STUDY REPORT

REASSESSMENT OF NATIONAL PARAMETERS FOR PROJECT APPRAISAL IN INDIA

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RESEARCH TEAM

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ACRONYMS AND ABBREVIATIONS

ARDL	*Auto-Regressive Distributed Lag Model*
ASI	*Annual Survey Industries*
BCR	*Benefit Cost Ratio*
CSO	*Central Statistical Organization*
DW	*Durbin-Watson Test*
EER	*Equilibrium Exchange Rate*
EFC	*Expenditure Finance Committee*
FE	*Foreign Exchange*
FIRR	*Financial Internal Rate of Return*
GDP	*Gross Domestic Product*
GNI	*Gross National Income*
GST	*Goods and Services Tax*
IEG	*Institute of Economic Growth*
IRR	*Internal Rate of Return*
MPCE	*Monthly Per Capita Expenditure*
NITI Aayog	*National Institution for Transforming India*
NNI	*Net National Income*
NPC	*Net Present Value*
NPSB	*Net Present Social Benefits*
NSS	*National Sample Survey*
OECD	*Organisation For Economic Co-Operation And Development*
OLS	*Ordinary Least Squares Method*
OPEC	*Organization of Petroleum Exporting Countries*
PAMD	*Project Appraisal and Management Division*
PC	*Planning Commission of India*
PCI	*Per Capita Income*
PCNNI	*Per Capita Net National Income*
PIB	*Public Investment Board*
PLR	*Prime Lending Rates*
RBI	*Reserve Bank of India*
ROR	*Rate of Return*
SCF	*Standard Conversion Factors*
SD	*Standard Deviation*
SE	*Standard Error*
SER	*Shadow Exchange Rate*
SRS	*Sample Registration System*
STPR	*Social Time Preference Rate*
UK	*United Kingdom*
UNIDO	*United Nations Industrial Development Organization*
US	*United States*
USD	*United States Dollars*
VAT	*Value Added Tax*
WDI	*World Development Indicators*

PREFACE

This is a report of the research project on 'Reassessment of National Parameters for Project Appraisal in India' funded by NITI Aayog, Government of India. It provides estimates of social time preference rate, rate of return on investment, shadow price of investment, and the shadow prices of foreign exchange for the Indian economy taking in to account changes that have taken place in Indian economy during last ten years. Institute of Economic Growth has done earlier two similar studies, one in the year 1992 and another in the year 2007 for the then Planning Commission, Government of India. We are grateful to NITI Aayog for asking us again to do this study.

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EXECUTIVE SUMMARY

Background

- The Project Appraisal and Management Division (PAMD) in NITI Aayog undertakes comprehensive appraisal of public funded schemes/projects costing more than Rs. 500 crore for consideration by the Expenditure Finance Committee (EFC) or Public Investment Board (PIB). For projects of commercial nature, financial and economic viability analysis is done by calculating internal rate of return (IRR), net present value (NPV), benefit-cost ratio etc. The main tool being used in computation of these viability ratios is discount rate/hurdle rate.
- The Government of India had been issuing guidelines on parameters (discount rates) and processes for project appraisal periodically. The national parameters for project appraisal reviewed and in operation since 1994, stipulated that projects must yield a minimum 12% financial and economic internal rate of return for the purpose of investment approval. The premium on foreign exchange is taken at 20% for economic analysis.
- However, there has been a significant transformation in the economic structure of the economy over the years after the introduction of economic reforms in early 1990s. In view of this it is felt desirable to re-assess the national parameters of project appraisal with respect to the following:
  a) Shadow price/discount rate of investment for financial viability analysis
  b) Social rate of discount for economic viability analysis
  c) Shadow price of foreign exchange rate
- This study provides revised estimates of these parameters for India taking in to account the changes that have taken place in Indian economy in recent years, and also by using methodological improvements in the estimation.
- Institute of Economic Growth (IEG) had provided these estimates in the past to then Planning Commission of India on two previous occasions one in the year 1992 and another in the year 2007, which have been used by Government of India until to date.

Social Rate of Time preference

- In an economy with perfect capital markets, the literature shows that the socially efficient discount rate can be estimated in three different ways:
  a) As the interest rate observed in financial markets, that reveals important information about society's willingness to transfer wealth to the future.
  b) As the marginal rate of return on productive capital in the economy.
  c) As the welfare-preserving rate of return on savings which guarantees that reduction in current welfare is more than compensated for by increase in the future welfare.
- In an economy with imperfect capital markets, as is the case for India, these three rates differ. Therefore, we try to estimate these three rates separately for India in this study.
- In an economy with imperfect capital markets, the welfare preserving rate of interest which is society's or government's time preference rate could be lower than either interest rate observed in the financial markets or the rate of return on investment. This could be a situation in an emerging economy like that of India requiring the estimation of social time preference rate (STR) as subjective or consumption rate of discount.
- The Ramsey rule (1928) is commonly used to estimate this rate. The generalized Ramsey rule reported below and used in this study accounts for three components of social time preference rate (r): impatience effect, wealth effect and the effect of uncertainty of future state of the economy (precautionary effect) in an additive form:

  Social Time Preference Rate = Impatience Effect + Wealth Effect + Precautionary Effect

- These three components are identified and estimated for the Indian economy in this study.
- Pure rate of time discount or the utility rate of discount in the literature accounts for the impatience effect on social time preference rate. In some of the earlier studies this rate is estimated as the probability of a representative individual of a population not surviving a year after. Using 2011-12 Sample Registration System (SRS) of India this probability is estimated as 2.34 per cent.

- Wealth effect is a product of the estimates of elasticity of social marginal utility (ν) and the rate of growth of per capita income (g) for India. The values of parameters ν and g depend upon several factors including policies of the government over time. There are four methods of estimating ν considered in the literature. They are, (i) equal absolute sacrifice approach, (ii) Euler equation approach from optimal Ramsey growth models, (iii) the want independent approach of Frisch based on estimates of consumer demand systems and, (iv) the subjective wellbeing approach using directly observed individuals/households' responses of subjective wellbeing through survey methods. Methods (ii) and (iii) assume existence of perfect capital market in the economy.
- We apply the revealed preference method of equal absolute sacrifice which does not subscribe to perfect capital market assumption. This method uses the information of policies of government that affect the distribution of income in the economy. The Government uses tax instruments - income and commodity taxes - to bring the desired income distribution in the economy. The Government may resort to progressive taxation and pro poor expenditure policies to achieve its objective of income distribution in the economy.
- Two estimates of elasticity of social marginal utility (ν) are made in this study. One is based on the incidence of commodity taxes borne by different expenditure classes using National Sample Survey consumer expenditure survey data and indirect tax data, and another on the incidence of income taxes by different income groups in India.
- These estimates for ν form a range from 0.91 to 1.50 for India suggesting that this estimate could be 1.2 on the average for India. Also an attempt is made in this study to estimate v using Euler equation in Ramsey optimal growth model. This estimate has to be viewed with the caution that Indian capital market is not perfect and thus violating the basic assumption of the model. The estimated value of v based on this model is 1.18.
- The rate of growth of real *per capita* income which is another important parameter in determining wealth effect is about 5 per cent in India based on data since 1991 provided by the Central Statistical Office. There have, of course, been shorter periods such as 2003-08 when per capita income growth has crossed 6.5 per cent. We have taken average growth since 1991 as more representative of

the emerging scenario for the next decade or so and have used 5 per cent per capita income growth.

- Estimation of precautionary effect requires information about the probability distribution of future rate of growth in India according to the extended Ramsey formula. The probability distribution of historical growth rates in India over a long period could be an indicator of uncertainty of future growth rate.
- For this purpose two different historical scenarios are considered. First, based on growth experience during the 25 years of post-economic reforms period and second, based on the growth experience of the Indian economy since 1950s.
- The precautionary effect on the rate of discount estimated with the assumption that rates of growth are uncorrelated over time is found to be lower as expected. The precautionary effect accounts for a difference of about 0.1 percentage point in the social time preference rate. In a scenario of having ν as 1.2 and a probability distribution of post-1950s growth rates (mean per capita NNI growth rate 3.1 per cent and standard deviation 3.3 per cent), the discount rate is estimated as 5.98 per cent.
- Considering the post-economic reforms scenario of 5 per cent growth rate of real per capita NNI for India, this study recommends an estimate of 8 per cent for the rate of discount for investment project appraisal in India. Given other things, the rate of discount used for making investment decisions depends upon the prevailing rate of growth of income during the year of making investment decisions.
- The case for having declining discount rates over time is considered for a probable scenario of uncertain future growth rates which may be correlated over time The current higher rates of growth may be cause of future lower rates of growth because of constraints on natural resources, climate change problems etc. Recent literature shows that if there is uncertainty and correlation between growth rates over time there will be a precautionary effect of declining discount rates over time.
- Some developed countries like France and UK use declining term structure of discount rates. Literature suggests that rates of discount should be lower for assessing the investment projects meant for climate change mitigation and environmental management projects which have very long run beneficial effects.

An important recent analytical study for developed country has recommended 4 and 2 per cent rates of discount for evaluating, respectively, projects for immediate future and medium future (Weitzman 2001).

- A lower discount rate for environmental management projects and climate change mitigation project is justified because: (a) the expansion of these services is slower than general economic activities and, (b) there is more uncertainty around evolution of environmental quality in future than the uncertainty around economic growth itself (Gollier 2012).
- The above conclusions are supported by the estimates based on Ramsey discounting of ecosystem services for India and other countries (Baumgärtner et al 2014). This study notes that the growth of environmental services is declining or stagnant.
- Based on the analysis, it is suggested for India the discount rates for general economic projects can be 8 per cent, for environmental projects can be 6 per cent and for long term climate change mitigation projects can be even lower than 6 per cent.
- However, further appraisal is desirable to study the discount rates structure for environmental, ecosystem and climate change mitigation projects in India.

Rate of Return on Investment

- The estimate of rate of return on investment in India is obtained as the marginal value productivity of capital in India. A production function for the Indian industry is estimated using panel or cross section-time series data from two sources: Capitaline, RBI and Annual Survey Industries (ASI).
- Capitaline data consists of 13271 observations for the 5 year period of 2011-12 to2015-16 while the ASI data used consists of 750 observations for the 5 year period of 2009-14. Both Cobb-Douglas and Translog production functions are considered for estimation. The estimates of rate of return of capital at 2015-16 prices are obtained using the estimated production functions.
- The estimates of rate of return on capital based on company balance sheet or Capitaline data form a range of 9.7-11.1 per cent while the range for those based on ASI data is 9.60-11.4. Therefore, based on these estimates, the rate of return of

capital in the Indian economy is estimated as 10 per cent at 2015-16 prices. Therefore, this study recommends 10 per cent as the rate of return on investment in the Indian economy.

