies that a change in compensated price outside the group such as shoes will alter all intra-group expenditures, i.e. expenditures on groceries and non-groceries, by the same proportion.

The third and most commonly assumed form regarding preferences is the strong form of separability which is also referred to as *additive separability*. In this case equation (3.27a) becomes a necessary condition but not a sufficient one. Additive separability means not only that the underlying utility function comprises sub-utility functions, but also that the latter enter the total utility function in an explicitly additive form as in equation (3.27b).

(3.27b) $U = f[v_F(x_1, x_2) + v_C(x_3, x_4) + v_E(x_5 x_6)$

The necessary and sufficient condition for additive separability for a more general case, i.e. the one involving n number of goods, is the axiom of "n^{th}-order cancellation". The proof of this condition is provided by Debreu (1960).

If there are only two goods without any sub-groups, such as food and non-food, as is the case in this study (see Chapter 1, Section 1.5.2 and Chapter 5, Section 5.2), then additively seaparable preferences can be represented by

(3.27c) $U(x_1, x_2) = v_1(x_1) + v_2(x_2)$

where x_1 and x_2 would denote the consumption of food and non-food respectively, and $v_1(x_1)$ and $v_2(x_2)$ would represent the utility functions relating to food and non-food respectively. The necessary and sufficient condition for additive separability in the case of two commodities is the axiome of 'double cancellation'. (See Bergstrom 2011 for a proof of this condition).

Although the condition of additive separability as expressed in equation (3.27b) looks rather strong, in the case of two groups of commodities such as food and non-food, it would appear that the assumption is not so stringent and hence too unrealistic. It is reasonable, in the case of broad categories of food and non-food, to assume that both inferiority and complementarity are absent or at least, even if complementarity existed, it would be rather weak. Therefore, it is fairly reasonable to assume that, if the quantity of of food were kept constant while the quantity of non-food were varied, the marginal utility of food would remains constant.

Nevertheless, Stern (1977) and Deaton and Muellbauer (1980a) regard this assumption unreasonably stringent for the reason that if additive separability is absent, then ε would have no meaning since for each monotonic transformation of the underlying preference function, ε would assume a different value. However, Fellner (1967), Evans (2004a and 2005), Evans and Sezer (2002), Kula (2004) and Selvanathan and Selvanathan (1993) have all argued that preference independence, at least in the case of food, is a plausible assumption. Furthermore, empirical testing of the preference-independence assumption for broad aggregates appears to be valid (see, for example, Selvanathan 1987 and Clements *et al.* 1997). So the approach does seem worthy of some attention.

The model

In this method an approximate estimate of ε is provided by the ratio of the estimated income elasticity of demand for food, η, to the compensated own-price elasticity, γ, (Fellner 1967) provided that the budget share of food is sufficiently small.

$$(3.28) \qquad \varepsilon = \frac{\eta}{\gamma}$$

where

ε = the elasticity of marginal utility of income

η = the income elasticity of demand for food

γ = the compensated own- price elasticity of demand for food

An additively-separable utility function based on a want-independent product group such as food can be expressed as follows.

$$(3.29) \quad U = U_1(F) + U_2(NF)$$

where

F = food product group

NF = non-food product group

The first-order maximisation condition is

$$(3.30) \quad \frac{\partial U / \partial F}{P_F} = \lambda = \frac{\partial U / \partial (NF)}{P_{NF}}$$

where

$\partial U / \partial F$ = the marginal utility of food

$\partial U/\partial(NF)$ = the marginal utility of non-food

P_F = the price of food

P_{NF} = the price of non-food

λ = the marginal utility of income (consumption)

Now if the price of food, i.e. P_F in (3.30), increases by x%, then consumers will normally substitute non-food for food and thus $\partial U/\partial(NF)$ will decrease by the same proportion so as to make (3.30) hold. Let us assume that we wish them to consume as much food as before at the new relative price which would result in lower $\frac{\partial U/\partial F}{P_F}$ but with $\partial U/\partial F$, i.e. the marginal utility of food, unchanged. For (3.30) still to hold it is necessary that their income be increased so that they will be able to buy more non-food which would also lower $\partial U/\partial(NF)$ and hence the value of $\frac{\partial U/\partial(NF)}{P_{NF}}$ accordingly. However, the marginal utility of income, λ, will also decline as a result of the income rise involved $(\%\Delta Y)$, and this decline is associated with percentage rise in the price of food, $(\%\Delta P_F)$.

Therefore

(3.31) $(\%\Delta\lambda) = -(\%\Delta P_F)$

Dividing both sides by $(-\%\Delta Y)$, we obtain

(3.32) $-\frac{(\%\Delta\lambda)}{(\%\Delta Y)} = \frac{(\%\Delta P_F)}{(\%\Delta Y)}$

However, the left hand side of (3.32) is the elasticity of marginal utility of income, ε. Thus

(3.33) $-\frac{(\%\Delta\lambda)}{(\%\Delta Y)} = \varepsilon = \frac{(\%\Delta P_F)}{(\%\Delta Y)}$

If we divide both the numerator and the denominator of the term on the right hand side of (3.33) by $(\%\Delta F)$, which is the common response in the quantity demanded of food to the changes in both the price of food and the income of the consumers of food, we obtain

$$(3.34)\quad \varepsilon = \frac{(\%\Delta P_F)\Big/(\%\Delta F)}{(\%\Delta Y)\Big/(\%\Delta F)}$$

where the numerator is the absolute value of the reciprocal of compensated price elasticity of demand, and the denominator is the reciprocal of income elasticity. Thus we have

$$(3.35)\quad \varepsilon = \frac{1/\gamma}{1/\eta} \qquad \text{or} \qquad \varepsilon = \frac{\eta}{\gamma}$$

which is equation (3.28)

However, if the budget share of the want-independent consumer good is significantly high, then the value of ε will have an upward bias. Therefore an adjustment is required for the budget share and the correct expression is given by the following elasticities formula (see Frisch 1959, equation 64).

$$(3.36)\quad \varepsilon = \frac{\eta(1-\omega\eta)}{\gamma}$$

where

ω = the budget share of food

Empirical Estimates (Table 3.1)

The advantage of models based on demand analysis is the availability of reliable data in sufficient quantities for empirical estimation. In general, the empirical studies using the demand-for-food method display a fairly wide range of estimated ε values. For example, Stern (1977) provides a survey of results that vary between 1 and 10. Another survey by Brown and Deaton (1972) covering different countries and data periods also displays a wide variety of ε values averaging out at around 2 but their own estimation using a model of linear expenditure system (LES) produces a figure of 2.8. Parks and Barten (1973) study, also using a LES model, produces ε values in excess of 7 for both France and The Netherlands.

Table 3.1 The different methods of estimating ε

METHOD	*STUDY*	*COUNTRY*	*MODEL*	*ε*
Survey methods	Amiel *et al* 1999			0.50*
	Barsky *et al* 1995	US		4.20
Life-Time consumption models	Attanasio and Browning 1995	UK		>1.00*
	Besley and Meghir 1998	Various		>1.00*
	Blundell *et al* 1994	UK		0.88*
	Cowell and Gardiner 1999	UK		1.00*
	Oxera 2002	UK		0.5-1.2
	Stern 1977	UK		4.0-5.0
Demand models	Banks *et al* 1997	UK	QUAIDS	1.07
	Blundell 1988	UK	AIDS	1.97
	Blundell *et al* 1993	UK	QUAIDS	1.06
	Brown & Deaton 1972	UK	LES	2.80
	Evans 2004a	UK	CEM	1.60
	Evans 2004b	France	AIDS	1.33
	Evans, Kula and Sezer 2005	UK	CEM	1.60
	Kula 1984	Canada	CEM	1.56
	Kula 1984	US	CEM	1.89
	Kula 2004	India	CEM	1.64
	Parks and Barten 1973	FR & NL	LES	7.05
	Percoco 2008	Italy	CEM	1.28
	Stern 1977	Various	Various	0-10
Income-Tax models	Cowell and Gardiner 1999	UK		1.41
	Evans 2004b	FR		1.33
	Evans 2005	OECD (20)		1.40*
	Evans 2008	UK		1.97
	Evans and Kula 2009	Cyprus		1.0-1.3
	Evans and Sezer 2004	6 major countries		1.3-1.7
	Evans, Kula and Sezer 2005	UK		1.63
	Lopez 2008	9 LA countries		1.50*
	Percoco 2008	Italy		1.35
	Sezer 2007	Turkey		1.25
	Stern 1977	UK		1.97

Source: Own compilation
* Average values

The variety of these estimates indicates that the results are sensitive to the particular data period chosen, the sample size, the level of aggregation in the data and the particular specification of the model employed (Evans 2007). For example Kula (1984), using a constant elasticity model (CEM), estimates ε to be 1.56 for Canada and 1.89 for the US.

Using a more sophisticated demand model such as the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980b), the Blundell (1988) study produces a figure of 1.97 for the UK, but a later study by Blundell *et al* (1993) estimates the same figure, using a quadratic extension of almost ideal demand system (QUAIDS), to be as low as 1.06. Banks *et al* (1997) also employing a QUAIDS model arrives at a similar result of 1.07. More recent studies produce a more consistent value for ε. For example, both Evans (2004a) and Evans *et al* (2005), using a CEM, estimate ε to be 1.60 for the UK in both studies. Evans (2004b) also uses an AIDS model to estimate ε for France and arrives at a figure of 1.33. Kula (2004) and Percoco (2008), both using a CEM, estimate the value of ε as 1.64 for India and 1.28 for Italy, respectively.

3.5.3 Revealed social values based on government policies

The third approach concerns the estimation of ε by considering social values of governments as revealed in their economic policies. A popular method is to regard ε as the parameter for income inequality aversion (see Section 3.3) and to measure its value by considering government's aversion to income inequality as revealed by the progressivity of the income tax structure. The method is based on two major assumptions. One is that the tax system concerned reflects the principle of equal absolute sacrifice which means that the income tax taken from individuals involves the same sacrifice of utility for all tax payers regardless of income levels. The other is the assumption of an iso-elastic utility function The latter has been discussed in detail in Chapter 2, Section.2.2.2, and the former will be discussed below.

The concept of equal absolute sacrifice is related to the generally accepted dictum that taxation must be fair (Brown and Jackson 1990). However, what constitutes 'fair' is a more controversial issue. The concept of horizontal equity, for example, relates fairness to different individuals in similar circumstances being treated similarly, i.e. those with the same amount of income and wealth should be regarded in the same light. However, this does not mean that persons with identical income and wealth should pay the same amount of tax, e.g. polluters may pay more tax. Vertical equity implies that those individuals with high levels of income and wealth should pay more tax than those with low levels. In general there are two competing approaches to the issue of fairness in taxation. One is the benefit principle which is based on the concept of taxation being a voluntary payment for a public good received by the taxpayer. This principle dictates that an individual's tax payments should be determined by the benefit she receives from consuming public goods. Apart from the obvious problem of free riding, this principle ignores the equity dimension of taxation. Thus, John S. Mill rejected the benefit principle and instead introduced the principle of ability-to pay (Brown and Jackson 1990). Implicit in the principle of ability-to-pay is the concept of equality of sacrifice associated with income tax paid.

The principle of equal absolute sacrifice implies that each taxpayer experiences the same amount of loss out of total welfare (utility). This features prominently in public sector economics; see, for example, Richter (1983), Vitaliano (1977) and Young (1987). The tax model based on the principle of equal absolute sacrifice, which is also called the basic model, is a simple mathematical model. This simplicity perhaps accounts for its popularity in the literature (see, for example, Cowell and Gardiner 1999, Evans 2005, Evans and Sezer 2004, Evans and Kula 2009, Lopez 2008, Percoco 2008 and Stern 1977). However, the use of this principle is criticised by Creedy (2006) on the grounds of being rather simplistic. He questions whether it is a good idea to model the tax structure as if it arose from equal absolute sacrifice indicating that other principles, such as the principle of proportional equal sacrifice, produce an even more progressive tax structure. Stem (1977), on the other hand, argues that the equal absolute sacrifice model fits the data better and thus statistically out-performs models using more complicated income tax structures. Evans (2005 and 2008) also claims that the basic model's simplicity is its virtue and that the model has strong statistical support compared with alternatives.

The theoretical underpinnings of the basic model, i.e. the one based on the assumption of equal absolute sacrifice, are as follows. Let us assume that

Y = taxable income and

$T(Y)$ = the tax function

The principle of equal absolute sacrifice requires that the absolute difference between the pre-tax and the post tax welfare (utility) be the same for all taxpayers (levels of income).

Thus

(3.37) $U(Y)-U[Y-T(Y)]=k$

where

$U(Y)$ = an iso-elastic utility function that is the same for all taxpayers

That is

(3.38) $$U(Y)=\frac{Y^{(1-\varepsilon)}-1}{1-\varepsilon}$$

Substituting (3.38) into (3.37) gives the following equation:

(3.39) $$\frac{Y^{(1-\varepsilon)}-1}{1-\varepsilon}-\frac{[Y-T(Y)]^{(1-\varepsilon)}-1}{1-\varepsilon}=k$$

Taking the total differential of equation (3.39) gives

(3.40) $Y^{-\varepsilon}-[Y-T(Y)]^{-\varepsilon}[1-t(Y)]=0$

After re-arranging terms and simplifying, the relationship becomes,

(3.41) $$[1-t(Y)]=\left[1-\frac{T(Y)}{Y}\right]^{\varepsilon}$$

Taking logs in (3.41) gives,

(3.42) $$\ln[1-t(Y)]=\varepsilon\ln\left[1-\frac{T(Y)}{Y}\right]$$

By re-arranging we obtain

$$(3.43) \quad \varepsilon = \frac{\ln\left[1 - t(Y)\right]}{\ln\left[1 - \frac{T(Y)}{Y}\right]}$$

where

$t(Y)$ = the marginal tax function

It is worth pointing out that the value of ε will vary according to which definition of the average tax rate is used in equation (3.43). For example, Stern (1977) uses the conventional definition and calculates the average tax rate as the ratio of tax liability to pre-tax income before the deduction of standard personal tax allowances. However, Evans (2005) argues that this particular definition introduces a strong upward bias into the calculation of ε at relatively low income levels. Thus, his definition of the average tax rate is the ratio of tax liability to pre-tax income after the deduction of standard tax allowances. He admits that this method would produce a unitary ε value at low levels of income where only a single tax rate applies. However he justifies the procedure by arguing that people do not start paying tax on income until they have at least reached a subsistence wage level and that it is reasonable to assume that diminishing marginal utility applies to incomes over and above the subsistence level. We will follow Evans (2005) in the calculation of ε for Turkey using the basic tax model in Chapter 5.

Empirical evidence (Table 3.1)

Empirical estimates of ε arising from the tax-based evidence show similar variation to those based on demand-for-food models. The highest one is given by Stern (1977) who estimates ε for the UK, without including the employees' social security contributions (ESSC), to be 1.97. The high value of ε is partly due to the definition of average tax represented by the ratio of average tax liability to pre-tax income before the deduction of personal tax allowances. The Cowell & Gardiner (1999) study estimates two values of ε for the UK, one with the ESSC and one without. Not surprisingly, the former, 1.28, is lower than the latter, 1.41 since the inclusion of the ESSC raises the average tax rate relative to the marginal rate. However, the study is ambiguous in the definition of pre-tax income regarding the deduction of personal tax allowances.

Both studies employ regression analysis to derive a value for ε based on equation (3.33) but suppress the constant. This constitutes the imposition of the underlying theory on the model specification. It would have been more desirable to include the constant in the equation to see if the theory is empirically supported since a small and statistically insignificant constant would provide such support. The appropriateness of regression can also be questioned for both the size of the sample and the direction of the causation. (Evans 2007). It would appear more plausible to regress the average tax rate on the marginal tax rate arguing that the causation would be from the latter to the former, not the other way around as presumed by equation (3.42). The relatively high value obtained by the Stern (1977) study is partly due to the fact that the pre-tax income is calculated before the deduction of standard tax allowances. In fact, reworking of the Stern data taking into account the tax allowances reduce the value of ε to 1.58. (See Evans 2008).

Evans (2004b and 2005) estimates ε to be 1.33 for France, 1.24 for the UK and an average of 1.40 for twenty OECD countries. Both studies are based on income tax data without the ESSC and pre-tax income after the deduction of standard tax allowances, and make use of equation (3.43) without regression. The pre-tax income is represented by the average production wage in manufacturing industries and the value of ε is calculated at four different points of the gross wage distribution in order to arrive at an average ε value. The use of the pre-tax income after deducting standard tax allowances is justified by arguing that diminishing marginal utility would apply only for income in excess of subsistence level. A similar study by Evans and Sezer (2005) provides estimates of ε for the EU-15 plus the 2004 entrants with a range of 1.10-1.81

Finally, Percoco (2008) employs a model based on income tax data provided by the OECD Taxation Statistics that include the employees' social security contributions (ESSC), and estimates an average ε value of 1.35 for Italy. However, the study does not explicitly state whether the pre-tax income is before or after the deduction of standard tax allowances.

The advantages of the basic tax model for estimating the ε value are its conceptual simplicity, its concern regarding fairness, its relation to marginal utility and its measurability (Spackman 2007). However, it is criticised on the grounds that the results obtained for ε are sensitive to tax coverage. For example, ε measures would be lower if employees' social security contributions are included in the tax rates. They would also be lower if average tax rates were measured relative to income after the deduction of basic allowances rather than before since both would increase the value $[t\ (Y)\ /\ Y]$ in equation

(3.43). The method as used in the literature could also be criticised for ignoring the weighting. For the purpose of estimating ε in the context of calculating a country's *STPR*, it is important to weight the data according to the number of individuals paying tax at each different rate, since changes in *per capita* national income (consumption) over time are the relevant consideration. In most countries, only a small number of different income tax rates apply with a relatively small proportion of tax-payers paying high marginal tax rates. Taking this fact into account would reduce the value of ε for use in social discounting.

Moreover, concentrating on income tax rates alone provides a somewhat distorted picture regarding a government's aversion to income inequality. For example, a government might shift the tax structure in favour of indirect taxation for reasons other than concerns for equity such as convenience; or because the government might worry about the incentive effects of a highly progressive tax system. In either case the actual income tax structure would be less progressive than otherwise, which would under-reveal the government's aversion to inequality and therefore give rise to the under-estimation of the value of ε (Spackman 2007).

These concerns led Evans (2006) to consider alternative ways in which governments might reveal social values that might be indicative of implied values of ε. One possibility is the arrangements for foreign aid. Currently, the internationally agreed target for foreign aid is 0.7% of the gross national income (GNI) of the members of the Development Assistance Committee of the OECD which consists of 22 rich countries and the European Commission (UN 2008). Although the achievement of the 0.7% target is a hotly debated topic in the development literature, the actual proportion itself is not the issue here. On the assumption of a constant proportion of the GDP for all developed countries, in conjunction with the principle of equal absolute sacrifice, equation (3.34) would *mutatis mutandis* produce a unitary value for ε since the marginal and average rates of foreign aid contributions would be the same over time.

The other alternative is income related fines for minor offences. A new law proposed by the government in *The Management of Offenders and Sentencing Bill, January 2005*, brings in income-related fines for certain traffic offences. The fine structure is based on the seriousness of the offence and the income of the offender. For example, a relatively minor offence, such as a child passenger not complying with the seatbelt regulations, incurs a fine of ten times the offenders' daily disposable income, subject to a maximum fine of £750. Whereas a more serious offence, such as driving without insurance incurs a fine of 200 times the offenders' daily disposable income with a maximum fine of £15 000. The definition of disposable income is the after-tax income minus basic living costs such as expenditure on food, housing and utilities. Again, the underlying assumption here is that diminishing marginal utility of income only kicks in after basic human needs are met (see Evans 2008).

3.6 Concluding remarks

A comparison of the values estimated by the different methods explored above reveals a fairly wide range of values for ε (see Table 3.1).

The survey methods show a wide variety of estimates of ε and little else needs to be said about this method for the reasons stated in section 3.1.1, but in particular for the fact that the estimates are highly sensitive to the nature of the questions asked and that it is not very easy to obtain a truly representative cross section of the whole population reflecting all the cultural characteristics which might be influential in the determination of risk aversion.

As for the life-time consumption models, they display a fairly high degree of variation with respect to the value of ε due to the high value estimated by Stern (1977). However, the figure of 5.00 by the study was criticised by Scott (1989) for being unduly high (see Section 3.5.2). In fact, if one excludes the Stern figure, this group contains the narrowest figures for ε varying from 0.88 to just over unity.

The demand models covering various countries and several different models also appear to produce a wide variety of figures for ε ranging from just over unity to 10! However, if one ignores the earlier studies of the 1970s, the figures seem to be much closer to each other for different countries ranging from 1.28 for Italy to 1.89 for the US (see Table 3.1).

The estimates of ε obtained from income-tax models show a degree of consistency with a range of 1.24-1.97. It is worth noting in this context that the average figure of 1.4 for 20 OECD countries in a study by Evans (2005) belies a remarkable degree of consistency since the variation of estimates of ε is confined to a fairly narrow band averaging from 1.3 for France to 1.6 for Germany.

Two conclusions can be drawn from the above discussion. One is that there is a fair degree of variation regarding the value of ε not only between the four different methods employed but also between different studies within the same method. The other is that after a critical evaluation of the methods of estimating ε , it would appear that the least controversial and the most commonly used method of estimating the elasticity of marginal utility of income are demand-for food analysis (the FFF model), and the income tax models

The survey model is highly problematic firstly because of the logistics of setting up a reliable representative sample to obtain direct evidence, secondly because of the subjective nature of eliciting information about the concept of risk aversion, and finally because of the sensitivity of the estimates to the nature of the questions asked.

The life-time consumption behaviour method is also empirically problematic because of the criticism of using a single bond rate, particularly, if the spread between the lending and the borrowing rates is reasonably wide. Another empirical issue is the interruption to the time series data when there is a restructuring of the financial system and/or financial crises occurring in the middle of the data period.

This is particularly important for Turkey since the country suffered two financial crisis, one in 1994 and another in 2000/01, the latter being followed up by a substantial restructuring of the banking system. The average interest rates were almost four times as high at the end of December 2000 as they were at the beginning of November (Özatay and Sak 2002). Thus, it would be very difficult to construct an inter-temporal consumption model to estimate the EIS for Turkey. An additional data problem would be the lack of a reliable time series regarding a reasonable measure of wealth.

Consequently, this study will use two approaches in order to arrive at an estimate of ε for Turkey in Chapter 5. Firstly, a suitable demand model such as CEM or AIDS will be employed to estimate the income and compensated-price elasticities for a want-independent composite commodity, namely food, in order to calculate the value of ε. Secondly, an income-tax model based on the assumption of equal absolute sacrifice will be employed using the Turkish progressive tax system to provide an alternative estimate for ε. The results of these two methods will be evaluated to select an appropriate value for the elasticity of marginal utility of income (consumption), ε, to be used in the calculation of the social discount rate and the regional welfare rates for Turkey to be applied in long-term project evaluation in Chapter 6.

Chapter 4 Evaluation of Empirical Evidence on Social Discount Rate and Social Welfare Weights

4.1 Introduction

In Chapter 2 we discussed the theoretical basis for and the issues surrounding the derivation of the social discount rate (*SDR*) and social welfare weights (*SWW*) and examined the relationship between per capita income (consumption) and diminishing marginal utility and the properties of iso-elastic utility functions. Also in Chapter 2 we established that the preferred *SDR* for long term government investment projects is the social time preference rate (*STPR*) which is defined as the rate at which the society is prepared to substitute future consumption for present consumption. For that reason it is also called the consumption rate of interest. In a two-period analysis, this rate is equal to the marginal rate of substitution of consumption at any point on a given societal indifference curve. Mathematically, it is derived by imposing a budget constraint involving consumption choices over two periods on a suitably simple inter-temporal consumption-utility function and treating it as a constrained-maximisation problem (see Chapter 2, Section 2.3.5). Thus, the *STPR* is given by equation (4.1) below

(4.1) $STPR = \rho + \varepsilon . g$

where
ρ = utility discount rate
ε = elasticity of marginal utility of consumption
g = average growth of per capita real consumption

A proper understanding of *STPR* requires the exploration and discussion of the issues surrounding the separate components of equation (4.1)

The theoretical issues surrounding ρ and g were discussed in Chapter 2 and both the theoretical and the empirical considerations with respect to ε were discussed in Chapter 3. What remains to be done is a discussion of the empirical results concerning ρ and g. Thus, this chapter will examine the empirical literature relating to the social discount rate

(SDR) focusing on the different components of the $STPR$, i.e. the utility discount rate, ρ and the growth rate, g. It will also explore the empirical literature on the different welfare weights, especially in a regional context.

4.2 Social time preference rate ($STPR$)

In this section the focus will be on surveying the empirical studies regarding the utility discount rate (the time preference rate), ρ, and the growth rate of consumption, g, and on the evaluation of the estimated values of these parameters in different studies. Then, combining this survey with the empirical estimates of ε, we will evaluate the empirical studies that provide the estimates of $STPR$ for various countries.

4.2.1 The utility discount rate, ρ

The term ρ in equation (4.1) is supposed to reflect a preference of what is available now over what is expected in the future. It defines the valuation of future marginal utility by the current society and is referred to as the utility discount rate. However, the utility discount rate itself contains two conceptual elements. One is the pure time preference rate, δ and the other is the rate of decrease in *life chances*, L which includes the concept of the *catastrophe risk* (see Chapter 2, Section 2.3.5).

Thus we have

(4.2) $\rho = \delta + L$

It should be noted that some studies ignore life chances, L, in which case the utility discount rate (the time preference rate), ρ, and the pure time preference rate, δ, become synonymous, that is, in equation (4.2) ρ becomes equal to δ. Conversely, other studies assume the pure time preference rate, δ is zero and hence equate the utility discount rate, ρ with life chances, L.

Several studies have, using average death rates, estimated mortality-based measures of L, for various countries. For example, Kula (1984) estimates ρ, based on life chances, to be around 1% for the US and Canada. He rejects the argument that the pure discount rate is based on irrational and myopic behaviour on the part of individuals (see Chapter 2, Section 2.3.4) and makes the assumption that individuals discount their future utility by the probability of being alive at a given future date. He, thus, calculates the annual average survival probability for 'Mr Average' on the basis of the average annual death rates. However, Kula (1985) also estimated the average annual survival probability in the UK during 1900–1975 to be 2.2%. In a later study he revises this and provides a figure of 1.2% for the average annual probability of death in the UK in 1975 (Kula 1987).

Pearce and Ulph (1999) argue that for long-term projects the appropriate concept of risk would be the life chances of whole generations -even though they employ a method of calculation that is similar to that of Kula- and produce a figure of 1.1%. Using a similar argument to that of Kula, Evans and Sezer (2002) estimate the probability of survival of an average consumer to be very close to 1% in the UK. Evans (2004b) makes the point that the pure time preference rate is hardly amenable to empirical analysis and that the literature suggests, nevertheless, that it is within the range of 0.0 – 0.5%. So he uses an intermediate figure of 0.2 for δ for France without further justification. He also stipulates that the death rates in France are similar to those in the UK and other developed countries and suggests, based on the figures provided in the literature, a figure of 1% for L. Thus, his estimate of ρ for France is 1.2.

Kula (2004), in another mortality-based estimation, produces a figure around 1% for ρ for India. Evans and Sezer (2005) also employing the mortality-based approach use the annual average death rates in 2003 and 2004 for 19 European countries (with a range of 0.8% to 1.3%) to calculate ρ to be 1%. Moreover, Evans (2007) also uses a figure of 1% based on the approximate average annual death rate in 2002–2004 in 15 countries of the European Union. Percoco (2008) reports that 60% of the respondents opted for a zero rate pure time preference in 'The Survey of Households Income and Wealth' conducted in 2000 by the Bank of Italy but the weighted average figure is 5.87%. He argues not only that this is too high but also that it is a statistical anomaly, and reasons that both ethically and statistically a value of zero for δ would be the appropriate rate. Moreover, using recent mortality rates for Italy he also estimates L to be 0.98-1%. Thus, his figure for ρ is around 1%. Lopez (2008) also bases his estimate of ρ for nine Latin American countries on mortality rates and opts for a figure of 1% by arguing that most of the empirical studies regarding developed countries suggest a figure between 1% and 1.5% with a mid-point of 1.25%. He 'corrects' this figure downwards to 1% by arguing that Latin American countries have lower mortality rates than developed countries. However, he bases his argument on a dubious procedure which involves comparing the average death rate (0.6%) of nine Latin American countries with the average death rate (0.8) of selected nine developed countries. Azar (2009), following Evans and Sezer (2004), allows the pure time preference rate, δ to be equal to 0.5% and estimates L to have a value of 1.0% and therefore assigns a value of 1.5% to ρ for the US. In a similar fashion, Evans and Kula (2009) assume that δ must be around 0.3%. They add to this the estimated value of L, based on crude death rate figures, of 0.7% and thus produce a figure of 1% for ρ for Cyprus. The EU Guide to CBA of investment projects states that mortality-based statistics would indicate a 1% death rate for the majority of the countries and thus stipulates 1% as the overall value of ρ (European Commission 2008). In fact, the value of ρ varies between 1.0% and 1.4% for Cohesion Fund (CF) countries and between 0.9% and 1.1% for the non-Cohesion Fund (NCF) countries.

A variant of the concept of life chances is the concept of *catastrophe risk*. It is the risk associated with the fact that future generations may not be able to enjoy the returns of the intended investment due to natural or man-made disasters such as war, a nuclear disaster or a major and devastating earthquake, etc. Despite the fact that the quantification of such risk is not easy by its very nature, Scott (1989) stated that the changing life chance due to the risk of total destruction of a society was 1%. He also considers myopia (see Chapter 2, Section 2.3.5) and attributes a value of 0.5 to δ. Newbery (1992) suggests a figure of 1% which is supposed to be consistent with 'perceived risk of the end of mankind in 100 years'.

HM Treasury's Green Book defines the catastrophe risk as the occurrence of an event which would wipe out most of the benefits of projects and policies at a future date. It assumes, based on some sort of average of various estimates in the literature, 1% for catastrophe risk and 0.5% for pure time preference and thus suggests an overall value of 1.5% for ρ (HM Treasury 2003). OXERA (2002) also uses the averaging method and assumes the risk of death to be 1.1% in the current period with a projected change in the near future to 1.0%. Evans and Sezer (2004) stipulate a catastrophe rate of 1% for European countries and 1.5% for countries such as Japan (earthquakes), Australia (bushfire) and the US (terrorism). More recently, the Stern Review refers to the risk of extinction of the human race, possibly as a result of random events such as an outbreak of an epidemic, a nuclear war, or even a collision with a meteorite, which is supposed to be 0.1% (Stern 2007). It must be stated that all the figures relating to catastrophe rate are rather arbitrary since it is not possible to determine the value of the catastrophe rate from actual observations.

Table 4.1 shows the empirical estimates of ρ given by various studies. A significant feature of the figures in this table is that they are, with the exception of Kula (1985), either equal to 1.0 or very close to it. Four of the relatively high figures, i.e. Azar (2009),

Table 4.1 Utility discount rate (*ρ*) estimates

Study	Country	Theoretical basis	*ρ (%)*
Arrow 1995	N/A	Pure social time preference	1.0
Azar 2008	US	CR and MR	1.5
EC 2008	EU	MR	1.0
Evans 2004	FR	MR	1.2
Evans 2007	EU 15	MR	1.0
Evans and Kula 2009	Cyprus	CR and MR	1.0
Evans and Sezer 2002	UK	MR	1.0
Evans and Sezer 2004	6 major countries	CR	1.3
Evans and Sezer 2005	EU 19	MR	1.0
HM Treasury 2003	UK	CR and MR	1.5
Kula 1984	Canada and US	MR	1.0
Kula 1985	UK	MR	2.2
Kula 1987	UK	MR	1.2
Kula 2004	India	MR	1.0
Lopez 2008	9 LA countries	MR	1.0
Newberry	Any	CR	1.0
OXERA 2002	UK	Myopia & CR	1.5
Pearce and Ulph 1999	UK	MR	1.1
Percoco 2008	Italy	MR	1.0
Scott 1989	N/A	Myopia & CR	1.3
Stern 2007	N/A	CR	0.1

Source: Own compilation

Notes:

MR: mortality rate

CR: Catastrophe risk

HM Treasury (2003), OXERA (2002), and Scott (1989), are due to the fact that the figure includes both a positive pure time preference rate and a catastrophe rate. The fifth one by Evans and Sezer (2004) refers to the average of six countries. The three European countries have a ρ value of 1% each but the three non-European ones are assigned a high catastrophe rate of 1.5% for exceptional reasons stated in the previous paragraph.

4.2.2 The growth rate of consumption,

The rationale for including the growth rate of consumption in the discount rate is that marginal utility diminishes as consumption increases. So, as per capita consumption tends to increase over time, future generations will be richer than the current generation and therefore marginal utility of consumption falls. Thus the discount rate will depend upon the future growth rate and the elasticity of marginal utility of consumption (Potts 2002) as well as the utility discount rate. This effect is represented by the second term in equation (4.1), $\varepsilon.\ g$, that is, the product of the elasticity of marginal utility of consumption, ε and the annual growth in per capita consumption, g.

a) Alternative methods of estimating g

A common method of representing g is to generate the expected growth rates of per capita consumption over the next few decades. This is done by considering the consumption (or the GDP) growth of the past few decades and then taking an average of these projected figures. There are however, four technical approaches to this standard method:

1) One is to consider the past annual growth rates and then take an arithmetic average and the resulting growth rate would be the projected growth for future periods.

2) The second is the same as the previous one but the geometric instead of arithmetic mean is used. The geometric average growth rate of consumption over N years is given by equation (4.3).

$$(4.3) \quad \frac{C_t}{C_0} = (1+g)^N$$

where

C_t = real per capita consumption in the final year of the data period

C_0 = real per capita consumption in the first year of the data period

g = the average growth rate

N = the length of the data period in years

Solving for g will give

$$(4.4) \quad g = \left(\frac{C_t}{C_0}\right)^{\frac{1}{N}} - 1$$

3) The third method is to employ a semi-log regression model given in equation (4.5) below

$$(4.5) \quad LnC = \alpha + gt$$

where
C = per capita real consumption
α = a constant
t = the number of years in the data period
g = the growth rate of per capita real consumption,

and variable LnC_t, the log of observed consumption values, is regressed on variable (t), the time. The resultant estimate for the coefficient g is the projected annual growth rate.

4) Finally, the fourth method of estimating g is to calculate the 'required' rate of growth of consumption. This is done when the country for which the *STPR* is estimated is expected to converge economically with a country or group of countries at some future date.

The actual calculation of the required growth rate is given by equation (4.6)

$$(4.6) \quad X = A(1+g)^N$$

Taking logs and rearranging

$$(4.7) \quad g \approx \frac{LnX - LnA}{N}$$

where

A = the current real GDP *per capita* of the country concerned

X = the projected real GDP *per capita* in the target country in N year's time

g = the required growth rate of real GDP *per capita* in country A

For example, the new entrants into the EU are expected to catch up with the more affluent members of the EU at some future date, after all this is the rationale behind the Cohesion Fund. Thus, taking the EU-15 as the norm and projecting the average growth rate of EU-15 to some future date, the 'required' growth rate for a new entrant would be based on its current GDP and this projected growth rate if the country is assumed to be capable of achieving 100% convergence with EU-15 by that date. Alternatively, if less than 100% convergence can be assumed the required growth rate would be lower accordingly.

b) Empirical estimates

Table 4.2 shows estimates of g provided by various studies for different countries. Kula (1984, 1985 and 2004) prefers the regression method and estimates g using this method to be 2.3%, 2.8%, 2.0% and 2.4% for the US, Canada, the UK and India respectively. However, Pearce and Ulph (1999) argue that basing g on the expected growth of per capita consumption might be problematic. If leisure is substituted for consumption then g will be under- estimated. If, on the other hand, real per capita consumption fails to take into account the rising social costs of consumption, e.g. environmental damage, then g will be over-estimated. They suggest that taking very long-run growth rates will smooth out these considerations. Their estimate of g for the UK is 1.3% p.a. for the period of 1885-95 and 2.2% p.a. for 1951-92. OXERA (2002) agrees with Pearce and Ulph (1999) and considers a long data period of 100–180 years for the UK. Making use of the calculations for long term growth rates of GDP in the UK by Maddison (2001), it suggests a value of 1.3–1.6 for g. The UK government's latest Green Book (HM Treasury 2003) considers a shorter time period and also refers to Maddison (2001) in which the growth rate of output for the UK is estimated to be 2.1% for the period of 1950-98. However, the Green Book also considers a survey by the Treasury itself, and suggests a figure of 2% for g for the UK.

Table 4.2 Real per capita consumption growth rate (g) estimates

Study	Country	g (%)
Azar 2008	US	2.2
EC 2008	NCF countries CF countries	1.9 4.0
Evans 2004	FR	2.0
Evans 2007	Euro Zone	Cons. 2.09 GDP 2.06
Evans and Kula 2009	Cyprus	3.1
Evans and Sezer 2002	6 major countries	1.8
Evans and Sezer 2004	6 major countries	1.8
Evans and Sezer 2005	EU-15 2004 entrants	2.2 2.8
HM Treasury 2003	UK	2.0
Kula 1984	US Canada	2.3 2.8
Kula 1985	UK	2.0
Kula 2004	India	2.4
Lopez 2008	9 LA countries	2.5
OXERA 2002	UK	1.5
Pearce and Ulph 1999	UK	2.2
Percoco 2008	Italy	Cons. 1.8 GDP 2.1
Scott 1989	UK	2.2
Stern 2007	UK	1.3

Source: Own compilation

Evans (2004) applies the geometric average method of equation (4.3) to the data period of 1970- 2001 and calculates g for France as 2%. Interestingly, Evans (2007), using the same method applied to the data period of 1970 -2004, calculates the average growth rate for both real consumption *per capita* and real GDP *per capita* for the Euro Zone as 2.09% and 2.06%, respectively. Evans and Sezer (2004) calculate the average growth rate of real per capita household consumption between 1970-2001 for six major OECD countries (Australia, France, Germany, Japan, the UK, and the US) to be 2.1% for the European countries and 2.2% for the other three. In another study, Evans and Sezer (2005) calculate g for two different groups of EU countries. The figures for the EU-15 before 2004 expansion range from 1% for Denmark to 3% for Ireland with an average of 2.18%; and for the four new entrants in 2004, namely, the Czech Republic, Hungary, Poland and Slovakia, based on a shorter data period growth ranges from 1.4% for the Czech Republic to 4.6% for Poland with an average of 3.83%.

Lopez (2008) without explicitly stating which method he is employing provides estimates of g-values for nine Latin American countries basing his calculations on the growth figures of GDP for the data period of 1961-2006. He points out two types of problems involved in taking such a long time period. One is that many of the countries concerned witnessed negative growth rates in per capita consumption in the 1980s with the exception of Chile and Colombia and thus the period covering the 1980s could be regarded as an outlier. The second is that due to the reforms undertaken in the 1980s and 1990s, the future growth prospects could be quite different from those suggested by the trend based on the past forty odd years. Consequently, he considers different scenarios under which the projected average value of g for the nine Latin American countries varies between 2.4% and 4.1%.

Percoco (2008) states that the average growth rate of per capita GDP in Italy over the period 1980 to 2004 has been 2.1%, and adopts this figure for g for Italy. He also points out that if the average growth rate of per capita consumption over the same data period were used the value of g would be 1.8%.

Evans and Kula (2009), instead of using the past growth rates for Cyprus, estimate the projected growth rates for the EU-15 between 2007 and 2035 and calculate the required growth rate for Cyprus on the assumption that North Cyprus will achieve 90% convergence with the EU-15 by 2035 while South Cyprus will achieve 100% convergence.

The EU Guide to CBA of investment projects (EC2008) suggests that the best approach to the estimation of g would be to select an appropriate growth model for each economy and then to estimate a long-term development path. However, contrary to its own suggestion, it opts for a value based on past annual growth rates. Thus, g varies between 1.3% and 2.5% for NCF countries and between 3.5% and 4.5% for CF countries.

4.2.3 Empirical estimates of *STPR*

So what would be the appropriate *STPR* for public projects? Not surprisingly there is not a single rate emerging in the literature. However, there is convergence towards a fairly narrow band. Table 4.3 combines the empirical estimates of ρ and g that have been discussed above with the estimates of ε discussed in Chapter 3 to display the *STPR* figures provided for various countries by a variety of studies.

Kula (2004) uses regression analysis based on the FFF model to estimate a value for ε, employs a mortality-rate based model to calculate the pure time preference rate, and a 30-year time series data set to estimate an average growth rate for consumption and arrives at an estimated *STPR* of 5.2% for India. He argues that this is a reasonable result for India when one considers the fact that the interest rate on advances by commercial banks varies between 7-10%. Moreover, given the private sector profitability of 10-12%, he argues that following the British government's practice of halving the rate of profitability to arrive at a SDR, his figure of 5.3% for India is a reasonable one. In a later paper (Kula 2006), he criticises the British government's reduced (HM Treasury 2003) rate of 3.5% for the SDR by arguing that the value of ε is more likely to be around 1.6 and thus even with a conservative figure of 2.5% for the growth of income *per capita* and the government's own figure of 1.5% for the pure time discount rate, the *SDR* for the UK becomes 5.5%, which is much higher than the current official rate.