- We may note that as per OM dated 5-8-2016 of Department of Expenditure, the Government uses a hurdle rate of 10% in assessing in calculating financial internal rate of return (FIRR) for viability of a project. This study thus supports the empirical validity of the current hurdle rate used by the Government in project appraisal.
- In an economy with imperfect capital market, there could be sub-optimal level of savings implying that social time preference rate discussed above is lower than rate of return on investment. In this case if the investment in public sector projects is at the cost of investment elsewhere in the economy, there could a social premium on public sector investments. It implies that the social cost (shadow price) of a rupee investment in public sector is more than one rupee. The estimates presented in the study account for this fact.
- By adopting 30 per cent, 8 per cent and 10 per cent as estimates respectively of rate of savings of private sector, social time preference rate and rate of return on investment, the shadow price of investment is estimated at 1.40 for the Indian economy. Therefore, in this scenario there is a social premium of 40 per cent on investment made in public sector projects in India. However, in the scenarios of 6 and 4 per cent social time preference rate, shadow price of investment becomes 2.33 and 7.00, respectively, given an estimate of rate of savings as 0.30.
- It is found that shadow price of investment is highly sensitive to social time preference rate, r. In the case of social time preference rate falling from 10 per cent to 4 per cent, the shadow price of investment has increased from 1.00 to 7.00. This is the likely scenario for the investment projects with long gestation period such as environmental management projects like river cleaning and climate change mitigation projects.
- That means for this type of projects with a recommended lower social discount rare for their economic evaluation, the social cost of initial investments are higher while the benefits in the distant future are also higher. For example, the climate change mitigation investment projects which normally having very long gestation periods and very low rates of discount for their evaluation will have very high initial social cost of investment and more than compensating very high future benefits.

- The cut off financial rate of return on investment for the financial analysis of projects depends on the market rate of interest for borrowing in the economy. Two approaches are considered for deciding on the financial cut off rate of return on the investment projects. The first approach is based on the concept of competitive interest rate in the market for which one may use prime lending rates by the commercial banks. The alternative approach is to consider the sources of government borrowings and ascertain the interest rate government pays at margin.
- On the basis of these two approaches, the financial cut off rate of return for public sector investments is estimated as the maximum of interest rates paid by government for different sources of borrowing.
- It is found that the appropriate cut off rate of return for the financial evaluation of investment projects in India could be also 10 per cent.

Shadow Exchange Rate

- Estimates of shadow exchange rate are obtained for the Indian economy using both equilibrium exchange rate and revealed preferences methods. The equilibrium exchange method described below and used in this study captures the effects of reducing tariffs on the exchange rate after keeping the pre-reform trade balance and equilibrium of import demand and supply and export demand and supply.
- Given that the Indian economy has been witnessing a gradual reduction in foreign trade restrictions since early 90's due to trade reforms, EER could be the appropriate method for estimating the shadow exchange rate for India.
- Derivation of the EER requires that the following assumptions be made about the trade sector: equality between export supply and export demand, equality between import supply and demand and balance of trade in foreign currency given by Exports + Δ = Imports where Δ is the current account balance or deficit of trade.
- Given the data on market exchange rate, and the estimates of price elasticities of import demand and supply and export demand and supply and volumes of

exports and imports and trade taxes, one can estimate the equilibrium exchange rate by using the above formula.

- We estimate EER for India using the new estimates of price elasticities of export supply and demand and import supply and demand made in this study and trade statistics for recent years.
- Revealed preference methods focus on distortions introduced in the external trade sector by trade policies of government (import tariffs and export subsidies) and accounts for their effects on incremental changes in consumption and welfare. Apart from trade taxes, domestic commodity taxes also can indirectly contribute to distortions in the trade sector. The difference between domestic market prices and world prices of tradable goods can be partly explained by the domestic commodity taxes.
- Therefore, a generalized revealed preference method has to account for the effects of trade taxes and domestic commodity taxes on the social premium of foreign exchange. The methods of estimation of shadow exchange rate used in this study show that there could be a social premium on foreign exchange as long as there are positive trade taxes. Trade taxes are not likely to be reduced to zero given that they are also revenue-raising instruments for the government.
- Estimates of the shadow exchange rate for the Indian economy obtained for different years show that the gradual reduction of trade taxes due to economic reforms had the effect of reducing the difference between the market and shadow exchange rates, as expected.
- The equilibrium exchange rate as a percentage of the market exchange rate has fallen from 1.68 to 1.08 during 1991-2015. The average rate of import tariff has fallen from 43 per cent to 7 per cent during the same period.
- Based on the estimates from different approaches, this study recommends 8 per cent social premium on foreign exchange rate for the public investment project appraisal in India.

Main Recommendations

The main recommendations of the study are as follows:

- **Social Time Preference Rate**

  Recommendation 1: For general economic projects, the recommended rate of discount is 8 per cent.

  Recommendation 2: For environmental management and infrastructure projects with over 50-year life, the recommended discount rate is 6 per cent. For climate change mitigation projects with benefits accruing over 100 years, the rate of discount can be lower than 6 per cent. A detailed empirical assessment is desirable in the context of environmental and climate change projects.

- **Rate of Return on Investment and Shadow Price of Public Investment**

  Recommendation 3: The recommended rate of return estimated as marginal value productivity of capital in the private sector in the Indian economy as well as based on the prime lending rates of commercial banks and maximum of interest rates paid by government for different sources of borrowing is 10 per cent.

  Recommendation 4: We may note that for appraisal of projects which have an identifiable stream of financial returns, Government of India in 2016 has advised the use of a hurdle rate of 10 per cent for financial internal rate of return (FIRR). This study thus recommends continuation of this rate in project appraisal.

- **Shadow Exchange Rate**

  Recommendation 5: Based on the equilibrium exchange method, this study recommends 8 per cent social premium on foreign exchange for the public investment project appraisal in India.

CHAPTER I: INTRODUCTION

1.1. Study Background

1.1. Project Appraisal and Management Division in NITI Aayog undertakes comprehensive appraisal of public funded schemes/projects costing more than Rs. 500 crore for consideration by the EFC/PIB. For commercial nature of projects, financial and economic viability analysis is done by calculating internal rate of return (IRR), net present value (NPV), benefit cost ratio etc. The main tool being used in computation of these viability ratios is discount rate/hurdle rate. To calculate internal rate of return, net present value, benefit cost ratio etc. in financial and economic terms, the National Parameters for Project Appraisal of Public Sector Projects were estimated in 1970s.

1.2. The Government of India had been issuing guidelines on parameters and processes for project appraisal periodically. The national parameters (discount rate, financial and economic IRR, premium on FE etc.) for project appraisal reviewed and in operation since 1994, stipulated that projects must yield a minimum 12% financial and economic internal rate of return for the purpose of investment approval. The premium on foreign exchange is taken at 20% for economic analysis. However, there has been a significant transformation in the economic structure of the economy over the years after the introduction of economic reforms in early 1990s.

1.3. Based on Study Report (2007) by the Institute of Economic Growth, the erstwhile Planning Commission had made the following recommendations:

i) The benchmark internal rate of return (IRR) for financial and economic viability may be 10% as against existing rate of 12%. Discount rate of 10% may be applied for calculating Net Present Value (NPV) in financial and economic terms.

ii) All evaluation of energy projects dependent on non-renewable energy sources would be based on assessment of projected energy prices in the next 5 years.

iii) In view of narrow gap between market and official rate of foreign exchange and import/export taxes structure, it will be appropriate to provide 10% premium of foreign exchange against existing rate of 20%.

iv) Income distributional effects of investment projects would be difficult to capture in project appraisal. However, these effects at present are captured through implementation of national level programmes on employment generation, poverty alleviation, and balanced regional development.

v) Although, study recommends 40% of industrial wage as shadow price of unskilled labour, considering small component of wages in most projects that are amenable to cost-benefit analysis and calculation of IRRs and NPVs, there was no need to specify shadow wage rate as a national parameter.

vi) The methodology suggested for evaluation of cost and benefits of environmental impact is a complicated and time-consuming process. The existing statutory provisions enacted by the Government of India in respect of environmental considerations and forest protection measures with set procedures and standards are taken care of through adequate provisions in cost of the projects.

1.4. While making above recommendations, the erstwhile Planning Commission had also opined that the national parameters may be reviewed during 12th Plan. In view of this it is felt desirable to get a fresh Research Study done to re-assess the national parameters of project appraisal with respect to the following:

a) Shadow price/discount rate of investment for financial viability analysis

b) Social rate of discount for economic viability analysis

c) Shadow price of foreign exchange rate

1.2. UNIDO and OECD Approach

1.5. Public sector investment projects in India are central for provisioning and supply of several public goods including merit goods such as health and education. Public investments in infrastructure services including roads, irrigation, power, drinking water, steel and fertilizers play an important role in overall economic growth and

development. Social cost-benefit analysis has been used in India for the choice of these investment projects.

1.6. There are a number of contributions for the development of the methodology of benefit–cost analysis in the 1950s and 1960s[1]. The methodological issues relating to the measurement of social benefits and social costs of public investment (taking into account imperfect markets of goods and services and the production and consumption externalities of investment projects, the externalities of capital accumulation and resource scarcities) and are discussed at length by researchers[2].

1.7. A synthesis of some earlier studies appeared in two comprehensive monographs on this subject entitled 'Guidelines for Project Evaluation' by Dasgupta, Sen and Marglin (1972) and 'Project Appraisal and Planning in Developing Countries' by Little and Mirrlees (1974)[3], with the former known as the United Nations Industrial Development Organization (UNIDO) method and latter as the Organisation for Economic Co-operation and Development (OECD) method. The UNIDO and OECD methods advocate the use of prices (shadow prices) different from domestic market prices for valuing the goods and services used and produced by investment projects in the presence of market imperfections and economic externalities.

1.8. The UNIDO method identifies three inputs: capital, unskilled labor and foreign exchange with imperfect markets and prescribes methodologies to compute their shadow prices. It accounts for capital market imperfections in the measurement of social benefits of public investment by prescribing the aggregate consumption as numeraire and the use of the social time preference rate as a discount rate along with the shadow price of investment in estimating the present value of net benefits of an investment project.

1.9. In contrast, the OECD method while recognizing the need for using the shadow price of unskilled labor in the presence of labor market imperfections, advocates the use of world prices as shadow prices for all tradable goods and services. Domestic capital market imperfections are accounted for by taking savings as a numeraire and

[1] Prest and Turvey (1965)

[2] These studies include among others Eckstein (1958); Krutilla (1961); Blaug (1965); Feldstein (1964); Marglin (1963a, 1963b, 1967); Foster (1966); Tullock (1964); Weisbrod (1966); Sen (1961); Mishan (1967); Haveman and Krutilla (1968); Henderson (1968); McGuire and Garn (1969) and Musgrave (1969)

[3] There are also other well-known books like Layard (1972) and Dasgupta and Pearce (1972)

the rate of return on investment or accounting rate of interest as the discount rate in estimating the present value of net social benefits of the project.

1.10. The UNIDO and OECD methods differ in dealing with imperfections in the foreign exchange market. The UNIDO and other shadow exchange rate methods[4] prescribe methodologies to compute shadow price of foreign exchange for estimating the social benefits of earning foreign exchange and social costs of using the foreign exchange by the investment projects. On the other hand, the OECD method takes care of the distortions in the foreign exchange market by suggesting that benefits and costs of a project, which are in the form of tradable commodities, should be valued at world market prices (cost, insurance and freight, cif, prices for imports and free on board, fob, prices for exports). For benefits and costs in the form of non-tradable commodities, computation of accounting ratios is suggested so that these ratios can be used to convert their prices in domestic currency into foreign exchange equivalent values.