Evans and Sezer (2004) criticise the inconsistency of approach within the EU. For example, in France the *SDR* based on the marginal product of capital was 8% in real terms while Germany had applied only a 3% rate based on financial market data. In their study, they assign a value of 1% for ρ for France, Germany and the UK and 1.5% for Australia, Japan and the US (see Section 4.2.1 above) and calculate the value of g as 2.1% for the first three and 2.2% for the other three. In estimating ε values they adopt the revealed social values approach and employ a taxed-based model making use of the concept of equal absolute sacrifice of satisfaction to produce a figure ranging from 1.3 to 1.7. Based on these figures they estimate the average *STPR* for France, Germany and

Table 4.3 STPR estimates in various studies

Study	Country	ρ (%)	ε	g (%)	STPR (%)
Azar 2008	US	1.50	1.0	2.2	**3.7**
EC 2008	Non CF countries CF countries	1.0 1.3	1.5 1.5	1.7 3.0	**3.5** **5.5**
Evans 2004	France	1.2	1.3	2.0	**3.8**
Evans 2007	Euro Zone CF countries	1.0 1.0	1.0 1.0	2.1 4.0	**3.1** **5.0**
Evans and Kula 2009	Cyprus	1.0	1.3	3.1	**5.0**
Evans and Sezer 2002	UK	1.0	1.6	2.3	**4.7**
Evans and Sezer 2004	FR, GER, UK AUS(1), JAP, US	1.0 1.5	1.4 1.5	2.1 2.2	**3.9** **4.8**
Evans and Sezer 2005	EU 15 2004 Entrants (4)	0.9 1.3	1.6 1.4	2.2 2.8	**3.5** **5.2**
HM Treasury 2003	UK	1.5	1.0	2.0	**3.5**
Kula 1984(2)	US Canada	1.0 1.0	1.9 1.6	2.3 2.8	**5.4** **5.5**
Kula 1985	UK	2.2	0.7	2.0	**3.6**
Kula 2004	India	1.3	1.6	2.4	**5.2**
Lopez 2008	9 LA countries	1.0	1.5	2.5	**4.8**
OXERA 2002	UK	1.5	1.0	1.5	**3.0**
Pearce and Ulph 1999	UK	1.7	1.0	2.2	**3.9**
Percoco 2008	Italy	1.0	1.3	2.1	**3.7**
Scott 1989	UK	1.3	1.5	2.2	**4.6**
Stern 2007	UK	0.1	1	1.3	**1.4**

Source: Own compilation

Notes:

(1) AUS = Australia

(2) The actual formula used by Kula is $STPR = (1+g)^{\varepsilon}\left(\frac{1}{\rho}\right) - 1$. Also figures given in the table are rounded-up versions of those used by Kula. Thus the figures in the table are slightly higher than the original figures estimated by Kula

the UK to be 3.9% and the *STPR* for Australia, Japan and the US to be 4.8% (see Table 4.3)

Evans and Sezer (2005) extend their estimation of *STPR* to 19 EU countries divided into two separate categories, namely, the EU-15 and the Cohesion Fund (CF) countries (4). They estimate ρ to be 0.9 for EU-15 and 1.3 for CF countries. Their figure for g is 2.2% for the former and 2.8% for the latter. Their estimated values of ε are based on the income-tax method and vary between 1.3 for Demark and 2.0 for Ireland. Based on these figures, the average value of *STPR* is 3.5% for the EU-15 and 5.2% for the four new entrants in 2004. However, they also make the point that although the *STPR* differs across EU countries, the differences are not as large as those that exist between Germany (3%) and France (8%). They point out that if all rates were consistently based on *STPR* then the French discount rate would fall sharply to 3.2% and the German rate would be a percentage point higher

In a later study Evans (2007) reiterates the desirability of a common approach to the application of the social discount rates. He also points out that the French government revised its *SDR* reducing it to 3.5% in 2005, and that there is now near convergence between three important European countries, namely, the UK, France and Germany.

Percoco (2008) following Evans and Sezer (2002, 2004 and 2005) employs both the FFF and the income-tax models to estimate ε and produces two similar figures of about 1.3. His value of 2.1% for g is based on the average growth rate of per capita GDP over a data period of 1980-2004 but he notes that if the consumption growth instead of the growth of GDP were used the figure would be 1.8%. Using survey data and some interesting arguments (see Section 4.2.1) he assumes that the value of δ would be zero and that the value of ρ based on mortality rates would be equal to 1%. Thus, his estimate of the *STPR* for Italy varies between 3.69% and 3.83% depending on whether one uses the ε value from the demand study or the income-tax model. He argues therefore that his estimated *STPR* is 1.2% -1.3% lower than the official discount rate of 5% set by the Ministry of the Economy based on European Commission (2002) Guidance.

The EU Guide to CBA (European Commission 2008, Annex B, Table B.2) provides estimates of ρ, ε and g values for the CF and Non-CF countries individually and estimates the *STPR* value for each country, which ranges from 5.3% to 8.1% for the CF and from 3.1% to 4.1 for Non-CF countries. On this basis, it suggests a reference *SDR* of 5.5% for the CF and 3.5% for Non-CF countries for 2007-2013.

Lopez (2008), notwithstanding a discussion of the problems of structural breaks, using a long data period of 1961-2006, estimates g on the basis of growth rates of GDP of 9 LA countries and arrives at an average figure of 2.5%. He argues for a figure of 1% for ρ based on mortality rates; and using the income-tax method estimates an average value of 1.5 for ε. Thus, his average figure of *STPR* for 9 LA countries is 4.8%.

Azar (2009) states that there are three methods of measuring the *SDR* in a country. One is the specification of a benchmark financial rate, the second is the *STPR* approach, and the third is the opportunity cost of private investment approach. He states that the first approach is the one followed by the US Office of Management and Budget (OMB) but his preferred method is the third one. However, he then argues that if one used the *STPR* approach to the determination of the social discount rate in the US, it would be appropriate, following Evans and Sezer (2002), to assign a value of 1.5% to ρ. He then departs from tradition and suggests a value of 1.0 for ε based on a CAPM model (see Chapter 2, Section 2.3.3) of returns on stocks and dividends computed in an earlier paper of his (Azar 2008). Thus, he suggests that given that the US g is estimated to be 2.2%, the *STPR* value for the US would be 3.7%. He then proceeds to estimate the *SDR* for the US according to the opportunity cost approach on the assumption that markets are perfect and that public spending displaces private investment. His figure for *SDR* using this method is also 3.7%.

Evans and Kula (2009) estimate both the *STPR* and the *RWW* (see Section 4.3.1) for Cyprus based on the division of the island into the North (Turkish) and the South (Greek). They allow a small percentage figure for the pure time preference rate, δ, and around 0.77% for L based on death rates and thus assign a value of 1% for ρ. They estimate using the income-tax method an average ε value of 1.3%. They concede that the recent growth rate of GDP on average has been over 6% for N. Cyprus and over 2% for S. Cyprus. However, instead of using a figure for g based on the past growth rates, they take the projected growth rates for the EU-15 between 2007 and 2035 and calculate the required convergence growth rate for both North and South Cyprus. On the assumption that N. Cyprus will achieve 90% GDP convergence with the EU-15 by 2035 while S. Cyprus will achieve 100% convergence, they estimate g to be 4.37% for N. Cyprus and 2.65% for and S. Cyprus respectively, with an average of 3.08% for 'All Cyprus' (see Section 4.2.2 above). Based on these projections they estimate the *STPR* for N. Cyprus as 6.7% and for S. Cyprus as 4.5% which give an average figure of 5% for 'All Cyprus'.

An interesting feature of Table 4.3 is that there is a direct correspondence between the estimates of *STPR* produced by Evans and Sezer (2005) and those stipulated by the EU Guide to CBA (EC 2008) since both suggest a value of 3.5% for EU-15 (or non-CF countries) while for the CF countries (or 2004 entrants) the former proposes 5.2% and the latter 5.5%. Another interesting feature of Table 4.3 is that, the *STPR* estimates, with the exception of Stern (2007), which is an *STPR* figure concerning the very long term, have a relatively narrow range of variation. The lowest figure is 3% produced by OXERA (2002) for the UK and the highest figure is 5.5% produced by Kula (1984) for Canada and also suggested by the EU Guide to CBA (EC 2008) for Cohesion Fund (CF) countries.

Another feature of Table 4.3 is that Europe and America are fairly well represented but Asia only by three countries and Africa by none. There seems to be a gap in the *STPR* literature with respect to Africa. However, the developing countries of Africa and Asia appear to be favouring alternative approaches to discounting since there have been several studies to estimate an appropriate social discount rate using the SOC or the shadow price approach in Africa and Asia (Zhuang 2007). For example, Stern (1970) uses the shadow price approach suggested by Little and Mirrlees (1969) and a discount rate of 10% to evaluate a project undertaken by the Kenya Tea Development Authority. UNIDO (1980) estimates the *SDR* to be 12% for public investment in Pakistan based on the social opportunity cost of capital. However, the study prefers to apply an IRR of 10% based on market prices but adjusts this by using shadow prices regarding specific projects. Harberger and Jenkins (2002) estimate for Papua New Guinea the social discount rate, which they call economic opportunity cost of capital, to be 12%. India also uses an *SDR* of 12% while the rate used by the Philippines is 15%, both based on the SOC approach. In China the suggested social discount rate based on the weighted average of social time preference and returns on capital is 8% for short- and medium-term projects and a smaller rate is suggested for long-term projects (Zhuang 2007). A study by World Food Programme (2010) regarding the long run costs and benefits of particular safety net programmes assumes a 5% discount rate for Bangladesh, Ghana, Kenya, Laos, Mozambique, Malawi, Cambodia and Zambia. Another study by Winter-Nelson (1996) on the topic of aggregate economic growth in Africa also assumes a 5% social discount rate for 18 African countries.

Some international institutions also tend to favour the SOC approach to discounting. For example, in addition to UNIDO (1980) and World Food Programme (2010) mentioned above, the World Bank provides guidance on the calculation of the social discount rate in its Handbook on Economic Analysis of Investment Operations (Belli et al. 1998). The Handbook states that the discount rate should reflect not only the opportunity cost of capital but also the consumption rate of interest and advises a discount rate between 10–12% for cost–benefit analysis. The Asian Development Bank (1997) also suggests an economic internal rate of return of 10–12% to be used for economic analysis for all countries and all projects. Similarly, the Inter-American Development Bank advises that a discount rate of 12% be used as a measure of the economic opportunity cost of capital. (See also Section 2.3.4b and Section 2.3.5 in Chapter 2).

4.3 Regional welfare weights

The theoretical issues regarding regional welfare weights were discussed in Chapter 2 and it was established that the social welfare weight for a 'group' of people in a given 'population' is given by:

$$(4.8)\quad W_A = \frac{MU_A}{MU_B} = \frac{Y_A^{-\varepsilon}}{Y_B^{-\varepsilon}} = \left(\frac{Y_B}{Y_A}\right)^{\varepsilon}$$

where

W_A = the SWW attached to group A (the weight for group B = 1)

MU_A = marginal utility of income of group A

MU_B = marginal utility of income of group B

Y_A = per capita income in group A

Y_B = per capita income in group B

ε = the elasticity of marginal utility of income

It should be noted that 'group' here can include countries and regions as well as any set of individuals that can be distinguished on the basis of income such as women, a particular age group or an ethnic group. Also, that B is the numeraire which may refer to another 'group' or to the whole 'population'. For example, if *A* represented a region of a country, then Y_B could be either the per capita income in region B or the per capita GDP of the country.

The theoretical and empirical issues regarding ε were discussed in detail in Chapter 3. As for per capita income, the suitability of income to represent the wellbeing of an individual and the issue of equivalisation were discussed in Chapter 2. However, there is a further issue regarding the use of *RWW* which was touched upon in Chapter 2 but remains to be discussed. This is the issue of intra-regional income distribution. Most studies (see for example, Weisbrod 1972, Cowell and Gardiner 1999, Kula 2002, Evans *at al* 2005, Evans and Kula 2009) use per capita GDP as the basis of welfare in estimating the *RWW* regarding inter-regional comparisons. However, these studies implicitly make the assumption that there are not significant differences in the intra-regional distribution of income between regions. If such differences are, in fact, significant, then the *RWW* would be estimated incorrectly. Normally, a region with a higher degree of income inequality should, *ceteris paribus*, be assigned a larger welfare weight. For example, even if region *A* has a lower per capita income than region *B*, it might end up with a lower regional weight than *B* if its distribution of income is much more equal than that of *B*. In short, the extent of the intra-regional dispersion of incomes enhances the regional weight attached to that region. Thus, if per capita GDP figures were to be used to compare the social welfare of two regions, they would need to be corrected for inequality within each region.

One way of considering intra-regional income inequalities is to use an approach based on a concept attributed to Kolm (1969), which is the concept of 'equally-distributed equivalent income'. This concept relates to the income level that is required, if incomes were equally distributed, to produce the same welfare as the 'unequally-distributed income' (Boarini et al 2006). Consider equation (4.9),

$$(4.9) \quad EDEI = \left[\left(\frac{1}{n} \right) \Sigma \left(Y_i^{1-\varepsilon} \right) \right]^{\frac{1}{1-\varepsilon}}$$

where

EDEI = equally-distributed equivalent income

Y_i = equivalised disposable income of an individual in the i^{th} income class of the distribution (e.g. docile, quintile, etc), and i =1, 2...., n

ε = inequality aversion parameter (see Chapter 3, Section 3.3 for the relation between inequality aversion parameter and the elasticity of marginal utility of income)

If, however, the income classes are not equal in size (deciles, quintiles are of equal size by definition), we need to introduce weights into equation (4.9) in order to take account of the relative importance of each class. Thus, equation (4.9) is modified as follows.

(4.10) $EDEI = \left[\Sigma w_i \left(Y_i^{1-\varepsilon}\right)\right]^{\frac{1}{1-\varepsilon}}$

where

w_i = the relative size of i_{th} class

Equation (4.10) is similar to the Atkinson Index which was introduced in Chapter 3 (see Section 3.1.2).

In the context of *RWW* we would have the following.

EDEI =	equally-distributed equivalent income of the region concerned
w_i =	the relative population weight for each income class or province within a region,
Y_i =	per capita income of the i^{th} income class or province
ε =	the inequality aversion parameter.

It is clear that *EDEI* takes account not only of inter-regional differences in average income levels but also inter-regional differences in the relative dispersion of intra-regional income. The value of *EDEI* depends on three factors: the average income of the region, the degree of income dispersion within the region and the value of ε, that is, the degree of aversion to inequality. For a given average income of the region, the *EDEI* figure will be lower, the higher is the intra-regional dispersion of incomes and the greater is the aversion to income inequality. In other words *EDEI* varies directly with average income of the region but inversely with the degree of dispersion within the region and the extent of aversion to inequality.

One problem with the concept of *EDEI* is that it breaks down if the value of ε is unity. This problem can be solved by simply using equation (4.11) instead of (4.10) for this special case only.

(4.11) $Log(EDEI) = \Sigma w_i \log Y_i$

A practical solution to the problem would be still to use equation (4.10) but letting the value of ε be equal to 0.99 or 1.01 which would provide an answer very close to that of equation (4.11) [see Evans and Kula 2009].

If we substitute the *EDEI* figures for the per capita income figures in equation (4.8) we obtain

$$(4.12)\quad RWW_A = \left(\frac{EDEI_B}{EDEI_A}\right)^{\varepsilon}$$

which gives the regional welfare weight for region A *vis-à-vis* region B,

where

RWW_A = regional welfare weight attached to region *A*
$EDEI_A$ = equally-distributed equivalent income of region *A*
$EDEI_B$ = equally-distributed equivalent income of region *B*

4.3.1 Empirical estimates of regional welfare weights

As pointed out, all empirical studies with the exception of Sezer (2007) base the estimate of social/regional welfare weights on average (equivalised or otherwise) income. For example, Weisbrod argues that economists providing criteria for decision-makers regarding public expenditure should take into account not only the economic efficiency of projects but also their distributional impacts. Referring to the CBA regarding the Beaver Creek Project in Ohio, he criticises the assumption that the recreational benefits of the project are equally distributed among the recipients. He then, in an effort to illustrate how the distributional equity considerations can be incorporated into the CBA, divides the recipients into four groups according to ethnic background and income; namely, poor whites, non-poor whites, poor nonwhites and non-poor nonwhites, on the basis of population-weighted incomes earned on average by these groups. He then estimates the welfare weights for these groups and applies these weights to the original CBA to show how the ranking of the projects changes from that without the welfare weights.

Kula (2002) in a pioneering study estimates regional welfare weights for 17 states of India for 1971/72, 1981/82 and 1991/92 on the basis of per capita income and an ε value of 1.64 in accordance with equation (4.8). Thus, Y_A represents the per capita income of each of the 17 states and Y_B the per capita income of India as a whole. In 1991/92 the poorest state Bihar had an average income which was 21% of the richest state Punjab.

Consequently, the welfare weight for Bihar, 2.92 was more than seven times as high as that for Punjab, 0.41. However, the study implicitly assumes that intra-regional distribution of income is similar in all 17 states.

Evans *et al* (2005) also assume that the intra-regional dispersion of income is similar between the four countries of the UK and calculate, on the basis of per capita income and an ε value of 1.60, welfare weights for each country using the per capita income of the UK as the numeraire. The poorest region, Northern Ireland is allocated a welfare weight of 1.45, followed by 1.39 for Wales, 1.03 for Scotland and 0.97 for the richest region England.

Sezer (2006) following a similar procedure to those above, provides welfare weights for seven regions of Turkey for 2001 based on per capita incomes and an ε value of 1.25 which is calculated using the tax-based method (see Chapter 3). The poorest region Eastern Anatolia is attached a welfare weight of 2.63 while Marmara Region, the richest one, has a regional weight of 0.64. Thus the poorest region with per capita income ($990), which is roughly one third of that of the richest region ($3050), has a welfare weight which is more than 4 times as high as that of the richest one.

However, Sezer (2007) in another study regarding Turkey departs from tradition and does take into account the differences in the income distribution between different regions. This is done by using income figures based on the concept of equally-distributed equivalent income (*EDEI*) as opposed to straight per capita income as explained above. Therefore the relevant equation in the estimation of the regional welfare weights in Turkey becomes equation (4.12) as opposed to equation (4.8), and accordingly the welfare weight attached to a region *vis-à-vis* another region increases. That is, the use of *EDEI* as opposed to per capita income enhances the welfare weight of a relatively poor region if the intra-regional income distribution is also less equal in that region.

Finally, Evans and Kula (2009) calculate regional welfare weights for Northern and Southern Cyprus. They state that they would rather use the *EDEI* figures as the basis for the calculation of regional welfare weights but the lack of relevant data forces them to employ per capita GDP in PPS figures instead. Their preferred estimate of ε is 1.3 based on the tax-method of calculation. They also calculate that average living standards based on PPS GDP in figures in 2007 are about 77% higher in S. Cyprus than they are in N Cyprus. Thus, employing equation (4.8) they estimate the welfare weight for N Cyprus to be 2.1. (S Cyprus = 1)

4.4 Concluding remarks

The theoretical issues surrounding the concepts of *SDR* and *SWW* were covered in Chapter 2 and both the theoretical and empirical aspects of the elasticity of marginal utility of income, ε, in Chapter 3. Thus, this chapter has focused on the empirical issues relating to the estimation of the components of *STPR*, such as the utility discount rate (ρ), the pure time preference rate (δ), life chances (L), the growth rate of consumption (g) as well as the empirical work regarding the estimation of *STPR* itself. It established that the empirical estimates of *STPR* figures varied within a fairly narrow band of 3% and 5.5%, and also that there is a good degree of agreement between academics and the policymakers regarding the *STPR* in Europe.

The chapter then moved on to explore the issues regarding the use of per capita income as the basis for welfare in estimating *SWW*, and to examine critically the empirical studies calculating regional welfare weights for various countries, the value of which ranging from 0.41 to 2.63.

Thus, both the theoretical and empirical issues regarding the *SDR* and *SWW* have now been covered. Consequently, Chapter 5 will focus on the estimation of the elasticity of marginal utility of consumption, ε, for Turkey using two different methods, namely demand analysis for a want-independent good and the tax-based model as explained in Chapter 3.

Chapter 5 Estimation of the Elasticity of Marginal Utility of Income (ε) for Turkey

5.1 Introduction

This chapter is devoted to the estimation of the elasticity of marginal utility of income (ε) for Turkey using two different methods. Firstly, a suitable demand model such as CEM or AIDS (see below) will be employed in the context of the FFF (see Chapter 3, Section 3.5.2) approach to estimate the income and compensated-price elasticities for a want-independent composite commodity, namely food, in order to calculate the value of ε.

Secondly, an income-tax model will be employed using the Turkish progressive tax system to estimate ε. As was discussed in Chapter 3, ε represents the societal weight attached to the inequality of income distribution (a high value of ε indicating a greater weight attached to inequality), and it is reflected in a government's aversion to income inequality as revealed by the progressivity of the income tax structure.

The results of these two methods will be evaluated to select an appropriate value for the elasticity of marginal utility of income (consumption) to be used in the calculation of the social discount rate and the regional welfare rates for Turkey. These key welfare parameters are then applied in long-term project evaluation which is the subject matter of Chapter 6.

5.2 The FFF approach: the CEM and AIDS models

The literature pertaining to the FFF approach to the estimation of ε was explored in Section 3.5.2 of Chapter 3 which included a detailed discussion of the theoretical and empirical considerations regarding this method. As was pointed out therein, empirical studies use a variety of demand models designed to estimate the income and the compensated price elasticities of demand for a preference-independent good, which, in turn, are used to calculate ε. It was also indicated that food was chosen as the representative of a preference-independent good best fitting the assumption of additive separability in the underlying utility function. Among the models based on demand for food as the want-independent good, two appear to be most popular. One of these models is the Almost Ideal Demand Systems (AIDS) which is developed by Deaton and Muellbauer (1980a and 1980b) and involves the estimation of complete demand systems regarding food (see, for example, Blundell *at al* 1993, Blundell 1988, Evans 2004b, and Percoco 2008). The other is called the Constant Elasticity Model (CEM) which is based on a single equation system (see, for example, Evans 2005, 2004a, Evans and Sezer 2002, Kula 1985 and 1984 and Percoco 2008). It is relatively easy to test for symmetry and homogeneity in both models but the AIDS model is more flexible since it does not put any restriction on the elasticities and has the advantage of being easily extended to many product groups.

The answer to the question of which is the most appropriate model specification depends on which model produces the best co-integrating relationship between the relevant variables (see below). Before explaining the co-integration techniques employed and interpreting and commenting upon the results, however, it would be useful to set out the theoretical structure of each model explicitly.

5.2.1 The CEM and the demand for food

The CEM involves regressing the dependent variable 'food' on the independent variables 'total consumption' and the 'relative price of food'. Formally,

$$(5.1) \qquad F_{87} = AC_{87}^{\eta}\left(\frac{P_F}{P_{NF}}\right)^{\gamma} P_{NF}^{\theta} U$$

where

F_{87} = household expenditure on food expressed *per capita* and at constant 1987 prices
C_{87} = household expenditure on all goods and services expressed *per capita* and at constant 1987 prices

$\left(\frac{P_F}{P_{NF}}\right)$ = an index of the relative price of food to non-food (1987 = 100)

P_{NF} = an index of the price of non-food (1987 = 100)
U = the error term

Taking logs we obtain

$$(5.2) \quad LnF_{87} = LnA + \eta LnC_{87} + \gamma Ln\left(\frac{P_F}{P_{NF}}\right) + \theta LnP_{NF} + LnU$$

where

η = expenditure (income) elasticity of demand (IED)

γ = compensated own price elasticity of demand (PED)

θ = compensated cross-price elasticity of demand (CPED)

Equation (5.2) indicates that the log of expenditure on food *per capita* is regressed on the log of household consumption expenditure *per capita* and the log of the relative price of food. The log of the price of non-food is included as a test for homogeneity.

If the model specification is correct we would expect the parameters η and γ to be statistically significant with the correct signs. That is, η should be positive and γ negative, and normally both numerically less than unity. Moreover, if the assumption of homogeneity holds, then we would expect θ to be both statistically and numerically insignificant.

5.2.2 The AIDS model and the demand for food

The AIDS model of the demand for food contains the same independent variables as those of the CEM but the dependent variable is the share of food in household consumption expenditure.

Formally,

$$(5.3) \quad SF_{87} = AC_{87}^{b}\left(\frac{P_F}{P_{NF}}\right)^{c} P_{NF}^{d}U$$

Taking logs on the right hand side

$$(5.4) \quad SF_{87} = LnA + bLnC_{87} + cLn\left(\frac{P_F}{P_{NF}}\right) + dLnP_{NF} + LnU$$

where

SF_{87} = budget share of expenditure on food expressed at constant 1987 prices

Equation (5.4) indicates that the budget share of food is regressed on the log of per capita household consumption, the log of the relative price of food and the log of the price of non-food.

However, in this model the income and the price elasticities are not represented by the parameters *b, c* and *d*, but are calculated according to the following formulae:

(5.5) $IED = \eta = 1 + \left(\frac{b}{\overline{\overline{SF}}} \right)$

(5.6) $PED = \gamma = \frac{c}{\overline{\overline{SF}}}$

(5.7) $CPED = \theta = -\frac{(c-d)}{\overline{\overline{SF}}}$

In other words, the interpretation of the coefficients is different from that in the CEM. Here *b, c* and *d*, represent a factor by which the budget share of food changes as household consumption, the relative price of food and the price of non- food change, respectively. Thus, we would expect these coefficients to have a negative sign since the budget share of food should decline as household consumption (income) and the relative price of food increases.

5.2.3 The data

The data used for the estimation of ε using the FFF method (see Appendix A) are provided by the Turkish Statistical Institute (TSI) made available through the internet (see TürkStat 2010a). TSI publishes a time series of expenditure on GDP, which contains the subsections of household consumption expenditure and expenditure on food, at both current prices and constant 1987 prices on a quarterly basis covering the period 1987 – 2007 (first three quarters). The data published by the TSI are estimated according to European System of Accounts (ESA) 1995.

The data series for the non-food category is obtained by simply subtracting per capita expenditure on food from per capita household consumption expenditure. The budget share is calculated by simply dividing the per capita expenditure on food by per capita household consumption expenditure. The food price index is obtained by dividing per capita expenditure on food at current prices by that expressed at constant prices. The price index for non-food is obtained using the same procedure. Then these series are converted into their natural log values –except the budget share- to obtain the variables used in the CEM and the AIDS models. These are

LnF_{87} = per capita real expenditure on food expressed in natural logs

SF_{87} = the budget share of food

LnC_{87} = per capita real consumption expenditure expressed in natural logs

$Ln\left(\frac{P_F}{P_{NF}}\right)$ = the relative price of food in natural logs

LnP_{NF} = the price of non-food in natural logs

5.3 The cointegrating approach to the demand for food and ε

Before we employ the CEM and the AIDS models to obtain the relevant elasticities in order to calculate the value of ε, we must first investigate and report the time-series properties of the data. More precisely, we must determine whether the time series we are using is stationary or not. A time series variable is said to be (weakly) stationary if its mean and variance are fixed and its covariance only depends on the lag of the two time periods but not on the actual time at which the covariance is calculated. This is also known as *covariance* stationarity. The regression method of OLS using time series data assumes that the underlying time series is stationary, i.e. variables are I(0). Using time series data on the assumption that it is stationary when in fact it is nonstationary would result in inconsistent OLS estimators since the assumption of fixed variance is violated. Also the diagnostic tests such as t and F statistics will not have their standard limiting distributions. Consequently, the coefficients of the regressors may appear to be statistically significant when in fact they are not. This situation is referred to as *spurious regression* (Dougherty 2007).

However, it is generally accepted that many economic variables are non-stationary, that is, they are usually of the type of I(1) and occasionally I(k) where k>1 (Gujarati 2003 and Harris 1995). Does this mean we cannot use the regression analysis to estimate the relevant elasticities in a FFF model? Fortunately, it does not, since it is still possible to use regression even if the time series data are nonstationary provided that a cointegrating relationship exists between the variables concerned. Put differently, when two or more nonstationary variables are related to each other in a long-run equilibrium, the resultant residuals will be stationary which will make it possible to apply regression analysis albeit not the simple OLS. Thus it is important to establish whether variables in a specified model are stationary or not.

5.3.1 Test for stationarity

There are several ways of determining whether a time series is stationary or not. One of them is graphical analysis. It is possible to observe the presence or absence of an upward or downward trend in a time series by simply plotting it against time. The presence of any trend will provide an intuitive indication about the non-stationarity character of the series.

Another method is to calculate the autocorrelation function (ACF) which is given by the ratio of the covariance of the series to the variance at a given lag, say *k*. Thus, we have

$$(5.8) \quad \Omega_K = \frac{\phi_K}{\phi_0}$$

where

Ω_K = the autocorrelation coefficient, $-1 < \Omega < 1$
Φ_k = covariance at lag k
Φ_0 = variance

Then the statistical significance of Ω_K can be tested, on the basis of its sampling distribution being *normal*, for the null hypothesis of $\Phi_k = 0$. The rejection of the null hypothesis would indicate a non-stationary time series.

A more formal and probably the most popular method of detecting nonstationarity is the *unit root test* (Dougherty 2007, Gujarati 2003 and Harris 1995). The standard unit root test, which is also referred to as the Dicky-Fuller (DF) test, is based on the following model:

(5.9) $X_t = \beta_1 + B_2 X_{t-1} + \beta_3 t + u_t$

where

X_t = is a time series variable
t = time
u_t = error term.

So

if $\beta_1 = 0$, $\beta_2 = 1$ and $\beta_3 = 0$

then, X_t is nonstationary [or difference-stationary since ($\Delta X_t = X_t - X_{t-1} = u_t$) will be stationary] and is also referred to as *pure random walk.*

If $\beta_1 \neq 0$, $\beta_2 = 1$ and $\beta_3 = 0$

then, X_t is a *random walk with drift* and therefore nonstationary.

If $\beta_1 \neq 0$, $\beta_2 = 0$ and $\beta_3 \neq 0$

then X_t is nonstationary with a deterministic trend or trend-stationary since detrending will make the series stationary.

Finally, if $\beta_1 \neq 0$, $\beta_2 = 1$ and $\beta_3 \neq 0$,

then X_t is nonstationary and referred to as a *random walk with drift* and *deterministic trend.*

The DF test and the Augmented Dicky-Fuller (ADF) test (the latter is an extension of the former to situations where the error term is serially correlated, which is corrected by adding enough lagged difference terms) are based on the *tau* (τ) statistic which is a version of the *t*-test.

If we subtract X_{t-1} from both side of equation (5.9) we obtain

$$(5.10)\quad \Delta X_t = \beta_1 + (\beta_2 - 1)X_{t-1} + \beta_3 t + u_t$$

The *tau* test is conducted by setting the null hypothesis of nonstationarity against the alternative hypothesis of stationarity, that is

$H_0 : (\beta_2 - 1) = 0$
$H_1 : (\beta_2 - 1) < 0$

Note that if the null hypothesis is not rejected then we would have $\beta_2 = 1$ which would indicate a form of random walk (Gujarati 2003).

5.3.2 Results of the unit root tests

The results of the stationarity tests on the variables used in the CEM and the AIDS models obtained by using the statistical package Microfit are given below in Table 5.1.

Table 5.1: The ADF tests for the variables of the CEM and the AIDS models

	Constant , no trend		*Constant and trend*	
Significance level	1%	*5%*	*1%*	*5%*
Critical (τ) values	-3.53	*-2.90*	*-4.08*	*-3.48*
Variables	Estimated (τ) values			
LnF_{87} (7)	-0.45		-1.15	
LnC_{87} (7)	-0.33		-2.02	
LnRP (1)	-5.20		-5.55	
LnP_{NF} (1)	-3.59		-5.58	
SF_{87} (1)	-0.37		-1.52	

As explained above, both the CEM and the AIDS models have the same regressors, namely, (*LnC_{87}*), (*LnRP*), and (*LnP_{NF}*); but the regressand in the CEM is the real amount of expenditure *per capita* on food (*LnF_{87}*), while in the AIDS model, it is the share of food in consumption *per capita* (SF_{87}). As can be observed from Table 5.1, the null hypothesis of nonstationarity holds, even at the 1% significance level, for the dependent variable in both models as well as for the first regressor, namely, (LnF_{87}), (SF_{87}), and (LnC_{87}). The optimum lag lengths for these three variables, chosen according both Schwarz Bayesian (SB) and the Akaike Information (AI) criteria, are (7), (7) and (1) respectively. Thus we assume that these three variables are all I (1).

In the case of the two price variables, however, the null hypothesis of nonstationarity has to be rejected and therefore we assume that ($LnPR$) and (LnP_{NF}) are both I (0).

5.3.3 The ARDL approach to cointegration

It is generally accepted that a linear combination of a mixture of variables, some with unit roots and some without, will be nonstationary (Harris 1995). More precisely, a linear combination of a mixture of I(0) and I(1) variables will itself be I(1). Since the variables in our model are exactly of this nature, both the CEM and the AIDS equations will themselves be I(1) and therefore carry the risk of spurious correlation. However, if a long-run equilibrium relationship exists between the variables then the variables concerned are said to be cointegrated and therefore it would be possible to employ regression analysis to obtain the estimates of the relevant parameters (see Section 5.3).

Two of the most popular approaches to cointegration are Vector Autoregressive Regression (VAR) and Autoregressive Distributed Lag (ARDL) models. The former is preferred if all the variables in the model are I(1). If, however, the variables are a mixture of I(0) and I(1), then the most suitable model is ARDL which would provide estimation of super-consistent long-run parameters (De Vita & Abbott 2004, Pesaran 1997 and Pesaran & Shin 1995). The additional advantage of the ARDL model is its flexibility with respect to lag structure (Evans 2005 and 2008).

a) The statistical evidence

Table 5.2 below provides the results and the supporting statistics for the CEM model and Table 5.3 does the same for the AIDS model. As can be observed from the comparison of the two tables, in the ARDL approach to cointegration, the CEM outperforms the AIDS model in some respects but the latter produces better results in others.

Table 5.2: Supporting Statistics for the CEM

Diagnostic Tests				
Test statistics	*LM version*		*F version*	
Serial Correlation	CHSQ (4) = 5.3071	[.257]	F(4, 54) = 1.0280	[.401]
Functional Form	CHSQ (1) = .031089	[.860]	F(1, 57) = .023638	[.878]
Normality	CHSQ (2) = .80138	[.670]	Not applicable	
Heteroscedasticity	CHSQ (1) = 3.7723	[.052]	F(1,73) = 3.8661	[.053]

Error Correction Model				
	Coefficient	*Standard Error*	*T-Ratio*	*[Prob]*
ecm(-1)	-.55692	.14876	-3.7438	[.000]

Estimated Long Run Coefficients				
Regressor	*Coefficient*	*Standard Error*	*T-Ratio*	*[Prob]*
LnA	-1.3509	0.19052	-7.0907	[.000]
LnC_{87}	η **= 0.6982**	0.12612	5.5361	[.000]
$Ln\ (P_F\ /P_{NF})$	γ **= - 0.2041**	0.07353	-2.7762	[.007]
LnP_{NF}	θ **= - 0.01229**	0.00589	-2.0878	[.041]

Notes: The statistics in the table refer to the regression analysis based on the equation below

$$LnF_{87} = LnA + \eta LnC_{87} + \gamma Ln\left(\frac{P_F}{P_{NF}}\right) + \theta LnP_{NF} + LnU$$

The 95% confidence intervals for the two elasticities for 59 degrees of freedom are given below.

For η: 0.6982 ± $t_{0.025}$ (s.e) = 0.6982 ± (2.00) (0.1261) = 0.6982 ± 0.2522, i.e. (0.45) – (0.95)

For γ: 0.2041 ± $t_{0.025}$ (s.e) = -0.2041 ± (2.00) (0.0735) =-0.2041 ± 0.1470, i.e. (-0.35) – (-0.06)

Table 5.3: Supporting Statistics for the AIDS model

Diagnostic Tests				
Test statistics	*LM version*		*F version*	
Serial Correlation	CHSQ(4) = 6.1208	[0.190]	F(4, 49) = 1.0886	[0.373]
Functional Form	CHSQ(1) = 0.32796	[0.567]	F(1, 52) = 0 .22839	[0.635]
Normality	CHSQ(2) = 1.1886	[0.552]	Not applicable	
Heteroscedasticity	CHSQ(1) = 0.24593	[0.620]	F(1, 73) = 0.24016	[0.626]

Error Correction Model				
	Coefficient	*Standard Error*	*T-Ratio*	*[Prob]*
ecm(-1)	-0.40628	0.17258	-2.3541	[0.022]

Estimated Long Run Coefficients				
Regressor	*Coefficient*	*Standard Error*	*T-Ratio*	*[Prob]*
LnA	0.20886	0.065872	3.1707	[0.003]
LnC_{87}	**b = -0.13262**	0.043795	-3.0282	[0.004]
$Ln\ (P_F\ /P_{NF})$	**c = -0.066207**	0.032744	-2.0220	[0.048]
LnP_{NF}	**d = -0.0034039**	0.0020841	-1.6333	[0.108]

Notes: The statistics in the table refer to the regression analysis based on the equation below

$$SF_{87} = LnA + bLnC_{87} + cLn\left(\frac{P_F}{P_{NF}}\right) + dLnP_{NF} + LnU$$

Elasticities

$IED = \eta = 1 + \left(\frac{b}{\overline{SF}}\right)$ = 1 + (-0.1326 / 0.3688) = 1+ (-0.3595) = 0.64

$PED = \gamma = \frac{c}{\overline{SF}}$ = -0.0662 / 0.3688 = -0.18

$CPED = \theta = \frac{-(c-d)}{\overline{SF}}$ = -(-0.0662 + 0.0034) / 0.3688 = 0.17

The 95% confidence intervals for the two parameters of *b* and *c* for 54 degrees of freedom are given below.

For b: -0.1326 $\pm$ $t_{0.025}$ (s.e) = 0.1326 $\pm$ (2.00)(0.0438) = -0.1326 $\pm$ 0.0876, i.e. (-0.2202) – (-0.0450)

For c: -0.0662 $\pm$ $t_{0.025}$ (s.e) = -0.0662 $\pm$ (2.00)(0.0327) = -0.0662 $\pm$ 0.0654, i.e. (-0.1316) – (-0.0008)

Therefore the confidence intervals for the elasticities are

For η [1+(-0.2202 / 0.3688)] – [1 +(-0.0450) / 0.3688] = (0.40) – (0.88)

For γ [-0.1316 / 0.3688] – [-0.0008 / 0.3688] = (-0.360) – (-0.002)

The optimum lag structure, selected according to three different criteria, namely, the Schwarz Bayesian (SBC), the Akaike Information (AIC) and the Hannan-Quinn (HQC) criteria, of the ARDL model based on equation (5.2) is (8,0,0,5) with respect to the variables in the order which they appear in the equation. The optimum lag structure, selected according to the same criteria, for equation (5.5) is the (8, 5, 0, 5)

Both models pass the diagnostic tests regarding homoscedasticity, normality, functional form and absence of serial correlation. However, the CEM performs better with respect to the tests for normality, correct functional form and absence of serial correlation while the AIDS model outperforms the CEM with respect to homoscedasticity.

Both models also pass the *t-test* regarding the validity of the error correction model indicating a cointegrating relationship between the demand-for-food variables. The equilibrium adjustment speed is just under two quarters for the CEM and just over two quarters for the AIDS model.

As for the coefficients on the income and relative price variables in the long run relationship for the demand for food, these are shown, together with supporting statistics, for both models in the section 'Estimated Long Run Coefficients' in Tables 5.2 and 5.3 respectively. The income coefficient is significant with the correct sign in both models but the statistical significance is stronger in the case of CEM. The coefficient for the relative price variable also has the correct sign in both models, however, its significance is supported at 1% level in the CEM but only at 5% in the AIDS model. As far as the confidence interval at 95% significance level is concerned, the results appear to be very similar in percentage terms for the income elasticity for both models; for the price elasticity, the CEM appears to perform slightly better.

As for the assumption of homogeneity, it is well supported in the AIDS model since the coefficient of (LnP_{NF}) appears to be insignificant even at the 10% level and the numerical value is very small. In contrast, the assumption of homogeneity is not strongly supported in the CEM since its numerical value is higher -but still quite small- and only becomes insignificant at the 1% level.

It is noted, of course that, although the coefficients of the variables LnC_{87} and $Ln(P_F/P_{NF})$, namely, η and γ, are themselves the income and the compensated price elasticities in the CEM, b and c in the AIDS model are not the elasticities *per se*, but the coefficients on which the calculations of the elasticities are based, as indicated in the last section of Table 5.3. A comparison of the relevant elasticities in both tables reveals that they are quite close, since the values for the compensated price elasticity in the CEM and the AIDS models are 0.20 and 0.18 respectively. The corresponding figures for the income elasticity are also fairly close with values of 0.70 and 0.64.

b) The implied ε values

It has been established in Chapter 3, Section 3.5.2 that the elasticity of marginal utility of income (consumption) is calculated as follows:

$$(5.11) \quad \varepsilon = \frac{\eta(1-\omega\eta)}{\gamma}$$

where

ε = the elasticity of marginal utility of income (consumption)
ω = the share of food in household consumption
and η & γ are the income elasticity and the compensated own price elasticity of demand for food, respectively.

Therefore, substituting the estimated values of η & γ from Table 5.2 into equation (5.11) we obtain

$$(5.12) \quad \varepsilon = \frac{\eta(1-\omega\eta)}{\gamma} = \frac{0.6982[1-(0.3688)(0.6982)]}{0.2041} = 2.54$$

Similarly, substituting the estimated values of η & γ for the AIDS model into equation (5.11) we get

$$(5.13) \quad \varepsilon = \frac{\eta(1-\omega\eta)}{\gamma} = \frac{0.64[1-(0.3688)(0.64)]}{0.18} = 2.72$$

Thus, we have

ε = 2.54 for the CEM, and

ε = 2.72 for the AIDS model.

As can be observed they are different but rather close and average out as $\varepsilon = 2.63$. This is well within the range of the ε values estimated in the demand-for-food studies, as indicated in Table 3.1 of Chapter 3, but relatively high in the ranking in terms of the ε values obtained in more recent demand studies.

5.4 The income-tax approach to the estimation of ε

In this approach a simple model can be employed to estimate ε. The model, as discussed in Chapter 3, Section 3.5.3, is based on two key assumptions. One is that the structure of the income tax rates of a country is at least implicitly based on the principle of equal absolute sacrifice of satisfaction, and the other is that the underlying social utility function is iso-elastic. Thus, an estimate of ε can be obtained according to the formula set out in equation (5.14) below.

$$(5.14) \quad \varepsilon = \frac{\ln\left[1 - t(Y)\right]}{\ln\left[1 - \frac{T(Y)}{Y}\right]}$$

where

$t(Y)$ = the marginal tax rate

$T(Y) / Y$ = the average tax rate

In order to estimate the value of ε for Turkey according to this model, OECD (2010) data on personal income taxation have been applied to equation (5.14) above. The Turkish personal income tax system has been made gradually less progressive over recent years. There were six different marginal tax rates ignoring the social security contributions (SCC), namely 15%, 20%, 25% 30%, 35% and 40% applying to six different income brackets in 2004. Then the top marginal rate was abolished in 2005 and the highest threshold was reduced from YTL 140 000 to YTL 78 000 accordingly. In 2006 there was a further adjustment involving only four different marginal income tax rates, namely, 15%, 20% 27% and 35%. This is the current situation regarding personal income taxation in Turkey (see Table 5.4).

The calculated figures relating to equation (5.14) together with the associated ε values are given in Table 5.4. The calculations are based on the data provided by the OECD (2010) regarding income tax in different countries.