1.11. There are different views about the social time preference rate in the literature[5]. In an economy with perfect capital markets, the socially efficient discount rate can be estimated in three different ways. First, as the interest rate observed in financial markets, that reveals important information about society's willingness to transfer wealth to the future. Second, as the marginal rate of return on productive capital in the economy and third, as the welfare-preserving rate of return on savings which guarantees that reduction in current welfare is more than compensated for by increase in the future welfare.

1.12. In an economy with imperfect capital markets, social time preference rate could be lower than either interest rate observed in the financial markets or the rate of return on investment. It is because of the fact that uncertainty associated with an individual's future consumption plans makes individual rationality in relation to inter-temporal choice unreliable. Therefore, an individual's preference for savings that are revealed through the market may be different from the society's preferences for savings. Failure of the capital market to take into account the externalities of capital

[4] Harberger (1968); Harberger and Schydlowsky(1968); Bruno (1967); Kruger (1966); Balassa and Schydlowsky (1968) and Taylor and Bacha (1971)
[5]Gollier (2012)

accumulation results in the market determined level of savings being lower than the optimal level in the economy.

1.13. The two well-known methodologies of investment project appraisal: UNIDO[6] and OECD[7] methods recognize this concern. The UNIDO and OECD methods call the social time preference rate as social rate of discount and consumption rate of interest respectively. This also implies, as explained in the next chapter, that there is a social premium on investment vis-a-vis consumption in the economy.

1.14. The methodology for estimating social time preference described in the next chapter uses extended Ramsey rule[8] for determining social time preference rate. It identifies three components of social time preference rate: impatience effect, wealth effect and the effect of uncertainty of future state of the economy (precautionary effect).

1.15. The impatience effect is measured as pure rate of time discount or utility rate of discount because individuals value future utility at lower rate than current utility. It could be due to their life uncertainty in future or due to their impatience to foresee the importance of future in relation to present.

1.16. The wealth effect is due to the inter-temporal welfare effects of positive rate of growth in the economy. Positive rate of growth means that the current generation is poorer than the future generation and therefore, the current society could show the aversion to the inequality of distribution of income over time.

1.17. Uncertainty effect is due to uncertainty of future rate of growth in the economy, and uncertain state of the economy in the very long run due to problems like climate change, unforeseen catastrophic events like wars, species extension, environmental and natural disasters etc.

1.18. The shadow exchange rate could be different from the market exchange rate when there are distortions in the foreign trade sector, contributed by trade policies

[6]Sen, Marglin and Dasgupta (1972)

[7]Little and Mirrlees (1972)

[8] Ramsey (1928); Gollier (2012)

and domestic fiscal policies of the Government. Trade reforms in India have resulted in the gradual reduction of trade taxes and the removal of quantitative restrictions.

1.19. The Equilibrium Exchange Rate methodology[9] is appropriate for estimating the shadow exchange rate for the economy, given the substantial trade liberalization and reforms that have taken place. This methodology captures the effects of reducing tariffs on the exchange rate after keeping the pre-reform trade balance and the import demand and supply and export demand and supply in equilibriums. It shows that the shadow exchange rate/equilibrium exchange rate could be higher than the market exchange rate so long as there are trade taxes.

1.20. Given that trade taxes have protective and revenue components, even if the protective tariffs are reduced to zero as a result of reforms, there could still be revenue tariffs. Also, domestic commodity taxes contribute to the difference between domestic market prices and world prices of tradable commodities. Therefore, even in a reformed economy the revenue tariffs and domestic taxes could make the shadow exchange rate higher than the market exchange rate.

1.3. An Overview of Previous Studies

1.21. There are a number of empirical studies using different methodologies for the public investment project appraisal in India[10]. The earlier studies of Chopra (1972), Murty (1972, 1979, 1982), and Beyer and Misra (1972) have used methodologies similar to the UNIDO method for the social cost benefit analysis of multi-purpose river valley projects and fisheries projects in India[11]. The studies of Deepak Lal (1972, 1977, and 1980) have used the OECD methodology.

1.22. Two earlier studies similar to the current study commissioned by the Planning Commission, Government of India were undertaken by Murty et al. (1992) and Murty and Goldar (2007) which provided estimates of national parameters for the

[9] Bacha and Tayor (1971)

[10] Kanchan Chopra (1972); Deepak Lal (1972, 1977, 1980); Murty (1972, 1979, 1982); Planning Commission, Government of India (1992); Murty et al. (1992)

[11] Studies by Chopra and Murty deal respectively with Bhakra-Nangal project on river Sutlez in Punjab and Nagarjuna Sagar project on river Krishna in Andhra Pradesh while the study by Misra and Beyer deals with the Ratnagiri Fisheries Project in Maharashtra.

investment project appraisal in India, using a methodology similar to the UNIDO method.

1.23. Recently, there have been cost-benefit studies of infrastructural and environmental management projects in India[12]. Markandya and Murty (2000) provide the cost-benefit analysis of the most important environmental management project in India, the Ganga Action Plan. Murty et al (2007) provide the social cost benefit analysis of an important infrastructural project Delhi Metro in India.

1.24. The project appraisal divisions of the Planning Commission and the Ministries of Commerce, Industry, Finance, Environment and Forests, Power, Health and Water Resources of the Government of India attempt regular cost-benefit analysis of public investment projects, mostly using the methodology similar to the UNIDO method.

1.25. Against the backdrop of these studies done in the past for the Indian economy, it is important to understand the relevance of the social cost-benefit analysis of public investment projects for the post-reforms period in the Indian economy. Some of the most important questions to be answered in this context are: In the Indian economy with as high a domestic rate of savings as 30 per cent, is the social time preference rate lower than the marginal rate of return on investment or the market rate of interest and is there a social premium on public investment? With the average trade taxes falling to 15 per cent and other trade distortions mostly eliminated in the post reforms India, is there still a social premium on foreign exchange i.e. is the shadow exchange rate higher than the market exchange rate? An attempt is made in this study to look for answers to some of these important questions taking in to account relevant developments in the Indian economy during last ten years.

1.26. The earlier studies done by Institute of Economic Growth (1992, 2007) for the Planning Commission of India (PC)[13] provide estimates of national parameters for social cost benefit analysis in India. They provide estimates of social time preference rate, rate of return on investment, financial rate of return, income distributional weights, shadow price of unskilled labor and shadow exchange rate. The current study aims at providing revised estimates of social time preference rate, rate of return on investment, financial rate of return and shadow exchange rate for the Indian

[12] Markandya and Murty (2000); Murty et al (2007)
[13] Murty, Misra, Kadekodi and Goldar (1992) and Murty and Goldar (2007)

economy taking in to account the changes in factors determining these parameters during last 10 years.

1.4. Structure of the Report

1.27. With **Chapter I** as Introduction, the remaining of this report is organized as follows:

- **Chapter II** describes the methodology of estimating social time preference rate taking into account new developments in the literature. Using this methodology, it provides estimate of social time preference rate for India.
- **Chapter III** discusses the methods of estimating rate of return on investment, financial rate of return and shadow price of investment for the Indian economy and estimates all these parameters.
- **Chapter IV** presents the approach for estimating shadow exchange rate and provides estimates of shadow exchange rate for India.
- **Chapter V** presents the major conclusions and recommendations.

CHAPTER II: SOCIAL TIME PREFERENCE RATE

2.1. Introduction

2.1. Social time preference rate is an important national parameter used in investment project appraisal by the government. In an economy with perfect capital market, the socially efficient discount rate can be estimated in three different ways[14]. First, as the interest rate observed in financial markets that reveals important information about society's willingness to transfer wealth to the future; Second, as the marginal rate of return on productive capital in the economy and; Third, as the welfare-preserving rate of return on savings which guarantees that reduction in current welfare is more than compensated for by increase in the future welfare.

2.2. In an economy with imperfect capital markets, the welfare preserving rate of interest which is society's or government's time preference rate could be lower than either interest rate observed in the financial markets or the rate of return on investment. It is because uncertainty associated with an individual's future consumption plans makes individual rationality in relation to inter-temporal choice unreliable. Therefore, an individual's preference for savings that are revealed through the market may be different from the society's preferences for savings.

2.3. Furthermore, there are externalities of capital accumulation, which a competitive capital market cannot take into account in determining the time preference rate. Failure of the capital market to account for these externalities may result in a savings rate different from the optimal level in the economy. Social rate of discount is the rate associated with that level of savings which society chooses as the optimal one. The two well-known methodologies of investment project appraisal: UNIDO[15] and OECD[16] methods recognize this.

2.4. The UNIDO and OECD methods call the social time preference rate as social rate of discount and consumption rate of interest respectively. This also implies that

[14] Gollier (2012)

[15] Sen, Marglin and Dasgupta (1972)

[16] Little and Mirrlees (1972)

there is a social premium on investment vis-a-vis consumption in the economy. The methodology for estimating social time preference described in the subsequent section identifies three components of social time preference rate: impatience effect, wealth effect and the effect of uncertainty of future state of the economy (precautionary effect).

2.5. The impatience effect is measured as pure rate of time discount or utility rate of discount because individuals value future utility at lower rate than current utility. It could be due to their life uncertainty in future or due to their impatience to foresee the importance of future in relation to present. The wealth effect is due to the inter-temporal welfare effects of positive rate of growth in the economy. Positive rate of growth means that the current generation is poorer than the future generation and therefore, the current society could show the aversion to the inequality of distribution of income over time. Uncertainty effect is due to uncertainty of future rate of growth in the economy, and uncertain state of the economy in the very long run due to problems like climate change, unforeseen catastrophic events like wars, species extension, environmental un-sustainability etc.

2.6. Original Ramsey formula[17] for the consumption rate of discount accounting for both impatience and wealth effects has been extended to account for uncertainty of future consumption and growth. This extension is made in two ways as shown in the next section[18]. One extension is based on the assumption that consumption next year is a random variable which is independently and identically normally distributed with *known* mean and variance. It results in a constant lower rate of discount than that is given by original Ramsey formula. The other extension uses the assumption that shocks to consumption growth are positively correlated over time with rate of growth of consumption being independently and identically distributed with *unknown* parameters. This extension shows declining rate of discount over time. Several authors[19] have dealt with this problem of lower and declining discount rates, especially in the context considering very long run effects on future growth of consumption arising out of climate change problems and other catastrophic effects.

[17] See Ramsey (1928)

[18] See Gollier (2012) for more details

[19] See Arrow et al. (2014), Weitzman (1998, 2001,2004), Gollier and Hammit (2014), Nordhaus (1994,2007)

2.7. The rest of the chapter is organized as follows: Section 2.2 describes the methodology accounting for impatience and wealth effects in estimating social time preference rate. Section 2.3 provides the extended methodology of Section 2.2 accounts for the effects due to the uncertain state of the economy. Section 2.4 reviews the important studies on applied social discount rates. Section 2.5 describes the methodology of estimating the elasticity of social marginal utility or inequality aversion parameter and provides estimates of this important parameter determining social time preference rate for the Indian economy. Section 2.6 describes the estimate of individuals' pure rate of time preference using Sample Registration System (SRS) Life Table estimates. Section 2.7 discusses the rate of growth of income and population in India. Section 2.8 presents the estimates of social time preference rates for India while section 2.9 concludes the chapter.