Table 5.4: Estimated ε in the tax model for Turkey

Y^* (YTL)	Y (YTL)	t	T/Y	$-Log([1-t)$	$-Log(1-T/Y)$	ε
Less than 7 800	3 900	0.150 (0.300)	0.150 (0.300)	-0.162519 (-.356675)	-0.162519 (0.356675)	1.000 (1.000)
7 800 -19 800	13 800	0.200 (0.350)	0.172 (0.322)	-0.223144 (-0.430783)	-0.188742 (-0.388608)	1.182 (1.109)
19 801 - 44 700	32 250	0.270 (0.420)	0.215 (0.365)	-0.314711 (-0.544727)	-0.242072 (-0.454130)	1.300 (1.199)
44 701 - 94700	69 700	0.350 (0.500)	0.273 (0.423)	-0.430783 (-0.693147)	-0.318829 (-0.549913)	1.351 (1.260)
					ε =	**1.208 (1.142)**

Source: OECD (2010), Table 1 and Table 4

Notes:

1) There are no income taxes in Turkey other than those of the central government.

2) There is a single rate of 15% for SSC which starts at YTL 7482.60 (the minimum wage set for 2008). There is also a ceiling at YTL 48637.80, i.e. for earnings above this amount the SSC is 15% of the ceiling.

Column one shows the taxable income bands based on the statutory thresholds set for 2008, the latest year for which the data are available. A figure of YTL 94700 is chosen to enable us to have a band and therefore a mid-point at the upper end of the distribution. It is calculated *pro rata* regarding the two previous income bands. Column two shows the midpoints of the income bands on which the calculations are based. The marginal tax rates (t) are given in column three. These are the central government statutory personal income tax rates for wage income. The information in column three is applicable for a single person without dependants. The average tax rates are given in column four. Their calculation is based on the information given in columns two and three. The figures in brackets are the tax rates plus the social security contributions rate, 15%, which is uniform throughout the income distribution (see notes for Table 5.4)

The last column shows the value of ε for each income band and the figure 1.208 is the average ε value. The value of ε when SSC are included goes down to 1.142 because the inclusion of the SSC reduces progressivity.

It is possible to argue that estimates of ε based on income tax rates without SSC adhere more to the principle of equal absolute sacrifice of satisfaction since after all the rationale for the latter is quite different from that for the former. From the government's perspective, SSC are imposed to finance health care which is a need-based rather than income-based benefit. Thus, one could argue that estimating the value of ε entirely on the basis of income tax rates, would be a more appropriate method since it would be more in keeping with the underlying principle involved.

Referring back to Chapter 3, Table 3.1 would reveal that our estimate of ε = 1.208 is at the lower end of the range of the estimated values.

5.5 A comparison of results

This chapter has exclusively been devoted to the estimation of a value for the all-important parameter in the *STPR* formula as well as the welfare weights, namely ε, by using two different methods that are commonly employed in many studies, i.e. the FFF approach and the tax model.

The FFF approach tries to elicit information from consumer behaviour and is based on the household demand for preference-independent consumer goods, e.g. food. (The assumption of preference-independent has been discussed in Chapter 3, Section 3.5.2). In this method the income elasticity and the compensated own-price elasticity of demand for food are estimated which are used to estimate a value for ε. It is possible to choose from a variety of demand models using the FFF approach. However, the two chosen in this study, which are also popular in the literature, have certain advantages over others. The constant elasticity model (CEM) is based on a single equation system in which it is fairly easy to test for symmetry and homogeneity. The Almost Ideal Demand Systems (AIDS), however, involves the estimation of complete demand systems regarding food. An ideal feature of the AIDS is that it possesses most of the properties usually thought desirable in conventional demand analysis; "*...it aggregates perfectly over consumers, ... it has a functional form which is consistent with known household-budget data, it is simple to estimate largely avoiding the need for non-linear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters*" (Deaton and Muellbauer 1980b, p 312). However, the justification for the particular specification indicated by either model comes from the presence of a cointegrating (a long run equilibrium) relationship between the variables. A popular approach to cointegration, i.e. the Autoregressive Distributed Lag (ARDL) model, has been employed which has shown that such a relationship existed. Consequently, the income elasticity and the compensated own-price elasticity of demand for food were estimated accordingly. The estimated values for these parameters indicated not only that there is little to choose between them statistically, but also that they are rather close.

The tax model is based on the social values of governments as revealed in specific economic policy measures. The empirical approaches to the estimation of ε employ different methods, with varying tax rate definitions and different measures of appropriate average tax rates. A common approach is to interpret ε as an income inequality aversion parameter from government's perspective and then measure its value according to the degree of progressivity in a country's income tax schedule. This is the approach adopted in this study and a model based on the Turkish personal income tax system was used to estimate a value for ε.

Table 5.5: The ε values

Model	η	γ	ω	ε
CEM	*0.6982*	*- 0.2041*	0.3688	**2.54**
AIDS	*0.64*	*- 0.18*	0.3688	**2.72**
Average				**2.63**
Tax model				**1.21**

Source: Own compilation

As has already been pointed out in section 5.3.3 the estimated values for ε from the two models employed in the demand-for-food method average out to be 2.63 whilst the corresponding value for ε in the income-tax method is 1.21 (see Table 5.5). This fairly wide but not unusual gap (see Table 3.1 in Chapter 3, Section 3.5.2) is partly due to the fact that the progressivity of the Turkish income tax system has declined in recent years thus having a dampening effect on the value of ε. Nevertheless, the figures for the ε values obtained from the demand models are above the average of the figures given in other empirical studies using the same model (see, for example, Blundell *et al* 1993, Evans 2004b, Kula 2004, Percoco 2008) which report ε values ranging from 1.28 to 1.89, if one ignores the earlier studies of the 1970s (see Chapter 3, Table 3.1). However, the figures obtained from the tax model are in line with other empirical studies using either the tax model or the demand model, (for example, Cowell and Gardiner 1999, Evans 2005, Percoco 2008 and Evans and Kula 2009) whose ε values vary between 1.0 and 2.0.

The implications of these ε values for the discount rate and the regional welfare weights applied in the CBA of long-term social investment projects in Turkey will be discussed in Chapter 6.

Chapter 6 Discount Rate and Welfare Weight Measures for Turkey

6.1. Chapter overview

Chapters 2, 3 and 4 covered the theoretical and empirical issues regarding the social discount rate (*STPR)* and the regional welfare weights (*RWW*). This chapter will be devoted to the empirical estimation of these two aggregates for Turkey.

A formula for *STPR* was derived in Chapter 2 (see Section 2.3.5) as in equation (6.1)

$$(6.1) \qquad (1+STPR)=(1+\rho)(1+g)^{\varepsilon}$$

Taking logs, this term can be expressed as

$$(6.2) \qquad STPR=\rho+\varepsilon.g$$

where

ε = the elasticity of marginal utility of consumption
ρ = the utility discount rate
g = the growth rate of per capita consumption

Since the elasticity of marginal utility of consumption (ε) for Turkey has already been estimated in Chapter 5, what needs to be done to calculate the *STPR* for Turkey here is to determine a suitable value for the utility discount rate (ρ) and the growth rate of consumption, (g).

As for the regional welfare weights, *RWW*, the theoretical issues surrounding *RWW* were discussed in Chapter 2, Section 2.2.3. It was established therein and reiterated in Chapter 4, Section 4.3, that the welfare weight for a region is given by

$$(6.3) \quad W_A = \frac{MU_A}{MU_B} = \frac{Y_A^{-\varepsilon}}{Y_B^{-\varepsilon}} = \left(\frac{Y_B}{Y_A}\right)^{\varepsilon}$$

where

W_A = the welfare weight for region A relative to region B
MU_A = marginal utility of income in region A
MU_B = marginal utility of income in region B
Y_A = per capita income in region A,
Y_B = per capita income in region B
ε = the elasticity of marginal utility of income

In the above formulation Y_B represents another region. It is of course possible to take the national average as the numeraire in which case Y_B would represent per capita income of the country as a whole.

Although this method of estimating *RWW* for different regions allows for differences in per capita income between the regions, it ignores such differences that might exists within each region. This issue was taken up in Chapter 4, Section 4.3, and the concept of equally-distributed equivalent income *(EDEI)* was introduced. *EDEI* takes account of not only inter-regional differences in average income levels but also intra-regional differences in the relative dispersion of income. Consequently, the formula in equation (6.3) was replaced by the formula in equation (6.4).

$$(6.4) \quad W_A = \left(\frac{EDEI_B}{EDEI_A}\right)^{\varepsilon}$$

Since the theoretical and empirical issues regarding ε were discussed in Chapter 3, and Chapter 5 was devoted to the empirical estimation of ε for Turkey, this chapter will focus on the estimation of the regional welfare weights as well as the *STPR* for Turkey.

6.2 Estimation of *STPR*

In this section we will determine the values of ρ and g for Turkey and then, together with the previously established preferred empirical estimate of ε, calculate a best estimate of the Turkish *STPR*, using equation (6.2).

6.2.1 The utility discount rate, ρ

The theoretical and empirical issues regarding the utility discount rate were discussed in Section 2.3.5 of Chapter 2. It was established therein that it is possible conceptually to separate the utility discount rate (ρ) into two different components: the pure time preference rate (δ) and the rate of decrease in *life chances* (L).

(6.5) $\rho = \delta + L$

Determining the value of the utility discount rate (ρ) is somewhat controversial since the value of δ cannot be estimated empirically and therefore depends on value judgment. Similar consideration would apply to life chance (L) if it were taken to represent the catastrophe risk (see Chapter 2, Section 2.3.5).

Many studies ignore the pure time preference rate (δ) and provide a value for ρ by quantifying life chances based on mortality rates in a country (see, for example, European Commission 2008, Evans 2007, Evans and Kula 2009, Evans *et al* 2005, Kula 1984 and 2004, Pearce and Ulph 1999, Percoco 2008). A few studies do stipulate a value for δ (see, for example, Azar 2009, Evans 2004b, HM Treasury 2003, OXERA 2002 and Scott 1989) as well as for catastrophe risk, L, (Evans and Sezer 2004, HM Treasury 2003 and Evans and Kula 2009) based on subjective judgment. The most common practice in the literature is to determine a value for ρ by quantifying life chances usually based on data regarding death rates. In the case of several studies, as previously cited, this figure would also include a value for δ based on subjective judgment. This will be the procedure followed here.

It is, following Kula (1984), argued that individuals discount their future utility by the probability of being alive at a given future date. The calculation of such probability for an average individual is based on crude death rates. Table 6.1 displays crude death rates for selected countries obtained from the data published by the World Bank (WB 2010). It can be seen that the death rate for Turkey averages out as 0.6%. The CIA World Factbook also gives the death rate for Turkey as 6.1 per thousand (CIA 2010). At first glance, this figure would appear to be rather low for a country such as Turkey. However, it is not all that surprising when one considers the fact that the median age of Turkish population is 28.8 (TSI 2010b).

As for the pure time preference rate, δ, the literature suggests a figure between 0.1% and 0.5%. If we are to select an average based on the figures suggested by the literature, then a figure of 0.3% for δ seems to be appropriate. Consequently, the round figure 1% for ρ is to be used in the calculation of the *STPR* for Turkey.

Table 6.1: Death rate, crude (per 1000 people), selected countries

Country Name	2000	2001	2002	2003	2004	2005	2006	2007	2008
Brazil	6.39	6.37	6.36	6.35	6.34	6.34	6.35	6.36	6.38
Mexico	4.66	4.64	4.64	4.67	4.73	4.80	4.78	4.81	4.85
Nicaragua	5.23	5.13	5.04	4.96	4.90	4.84	4.79	4.74	4.70
Norway	9.80	9.70	9.80	9.40	9.00	8.92	8.85	8.91	8.75
Oman	2.93	2.86	2.81	2.76	2.73	2.71	2.69	2.69	2.70
Pakistan	8.02	7.85	7.69	7.54	7.40	7.27	7.15	7.03	6.92
Turkey	5.94	5.87	5.82	5.80	5.80	5.82	5.86	5.91	5.95
Turkmenistan	7.61	7.61	7.62	7.65	7.68	7.70	7.70	7.69	7.67
Uganda	16.41	15.98	15.50	15.01	14.51	14.02	13.55	13.10	12.67
Ukraine	15.30	15.30	15.30	16.01	16.04	16.60	16.20	16.40	16.31
United Arab Emirates	1.57	1.55	1.54	1.53	1.53	1.52	1.51	1.51	1.50
United Kingdom	10.20	10.20	10.40	10.20	9.80	9.68	9.44	9.42	9.44
United States	8.70	8.50	8.50	8.44	8.34	8.26	8.10	8.16	8.09
Uruguay	9.20	9.40	9.40	9.35	9.26	9.39	9.39	9.39	9.40
Uzbekistan	5.50	5.31	5.42	5.32	5.04	5.37	5.27	5.26	5.30
Vanuatu	6.25	6.06	5.86	5.68	5.51	5.35	5.22	5.09	4.98
Venezuela, R. B.	4.91	4.95	4.98	5.01	5.03	5.06	5.07	5.09	5.11
Vietnam	5.43	5.38	5.34	5.33	5.33	5.34	5.35	5.37	5.39

Source: WB (2010)

6.2.2 The estimation of the growth rate of income, g

Several different methods of projecting g were considered in Chapter 4. The main issue here is the length of the data period. Relatively recent data might avoid the structural beaks and exclude the distant irrelevant past but might also fail to include relevant cycles which would be desirable for the estimation of the average figure. A suitably long period of data, on the other hand, would perhaps include several cycles but have the disadvantage that the consumption growth patterns might have changed during this period.

One method for the estimation of growth rates would be to calculate the geometric average which is based on equation (6.6).

$$(6.6) \quad g = \left(\frac{Y_t}{Y_0}\right)^{\frac{1}{N}} - 1$$

where

g = the growth rate of GDP
Y_t = the end-year GDP
Y_0 = the base-year GDP
N = number of years in the data period

OECD (2010b) provides real per capita GDP figures in US \$, in PPS for the 1970-2009 period with year 2000 as the base year. Based on these data, the average growth rate for Turkey is estimated to be 2.1% (see Table 6.2).

Unfortunately, similar data are not available for consumption. However, an average figure for consumption growth for such a long period might not make much sense due to the likely changes in consumption patterns (see above). Instead, a shorter time period is considered for which data are available. The Turkish Statistical Institute (TurkStat 2010a) provides figures for per capita real consumption as well as for GDP on a quarterly basis. Thus, the average annual growth rate of per capita real consumption for the data period of 1987-2006 is estimated to be 2.0%. If the GDP figures are used, then the growth rate is estimated to be 2.3% for the same data period (see Table 6.2).

Table 6.2 Growth rates: geometric average

Data period	*Variable*	*Method*	g, %
1970-2009	$GDP_{\$}$	$g=\left(\frac{GDP_t}{GDP_0}\right)^{\frac{1}{N}}-1$	**2.1**
1987-2006	GDP_{TL}	$g=\left(\frac{GDP_t}{GDP_0}\right)^{\frac{1}{N}}-1$	**2.3**
1987-2006	C_{TL}	$g=\left(\frac{C_t}{C_0}\right)^{\frac{1}{N}}-1$	**2.0**

Notes: $GDP_{\$}$ = per capita real GDP in US$, PPS, 2000

GDP_{TL} = per capita real GDP in TL, 1987

C_{TL} = per capita real consumption in TL, 1987

Source: Own compilation

The per capita growth of consumption and GDP figures for Turkey as displayed in Table 6.2 are very close to each other. However, they appear to be rather low for an emerging economy. The reason is that they are average figures which hide fairly wide fluctuations over a period of time. For example, the growth rates for per capita real GDP were as high as 8.2% in 1976, 7.6% in 1987, 8% in 2004 and 7.1% in 2005. Conversely, it has also plunged into negative figures in times of crises; being, for example, as low as -6.9% in 1994, -7% in 2001 and -5.8% in 2009 (see OECD 2010b)

An alternative method is the regression method in which the logged value of real per capita consumption (income) is regressed on time, as shown by equation (6.7):

(6.7) $LnC = \alpha + gt$

The logged values of quarterly per capita consumption have been regressed on time in accordance with equation (6.7). According to the results obtained from the OLS method, the value of g is 0.47%, and the associated t-ratio is 8.2269. However, the R^2 is not very high and there seems to be a problem of serial correlation (For full statistical results, see Appendix B). Nevertheless, the annual growth rate of per capita real consumption based on this method would be roughly four times as high as this, i.e. approximately 2%, which is very close to the figure obtained by the geometric average method.

The final method to consider is the 'required' growth rate of consumption (or GDP). It may be relevant to calculate a 'required' growth rate for Turkey with a reference to either EU-15 or EU-27 as the target group of countries since Turkey has a candidate country status for full membership of the EU and thus eligible for EU funds (see chapter 1, Section 1.1). According to this method, we first calculate an average growth rate of the per capita GDP of the target country, say EU-27, based on the past growth rates (see equation 6.6). Then the GDP of the target country is projected, based on this estimated average growth rate, to some future date that is broadly in line with the average investment horizon of projects, say 25 years' time from now, according to equation (6.8).

(6.8) $X = A(1+g)^N$

where

A = the current real GDP

X = the projected real per capita GDP

g = average growth rate of real per capita GDP

N = the projection period in years

Then we find the answer to the question: what would be the required growth rate for the GDP of country A (Turkey) to catch up with the GDP of the target country (EU-27) in 25 years' time? The answer is provided by equation (6.9) below (see Chapter 4, Section 4.2.2).

Taking logs of equation (6.8) and rearranging

(6.9) $g \approx \frac{LnX - LnA}{N-1}$

Table 6.3 provides information on the required growth rates for Turkey. OECD (2010b) provides data on per capita GDP of member countries expressed in US$ in PPS. Based on such data, the average growth rate for EU-27 (over the period of 1970-2009) and EU-15 (over the period of 1995-2009) is 1.5% and 2.1% respectively (column 3 in Table 6.3). The average investment horizon for the EU projects that are financed out of the Structural Funds budget for 2007-13 is 25 years. If this horizon covers the period beginning from the mid-point of the budget period (2010) then the target year is 2035. If we base our projection on the year for which the most up-to date figures exist, i.e. 2009, then the projection period is 27 years. The average per capita GDP in 2009 for the EU-15, the EU-27 and Turkey were \$29715, \$23691 and \$10986 respectively. Index numbers regarding these GDP figures based on the per capita GDP of EU27 in 2009, i.e. \$23691 = 100, are given as A in column 2 of Table 6.3. Column 6 gives the projected index numbers (X) for per capita GDP calculated according to equation (6.8), and the final column gives the required growth rate calculated according to equation (6.9) and expressed as a percentage.

Table 6.3: Required growth rates

	A	g	1+g	$(1+g)^N$	X	LnX	LnA	V	g (%)
EU-27	100	0.015	1.015	1.499	149.9				
EU-15	125	0.021	1.021	1.753	219.1.				
Turkey	46	100% of EU-27			149.9	5.010	3.829	0.045	**4.54**
Turkey	46	90% of EU-27			134.9	4.904	3.829	0.041	**4.14**
Turkey	46	80% of EU-27			119.9	4.787	3.829	0.037	**3.68**
Turkey	46	100% of EU-15			219.1	5.390	3.829	0.060	**6.00**
Turkey	46	90% of EU-15			197.2	5.284	3.829	0.056	**5.60**
Turkey	46	80% of EU-15			175.3	5.166	3.829	0.051	**5.15**

Source: Own compilation

Notes

A = Index values based on GDP of EU27 in 2009, i.e. \$23691 = 100
g = growth rates calculated according to equation (6.6)
X = the projected GDP (index values) according to equation (6.8)
Ln = natural log
V = (LnX-LnA)/26
g (%) = the required growth rate

Based on these figures several scenarios have been considered the results of which are shown in the last column of Table 6.3. For example, if we assume that Turkey's per capita GDP will catch up completely with the average GDP of the EU-27 countries by 2035, it should grow annually by 4.5% on average. The assumptions of 90% and 80% convergence reduce the required growth rate to 4.1% and 3.7% respectively. If, however, convergence with EU-15 is considered, then the required growth rates are higher than the previous case, ranging from 5.2% to 6.0%.

6.2.3 Social time preference rate for Turkey

The estimated values for ρ (1%) and g in (Tables 6.2 and 6.3) can be put together with the estimated ε values from Table 5.5 in Chapter 5, Section 5.5 to calculate *STPR* using equation (6.2). A range of *STPR* values for Turkey are presented in Table 6.4

If the income-tax based estimate of ε, i.e. 1.2, is combined with the growth rates of Turkish GDP or consumption, based on the past growth rates, the *STPR* values tend to be rather low and varying within a narrow range of 3.4% to 3.7%. If the income-tax based estimate of ε is, instead, combined with the *required* growth rates then the value of the *STPR* vary between 5.5% and 8.3%. Alternatively, if the average growth rate of GDP (2.21%) is combined with the demand-model estimates of ε, then the *STPR* is 6.6% for CEM and 7.1% for the AIDS model. However, if the required growth rate figures are used together with the ε values obtained from the CEM and AIDS models, then the *STPR* exceeds 10%.

There is a fairly wide variation in the estimated values as indicated in Table 6.4. The variation in the estimated *STPR* is mainly due to the variation in the ε values and the relatively wide range of growth rates considered. However, as it was discussed in Chapter 5, the figures for the ε values obtained from the demand models are above the average of the figures given in other empirical studies using the same model while the figures obtained from the tax model are in line with other empirical studies using either the tax model or the demand model. Thus, the estimated ε value that is most appropriate for the calculation of the *STPR* for Turkey would appear to be equal to 1.2. Therefore, only the ε values that appear in the first six rows of Table 6.4 are the relevant figures. Accordingly, the corresponding *STPR* values would vary within a narrower band of 3.4% and 8.3%.

Table 6.4: The range of *STPR* (= $\rho + \varepsilon g$) values

ρ (%)	Model	ε	Model	g %	*STPR* (%)
1	Tax	1.21	Consumption 1987-2006	2.00	**3.42**
1	Tax	1.21	GDP Geom. avg. 1970-2009	2.21	**3.67**
1	Tax	1.21	80% of EU-27	3.68	**5.45**
1	Tax	1.21	100% of EU-27	4.54	**6.49**
1	Tax	1.21	80% of EU-15	5.15	**7.23**
1	Tax	1.21	100% of EU-15	6.00	**8.26**
1	CEM	2.54	GDP Geom. avg. 1970-2009	2.21	**6.61**
1	CEM	2.54	80% of EU-27	3.68	**10.35**
1	AIDS	2.72	GDP Geom. avg. 1970-2009	2.21	**7.01**
1	AIDS	2.72	80% of EU-27	3.68	**11.00**
1	AIDS	2.72	100% of EU-27	4.54	**13.35**
1	CEM & AIDS avg.	2.63	GDP Geom. avg. 1970-2009	2.21	**6.81**
1	CEM & AIDS avg.	2.63	80% of EU-27	3.68	**10.68**
1	Overall avg.	1.92	GDP Geom. avg. 1970-2009	2.21	**5.24**
1	Overall avg.	1.92	80% of EU-27	3.68	**8.07**

Source: Own compilation

As for the appropriate growth rate according to the possible scenarios considered in the previous section, 100% convergence with the EU-15 average by 2035 would require an average annual growth rate of 6%, while 80% convergence would require 5.2%. However, the same rates of convergence with the EU-27 average would require growth rates of 4.5% and 3.7% respectively. Thus, the required minimum average annual growth rate for the Turkish per capita GDP for the next 25 years or so is 3.7% and the maximum is 6%.

Some might argue that even this range is somewhat ambitious since the experience of past 30 years points to a more modest range of 2% - 2.3%. However, this figure also includes the negative rates due to several severe economic crises during the past few decades. If a greater degree of stability in the Turkish economy can be achieved in the future, then the growth rate required for convergence with the EU-27 is not all that ambitious. In fact, if one considers the more recent performance of the Turkish economy, the range of 3.7-4.5% itself appears to be rather modest since the average growth rate of per capita GDP (PPP) was 7.7% between 2000 and 2009 (Index Mundi 2010). Moreover, according an IMF (2011) report, the growth rate of the GDP of Turkey is expected to be 45.3% between 2011 and 2016 over-shadowing its neighbours and several European countries. The Economist Intelligence Unit (EIU 2011) also reports that Turkey's growth performance will surpass that of the EU27 in the future and predicts that the average annual growth of the per capita GDP of Turkey to be 3.6% between 2011 and 2030. More significantly, it notes that greater improvements in the policy environment could produce substantially better results. Finally, an econometric study (Beyazit 2004) using a random walk model estimates that the growth rate of GNP in Turkey has a long term trend of approximately 4.3% per annum. Consequently, the growth rate in per capita GDP of Turkey within the range of 3.7- 4.5% does not seem to be too implausible.

The implication of such a range of growth rates is that the appropriate *STPR* for long term investment projects, if full convergence with the EU-27 is to be achieved, would be 6.5% . However, a more realistic aspiration for the Turkish economy is perhaps 80% convergence which will require only 3.7% growth, which is well within the range of predictions discussed above. Consequently, the implied *STPR* value by this growth rate would be 5.5%. This is, in fact the same rate as that recommendation by the European CBA Guide for the Cohesion Fund countries (European Commission 2008).

6.3 Estimation of Regional Welfare Weights

Equation (6.3) tells us that the welfare weight for a region depends on the per capita income of that region in relative terms and the value of ε. The possible empirical values of ε were estimated in Chapter 5 (see Table 5.5), and the choice of an appropriate ε value was considered in the previous section. Thus all that is needed here is the estimation of the relevant income figures for a given region.

6.3.1 RWW based on per capita income

For estimation purposes, the Level-1 regions have, in this study, been aggregated into six main regions by combining the neighbouring regions of Level-2 classification (see Chapter 1, Section 1.3.3 and Table 1.3). Thus, Marmara Region combines Istanbul, Western Marmara (Batı Marmara) and Eastern Marmara (Doğu Marmara) regions of Level-2. Similarly, Black Sea Region consists of Western Black Sea (Batı Karadeniz) and Eastern Black Sea (Doğu Karadeniz), whilst Central Anatolian Region is made up of Western Anatolia (Batı Anadolu) and Middle Anatolia (Orta Anadolu), and finally Eastern Anatolian Region combines North-eastern Anatolia (Kuzeydogu Anadolu), Middle-eastern Anatolia (Ortadoğu Anadolu) and South-eastern Anatolia (Güneydogu Anadolu). However, Aegean (Ege Bölgesi) and Mediterranean (Akdeniz Bölgesi) regions remain as they are in the Level-2 classification.

As was explained in Chapter 1, Section 1.3.3, there are sharp differences between regions in Turkey in terms of per capita income, poverty levels and other indicators of welfare. Table 6.5 provides per capita GDP figures at the regional level indicating that average living standards are much higher in the western regions of the country than the eastern regions.

For example, Marmara region enjoys an average standard of living which is 44% higher than the Turkish average. Similarly, Istanbul is the richest sub-region at Level-2 with an average standard of living which is 55% above the Turkish average. In contrast, the Eastern Anatolia region has an average standard of living which is only 46% of the Turkish average with the sub-region of North-eastern Anatolia (TR B2) having an average standard of living which is only 35% of the Turkish average. Thus, the inter-regional differences in per capita income appear to be rather large in Turkey and they get larger as one travels to the east.

Table 6.5: Regional distribution of GDP per capita in Turkey, 2006

	REGIONS	TL	TR=100
TR	**Turkey**	**9628**	100
TR 1-2-4	**Marmara Region**	**13908**	144
TR10	İstanbul	14914	155
TR21	Tekirdağ, Edirne, Kırklareli	12504	130
TR22	Balıkesir, Çanakkale	8248	86
TR41	Bursa, Eskişehir, Bilecik	13509	140
TR42	Kocaeli, Sakarya, Düzce, Bolu, Yalova	13862	144
TR3	**Aegean Region**	**10169**	106
TR31	İzmir	12099	126
TR32	Aydın, Denizli, Muğla	9868	102
TR33	Manisa, Afyon, Kütahya, Uşak	8048	84
TR6	**Mediterranean Region**	**7962**	83
TR61	Antalya, Isparta, Burdur	11110	115
TR62	Adana, Mersin	7661	80
TR63	Hatay, Kahramanmaraş, Osmaniye	5629	58
TR 8-9	**Black Sea Region**	**7382**	77
TR81	Zonguldak, Karabük, Bartın	10247	106
TR82	Kastamonu, Çankırı, Sinop	6906	72
TR83	Samsun, Tokat, Çorum, Amasya	6794	71
TR90	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	7004	73
TR 5-7	**Central Anatolian Region**	**9467**	**98**
TR 5-7	**Central Anatolian Region (without Ankara)**	**6834**	**71**
TR51	Ankara	13047	136
TR52	Konya, Karaman	7115	74
TR71	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir	6705	70
TR72	Kayseri, Sivas, Yozgat	6683	69
TR A-B-C	**Eastern Anatolian Region**	**4470**	46
TRA1	Erzurum, Erzincan, Bayburt	5416	56
TRA2	Ağrı, Kars, Iğdır, Ardahan	3867	40
TRB1	Malatya, Elazığ, Bingöl, Tunceli	5583	58
TRB2	Van, Muş, Bitlis, Hakkari	3392	35
TRC1	Gaziantep, Adıyaman, Kilis	5098	53
TRC2	Şanlıurfa, Diyarbakır	4183	43
TRC3	Mardin, Batman, Şırnak, Siirt	4159	43

Source: Compiled from TürkStat (2011)

We can, based on the formula of equation (6.3), calculate welfare weights for the different regions of Turkey. Table 6.6 shows the welfare weights based on per capita GDP for the main regions of Turkey. Column two gives the per capita GDP, column three shows the per capita GDP for each region relative to the per capita GDP for Turkey as a whole and column four displays the welfare weights on the basis of ε = 1.2, the choice of which was discussed in Section 6.2.3 above. As can be observed, the poorest main region, the Eastern Anatolian Region, has a weight that is almost four times as high as the richest Marmara Region.

Table 6.6: RWW based on per capita GDP, ε = 1.21

Regions	Y_i	Y^*_{TR}	*RWW*
TURKEY	**9628 (Y_{TR})**	**1.000**	**1.000**
Marmara Region	13908	0.692	0.64
Aegean Region	10169	0.947	0.94
Central Anatolian Region (Without Ankara)	9468 (6834)	1.017 (1.41)	1.02 (1.52)
Mediterranean Region	7962	1.209	1.26
Black Sea Region	7382	1.304	1.38
Eastern Anatolian Region	4470	2.154	2.53

Notes: Y_i = per capita GDP of a region, 2006

Y_{TR} = per capita GDP of Turkey

$$Y^*_{TR} = \frac{Y_{TR}}{Y_i}$$

$$RWW = \left(\frac{Y_{TR}}{Y_i}\right)^{\varepsilon}$$

Source: Own compilation

An interesting aspect of Table 6.6 is that the Central Anatolian Region has a weight lower than those of the Mediterranean or the Black Sea regions despite the fact that most of its sub-regions are not necessarily any richer than the sub-regions of the latter two main regions. The reason for this is that the Central Anatolian Region includes Ankara as one of the sub-regions, and it is the capital and the second big city of Turkey and thus has a relatively high per capita income. If Ankara as an outlier is taken out of the Central Anatolian Region, then the weight attached to the Central Anatolian Region becames the second highest with 1.52.

Table 6.7 provides information about how sensitive the welfare weight figures are to variation in the value of ε. The intra-regional variation in RWW with respect to ε values ranging from 1.2 to 2.6 for the Aegean and the Central Anatolian regions (with Ankara) is relatively small, i.e. 7.4% and 2.9% respectively. The reason is, of course, that the weight for these regions is close to unity. However, as one moves towards regions with weights significantly different from unity, the variation gets increasingly larger.

Table 6.7: RWW (based on per capita GDP) for different ε values

Region	*RWW* $\varepsilon = 1.21$	*RWW* $\varepsilon = 1.50$	*RWW* $\varepsilon = 1.92$	*RWW* $\varepsilon = 2.63$
TURKEY	**1.00**	**1.00**	**1.00**	**1.00**
Marmara	0.64	0.58	0.49	0.38
Aegean	0.94	0.92	0.90	0.87
Central Anatolian (without Ankara)	1.02 (1.52)	1.03 (1.67)	1.03 (1.93)	1.05 (2.47)
Mediterranean	1.26	1.33	1.44	1.65
Black Sea	1.38	1.49	1.67	2.01
Eastern Anatolian	2.53	3.16	4.36	7.52

Source: Own compilation

For example, it is 31% for the Mediterranean region, 41% for Marmara Region, 46% for Black Sea Region and almost 200% for the Eastern Anatolian Region due to the high weight attached to this region. This indicates the important role played by the elasticity of marginal utility of income in the estimation of income based welfare weights.

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More significantly, the interregional variation in *RWW* with respect to different ε values is much greater compared to intra-regional variation. For example, the weight for the poorest Eastern Anatolian region is around four times as lare as the richest Marmara region when the weights are based on ε = 1.21. However, the weight for the poorest region becomes almost twenty times as large as that of the richest region if the weights are based on ε = 2.63. This emphasises the importance of the value of ε in the estimation of welfare weights.

6.3.2 Regional welfare weights based on equally-distributed equivalent income (*EDEI*)

As was discussed briefly in Section 6.1 above and in greater detail in Chapter 4, Section 4.3, welfare weights based on per capita income do not take into account the differences in the intra-regional income dispersion between regions. It is argued that welfare weights based on the *EDEI* measure would overcome this difficulty.

The formula for *EDEI* was derived in Chapter 4 and can be expressed as follows:

$$(6.10)\quad EDEI_i = \left(\Sigma w_j Y_j^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}$$

where

$EDEI_i$ = equally-distributed equivalent income of broad region *I*

w_J = the relative population weight for each sub-region within broad region *I*,

Y_J = per capita income of the j[th] sub-region, and

ε = the income inequality aversion parameter (or the elasticity of marginal utility of income)

After obtaining the *EDEI* for each region according to equation (6.10), it is easy to calculate the regional welfare weights by using the formula in equation (6.4).

Table 6.8 shows the estimated welfare weights for the six main regions of Turkey on the basis of the inequality aversion parameter = 1.2, using the *EDEI* for Turkey as a whole (Y_{TR}) as the numeraire. It can be seen that the Eastern Anatolian Region has the highest weight of 2.32, since it is the poorest region, while the richest Marmara Region has the lowest weight of 0.59. This indicates that the welfare level of the poorest region is almost four times as low as that of the richest region in Turkey.

Table 6.8: RWW based on EDEI for ε = 1.21

Region	Y_i	$\frac{Y_{TR}}{Y_i}$	$\left(\frac{Y_{TR}}{Y_i}\right)^{\varepsilon}$
TURKEY	**8782**	**1.0000**	**1.00**
Marmara	13678	0.6421	0.59
Aegean	9953	0.8824	0.86
Central Anatolian (without Ankara)	8862 (6819)	0.9910 (1.2879)	0.99 (1.36)
Mediterranean	7610	1.1539	1.19
Black Sea	7262	1.2093	1.26
Eastern Anatolian	4382	2.0040	2.32

Notes: Y_i = EDEI of i[th] region

Y_{TR} = EDEI of Turkey

$\left(\frac{Y_{TR}}{Y_i}\right)^{\varepsilon}$ = regional welfare weights

Source: Own compilation

Table 6.9 shows the *EDEI*-based *RWW* for different ε values which displays similar ranking and pattern to those in Table 6.8 for the reasons explained in Section 6.3.1 above.

Table 6.9: RWW based on EDEI for different ε values

Region	*RWW* $\varepsilon = 1.21$	*RWW* $\varepsilon = 1.50$	*RWW* $\varepsilon = 1.92$	*RWW* $\varepsilon = 2.63$
TURKEY	**1.00**	**1.00**	**1.00**	**1.00**
Marmara	0.59	0.51	0.43	0.31
Aegean	0.86	0.83	0.79	0.72
Central Anatolian (without Ankara)	0.99 (1.36)	0.99 (1.46)	0.98 (1.63)	0.98 (1.95)
Mediterranean	1.19	1.24	1.32	1.46
Black Sea	1.26	1.33	1.44	1.65
Eastern Anatolian	2.32	2.84	3.80	6.22

Source: Own compilation

6.4 Concluding remarks

This chapter has focused on the estimation of the social discount rate and the regional welfare rates for Turkey. The estimate of ε obtained in Chapter 5 and the estimates of ρ and g derived in this chapter have been used to calculate various *STPR* figures for consideration. The chosen value for the *STPR* for Turkey is 5.5% which is well in line not only with comparable studies in the literature (Evans 2007, Evans and Kula 2009, Evans and Sezer 2005, Kula 1984 and 2004 and Lopez 2008) but also with the recommendation of the European CBA Guide of 5.5% for the Cohesion Fund countries (European Commission 2008). It could be argued that the appropriate income measure to use in the estimation of the *STPR* would be equivalised income but such data, unfortunately, are not provided by Turkish Statistical Institute. For future research more detailed household survey data would be a requirement.

As for the *RWW*, the estimated values of welfare weights based on per capita income are not significantly different from those based on *EDEI* due to the data not being disaggregated enough with respect to intra-regional dispersion of income. However, the *RWW* do display significant sensitivity to variation in value of ε.

It is argued that the *EDEI* method is superior to the GDP method in at least one respect since it considers the intra-regional income dispersion as well as the inter-regional dispersion. However, this method becomes really useful when disaggregated income data at the household level exist. For Turkey such data are not currently available. It is also argued that the ε value of 1.2 obtained from the tax model is perhaps even more appropriate in the estimation of the regional welfare weights since the aversion to income inequality by the government (on behalf of society) is more relevant than consumer behaviour in this context.

The next and final chapter will contain a summary of findings, a discussion on the government policies regarding the social discount rate and regional development, and the policy implications of the chosen *STPR* and *RWW* for Turkey.

Chapter 7 Policy Issues

7.1 Chapter overview

The main objective of this study has been the estimation of the social discount rate, i.e. the *STPR*, for long term projects and the derivation of the regional welfare weights (*RWW*) for Turkey as well as the evaluation of the implications of these two measurements for government policy. The significance of the *STPR* and *RWW* arises because economic welfare depends on growth and growth in turn depends on investment. Any investment decision, on the other hand, will involve the twin issues of efficiency and equity. This study is concerned with the equity dimension of investment decisions and has focused on the spatial (interpersonal) and intergenerational equity. Spatial equity is the distribution of benefits and costs between different groups of people in the same time period whereas intergenerational equity is the distribution of benefits and costs between generations. The former is considered in the context of the *RWW* and the latter in the context of the discount rate.

In this chapter we will summarise and evaluate the results obtained in Chapter 6 in the light of the research objectives set out in Chapter 1, Section 1.5.1. We will discuss the choice of discount rate and its implications for the long term public projects in Turkey as well as for the EU-Turkey relationship in the context of Turkey's candidacy for full membership of the EU (see Chapter 1, Section 1.1). We will also evaluate the welfare weights estimated and discuss their policy implications for the allocation of public funds in the context of Turkish regional policy with reference to the EU regional policy rules.

7.2 Summary of findings

In this section the main findings of the study with respect to the social discount rate and regional welfare weights will be summarised leaving the discussion on the policy applications of these two measurements to the next section.

7.2.1 Findings on the social time preference rate

In Chapter 2 we discussed the theoretical issues surrounding the social discount rate and pointed out that, although the final decisions regarding economic choices are taken by policy-makers, it is important that they are aware of the issues and the trade-offs and have the necessary information to make informed decisions. It was also pointed out that CBA analysis is regarded as a method which provides technical information and clarifies such trade-offs and that a positive social discount rate is an integral part of that process. More specifically, there appears to be general agreement (see, for example, Evans 2007, Evans and Sezer 2005, Kula 2004, Percoco 2008, Rambaud and Torrecilas 2006, and Spackman 2008, as well as the European Commission 2008 and HM Treasury 2003) that the social time preference rate (*STPR*) is superior to its alternatives such as the market bond rate and the social opportunity cost of capital or shadow pricing, and thus is the most appropriate method of discounting and should be used in discounting both intra- and inter-generational public projects. It is indeed the preferred method by both national governments and international bodies such as HM Treasury (2003) and the European Commission (2008).

Consequently, a formula for the calculation of the *STPR* was derived using an inter-temporal choice model regarding consumption as expressed in equation (7.1)

(7.1) $STPR = \rho + \varepsilon . g$

Chapter 3 was devoted to the discussion of the theoretical and empirical issues relating to an important component of the *STPR* (and indeed that of regional welfare weights too), namely, the elasticity of marginal utility of income *(ε)*, due to its special place in both the literature and the actual formulation of the *STPR* and the *RWW*. An important point of discussion in Chapter 3 was that the *STPR* relates to the correspondence between the concept of the elasticity of marginal utility of income and the concept of aversion to income inequality which were both represented by ε. Chapter 3 also included a discussion on the alternative methods of estimating ε and established that the most commonly used methods of estimating ε are the demand-for-food analysis and the income tax models. Moreover, it was argued that these two methods of estimating ε were, in the light of the experiences of the Turkish economy during the past thirty years and the considerations of data availability, also the most appropriate methods of estimation for Turkey as well. In fact, employing these two methods, several estimates of ε were provided in Chapter 5, which varied from 1.21 by the tax method to 2.63, the average of the CEM and the AIDS models, i.e. the two demand models. It was further argued in Chapter 6, Section 6.2.3 that the ε values obtained from the demand models appeared to be out of line with other similar empirical studies while the figures from the tax model were in line with other empirical studies and therefore the estimated ε value that is most appropriate for the calculation of the *STPR* for Turkey would appear to be equal to 1.21. Nevertheless, some sensitivity analysis involving higher and lower values of ε would be desirable.

As for the other two components of the *STPR*, empirical studies providing estimates for the utility discount rate (ρ) and the growth rate of consumption (g) were evaluated in Chapter 4. It was then established that most empirical studies attribute to ρ a value varying between 0.1% and 1.5%, and to g a value between 1.5% and 4%. However, in Chapter 6, where an appropriate *STPR* for Turkey was derived, it was argued that the most appropriate value for ρ would be 1%. Similarly, several possible values were considered for g and it was concluded that in the context of a desired target of 80% convergence of the Turkish economy with the EU-27 in the next 25 years, the appropriate value for g would be 3.7% (see Chapter 6, Section 6.2.3).

Consequently, it was established that the chosen value for the *STPR* for Turkey would be 5.5% which is the same as that recommended by the EU Guide to CBA of investment projects for the Cohesion Fund countries (European Commission 2008). Therefore, Turkey might as well apply the same guideline rate as that of the EU.