2.2. Impatience, Wealth, Precautionary Effects and Ramsey Rule

2.8. Consider a time stream of consumption plan $C = (C_0, C_1, C_2 \ldots C_t)$ for the economy. There is a general welfare function in the form of $W(C)$ which is smoothly differentiable, concave with positive first derivatives. Pure time preference rate (p) is already built in to the general utility function. A special case of this utility function could be written as:

$$W(C) = \sum_{t=0}^{\infty} e^{-pt} U_t \quad \ldots (1)$$

Where, $p > 0$, $U'(0) = \infty$ and $U'(\infty) = 0$. There is only one commodity serving as both consumption and investment. The production relations for converting current consumption into future consumption are such that reducing consumption in period 0 by one unit requires, e^{rt}, extra units available at period, t, for obtaining the same utility as one unit of consumption provides in period 0. Therefore, the optimal consumption plan must satisfy the following first order condition:

$$\frac{\partial W}{\partial C_0} = \frac{\partial W}{\partial C_t} e^{(rt)} \quad \ldots (2)$$

From equation (1) we have,

$$\frac{\partial U(C_0)}{\partial C_0} = e^{(-pt)} \frac{\partial U(C_t)}{\partial C_t} e^{(rt)} \quad \ldots (3)$$

The marginal rate of substitution between consumption in year 0 and consumption in year, t, is given as,

$$e^{(rt)} = \frac{\partial U(C_0)}{\partial C_0} / e^{(-pt)} \frac{\partial U(C_t)}{\partial C_t} \quad \ldots (4)$$

Equation (4) could be written as,

$$r = \frac{1}{t} ln \left[\frac{\frac{\partial U(C_0)}{\partial C_0}}{e^{(-pt)} \frac{\partial U(C_t)}{\partial C_t}} \right] \quad \ldots (5)$$

Equation (5) could be rewritten as

$$r = p - \frac{1}{t} ln \left[\frac{\frac{\partial U(t)}{\partial C_t}}{\frac{\partial U(C_0)}{\partial C_0}} \right] \quad \ldots (6)$$

Further, the Taylor's expansion of $\frac{\partial U(t)}{\partial C_t}$ around, C_o, yields

$$r = p + \frac{C_t - C_0}{tC_0} v(C_0) \quad \ldots (7)$$

Where, $v(C_0) = C \frac{\partial^2 U(C_0)}{\partial {C_0}^2} / \frac{\partial U(C_0)}{\partial C_0}$

The parameter, $v(C_0)$, is the elasticity of marginal utility with respect to consumption which is considered as inequality/ risk aversion parameter.

Equations (6) and (7) show that the social rate of discount (r) has two components: impatient effect or pure rate of time discount (p) and the wealth effect and wealth effect which is positive with non-zero growth of income. Considering a utility function having constant elasticity of marginal utility, the welfare function in equation (1) becomes:

$$W(C) = \sum_{t=0}^{\infty} e^{-pt} U_t = \sum_{t=0}^{\infty} e^{-pt} A \frac{C_t^{1-v}}{1-v} \quad \ldots (8)$$

The corresponding marginal utility of consumption function is,

$$e^{-pt} \frac{\partial U(t)}{\partial C_t} = e^{-pt} A C_t^{-v} \quad \ldots (9)$$

Assuming constant exponential growth of consumption, $C_t = C_0 e^{gt}$, and $t=1$, we have

$$\frac{\partial U(0)}{\partial C_0} = AC_0^{-v} \text{ and } e^{-p}\frac{\partial U(1)}{\partial C_1} = e^{-p}e^{-gv}AC_0^{-v} \quad \ldots (10)$$

Substituting (10) in (5) yields

$$r = p + (-vg) \quad \ldots (11)$$

Equation (11) decomposes the social time preference rate as impatience effect (p) and the wealth effect ($-vg$).

2.3. Uncertainty of Future Consumption and Social Discount Rate

2.9. Positive wealth effect on social rate of discount becomes uncertain in future if there is uncertainty about future rate of growth in the economy. Uncertain lower and declining rate of growth means future generations are worse off in comparison to present generation. This casts doubts about importance of wealth effect to advocate the use of higher discount rate. The current discourse has mixed opinion regarding future of growth sustainability. Some suggest higher future rate of growth with still unexploited technological improvements while others predict very low or negative future rates of growth due to natural resource constraints, population growth, climate change etc.

Hence, let us rewrite the welfare function in equation (1) assuming that there is uncertainty about future consumption C_t at year, t, and certain utility in year, t, is replaced by the expected utility, $EU(C_t)$, as

$$W = U(C_0) + exp^{-pt}EU(C_t) \quad \ldots (12)$$

Consider that investment of one rupee in year 0 yields a certain benefit, e^{rt}, in year, t. It preserves the inter-temporal welfare in W in (12) if and only if:

$$\frac{\partial U(C_0)}{\partial C_0} + e^{(-pt)}\frac{E\partial U(C_t)}{\partial C_t}e^{rt} = 0$$

which could be written as,

$$r = p - \frac{1}{t} ln \left[\frac{\frac{\partial U(t)}{\partial C_t}}{\frac{\partial U(C_0)}{\partial C_0}} \right] \quad \ldots (13)$$

If π is the precautionary or risk premium it could be written that

$$E \frac{\partial U(C_t)}{\partial C_t} = \frac{\partial U((1-\pi)(EC_t))}{\partial C_t} \quad \ldots (14)$$

Therefore equation (14) becomes

$$r = p - \frac{1}{t} ln \left[\frac{\frac{\partial U\left((1-\pi)(EC_t)\right)}{\partial C_t}}{\frac{\partial U(C_0)}{\partial C_0}} \right] \quad \ldots (15)$$

Using Taylor's expansion we have from (15)

$$r = p + \frac{(1-\pi)(EC_t)-C_0}{tC_0} v(C_0) \quad \ldots (16)$$

It is the Ramsey's rule accounting for risk of future growth.

If $C_t$is normally distributed random variable with mean EC_t = a and variance σ^2Arrow and Pratt approximation of π gives the following relationship between $\pi$and σ^2 and ν, the inequality aversion parameter as:

$$\pi = 0.5\, \sigma^2 v \quad \ldots (17)$$

Considering t = 1 and constant exponential growth of consumption $C_1 = C_0 e^g$ and constant elasticity marginal utility function $\frac{\partial U(C_0)}{\partial C_0} = {C_0}^{-v}$ and substituting (17) in (15) we get the extended Ramsey formula as:

$$r = p + v\, \mathrm{g} - 0.5 v^2 \sigma^2 \quad \ldots (18)$$

Equation (18) accounts for impatience effect (p), wealth effect vg and uncertainty of future consumption and growth.

If we consider the growth, g, of expected consumption, $g = lnE(C_1/C_0) = \mu + 0.5\,\sigma^2$, equation (18) becomes,

$$r = p + v\mu - 0.5\,v(v+1)\sigma^2 \quad \ldots (19)$$

Equation (19) gives extended Ramsey rule accounting for impatience and wealth effects and effect of uncertainty (precautionary effect) of future consumption and growth in the economy.

2.10. The wealth and precautionary effects determining the discount rate as explained above may change over time suggesting term structure of discount rates. Considering equation (13) above both sides of equation depend on time, t, thus yielding a term structure of discount rates. Considering two time intervals from the present to two different points of time t_1 and t_2 $(t_2>t_1)$ the intensity of wealth and precautionary effects could be different suggesting two different rates of discount r_{t1} and r_{t2}. The extended Ramsey formula is based on the assumption that the uncertain growth process could be modeled using historical data. The wealth effect will be changing with varying rates of growth in the short run and long run. Historical data of growth for many countries shows that growth is subjected to business cycles and it should be taken in to account in determining the term structure of discount rates. With higher growth rate in the short run, the discount rate is high because of stronger wealth effect. However, in the long run if the economy is reverted to lower growth the wealth effect becomes weak resulting in the lower discount rate.

2.11. It is argued that there could be subjective variability about future growth that a society or a group of people perceives than past observations seem to suggest. This requires for treating mean μ and variance σ^2 of consumption growth in equation (19) as uncertain. It is shown in the literature that this subjective uncertainty about trend and volatility of growth will lead to declining discount rate[20] over time. If there is positive serial correlation in the growth, the long run risk of growth is increased intensifying the precautionary effect and leading to declining discount rate over time.

[20] Arrow et al. (2011), Weitzman (2004) and Gollier (2008)

2.12. There are various theoretical strands that support a view of declining term structure of discount rate over time. Most are related to uncertainty and persistence in either growth or discount rates. If growth of consumption is inter-related overtime (i.e., current growth rate determines the future growth rate or growth is subjected to persistent changes), it is shown that there is a case for declining discount rates over time[21].

Consider that consumption evolves according to the following system following mean reverting process: $g_t = \mu e^{(\varepsilon_t)}$. Taking log on both sides,

$$ln(g_t) = \mu + \varepsilon_t \quad \ldots (20)$$

Let, $\varepsilon_t = \phi\varepsilon_{t-1} + \eta_t$

Where, ϕ, measures the degree of persistence. The error terms are assumed to be identically and independently distributed normally with a mean of zero. In this case, the short run and long run discount rates become, respectively,

$$r_t = p + v\mu - 0.5v^2[\sigma_g^2 + \sigma_\varepsilon^2] \text{ for } t=1$$

$$r_t = p + v\mu - 0.5v^2[\sigma_g^2 + \frac{\sigma_\varepsilon^2}{(1-\phi)^2}] \text{ for } t=\infty \quad \ldots (21)$$

2.4. Review of Applied Social Discount Rates

2.13. Weitzman (2001) has shown that the responses in a survey of the opinions of 2,160 economists, about the possible rate of discount for evaluating investment projects with long term benefit and cost profiles such as investments for climate change mitigation form gamma distribution. He has found out empirically that the second, non-exponential parameter of the gamma distribution plays, or at least should play an extremely significant role in actual long-term discounting. Weitzman has found that the aggregate responses from the panel of experts have a probability distribution with mean μ = 4 per cent per annum and standard deviation σ = 3 per cent per annum. Using these numerical values, Weitzman calibrates the model of

[21] Gollier (2012)

gamma discounting to arrive at a schedule of discount rates to be used for evaluating climate change investments (Table 2.1). The table shows that the discount rate uncertainty generates declining effective discount rate schedule for evaluating long term environmental projects.

Table 2.1: Calibrated Discount Rates for Evaluating Long Run Investments

Time Period (Years)	Classification	Marginal Discount Rate
1 – 5 Years	Immediate Future	4 per cent
6 – 25 Years	Near future	3 per cent
26 – 75 Years	Medium Future	2 per cent
76 - 300 Years	Distant Future	1 per cent
300+ Years	Far Distant Future	0 per cent

Source: Weitzman (2001)

2.14. Ramsey rule has been a basis for calibrating discount rates used by different countries and suggested by different authors in the literature. Historically there has been a serious debate in many countries especially the developed countries of USA, France and UK about the rate of discount to be used for evaluating public investment projects. The Office of Management of Budget (OMB) in United States had recommended 10 per cent rate of discount in 1972 which was revised downward to 7 per cent in 1992. In 2003, OMB has recommended 3 per cent rate of discount which corresponds to the average real rate of return of 10-year Treasury Notes between 1973 and 2003.

2.15. Several international institutions have been using the discount rate of 10 per cent for evaluating the investment projects funded by them. For almost two decades during 1985-2005, the French government had used 8 per cent discount rate for evaluating public investment projects. In 2005, an expert committee appointed by the French government[22] has recommended 4 per cent rate of discount for the projects with less than 30 years life time and 2 per cent for the projects with a life longer than 30 years. In 2003, the UK government recommends 3.5 per cent rate of discount on the basis of Ramsey rule. However, the rate is reduced to 3, 2 and 1 per cent respectively for projects having more than 30, 125 and 200 years. This declining

[22] Lebègue Report (2005)

schedule of rates of discount used by the French and the UK governments correspond with the simulated Weitzman's model-based schedule of discount rates (Table 2.1).

2.16. Gollier (2012) has calibrated extended Ramsey rule given in equation (19) for different countries including India assuming estimates of p and ν as 0 and 2. He has obtained the country-specific estimates of g and σ^2 using time series data as shown in Table 2.2. China is shown to have highest rate of discount of 14.82 per cent followed by South Korea, 10.41, Taiwan, 9.93 and India, 6.61 forming a range of 6-15 per cent for the emerging economies. Among the developed countries Japan is shown to have the highest discount rate of 4.47 per cent forming a range of 3-5 per cent for this block of countries that includes USA, Germany, UK and Japan.

2.17. In many of the estimates of rate of discount discussed above the values used for impatience effect (p) and inter-temporal inequality aversion (ν) respectively range from 0-1.5 per cent and 1 – 2 per cent. Gollier (2012) has used values of 0 and 2 per cent for calibrating Ramsey formula for different countries including India as reported in Table 2.2. Weitzman[23] suggests using value 2 per cent for both p and g and 2 for ν to compute rate of discount as 6 per cent for climate change mitigation projects. Instead Nordhaus[24] suggests 5 per cent rate of discount using 1 per cent for impatience. Stern suggested 1.4 per cent discount rate using 0.1 and 1.3 per cent for p and g and 1 for ν.

Table 2.2: Discount rate using extended Ramsey Rule for historical data, 1969–2010

Country	g(%)	σ^2(%)	R(%)
China	7.60	3.53	14.82
Germany	1.76	1.83	3.42
India	3.34	3.03	6.61
Japan	2.34	2.61	4.47
Russia	1.54	5.59	2.14
South Korea	5.38	3.40	10.41
Taiwan	5.41	5.20	9.93
UK	1.86	2.18	3.57
USA	1.74	2.11	3.35

Source: As estimated by Gollier (2012) for selected countries.
Note: Mean g and standard deviation σ of growth rates of real GDP per capita, 1969-2010.

[23] Weitzman (2007)

[24] Nordhaus (2008)

2.18. The Planning Commission and Government of India have been using 10 per cent rate of discount for evaluating public investment projects. This is the rate recommended by a research study commissioned by Planning Commission in the year 2007[25] on the basis of Ramsey rule. This study makes estimates of p, ν and g for the Indian economy. The estimates of ν based on the commodity tax policy of government and taking into account rural-urban differences in consumer expenditure data form a range of 1.00-1.04, while the estimates based on income tax policy of government have a range of 1.26-1.80. Therefore the average of estimates of ν for commodity taxes is 1.02 while that of income taxes is 1.52. The shares of domestic commodity taxes and personal taxes in the combined tax revenue of both taxes are 83 and 17 per cent, respectively.

2.19. Based on these estimates the weighted average of ν for the Indian economy is estimated to be 1.1. An estimate of p is obtained as the probability of a representative individual of India not to survive a year after. It is estimated as 0.0274 using SRS Life Table data. An estimate of rate of growth of per capita income g is taken as 6.65 per cent for the Indian economy. Considering these estimates an estimate of social time preference rate for the Indian economy is obtained as 10 per cent which is in sharp contrast with the estimate of 6.6 per cent suggested by Gollier in Table 2.1.

2.5. Estimation of Elasticity of Social Marginal Utility of Income

2.20. There are four methods of estimating ν in the literature. They are (i) equal absolute approach which we used in current study as well as in the earlier Planning Commission (2007) study, (ii) Euler equation approach from optimal Ramsey growth models, (iii) the want independent approach of Frisch based on estimates consumer demand systems and (iv) the subjective wellbeing approach using directly observed individuals/households responses of subjective wellbeing through survey methods. Methods (ii) and (iii) assume that there is a perfect capital market in the economy which is not the case with a developing economy like that of India. Groom and Maddison (2013) attempting a meta-analysis of estimates of ν for UK based on these four approaches, has recommended an estimate of 1.5 for this parameter.

[25] Murty et al. (2007)

2.5.1. Equal Absolute Sacrifice Approach

2.21. An estimate of the elasticity of social marginal utility (ν) of income could be obtained by modeling Government behavior manifested in the form of policies that affect the distribution of income in the economy. The Government uses tax instruments: income and commodity taxes to bring the desired income distribution in the economy. The Government may resort to progressive taxation and pro poor expenditure policies to achieve its objective of income distribution in the economy. A number of studies since Stern (1977) provide estimates of ν for some countries especially UK and some other European countries using revealed preference method of equal absolute sacrifice[26]. Earlier estimates of ν for India using this method could be found in Murty (1982) and PC (2007).

2.22. A method of estimation of ν implicit in the tax policies of Government using equal absolute sacrifice approach is described as follows. We assume that the Indian tax structure is based on the 'principle of equal absolute sacrifice'. This supposes that the social welfare loss attached by the government to the various amounts of tax it collects from the individuals in different income/expenditure groups is identical. Given the assumption of diminishing marginal utility of income, this principle implies that people with higher incomes will pay higher absolute amounts of taxes resulting in progressive taxation of income. If the tax levied on income Y is $T(Y)$ and utility of income is $U(Y)$, for absolute sacrifice of utility we have,

$$U(Y) - U[Y-T(Y)] = \text{Constant for all } Y \text{ where } T(Y) > 0 \quad \ldots (22)$$

Differentiating (22) with respect to Y we have

$$U'(Y) - U'[Y-T(Y)][1-T'(Y)] = 0 \quad \ldots (23)$$

$$\text{Defining } U(Y) = \frac{AY^{1-\nu}}{1-\nu} \quad \ldots (24)$$

Where, ν is the elasticity of marginal utility with respect to income, which is constant. We then have

[26] Groom and Maddison (2013)

$$U'(Y) = AY^{-\nu} \quad \ldots (25)$$

Substituting (25) in (23) and taking logarithms, we have

$$\ln[1 - T'(Y)] = \nu ln\left[\frac{Y}{Y - T(Y)}\right] \quad \ldots (26)$$

2.23. Given the data on pre-tax and post-tax incomes (Y) and [Y-T(Y)] and marginal rates of taxes T'(Y) for a representative sample of individuals in the economy, we could estimate the equation (26) to obtain the estimate of ν.

Incidence of Commodity and Income Taxes in India

2.24. Incidence of commodity taxes in India by fractile groups of monthly per capita expenditure (MPCE) classes and 15 commodity groups for both rural and urban sector is estimated as given in Appendix A2 (Table A2.1 and A2.2). The National Sample Survey (NSS) consumer expenditure survey (68th round), 2011-12 and the information about state Value Added Tax (VAT) rates and central excise or Mod-VAT rates for the year 2013-14 are used for this purpose.

Table 2.3: Incidence of indirect taxes by expenditure groups in India (Rural), 2011-12

Fractile Class	Y	T(Y)	T'(Y)	F(Y)
0-5%	446.2	57.5	-	0.034
5-10%	563.7	72.4	0.127	0.036
10-20%	663.5	85.9	0.134	0.073
20-30%	773.8	100.1	0.129	0.076
30-40%	876.2	114.1	0.136	0.081
40-50%	976.6	127.3	0.131	0.086
50-60%	1099.8	144.4	0.138	0.094
60-70%	1248.5	162.1	0.118	0.104
70-80%	1451.7	187.0	0.122	0.118
80-90%	1785.6	224.6	0.112	0.135
90-95%	2291.9	275.0	0.099	0.076
95-100%	4525.6	383.5	0.049	0.087
All classes	**1278.9**	**153.9**	**0.070**	**1.000**

Note: Y = Average expenditure; F(Y) = Relative frequency; T(Y) = Tax liability and T'(Y) Marginal tax rate

2.25. Table 2.3 and 2.4 provide information about these tax rates by NSS 15 commodity groups for rural and urban areas. The estimates of state VAT rates are obtained as averages of rates in 10 major states in India. Since commodity groups

considered for tax purposes is much broader than the NSS commodity groups, an attempt is made to match the NSS groups with tax groups after careful examination.

Table 2.4: Incidence of Indirect Taxes by Expenditure Groups in India (Urban), 2011-12

Fractile Class	Y	T(Y)	T'(Y)	F(Y)
0-5%	617.7	78.5	-	0.07
5-10%	795.8	101.3	0.13	0.06
10-20%	978.5	121.3	0.11	0.12
20-30%	1192.0	146.2	0.12	0.10
30-40%	1400.9	167.4	0.10	0.10
40-50%	1632.2	190.9	0.10	0.09
50-60%	1907.5	219.9	0.11	0.09
60-70%	2245.7	253.6	0.10	0.09
70-80%	2729.8	300.6	0.10	0.09
80-90%	3562.6	370.6	0.08	0.10
90-95%	4994.4	475.8	0.07	0.05
95-100%	10279.4	722.8	0.05	0.04
All classes	**2399.2**	**246.0**	**0.06**	**1.00**

Note: Y = Average expenditure; F(Y) = Relative frequency; T(Y) = Tax liability and T'(Y) Marginal tax rate

Table 2.5: Incidence of GST by Expenditure Groups in India (Rural)

Fractile	Y	T(Y)	T'(Y)	F(Y)
0-5%	446.2	45.1	-	0.03
5-10%	563.7	57.0	0.101	0.04
10-20%	663.5	68.4	0.115	0.07
20-30%	773.8	79.8	0.104	0.08
30-40%	876.2	91.4	0.113	0.08
40-50%	976.6	102.6	0.112	0.09
50-60%	1099.8	117.0	0.117	0.09
60-70%	1248.5	131.2	0.095	0.10
70-80%	1451.7	153.0	0.108	0.12
80-90%	1785.6	185.7	0.098	0.14
90-95%	2291.9	230.2	0.088	0.08
95-100%	4525.6	338.6	0.049	0.09
All classes	**1278.9**	**126.4**	**0.065**	**1.00**

Note: Y = Average expenditure; F(Y) = Relative frequency; T(Y) = Tax liability and T'(Y) Marginal tax rate

2.26. Tables 2.3 and 2.4 provide frequency distribution of NSS sample households, and estimates of commodity tax liability T(Y) and marginal tax rates T'(Y) by monthly per capita expenditure (Y) classes respectively for rural and urban sectors in India. Given the data from these tables, equation (25) is estimated for both rural and urban sectors separately and pooled panel data of both rural urban sectors. Since we are having frequency distribution of sample households with computed relative frequencies we used weighted least squares method or regression for grouped data.