7.2.2 Findings on regional welfare weights

It was pointed out in Chapter 2, Section 2.2.3 and reiterated in Chapter 4, Section 4.3, that the important variables making up the welfare weight for a region are the per capita income and the elasticity of marginal utility of income and that the formula for the calculation of the *RWW* is as follows:

(7.2) $$W_A = \left(\frac{Y_B}{Y_A}\right)^{\varepsilon}$$

where

W_A = the welfare weight for region A relative to region B
Y_A = per capita income in region A,

Y_B = per capita income in region B, the numeraire (W_B =1)

ε = the elasticity of marginal utility of income or the coefficient of relative aversion to income inequality

The theoretical issues surrounding *RWW* such as the choice of the underlying utility function, the properties of the related social welfare function, the suitability of income to represent the wellbeing of an individual and the issue of equivalisation were also discussed in Chapter 2, Section 2.2.3. However, the issue of intra-regional income dispersion was left to Chapter 4, Section 4.3, where the concept of equally-distributed equivalent income (*EDEI*) was introduced. The reason for introducing *EDEI* is the fact that the *RWW* as expressed in equation (7.2) is based on the distribution of per capita income among regions but ignores the differences in the intra-regional income distribution between regions or more precisely makes the assumption that the intra-regional income distribution is the same for all regions. Thus, the welfare weight for a region is now based not on the relative per capita income of the region as in equation (7.2) but on the relative *EDEI* as in equation (7.3).

$$(7.3) \quad RWW_A = \left(\frac{EDEI_B}{EDEI_A}\right)^{\varepsilon}$$

where

RWW_A = regional welfare weight attached to region *A*
$EDEI_A$ = equally-distributed equivalent income of region *A*
$EDEI_B$ = equally-distributed equivalent income of region B, the numeraire.

The second variable in the formula for the *RWW*, namely the elasticity of marginal utility of income or the income inequality aversion parameter (ε) has already been referred to in Section 7.1.2.

The empirical evidence in the literature regarding the *RWW* was examined in Chapter 4 by critically evaluating the studies which have provided estimates of the regional welfare weights for various countries. It was established that in all of the studies considered but one, the *RWW* were based on per capita income, the exception being that by Sezer (2007) who used *EDEI* as the basis.

The *RWW* for Turkey were estimated in Section 6.3 of Chapter 6 on the basis of both per capita income and *EDEI*. Both measures indicated that the poorest region has a welfare weight almost four times as large as that of the richest region. Moreover, the sensitivity analysis therein indicated that there is some variation in the intra-regional welfare weights with respect to the value of ε and that the degree of variation increases as the value of the weights move away from unity. However, the sensitivity analysis also indicated that the variation in the inter-regional welfare weights are much more responsive to the variation in the value of ε than the variation in the intra-regional weights is (see Chapter 6, Section 6.3).

7.3 Policy issues regarding the social discount rate

In this section we will first set out the policy framework regarding the social discount rate in Turkey and then discuss this framework and the current practices involving the implementation of *SDR* with respect to the evaluation of long term projects, i.e. with a horizon of 20-30 years.

7.3.1 The framework

As was explained in Chapter 1, Section 1.4, the SPO is the government body charged with the formulation and implementation of public investment policies in Turkey. The general principles of these policies are set out in the five-year plans but specific policies are determined by government directives, guides and announcements published by the SPO. There are also special commissions charged with the responsibility of gathering information, undertaking research and developing appropriate policies.

Until the mid-1970s, the main method used in the allocation of funds to public sector projects was the CBA and the main approach used to calculate labour cost, exchange rate and the discount rate was the shadow-price approach. This method was abandoned after 1975 in favour of a market rates approach due to lack of reliable data and thus the evaluation of public projects after 1975 was based on market prices (Gökgöz and Çınar 2010). This approach became even more entrenched after 1980 when interventionist economic policies were replaced by more market oriented approach (see Chapter 1, Section 1.4).

Despite this development, the SPO and the five-year plans, although no longer enjoying the same prestigious status they once had, have still remained as the major instruments in the formulation and implementation of public investment policies. The seventh five-year plan, covering the period of 1996-2000, was the first one to contain an explicit chapter on investment policies. The plan stated that in considering the funding of the continuing projects, priority be given to those which use existing resources most effectively, have already achieved significant progress towards completion and have significant impact on the completion of other projects. Most importantly, it stipulated that in the selection of new projects, procedures be rationalised by using techniques of financial, economic and social analysis (see SPO 2010a). The eighth and the ninth five-year plans, covering years 2001-2013, and the associated directives and guides have, however, been prepared with a view of compliance with the *acquis communautaire* of the EU. Although they maintain the criteria set out in the seventh plan, they also include targets and priorities which are necessitated by the process of membership of the EU such as developing policies to reduce regional inequalities (see Section 7.4).

7.3.2 The evaluation of policies

It was pointed out in Chapter 1, Section 1.4 that the formulation and the implementation of *SDR* with respect to the evaluation of long term projects in Turkey lacks coherent and consistent policies despite the existence of development plans going back to the 1960s. In the past, different criteria have been used at different times. For example, in the evaluation of some public projects, the criterion of private sector profitability has been used and therefore the relevant discount rate has been the market rate of interest based on time-deposit interest rates. At other times the choice of projects has been based on whether similar projects have been successful in the past. However, projects have also often been funded on the basis of political considerations.

These inconsistencies and lack of coherence were also present in the application of the discount rate. The *SDR* would differ according to not only whether the financial or the economic and social analyses were implemented but also the way the project is financed. Most importantly, despite references in the five-year plans and associated documents to the necessity of subjecting public sector projects to financial, economic and social analyses, there has been no mention of a specific *SDR*. For example, a directive issued by the SPO (2009) stipulates that priority will be given to those projects that contribute to the realisation or the acceleration of the programmes which have been undertaken in the context of EU membership. The directive also prioritises certain investments projects, such as the South-eastern Anatolia Project (GAP), the East Anatolia Project (DAP), and Konya Plain Project (KOP) that are important in the context of regional development on which the EU programmes put a particular emphasis; but it is pointedly silent on the issue of a specific *SDR*. One possible exception is the Guide for the Preparation of Public Information Technology and Communication (ITC) Projects (SPO 2010b), which states that in the allocation of funds to the public ITC projects certain criteria will be applied. Such criteria may include whether the project has a supporting viable feasibility study; whether it is based on *effective technical, financial, economic* and *social analysis;* and whether it has already obtained external financing. Interestingly, it also states that the discount rate to be used in the financial and economic analysis of the ITC projects is 10%. However, there is no rationale or even a discussion provided for this particular rate, nor is it indicated that this rate is also applicable to other public sector projects.

Consequently, it can be said that there is an urgent need for the formulation of appropriate policies regarding the determination and the implementation of the *SDR* in the evaluation of long term projects in Turkey.

7.4 Policy issues regarding regional development

As has been stated in Chapter 1, section 1.3 Turkey faces serious problems regarding regional development since there are significant differences in the level of development between different regions in Turkey in terms of per capita income as well as other indicators of development such as unemployment levels, demographic indicators, education levels and provision of health services (Pınar & Arıkan 2003). For example, the average poverty rate for the western regions of Istanbul, West Marmara, and the Aegean is 8.7% whereas this rate for the eastern regions of North East Anatolia, Central East Anatolia and South East Anatolia is 39.6% (see Chapter 1, Section 1.3.3, Table 1.4).

7.4.1 The framework

As in the case of the *SDR* regarding the evaluation of long term public projects, the SPO and the five-year plans together with the associated guides and special committees are the main institutions that are responsible for the development and the implementation of regional policies in Turkey.

The issue of regional inequality was acknowledged right from the beginning of the planned period and the reduction of such inequality was one of the main objectives of the first five-year plan and indeed of the subsequent plans right up to the present day along with the objective of the maximisation of national income. For example, the first two five-year plans, covering the period of 1963-72, acknowledged the difference in the volume of economic activity and per capita income between regions and introduced the concept of Priority Development Regions (PDR), known as KÖY, with the establishment of 22 PDR in 1968. South-east Anatolia is mentioned explicitly as a Priority Development Region and Keban dam is cited as a significant public project to help this region. These plans also stipulated that regional development plans be prepared for, Antalya, Çukurova and Zonguldak regions; that among similar public projects those located in these regions be given priority; and that the private sector be encouraged via subsidies to invest in these regions (SPO 2010a).

The subsequent five-year plans focused, particularly after 1980 in accordance with the market approach to economic problems, on incentives given to private investment as a policy to reduce regional differences. They proposed the instigation of regional development projects especially for the Eastern and South-eastern regions and stipulated that 'regional action plans' be prepared for each province of these two regions. The Southern Anatolian Project (GAP), which consists of 22 dams regarding hydroelectric and irrigation schemes and 19 hydro-electric power stations, was initiated in 1989 and subsequently other projects designed to help the social and cultural development of the region were also undetaken. However, political instability and the problem of ethnic strife combined with macroecnomic instability rendered the 1990s as 'lost years' during which both national and regional development were rather constrained (Filiztekin 2008).

The latest two five-year plans, the eighth and the ninth, covering years 2000-2013, have been prepared with a view of compliance with the *acquis communautaire* of the EU. Thus, they stress the importance of economic balance between the regions, improvement in the quality of life, equal opportunity, and a greater degree of participation of local and regional authorities as well as NGOs in the political decision-making process. The ninth plan stipulated that suitable strategies, which would make good use of the economic and social potential and the dynamics of the regions and provinces, be developed. However, it also recognised the fact that regions and provinces do not have the required infrastructure and hence the capacity to implement such strategies. It, therefore, suggested the establishment of Regional Development Agencies based on the EU model in order to enhance the capacity of the regions on the one hand and to enable the local institutions to assume the ownership of the regional plans and projects on the other (SPO 2010a).

Since the 1980s the main economic approach to regional policy in Turkey has been neoclassical in character and therefore greater emphasis has been put on private sector involvement in regional development. In order to encourage suitable private investment, several laws were passed by the parliament providing various incentives for private projects. These incentives can be grouped into four main categories: cash incentives, tax incentives, land grants and energy cost support (Pınar and Arıkan 2003). Incentives as part of regional policy have been in existence since 1913 (Çiloglu 2000). However, the first package of incentives specifically designed to encourage investment in East and South-east Anatolia was introduced in 1998. It provided total exemption from Income/Corporation Tax and the allocation of free land for those investment projects employing ten or more people and located in one of the 21 provinces of the Eastrn and Southern Anatolian regions (Act of Parliament 1998). In 2004, a change was made to this scheme by increasing the minimum number of employees to thirty but extending the incentives to include not just tax exemption but also exemption from employers' social security contibutions, free land allocation and energy cost reduction. Moreover, the number of provinces benefiting from the scheme was increased to 36 by the introduction of a new criterion of eligibility. The new criterion stated that the scheme was extended to any province with a per capita income of $1500 based on the figures of 2001 provided by the Turkish Statistical Institute. With another change a year later, the scheme was extended to 49 provinces and thus more than half of all 81 provinces were made eligible (Act of Parliament 2004).

7.4.2 Evaluation of regional policy in Turkey

The development of coherent and viable regional policies and the effective implementation of these policies are important issues for Turkey. The main reason for this is the Kurdish problem which requires radical and region-based policies, appropriate strategies and effectice mechanisms. Another reason is Turkey's candidacy for full membership of the EU, since regional policy constitutes one of the most important policy areas in the EU as set out in Chapter 21 of the *acquis communautaire* on Regional Policy and the Co-ordination of Structural Instruments. For the period 2007-13, the planned expenditure on regional policy constitutes the second largest item in the EU budget with an allocation of €348 billion (Europa 2010a). The EU regional policy is rather important to Turkey not only for its finacial implications, i.e. Turkey is eligible for EU pre-accession funding (see Chapter 1, Section 1.1), but also for the fact that Turkey is under obligation to undertake, during the accession negotiations, the infrastructural and institutional reforms as required by the EU regional policies. These reforms involve regional decentralisation and the establishment of democratised regional governance structures (Beleli 2005).

It is clear from the statistical evidence submitted in Chapters 1 and 6 and from several studies on this subject (see, for example, Elvan et al 2005, Filiztekin 2008, Pınar and Arıkan 2003 and so on) that regional development policies have been generally unsuccessful so far. Some argue that this failure is due not to the policies themselves but the fact that they have never been properly implemented or not even implemented at all. For example, despite the fact that the ninth five-year plan required the establisment of Regional Development Agencies, only two such agencies (Izmir and Cukurova) were established by the end of 2008 and both were in reletively well-off areas (Filiztekin 2008). Others argue that the policies themselves are inappropriate for regional development in Turkey because they are usually imposed by international institutions and that policy-makers and bureaucrats in Turkey have not been creative enough in producing appropriate regional policies (Doğruel 2006).

There are two main historical reasons for the relative failure of Turkish regional policies. One is the fact that maximum growth of national income and thus sectoral considerations have also been an important objective in parallel to the objective of reducing regional inequalities (SPO 2008). Some would say that the former have always had priority over the latter (Ertugal 2005a). The other, more importantly, is that the policy-making and implementation process with respect to regional development is highly centralised with no local institutions with the ownership of or the power to supervise any policy initiative at the regional level. This is typical of Turkish political structure in which most of the political power is concentrated in the capital, Ankara. There are local authorities at the provincial level but they are financed mainly by the central government thus do not have much independent power to exercise. As for the regional institutions, they simply do not exist (Elvan. *et al* 2005). One exception to this picture is the Southern Anatolian Project (GAP). The setting up of the Regional Development Administrtions was specifically for the administration and implementation of the GAP at the local level for the Southeast Anatolian region.

The centralist nature of the Turkish approach to regional development is in contrast to the partnership principle of the EU regional policy which requires multi-level governance in the implementation of the European Social Fund (ESF), the European Regional Development Fund (ERDF) and the Cohesion Fund (CF). This has presented a challange to the traditional approach to regional policy in Turkey. The response has been a number of changes in regional policy. One such change is the adoption of the European system of

Nomenclature of Territorial Units for Statistics (NUTS) in order to achieve consistency in gathering and presenting statistical data in the context of regional development. Another was the preparation of the Preliminary National Development Plan (PNDP) aimed to draw up the guidelines of economic and social cohesion policy for 2004-2006. Yet another one was passing of a law establishing Regional Development Agencies (RDAs) for 26 new regions in 2005. Nevertheless, partly due to lack of political will with respect to the policy of decentralisation for fear that they may undermine territorial integrity and encourage Kurdish separatism (Reeves 2005), and partly because they have not been implemented properly, these measures have proved to be largely inadequate.

However, it can also be said that, a degree of 'Europeanisation' has taken place in Turkish regional policy especially since the approval of Turkey's status as a candidate country for the membership of the EU in 1999. Since then, the failure of the past policies and the necessity of a fresh look at the regional issues have been acknowledged. Thus, it would appear that the EU accession process has provided an opportunity to install the concept of 'region' into the regional policy and take the necessary steps to instigate the required infrastructural institutions for viable regional development (Ertugal 2005a). Ironically, the Kurdish question, or rather the desire to find a solution to the problem, is also partially responsible for this process which has culminated in the 20 minor and major changes to the Turkish Constitution in the past decade or so. In short, Turkey has made some considerable progress towards compliance with the *acquis* but still has some way to go for full integrity with the European institutions (European Commission 2010 and Congressional Research Service 2010).

Given the conclusion in Section 7.3.2 that there is an urgent need for the formulation of appropriate policies regarding the determination and the implementation of the *SDR* and the importance and therefore the reform of regional policy in the context of eligibility for the EU funds as discussed above, the next section aims to provide technical information that could be used in the development of such policies.

7.5 Practical application of the SDR and RWW in Turkey

In this section, we will discuss the possible use to which the estimated values of the *STPR* and the *RWW* for Turkey can be put. It is worth reiterating that the primary concern of this study is the estimation of values for the *STPR* and the *RWW* for Turkey to be used in the application of CBA to long term projects in Turkey rather than the operation of CBA *per se*. In this context the aim is not only to provide the national and international evaluators with information that could be useful in the application of CBA to long term projects but also to take both social efficiency and equity criteria into account in the appraisal of public projects and the evaluation of policy options.

7.5.1 The social discount rate

In Section 7.3.1, it was indicated that there is no discussion regarding the choice of a social discount rate set by the SPO in the five-year development plans or associated publications in Turkey. There are of course references to the necessity of financial, economic and social analysis in the evaluation of public projects and hence references to long term government bonds, matket rates of interest and the international rate of interest depending on the source of finance of such projects. However, such references do not amount to a coherent and consisitent policy statement regarding the setting of an appropriate discount rate and there has been no officially declared discount rate except for the 10% rate stated by the SPO for the public ITC projects (see Section 7.3.1). This is in contrast with the European practice where several European countries have set an explicit discount rate based on the *STPR* approach (see Chapter 1, Section 1.2) .

The preferred *STPR* for Turkey in this study is estimated as 5.5%. This estiamate is significant in several aspects. First, the figure of 5.5% is the same as the recommendation of the European CBA Guide for the Cohesion Fund countries and therefore would prove to be helpful in the applications by Turkey for IPA funds currently and for the Structural and Cohesion funds after accession. Moreover, it would appear to be the only academic estimation of the *STPR* employing the most recent techniques used in the literature and thus it fills an important gap in the literature regarding *SDR* with respect to Turkey. Finally, given the lack of a coherent official policy regarding the discount rate applicable to public projects, it would provide a useful guide for the policy-makers in Turkey regarding the application of economic analysis to long-term public projects. Although the SPO does recommend a 10% discount rate to be used in the financial and economic analysis of the ITC projects, the rate is highly sector-specific, the SPO provides no justification, nor any discussion, for the figure itself, and 10% is well out of line with the rates applied in Europe.

7.5.2 The regional welfare weights

The application of welfare weights is, however, less straightforward since it is more controversial due to the fact that it involves equity issues. Some economists argue that distributional issues should be left out of CBA altogether, some argue that they should be considered but through shadow pricing, and yet others argue that they should be explicitly taken into account through the use of the distributional weights (see Chapter 2, Section 2.1). However, from the policy application point of view, the UK government makes an explicit reference to the use of distributional welfare weights in its expenditure policy in the Green Book (HM Treasury 2003). The recent EU Guide to CBA of investment projects also refers to the explicit use of the welfare weights based on income differences (see European Commission 2008, Annex E).

In this study the expressed view is that the *SDR* based on *STPR* deals with the efficiency issue as well as with the issue of inter-temporal equity but leaves out the issue of spatial (interpersonal) equity based on income differences. Consequently, the study provides estimates of regional welfare weights for Turkey. The next issue is the practical application of welfare weights to CBA in evaluating long term public projects so that proper account of both efficiency and equity criteria is taken.

a) Equity-adjusted net present value (NPV*)

Following Potts (2002), we can use the concept of NPV as a measure of project worth in order to rank projects that compete for limited funds.

$$(7.4) \quad NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t}$$

where

NPV = standard net present value of project where benefits, operational costs and capital costs are all taken into account.

B_t = project benefits in year t

C_t = project costs in year t

r = the discount rate

n = the life of the project in years.

Thus, NPV and associated measures deal with the efficiency of projects. However, equity issues can also be explicitly taken into account through the incorporation of welfare weights into equation (7.4). Thus we would have the following equation

(7.5) $$\frac{NPV*}{K_{PV}} = \frac{\sum_{t=0}^{n}\left[\frac{w_i\left(B_t - OC_t\right) - K_t}{(1+r)^t}\right]}{\sum_{t=0}^{n}\left[\frac{K_t}{(1+r)^t}\right]}$$

where

NPV^* = equity adjusted NPV of the project concerned

w_i = regional welfare weight

OC_t = operating costs

K_t = capital costs

$$K_{pv} = \sum_{t=0}^{n}\left[\frac{K_t}{(1+r)^t}\right].$$

Please note that

$C_t = OC_t + K_t$

Equation (7.5) can be expressed more conveniently as

(7.6) $$NPV^* = w_i(NPV) - (1 - w_i)K_{pv}$$

The procedure described above is a way of incorporating the regional welfare weights into the NPV method of ranking projects. However, comparing projects with different overhead costs and with different time horizons does not make much sense. Thus, what we need is a measure which would give the annual equity-adjusted NPV per unit of capital outlay.

This can be obtained by modifying equation (7.6) as follows.

(7.7) $$\frac{NPV^*}{nK_{pv}} = \frac{w_i(NPV)}{nK_{pv}} - \frac{(1 - w_i)}{n}$$

where

$$\frac{NPV^*}{nK_{pv}}$$ = the expected annual rate of equity-adjusted premium return (in relation to the relevant discount rate) on capital

Suppose, for example, that the SPO in Turkey is presented with ten projects to evaluate for funding and further assume that four of the projects impact on the richest Marmara Region, three on the poorest Eastern Anatolian Region, and the other three on the middle-income Central Anatolian Region. The first step would be to calculate the NPV of each project according to equation (7.4) and then apply the regional welfare weights according to equation (7.6) to obtain NPV^*. Finally, the annual equity-adjusted premium return on capital is obtained by dividing through by the product of the life-span of the project in years and the present value of capital cost, i.e. (n K_{pv}) [equation (7.7)].

Table 7.1 is constructed for illustrative purposes to indicate how the ranking of the projects changes with the incorporation of the regional welfare weights into the NPV method and the derivation of the annual equity-adjusted return on capital.

Column 2 provides illustrative NPV figures and Column 3 shows *EDEI*-based regional welfare weights as estimated in Chapter 6 with ε =1.2 (see Table 6.8). Column 4 indicates the life-time of project in years and Column 5 provides net present value of capital costs for each project. Column 6 provides the estimated figures for the annual rate of unadjusted return on capital (ARUR) which are calculated by dividing the NPV figures in Column 2 by the product of life-time of project in years, n, and the net present value of capital costs, K_{pv}, i.e. Columns 4 and 5. Column 7 indicates the ranking of the projects with respect to ARUR values. Column 8 shows the equity adjusted NPV figures which are calculated according to equation (7.6), and Column 9 shows the figures of the annual rate of equity-adjusted return on capital (AREAR), which are calculated by dividing the figures in Column 8 again by the product of (nK_{pv}) in accordance with equation (7.7). Finally, Column 10 ranks the projects with respect to their AREAR values.

In this illustrative example, ranking the projects according to ARUR values indicates that the richest Marmara Region has three projects in the top five and the poorest Eastern Anatolian region has only one. However, after applying the regional welfare weights to the net present values, the ranking changes such that the top five projects include the three from the poorest region and none from the richest region as indicated by Column 10.

Table 7.1 An example of equity adjusted NPV expressed as an annual rate of return on capital

1	2	3	4	5	6	7	8	9	10
Region	NPV € 000	RWW	n	K_{PV} €000	ARUR %	Rank	NPV* € 000	AREAR %	Rank*
Marmara	12600	0.59	30	5040	8.3	6	5368	3.6	9
Marmara	11000	0.59	30	3850	9.5	3	4912	4.3	8
Marmara	10050	0.59	26	3300	11.7	1	4577	5.3	7
Marmara	9500	0.59	26	4200	8.7	5	3883	3.6	10
Central Anatolian	11300	0.99	30	5750	6.6	10	11130	6.5	6
Central Anatolian	8800	0.99	20	3800	11.6	2	8674	11.4	4
Central Anatolian	8100	0.99	28	4000	7.2	7	7979	7.1	5
Eastern Anatolian	12500	2.32	28	6250	7.1	8	37250	21.3	2
Eastern Anatolian	9600	2.32	30	4500	7.1	9	28212	17.4	3
Eastern Anatolian	9300	2.32	25	4000	9.3	4	26196	35.6	1

Source: Own compilation

Notes:
NPV = standard net present value of project
RWW = regional welfare weights as estimated in Chapter 6 (RWW =1 for Turkey as a whole)
n = life-time of project in years
K_{pv} = present value of capital costs
ARUR = annual rate of unadjusted return on capital, i.e. $ARUR = \dfrac{NPV}{nK_{PV}}$
Rank = ranking according to *ARUR*
*NPV** = equity adjusted *NPV* [see equation (7.6)]
AREAR = annual rate of equity-adjusted return on capital [see equation (7.7)]
Rank* = ranking according to *AREAR*

b) Equity-adjusted internal rate of return (IRR*)

It is possible that one wishes to employ the method of internal rate of return (IRR) to the selection of the projects (see Chapter 2, Section 2.3.5), Then this can be done by setting equation (7.6) to zero and solving for r^* (equity-adjusted internal rate of return). Thus, (7.8) $NPV^* = w_i(NPV) - (1 - w_i)K_{pv} = 0$

Note that if $w > 1$, then NPV must be negative at r^* by an amount that depends on the extent to which w exceeds unity and the size of the last term (K_{PV}), i.e. capital costs associated with the project. In this case, r^* exceeds the standard unadjusted internal rate of return (IRR).

If $w = 1$, then NPV = NPV* = 0, and this gives the standard Internal Rate of Return (IRR). There is no equity adjustment in this particular case. So, IRR* = IRR.

If $w < 1$, then NPV must be positive by an amount reflecting the extent to which w is below 1 and the value of KPV_{PV} (IRR* < IRR).

Using IRR*, projects should be ranked for funding purposes according to the extent to which IRR* exceeds the appropriate discount rate reflecting the minimum required rate of project return (which may differ across projects).

However, one needs to be careful in the application of regional welfare weights due to the spill over effects referred to in Chapter 3, Section 3.2. For example, the South-eastern Anatiolian Project (GAP) is a mega project involving several dams being built for irrigation and hydroelectric power generation. In fact, it is a cluster of several projects which has distributional impacts across several regions in the eastern part of the country and some in the western regions as well. Therefore, in the application of CBA to such a project, the appropriate welfare weight would be the weighted average of the relevant regional welfare weights on the basis of the distribution of benefits. However, such a big project would also produce positive and negative externalities which would need to be considered. For example, although the project has not been completed yet, it has already caused a change in the ecological balance of several regions with completely new flora and fauna being introduced with important implication for farming communities. Conversely, many villagers have had to be relocated in order to make room for new reservoirs which resulted in migration into areas not associated with the project. Thus, where such mega projects apply, not only these positive and negative impacts should be weighted on a *pro rata* basis but also a full economic and environmental impact analysis is required.

In applying the welfare weights, care should also be taken where the location of a project and the location of the beneficieries differ. In such a case, the relevant region would, as stated in Chapter 3, Section 3.2, be the region of the beneficieries rather than the one where the project is located.

Another issue relates to the practicality of applying the *RWW*. Some might argue that, if the aim of the government is to reduce poverty, this can be done by using the UNIDO approach (see Chapter 2, Section 2.3.5) where "... *the income flows arising from the project are identified, and income weights or shadow prices are placed on the incomes going to different groups.*" (UNIDO 1980, p 4). More explicitly, the approach is based on the identification of different beneficiaries (income groups) at micro level and applies a shadow price to each beneficiary in order to calcualte the NPV of a project and, if necessaray, ranks the projects accordingly, whereas the *RWW* approach focuses on the re-ranking of the projects according to weighted NPVs. Thus, the *RWW* approach provides the decision maker in the allocation of funds to different projects with a guideline as to how to differentiate between different regions. If there are certain benefits and costs of the project that are not entirely income related such as environmental impacts, then the application of shadow prices rather than welfare weights would be more appropriate. However, it is worth noting that the two approaches relate to different policy decisions. The UNIDO approach is useful for the practitioner at micro level either to accept (or reject) a project or to distinguish between projects on the basis of NPV, whereas the *RWW* are useful to the policy maker at macro level in deciding regional priorities in the allocation of funds among different projects.

Despite the qualifications discussed above, it would still be beneficial to incorporate regional welfare weights into the CBA of investment projects in Turkey. The procedure would provide a particularly useful guideline to the policy-makers at the central government level in deciding how to allocate public funds among the proposals submitted by different regions since the *RWW* together with an appropriate discount rate take into account both equity and efficiency criteria in the appraisal of social investment projects.

7.6 CONCLUSION

The aim of this study has been to provide estimates of the social discount rate (*SDR*) to be used in the evaluation of public sector projects and of regional welfare weights (*RWW*) to facilitate the implementation of regional development policy in Turkey. It should be stated that this study has been primarily concerned with the issues of the *SDR* and the *RWW* rather than the operational aspects of CBA and thus focused on the estimation of the *STPR* and the *RWW* for Turkey. Nevertheless, it has included a discussion on how these estimates can be used to derive equity-adjusted NPV and IRR measures for application in social CBA.

In order to achieve the stated objective of this study (see Chapter 1, Section 1.5), first, the theoretical issues surrounding the derivation of the social discount rate and the distributional welfare weights were discussed in Chapter 2. This was done in the context of the relationship between per capita income/consumption and diminishing marginal utility (MU) and the properties of social valuation functions.

The theoretical and policy significance of the concept of the elasticity of marginal utility of income (ε) in the estimation of both the *STPR* and the *RWW* necessitated the allocation of a whole chapter to this topic. Thus, Chapter 3 explored the theoretical issues surrounding this concept in detail such as the correspondence between this concept and that of the aversion to inequality of income. It also critically evaluated the different methods of measuring the value of ε. It considered four different categories of methods, namely, survey methods, the life-time consumption model, the demand model based on want-independent consumer goods such as food, and the income-tax model based on revealed social value. After critical evaluation of these methods it was decided that survey methods are not very suitable for eliciting information regarding ε and hence not favoured in the literature, and that data limitations weakens the case for the life-time consumption type of approach. Thus, it was decided that the demand-for-food model and the income-tax model would be the most appropriate approaches to estimate the value of ε to be used in the calculation of the social discount rate and the regional welfare rates for Turkey to be applied in long-term project evaluation.

Chapter 4 focused on the empirical issues relating to the estimation of the components of *STPR*, such as the utility discount rate (ρ), the pure time preference rate (δ), life chances (L), the growth rate of consumption (g) as well as the empirical work regarding the estimation of *STPR* itself. It was established that the empirical estimates of *STPR* figures provided in the literature varied within a fairly narrow band of 3% and 5.5%, and also that there is a good degree of agreement between academics and the policymakers regarding the use of the *STPR* in Europe. The chapter then moved on to explore the issues regarding the use of per capita income as a basis for welfare comparisons, and to the evaluation of the empirical studies calculating regional welfare weights for various countries.

Having covered the theoretical and the empirical aspects of the relevant literature regarding the *SDR* and *SWW*, Chapters 5 and 6 were devoted to the actual estimation of the relevant parameters for the calculation of the *STPR* and the *RWW* for Turkey. Specifically, Chapter 5 focused on the estimation of the elasticity of marginal utility of income (ε) by using two different approaches. The first one is based on demand for a want–independent good, also known as the FFF model in which the income elasticity and the compensated price elasticity with respect to demand for food are estimated. In this approach two separate models have been employed searching for the best result. The results obtained from experimenting with a CEM equation and an AIDS model produced fairly close estimates with those from CEM being marginally superior. The second approach is the income-tax model based on the assumption of equal absolute sacrifice which used the Turkish progressive income tax system. The results obtained from this approach appeared to be well in line with other empirical studies and thus the estimated ε value obtained from the tax model seemed to be the most appropriate for the calculation of the *STPR* for Turkey, which is approximately 1.2.

Chapter 6 provided the estimates of the remaining parameters, namely the pure time preference rate (ρ) and the growth rate of consumption/income (g) that are needed for the calculation of the *STPR* and thus provided an appropriate figure for the *STPR* for Turkey. The appropriate value for the pure time preference rate is considered to be 1% and the value for the required rate of growth of consumption 3.7%. Therefore the value of *STPR* is calculated as 5.5% which is the same figure as that recommended by the European Commission (2008) for the Cohesion Fund countries. Chapter 6 also provided the estimated values for *RWW* for six regions of Turkey using the *EDEI* method as the basis of income differences, which appear to be consistent with the estimates provided elsewhere in the literature. It is argued that the *EDEI* method is superior since it takes into account the differences between regions with respect to intra-regional income dispersion as well as the inter-regional dispersion. However, the impact of the intra-regional income dispersion would be even more strongly felt if income data disaggregated at the household level existed.

In a wider context, distributional issues and an appropriate discount rate for public projects have been a part of welfare economics in general and of CBA in particular across generations (Ekstein 1958, Sen 1961, Musgrave 1969, Harberger 1978, and 1984, Arrow 1995, Stern 1977 and 2007). More recently several European governments have explicitly adopted policies relating to the *SDR* and social welfare weights (see for example HM Treasury 2003, Evans 2007, the European Commission 2008, Percoco 2008 and Spackman 2008). Therefore, the issue of an appropriate *SDR* and a set of *RWW* is particularly important for Turkey. This is because Turkey has a candidate status of and is currently negotiating for the membership of the EU; and she is yet to develop coherent and consistent policies with respect to both the application of social discount rate and the implementation of regional policies. Consequently, this study fills an important gap both in the academic literature and in terms of technical information in the context of appropriate policies regarding long term project evaluation and regional development. Nevertheless, there is a need for further research preferably using panel data for further refinement of the measures of *STPR* and the *EDEI*-based estimates of the *RWW* for Turkey. However, this would require more comprehensive time series and cross-section data on income and expenditure disaggregated at the household level

As for the policy issues, it should be stated that although the final decisions regarding economic choices are taken by the policy-makers, it is important that they are aware of the issues and the trade-offs and have the necessary information to make informed decisions (see Section 7.2.1). In this context, estimated values of both the *STPR* and the *RWW* for a particular country can be useful in the formulation of relevant policies. However, it is not the intention of this study to present the findings in general and the estimates relating to the *SDR* and the *RWW* in particular in a prescriptive manner. It is not the function of the economist to state what should be done but only to point out the consequences of a particular action by providing technical information for the policy-maker. Thus, it is hoped that the findings of this study will shed some light on the issues of discounting social projects for regional development purposes in Turkey and facilitate the formulation of appropriate policies in these areas. Therefore, the lack of coherent and consistent policy regarding the formulation and the implementation of both the *SDR* with respect to the evaluation of long term projects and regional policy in Turkey renders the findings of this study all the more significant. The preferred approach to the setting of a social discount rate by many European governments (see Section 7.4.1) is the *STPR* approach and the suggested *STPR* by this study is well in line with that recommended by the European Commission (2008) for the CF countries. Thus, this estimate could be made use of by the government of Turkey in its guidance to the application of CBA to long term public projects. Similarly, the estimates of the *RWW* presented in this study could provide the government with useful information in relation to how European funds can best be allocated to projects to achieve an optimal welfare outcome.

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Appendix A: Time series data used in the demand models

Time	CONS (nom)	FOOD (nom)	CONS (real)	FOOD (real)	POP
1987Q1	9875307	4037141	10,793,036	4,176,865	52370000
1987Q2	11257231	4704329	11,492,853	4,565,687	52370000
1987Q3	14203271	6426551	14,644,339	6,922,212	52370000
1987Q4	15682732	5799372	14,088,313	5,302,629	52370000
1988Q1	15706077	6013859	11,429,200	4,302,866	53268000
1988Q2	18696759	7133513	11,887,984	4,592,698	53268000
1988Q3	23779091	10273141	15,028,703	7,198,337	53268000
1988Q4	23868239	8689989	13,292,107	5,230,606	53268000
1989Q1	25552668	9952202	10,592,816	4,044,827	54192000
1989Q2	32209948	12758019	11,559,154	4,623,546	54192000
1989Q3	42568317	18332869	15,246,152	7,248,989	54192000
1989Q4	48809330	19238208	13,706,870	5,109,751	54192000
1990Q1	49298899	18379266	12,478,301	4,551,632	55120000
1990Q2	62134351	25557759	13,746,821	5,084,235	55120000
1990Q3	78007043	34909707	16,756,208	7,637,164	55120000
1990Q4	80122181	28608284	14,821,944	5,312,047	55120000
1991Q1	79816802	30526730	12,769,160	4,852,866	56055000
1991Q2	95248644	35958166	13,700,305	5,166,824	56055000
1991Q3	133911981	54869250	17,676,008	7,990,495	56055000
1991Q4	135893390	49059591	15,220,845	5,633,568	56055000
1992Q1	140743852	52267943	13,285,283	4,954,219	56986000
1992Q2	162346138	62072387	14,208,805	5,449,779	56986000
1992Q3	221876756	87667018	18,031,970	8,126,995	56986000
1992Q4	235289112	79397723	15,755,486	5,623,075	56986000
1993Q1	235502393	87754549	14,157,806	5,315,103	57913000
1993Q2	294318283	108884437	15,860,244	5,775,467	57913000
1993Q3	418409116	177870063	19,421,202	8,346,988	57913000
1993Q4	421109343	151249065	17,105,489	5,966,464	57913000
1994Q1	424556686	166804775	14,788,892	5,504,595	58837000
1994Q2	572976555	215840512	14,038,130	5,374,535	58837000
1994Q3	802611186	335655824	18,196,245	8,468,858	58837000
1994Q4	906118043	345957528	15,938,972	5,665,875	58837000
1995Q1	998050029	422897687	14,008,759	5,330,961	59756000
1995Q2	1200932766	488586038	15,527,878	5,973,653	59756000
1995Q3	1626735956	716904488	19,678,108	8,758,053	59756000
1995Q4	1632183913	641187130	16,796,609	6,059,609	59756000
1996Q1	1750823819	701725177	15,551,824	5,724,853	60671000
1996Q2	2164779394	808864876	16,998,127	6,233,240	60671000
1996Q3	2996843229	1264211971	20,902,718	8,994,865	60671000
1996Q4	3025250531	979217321	18,160,914	5,799,411	60671000
1997Q1	3260486262	1206275694	16,831,959	5,723,327	61582000
1997Q2	4267599558	1573806354	18,661,991	6,488,857	61582000
1997Q3	5915474632	2320603321	22,766,786	8,974,992	61582000
1997Q4	6175535486	2012764418	19,359,557	5,792,164	61582000
1998Q1	6800737683	2686592842	18,275,676	5,816,498	62464000

1998Q2	8210354424	3099410905	18,555,044	6,118,236	62464000
1998Q3	10752271654	4580295485	23,055,207	9,355,720	62464000
1998Q4	10359191064	3821606409	18,227,421	5,656,839	62464000
1999Q1	10035552963	4087258260	17,317,801	5,837,086	63366000
1999Q2	12722499045	4811435286	18,386,771	6,369,616	63366000
1999Q3	16661767842	7057907476	22,376,322	9,461,794	63366000
1999Q4	16507941277	5692089912	17,996,013	5,779,641	63366000
2000Q1	17021329380	6222786507	18,012,918	5,898,800	64259000
2000Q2	21444004659	7414063909	19,233,563	6,602,225	64259000
2000Q3	26534209317	10819576103	24,531,000	10,028,882	64259000
2000Q4	24098247765	8131607671	18,996,090	5,792,277	64259000
2001Q1	22792519201	8679908890	17,474,105	5,928,485	65135000
2001Q2	29686323291	10027052227	16,928,161	6,272,323	65135000
2001Q3	38567122676	14843027637	22,112,226	9,520,896	65135000
2001Q4	37467051912	12183802856	16,841,367	5,585,865	65135000
2002Q1	35701255353	12744973946	17,149,884	5,884,782	66009000
2002Q2	43369194205	14164610584	17,464,230	6,253,058	66009000
2002Q3	54950224893	20982360766	22,698,772	9,775,757	66009000
2002Q4	50399526368	15868666536	17,580,686	5,685,988	66009000
2003Q1	48929588873	16807399192	18,493,074	6,144,762	66873000
2003Q2	55932624421	18914356695	17,963,988	6,506,518	66873000
2003Q3	71783625746	29089693693	24,016,316	10,336,298	66873000
2003Q4	62940060946	19068699537	19,388,897	5,743,775	66873000
2004Q1	59746289268	20644383615	20,792,525	6,471,681	67734000
2004Q2	68382524073	20890069096	21,263,082	6,675,998	67734000
2004Q3	83845084272	31167444329	25,758,328	10,333,930	67734000
2004Q4	72657418951	21268637969	20,082,815	6,051,904	67734000
2005Q1	68209034446	22431967117	21,636,673	6,687,507	68852000
2005Q2	78038341336	21666881908	22,092,359	7,246,849	68852000
2005Q3	95700179986	33423928767	28,435,662	11,449,286	68852000
2005Q4	86613033352	23925189169	23,429,255	6,580,104	68852000
2006Q1	79698344216	25946327296	23,394,369	7,127,180	69421000
2006Q2	95692815644	23687616565	24,642,956	7,648,499	69421000
2006Q3	111280895031	37438600808	29,090,532	11,586,134	69421000
2006Q4	96085006743	25603642975	23,455,898	6,592,891	69421000
2007Q1	89803134470	29082356239	23,888,483	7,391,817	70256000
2007Q2	102767199388	26474366338	24,466,371	7,927,062	70256000
2007Q3	122833135589	43662366887	30,124,556	11,757,465	70256000

Source: TürkStat (2010a) and TürkStat (2010c),

Notes

CONS (nom): Private final consumption expenditure at current prices
FOOD (nom): Expenditure on food at current prices
CONS (real): Private final consumption expenditure at constant prices of 1987
FOOD (real): Expenditure on food at constant prices of 1987
POP: Population figures

Appendix B: Consumption growth regression results (Chapter 6)

Estimated Long Run Coefficients				
Dependent variable is X1				
83 observations used for estimation from 1987Q1 to 2007Q3				
Regressor	*Coefficient*	*Standard Error*	*T-Ratio*	*[Prob]*
INT	-1.4396	0.027350	-52.6361	[.000]
X2	0.0046535	0.5656E-3	8.2269	[.000]

R-Squared	0.45521	R-Bar-Squared	0.44848
S.E. of Regression	0.12346	F-stat. F(1, 81)	67.6811 [.000]
Mean of Dependent Var	-1.2442	S.D. of Dependent Variable	0.16625
Residual Sum of Squares	1.2347	Equation Log-likelihood	56.8607
Akaike Info. Criterion	54.8607	Schwarz Bayesian Criterion	52.4419
DW-statistic	1.7754		

Diagnostic Tests				
Test statistics	*LM version*		*F version*	
A: Serial Correlation	CHSQ (4) = 59.0262	[.000]	F(4, 77) = 47.3956	[.000]
B: Functional Form	CHSQ (1) = 0.005447	[.941]	F(1, 80) = 0.0052510	[.942]
C: Normality	CHSQ (2) = 3.6440	[.161]	Not applicable	
D: Heteroscedasticity	CHSQ (1) = 0.012500	[.911]	F(1,80) = 0.012201	[.912]

A: Lagrange multiplier test of residual serial correlation

B: Ramsey's RESET test using the square of the fitted values

C: Based on a test of skewness and kurtosis of residuals

D: Based on the regression of squared residuals on squared fitted values