Table 2.6: Incidence of GST by Expenditure Groups in India (Urban)

Fractile	Y	T(Y)	T'(Y)	F(Y)
0-5%	617.7	62.2	-	0.07
5-10%	795.8	80.4	0.10	0.06
10-20%	978.5	97.1	0.09	0.12
20-30%	1192.0	118.8	0.10	0.10
30-40%	1400.9	137.1	0.09	0.10
40-50%	1632.2	158.0	0.09	0.09
50-60%	1907.5	183.5	0.09	0.09
60-70%	2245.7	215.0	0.09	0.09
70-80%	2729.8	258.5	0.09	0.09
80-90%	3562.6	323.1	0.08	0.10
90-95%	4994.4	430.0	0.07	0.05
95-100%	10279.4	695.0	0.05	0.04
All classes	**2399.2**	**212.5**	**0.06**	**1.00**

Note: Y = Average expenditure; F(Y) = Relative frequency; T(Y) = Tax liability and T'(Y) Marginal tax rate

Table 2.7: Elasticity of social marginal utility (ν) implicit in commodity taxes in India

Estimated ν based on incidence of indirect tax (excise duty + state VAT)			
	Rural	**Urban**	**All**
Coefficient	-0.948	-0.884	-0.952
Std Error	*(0.033)*	*(0.025)*	*(0.028)*
t-value	-28.3	-34.9	-34.1
R^2	0.988	0.992	0.990
Estimated ν based on incidence of excise duty only			
	Rural	**Urban**	**All**
Coefficient	-0.996	-0.903	-1.000
Std Error	*(0.041)*	*(0.027)*	*(0.033)*
t-value	-24.2	-33.2	-30.4
R^2	0.983	0.991	0.987
Estimated ν based on incidence of GST			
	Rural	**Urban**	**All**
Coefficient	-0.991	-0.925	-0.993
Std Error	*(0.035)*	*(0.017)*	*(0.027)*
t-value	-28.1	-55.3	-37.1
R^2	0.988	0.997	0.992

Note: The regression model for All-India also includes a dummy variable for urban India.

2.27. Table 2.7 reports the estimated equations. The estimates of marginal tax rates reported in Table 2.3 and 2.4 reveal that commodity taxes (central excise plus state VAT) are not consistently progressive as the MPCE increases up to median level and,

thereafter, become is found to be regressive. This resulted in an estimate of ν lower than 1 for both the sectors, 0.948 for rural and 0.884 for urban sector as shown in Table 2.7. However, as expected in the pooled panel data of both rural and urban sectors commodity taxes are found to be relatively progressive resulting in an estimate of ν equivalent to 0.952. The estimates of ν implicit in the Goods and Service Tax (GST) (as on June 2017) are 0.991 and 0.925, respectively, for rural and urban areas of India.

2.28. Incidence of income taxes in India is estimated using income tax schedules for the assessment years 2012-13, 2013-14 and 2014-15. Table 2.8a, 2.8b and 2.8c provide estimates of tax liability and marginal tax rates for gross income classes respectively for the assessment years 2012-13, 2013-14 and 2014-15 while Table A2.10a, A2.10b and A2.10c in Appendix A2 provide similar estimates for returned income.

Table 2.8a: Incidence of income taxes in India (assessment year, 2012-13)

(Y) in Rs.'000	N	F(Y)	T(Y) in Rs.'000	T'(Y)
78	3757935	0.120	0	0
180	7692552	0.246	0	0
222	4528552	0.145	4.2	0.1
293	4949387	0.158	11.3	0.1
374	1456626	0.047	19.4	0.1
424	1222875	0.039	24.4	0.1
474	1061284	0.034	29.4	0.1
524	896094	0.029	34.4	0.1
698	3090118	0.099	53.6	0.1
975	161161	0.005	109	0.2
1205	869656	0.028	159.5	0.2
1718	328148	0.011	313.4	0.3
2228	173780	0.006	466.4	0.3
3375	245981	0.008	810.5	0.3
6891	93444	0.003	1865.3	0.3
19484	60612	0.002	5643.2	0.3
69568	6421	0.000	20668.4	0.3
153663	4125	0.000	45896.9	0.3

Note: Y = Average income; N = Persons; F(Y) = Relative frequency; T(Y) = Tax liability; T'(Y) Marginal tax rate

Table 2.8b: Incidence of income taxes in India (assessment year, 2013-14)

(Y) in Rs.'000	F(Y)	T(Y) in Rs.'000	T'(Y)
76	0.095	0	0
186	0.157	0.6	0.01
221	0.183	4.1	0.1
295	0.186	11.5	0.1
374	0.056	19.4	0.1
424	0.046	24.4	0.1
475	0.040	29.5	0.1
524	0.034	34.4	0.1
696	0.113	53.2	0.11
975	0.006	109	0.2
1206	0.031	159.8	0.22
1716	0.012	312.8	0.3
2225	0.006	465.5	0.3
3375	0.008	810.5	0.3
6878	0.003	1861.4	0.3
19246	0.002	5571.8	0.3
69056	0.000	20514.8	0.3
153096	0.000	45726.8	0.3

Note: Y = Average income; F(Y) = Relative frequency; T(Y) = Tax liability; T'(Y) Marginal tax rate

Table 2.8c: Incidence of income taxes in India (assessment year, 2014-15)

(Y) in Rs.'000	F(Y)	T(Y) in Rs.'000	T'(Y)
75	0.080	0	0
184	0.078	0.4	0.004
224	0.220	4.4	0.1
296	0.212	11.6	0.1
373	0.061	19.3	0.1
424	0.048	24.4	0.1
475	0.042	29.5	0.1
524	0.036	34.4	0.1
696	0.129	53.2	0.11
974	0.006	108.8	0.2
1204	0.033	159.2	0.22
1718	0.013	313.4	0.3
2224	0.007	465.2	0.3
3382	0.009	812.6	0.3
6888	0.003	1864.4	0.3
19234	0.002	5568.2	0.3
69078	0.000	20521.4	0.3
151922	0.000	45374.6	0.3
346746	0.000	103821.8	0.3

Note: Y = Average income; F(Y) = Relative frequency; T(Y) = Tax liability; T'(Y) Marginal tax rate

2.29. Given that income tax schedules reported in these tables provide frequency distribution of tax payers by taxable income groups, least squares regression for grouped data is used for estimating equation (26). Estimates are separately made using data for each assessment year and pooled time series cross section data of three assessment years considered. The pooled time series cross section data is expressed at constant prices of assessment year 2014-15.

2.30. Table 2.9 provides estimates of equation 25 for these cases. Table 2.9 shows that estimates of ν made for each assessment year considered form a range of 1.212 to 1.665 showing significant progressivity. However, the estimate of ν based on pooled data of three assessment years is obtained as 1.503.

Table 2.9: Elasticity of social marginal utility (ν) implicit in income taxes in India

Estimated ν based on returned income				
	2012-13	**2013-14**	**2014-15**	**2012-15**
Coefficient	-1.213	-1.653	-1.590	-1.503
Std Error	*(0.075)*	*(0.158)*	*(0.918)*	*(0.072)*
t-value	-16.1	-10.4	-17.3	-20.9
R^2	0.878	0.850	0.940	0.921
Estimated ν based on total income				
	2012-13	**2013-14**	**2014-15**	**2012-15**
Coefficient	-1.212	-1.655	-1.665	-1.748
Std Error	*(0.075)*	*(0.148)*	*(0.145)*	*(0.172)*
t-value	-16.1	-12.0	-11.5	-10.2
R^2	0.879	0.870	0.870	0.888

Note: The regression model for the period 2012-15 also includes dummy variables for 2013-14 and 2014-15.

2.5.2. Estimation using Ramsey Optimal Growth Model

2.31. Consider an economy producing a commodity X_t using capital, K_t and labor L_t at time t. The production function of X_t is given by

$$X_t = F(K_t, L_t) \quad \ldots (27)$$

$F(.)$ is concave and an increasing and continuously differentiable function of each of its variables with $\delta X_t/\delta K_t \geq 0$ and $\delta K_t/\delta L_t \geq 0$. Dividing (27) throughout by L_t we have,

$x_t = f(k_t)$ with $\delta f(k_t)/\delta k_t = f'(k_t) \geq 0$ … (28)

Where, x_t and k_t represent output-labor and capital-labor ratios.

Let C_t represent aggregate consumption and c_t per capita consumption at time t. The net accumulation of man-made capital ($\dot{k}$) therefore satisfies the condition (29)

$\dot{k} = f(k) - c - a - \mathrm{dk}$ … (29)

Where, d is rate of depreciation of man-made capital. Considering the utility rate of discount r, the planner's problem is to maximize:

$\int_0^\infty e^{-rt}\, U(c,E)dt$ … (30)

With respect to c and a subject to the condition

$\dot{k}=f(k) - c - \mathrm{d\,k}$

The current value Hamiltonian of the problem is

$H = U(c,E) + q(f(k) - \mathrm{dk})$ … (31)

Where, c_t is control variable, k_t is state variables, and q is co-state variable.

The first order condition for maximizing H with respect to control variable is

$U_c(c,E) = q$ … (32)

The canonical equation of Hamiltonian (31) defining the time paths of co-state variable is given as:

$\dot{q} = q\big(r + d - \mathrm{f'(k)}\big)$ … (33)

Taking the time differential of (32) and substituting for $\dot{q}$ from (33) we have

$\frac{\dot{c}}{c} = 1/v\,[\,(\mathrm{f'(k)} - \mathrm{r} - \mathrm{d})]$ … (34)

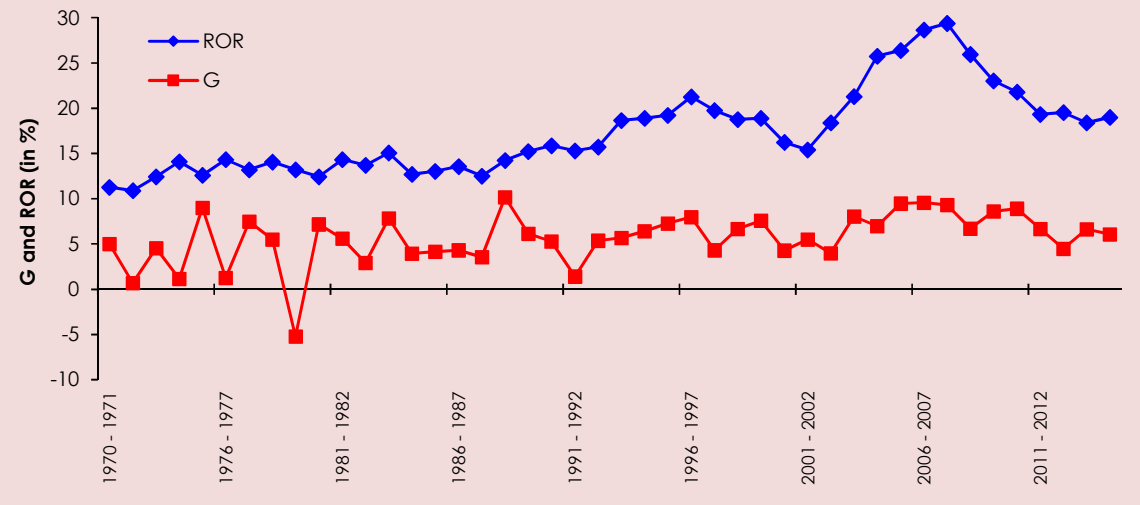
Where, $\nu = -(U_{cc}/U_c)C$, is the elasticity of marginal utility of consumption with respect to consumption.

Equation (8) explains the relationship between rate of growth of consumption and the rate of return on capital. Using time series data for rate of growth of consumption, net rate of return on investment, equation (34) could be estimated. The utility rate of discount may be taken as zero or constant 2 per cent as we considered in the report.

Estimation of the Model

2.32. The time series data of rate of growth of real per capita income for India during the last 44 years obtained from Economic Survey, Government of India, 2016-17 is considered for the estimation of equation (34). Therefore, rate of growth of real per capita income is taken as a proxy for rate of growth of per capita consumption ($\dot{C}/C$). Using production accounts for the Indian industry from the Annual Survey of Industries (ASI) data, time series estimates of net rate of return on capital invested in the industry [f'(k) – d]) are obtained for the last 44 years.

Figure 2.1: Growth rate (G) of GDP and rate of return (ROR) on capital, 1970-2014



2.33. Figure 2.1 shows the graphs of rate of growth of real per capita income and net rate of return on investment over the period 1970-71 to 2014-15. Table 2.10 provides the descriptive statistics of variables considered for estimation. The mean rate of growth real per capita income during last 44 years is found to be 5.66 per cent while the mean net rate of return on investment is found to be around 17.36 per cent.

Table 2.10: Descriptive statistics of rate of return on capital and growth rate

Indicator (1970-71 to 2014-15)	N	Mean	Variance
Growth Rate of GDP	44	5.66	8.35
Net Rate of Return on Capital	44	17.36	22.37

2.34. Table 2.11 reports the estimated growth equation. The estimated coefficient of variable net rate of return on capital (0.85) in the equation is interpreted as elasticity of inter-temporal consumption substitution. The inverse of this coefficient (1/0.85) is elasticity of social marginal utility of consumption with respect to consumption (ν) which happens to be 1.176. This estimate of ν is found to be well within the range of estimates made using revealed preference method and commodity tax and income tax data for the Indian economy. However, Ramsey growth model used here to estimate ν assumes that the capital market in the Indian economy is perfect which may not be true for the Indian economy.

Table 2.11: Estimate of Ramsey growth equation

	Coefficient	Std Err.	t	R^2
Growth Rate	0.85	0.165	5.16	0.579
Lag of Growth Rate	0.87	0.165	5.26	
Constant	7.79	1.390	5.59	

2.6. Pure Rate of Time Discount

2.35. Pure rate of time preference (p) may be interpreted as the extra premium an individual puts on the present consumption due to life uncertainty. The lower the life expectancy of people in a country, the higher should be the pure rate of time preference. This rate may be interpreted as the probability of a person belonging to a given population group or class not to survive a year after. It could be estimated as the probability of a person not surviving a year after by different age groups. An estimate of p for the Indian economy could be obtained as:

$$p = \sum_{i=1}^{15} p^i a^i \quad \ldots (35)$$

Where, p^i: probability of a person belonging to i^{th} age group not to survive a year after. a^i: population proportion in i^{th} age group.

2.36. It may be appropriate to consider that only population above 15 years of age in India will express pure rate of time preference while taking savings and consumption decisions. Children up to the age of 15 years may not be having opportunities to take decisions affecting their present and future consumptions. Appendix table A2.11 provides estimates of distribution of population by age group and survival probabilities (2010-2014) for India. Table 2.12 reports estimates of p for all-India population and population above 15 years age as per the Census of India, 2011. The estimate of pure rate of time discount for the Indian economy is obtained as 2.34 per cent.

Table 2.12: Estimates of pure rate of time discount for Indian economy

Rate	All India			Rural India			Urban India		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
p^*	0.0221	0.0245	0.0195	0.0242	0.0266	0.0216	0.0168	0.0193	0.0141
p^*	0.0234	0.0274	0.0193	0.0255	0.0297	0.0212	0.0187	0.0222	0.0149

Note: p - pure rate of time preference of the entire population; p^* - pure rate of time preference for the population of age above 15 years

2.7. Rate of Growth of Per Capita Income and its Volatility

2.37. India has been one of the fast growing economies in the world. Table 2.13 reports the real rates of growth of gross national income (GNI) and per capita net national income (NNI) in India for the post-liberalization period. The average rate of GNI growth during last 25 years being 6.9 per cent and per capita NNI growth of 5.0 per cent. This is consistent with the declining growth of population in India during last few decades from 2.2 per cent per annum in the 1970s to 1.6 per cent in the 2000s.

2.38. With these considerations, the rate of growth of per capita NNI for the Indian economy could reasonably be expected to be at about 5 per cent per annum over next one or two decades. The standard deviation of per capita income growth rates for the above period turns out to be 2.2 per cent. This reflects the likely medium-term volatility in income growth for the future.

Table 2.13: Real growth rates of GDP (at factor cost) in India, 1992-2017

Year	GNI (%)	NNI (%)	PCNNI (%)
1992-93	5.5	5.5	3.6
1993-94	4.9	5.0	2.6
1994-95	6.7	6.7	4.6
1995-96	7.6	7.7	5.6
1996-97	7.7	7.8	5.7
1997-98	4.2	3.9	1.9
1998-99	6.2	6.1	4.1
1999-00	8.8	8.9	7.0
2000-01	3.6	3.2	1.4
2001-02	5.0	4.8	2.7
2002-03	3.9	3.8	2.2
2003-04	7.9	8.0	6.4
2004-05	7.9	7.7	6.0
2005-06	9.3	9.2	7.5
2006-07	9.2	9.1	7.6
2007-08	10.2	10.1	8.6
2008-09	3.7	3.0	1.6
2009-10	8.5	8.1	6.7
2010-11	9.8	9.8	8.3
2011-12	6.9	6.5	5.1
2012-13	5.1	4.5	3.3
2013-14	6.3	6.0	4.6
2014-15	7.6	7.6	6.3
2015-16	8.0	8.1	6.8
2016-17 (PE)	7.0	7.1	5.7
Average	**6.9**	**6.7**	**5.0**
Standard Deviation	**2.0**	**2.1**	**2.2**

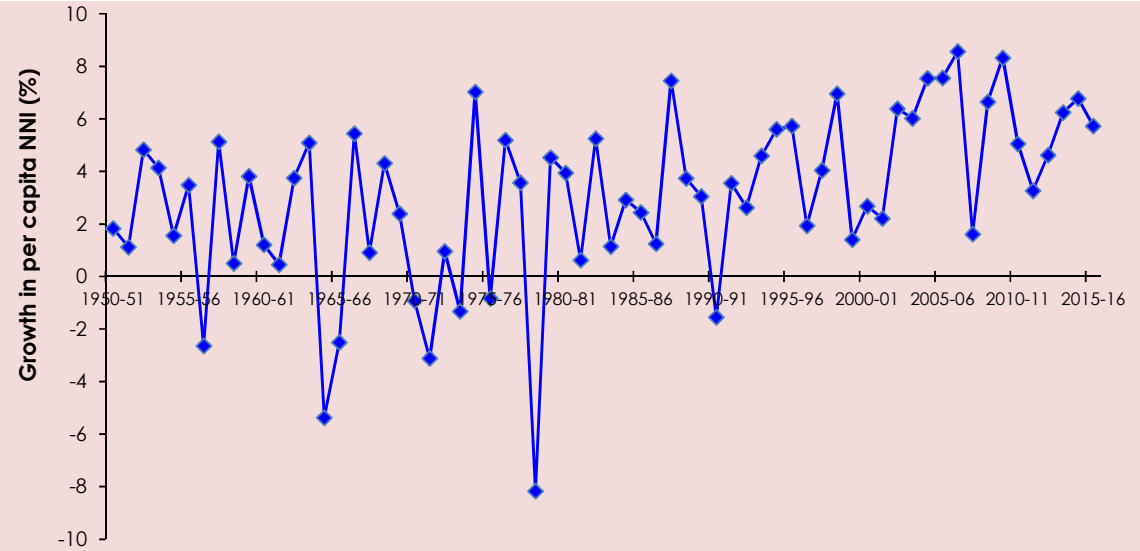
Note: Growth rates computed using Economic Survey 2016-17 (at 2011-12 Prices)

GNI – Gross National Income; NNI – Net National Income; PCNNI – Per Capita Net National Income; PE – Provisional Estimates

2.39. In the section below, we also carry out a sensitivity analysis with respect to likely volatility considering a longer term historical time series data of per capita NNI growth of India for 6 decades. This series shows a higher volatility in the rate of growth as shown in Figure 2.2. The figure shows that there are episodes of negative per capita growth rates for at least 9 years and also there are episodes of very high per capita growth rates of 8-10 per cent for 2 years. The Figure also reveals that there is considerable volatility in growth rates. The mean and standard deviation of these

growth rates over the period 1950-51 to 2016-2017 are 3.1 per cent and 3.3 per cent, respectively.

Figure 2.2: Trend of Growth Rates of Real Per Capita Net National Income of India during 1950-51 to 2016-17



2.8. Estimates of Social Rate of Discount

2.40. Estimation of social discount rate or consumption rate of discount using the Ramsey formula derived in Section 2.2 requires the estimates of parameters accounting for the impatience effect and the wealth effect. Further, the extended Ramsey formula in Section 2.3 requires estimations of parameters for the precautionary effect. We provide estimates of discount rate based on both the formulae.

2.41. The impatience effect p is estimated as the probability of a representative individual not to survive a year after. Using SRS Life Table data of 2010-11, this is estimated as 2.34 per cent as reported in Section 2.5. This revised estimate of p is slightly lower than the estimate of 2.74 per cent based on 2000-01 SRS Life Table used in an earlier study (Murty and Goldar, 2007).

2.42. Estimation of wealth effect requires the estimates of parameters of rate of growth of per capita income (g) and the elasticity of social marginal utility of income (ν) for India. We argue above in Section 2.6 for a value of 5.0 per cent for g. Section

2.4 describes a method of estimation of ν implicit in the tax policies of government. It provides alternative estimates of ν considering incidence of taxes in India for different income classes. The estimate of ν based on the incidence of commodity taxes on rural and urban households in India is found to be 0.916. On the other hand, an estimate of ν based on income taxes in India is found to be 1.503. Therefore, we adopt for this study an estimate of 1.2 which happens to be an average of these two estimates.

Table 2.14: Sensitivity of social time preference rate (r) by per capita income growth (g) with p = 2.34% and ν = 1.2

g	$r = p + \nu g$
4.5 %	7.74 %
5.0 %	8.34 %
5.5 %	8.94 %
6.0 %	9.54 %
6.5 %	10.14 %

2.43. Tables 2.14 and 2.15 provide estimates of social time preference rate for India considering alternative growth of real per capita income g and the elasticity of social marginal utility ν. In the scenario of 5 per cent rate of growth of real per capita income and an estimate of ν as 1.2, the social time preference rate for India is estimated approximately as 8 per cent. Given that the social time preference rate is highly sensitive to rate of growth, the rate of discount that has to be used for the evaluation of public investments depends on the prevailing rate of rate of growth in the Indian economy in the year of making investment decisions.

2.44. Volatility of growth rates displayed by historical data explained in Section 2.7 could be an indication of uncertain growth rates in the near and far-off future in India. The extended Ramsey formula given in equation (18) accounts for precautionary effect assuming that future annual growth rate is a random variable which is independently and identically distributed with normal distribution having mean, μ, and standard deviation, σ. In this way of modeling uncertainty of growth, it is assumed that mean growth rate in future remains similar but uncorrelated with lag values. Therefore, the rate of discount is constant over time even with this extended Ramsey rule but lower than the one given by conventional Ramsey rule.

Table 2.15: Sensitivity of social time preference rate (r) by ν with p = 2.34%, μ = 5.0% and σ = 2.15%

ν	$r = p + \nu g$	$r = p + \nu g - 0.5\nu^2\sigma^2$
1.0	7.34 %	7.32 %
1.2	8.34 %	8.31 %
1.5	9.84 %	9.79 %

Table 2.16: Sensitivity of social time preference rate (r) by ν with p = 2.34%, μ = 3.1% and σ = 3.27%

ν	$r = p + \nu g$	$r = p + \nu g - 0.5\nu^2\sigma^2$
1.0	5.44 %	5.39 %
1.2	6.06 %	5.98 %
1.5	6.99 %	6.87 %

2.45. The historical average growth rates and standard deviation of per capita NNI of last 6 decades is used for sensitivity analysis of social time preference rate, r, with varying values of, ν. Table 2.16 reports that the precautionary effect has the effect of reducing rate of discount. For the given value of 1.2 for ν, it has the effect of reducing rate of discount from 8.34 per cent to 5.98 per cent. However, the historical average rate of growth of real per capita NNI, as low as 3.1 per cent, can be an indication of growth in far off future, the discount rate for long run projects could be lower than short run projects with gestation period less than 30 years.

2.46. In the case of modeling uncertainty of growth rates, there will be time dependence or term structure of discount rates as given in equation (21). In this case there will be a distribution of growth rates in each year with unknown parameters with the mean growth of this distribution itself having a probability distribution. Literature shows in this case that there will be declining discount rates or term structure with declining rates as given by equation (21). Given that rates of growth of income may be correlated over time and may be lower in the long run in India, there could be case for having term structure of discount rates for India.

Ecological Discount Rates

2.47. Gollier (2012) argues that the economic and ecological discount rates can differ if the monetary value of environmental assets evolves over time. With

uncertainty around the value of environmental assets in future it is critical to allow for a difference between the two to account for the stochastic changes in the relative social valuation of the environment. Assumptions of future increments in environmental quality and per capita income can raise the ecological discount rates whereas assumptions of increased uncertainty around these factors can reduce the ecological discount rates. Using an ecological discount rate that is lower than economic discount rate is justified because a) growth rate for environmental quality is lower than the economic growth rate and b) there is more uncertainty surrounding evolution of environmental quality than the evolution of economy itself.

2.48. The theoretical arguments are empirically verified through estimates based on Ramsey discounting of ecosystem services for India and other countries (Baumgärtner et al 2014). This study uses data for ten ecosystem services across five countries and the world at large, and estimates that the discount rates for ecosystem services should be lower than those for the manufactured consumption goods. The study finds that the growth in aggregate ecosystem services is stagnant or declining and that they are not growing at a significantly positive rate anywhere. Based on the finding, the study suggests that the discount rates for ecosystem services can be 2.1 ± 0.9 percentage points lower than those used for manufactured consumption goods.

2.9. Conclusion

2.49. Based on the analysis, we recommend the following discount rate structure for economic projects, environmental projects and climate change mitigation projects.

- For general economic projects, the recommended rate of discount is **8 per cent**.
- For environmental management and some infrastructure projects with life period of over 50 years, the recommended rate of discount is **6 per cent**.
- Following Section 2.4, the rate of discount can be lower than 6 per cent for climate change mitigation projects with benefits accruing for over 100 years. A detailed empirical assessment, however, is desirable in the context of environmental and climate change projects.

Appendix A2

Table A2.1: Rates of taxes on NSS Commodity Groups for India

Items	Average VAT	Central Excise	Central Excise + Average VAT	GST
Cereal	1.5	0.0	1.5	0.0
Gram	1.5	0.0	1.5	0.0
Cereal products	3.3	6.0	9.3	5.0
Pulses & Pulse Products	4.0	6.0	10.0	5.0
Milk & milk products	4.7	12.5	17.2	12.0
Sugar	5.4	12.5	17.9	12.0
Salt	0.0	0.0	0.0	0.0
Edible oil	4.7	6.0	10.7	5.0
Egg, fish & meat	4.2	6.0	10.2	5.0
Vegetables	2.3	6.0	8.3	5.0
Fruits (fresh)	1.7	6.0	7.7	5.0
Fruits (dry)	6.4	6.0	12.4	5.0
Spices	4.8	-	4.8	12.0
Beverages etc.	10.5	12.5	23.0	28.0
Pan	29.4	81.0	110.4	110.4
Tobacco	30.9	34.0	64.9	64.9
Intoxicants	50.2	12.5	62.7	62.7
Fuel and light	13.8	10.0	23.8	12.0
Clothing	4.8	12.5	17.3	12.0
Footwear	5.7	12.5	18.2	12.0
Education	4.9	1.0	5.9	12.0
Medical (non- inst.)	4.9	6.0	10.9	12.0
Minor durable- type goods	6.6	12.5	19.1	28.0
Toilet articles	6.2	12.5	18.7	18.0
Other Consumables	6.3	12.5	18.8	28.0

Source: Estimated as explained in text.

Table A2.2: Incidence of central excise duty by expenditure groups in India (rural)

Fractile Class	Y	T(Y)	T'(Y)	F(Y)
0-5%	446.2	29.9	-	0.034
5-10%	563.7	38.6	0.075	0.036
10-20%	663.5	46.6	0.080	0.073
20-30%	773.8	54.9	0.075	0.076
30-40%	876.2	63.1	0.080	0.081
40-50%	976.6	71.1	0.080	0.086
50-60%	1099.8	81.0	0.080	0.094
60-70%	1248.5	91.5	0.071	0.104
70-80%	1451.7	105.6	0.069	0.118
80-90%	1785.6	127.6	0.066	0.135
90-95%	2291.9	156.4	0.057	0.076
95-100%	4525.6	216.7	0.027	0.087
All Classes	**1278.9**	**86.2**	**0.040**	**1.000**

Note: Y = Average expenditure; F(Y) = Relative frequency; T(Y) = Tax liability and T'(Y) Marginal tax rate

Table A2.3: Incidence of central excise duty by expenditure groups in India (urban)

Fractile Class	Y	T(Y)	T'(Y)	F(Y)
0-5%	617.7	42.3	-	0.075
5-10%	795.8	55.5	0.074	0.062
10-20%	978.5	67.0	0.063	0.117
20-30%	1192.0	81.5	0.068	0.103
30-40%	1400.9	93.1	0.056	0.096
40-50%	1632.2	106.5	0.058	0.086
50-60%	1907.5	123.9	0.063	0.090
60-70%	2245.7	142.7	0.056	0.091
70-80%	2729.8	169.8	0.056	0.092
80-90%	3562.6	208.6	0.047	0.098
90-95%	4994.4	266.0	0.040	0.051
95-100%	10279.4	397.5	0.025	0.039
All Classes	**2399.2**	**137.4**	**0.033**	**1.000**

Note: Y = Average expenditure; F(Y) = Relative frequency; T(Y) = Tax liability and T'(Y) Marginal tax rate

Table A2.4: Incidence of commodity taxes by NSS commodity groups and fractile expenditure classes in India (rural)

ITEMS	Fractile class of MPCE (URP)												All Classes
	1	2	3	4	5	6	7	8	9	10	11	12	
Cereal	1.5	1.8	1.9	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.8	3.0	2.3
Gram	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Cereal products	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.1
Pulses & Pulse Products	2.3	2.6	2.9	3.3	3.6	3.8	3.9	4.2	4.7	5.0	5.4	6.3	4.0
Milk & milk products	2.6	5.2	7.3	9.6	13.1	15.1	19.2	22.8	26.6	34.1	42.7	54.0	20.0
Sugar	1.8	2.2	2.7	3.1	3.5	3.9	4.2	4.6	5.2	5.8	6.8	7.9	4.2
Salt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oil	2.8	3.4	3.9	4.4	4.7	4.9	5.2	5.7	6.1	6.4	7.0	7.8	5.2
Egg, fish & meat	1.3	1.9	2.5	3.3	3.4	3.9	4.3	5.1	5.5	6.9	8.6	11.3	4.6
Vegetables	3.1	3.6	4.0	4.4	4.6	4.9	5.0	5.5	5.9	6.3	7.1	7.8	5.1
Fruits (fresh)	0.2	0.3	0.5	0.7	0.8	1.1	1.2	1.5	1.9	2.6	3.5	5.0	1.5
Fruits (dry)	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	1.0	1.1	1.7	2.5	0.7
Spices	0.7	0.8	0.9	1.1	1.1	1.3	1.4	1.5	1.7	1.8	2.1	2.4	1.4
Beverages etc.	7.3	8.4	10.2	11.7	12.8	14.4	15.6	16.7	19.5	22.9	28.1	52.5	17.2
Pan	1.7	2.6	3.5	3.7	4.2	4.9	5.1	5.6	6.1	6.4	6.2	6.5	4.8
Tobacco	3.8	5.0	6.0	7.3	8.0	8.7	10.6	11.3	12.7	14.2	15.6	16.3	9.9
Intoxicants	2.7	2.7	3.0	3.4	4.2	4.3	5.8	6.1	8.3	10.6	14.7	19.9	6.6
Fuel and light	16.3	19.0	20.2	22.4	24.4	25.7	27.4	30.2	33.0	36.4	41.0	48.0	28.2
Clothing	1.9	3.5	4.7	6.1	7.4	9.5	11.8	13.8	16.9	23.9	32.4	52.8	13.9
Footwear	0.7	0.7	1.1	1.5	1.7	2.3	2.8	3.1	3.8	5.2	6.9	10.0	3.1
Education	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.7	2.3	3.8	5.7	15.1	2.4
Medical (non- inst.)	1.5	2.4	2.8	3.4	4.1	4.8	5.6	6.6	8.6	11.4	15.8	27.1	7.1
Minor durable- type goods	0.2	0.4	0.4	0.4	0.5	0.7	0.7	0.9	1.0	1.3	1.7	2.7	0.8
Toilet articles	2.6	3.0	3.5	3.9	4.5	5.0	5.5	6.2	7.1	8.0	9.6	11.9	5.7
Other Consumables	2.1	2.5	2.9	3.4	3.9	4.3	4.9	5.6	6.7	7.8	9.6	12.5	5.3
TAX INCIDENCE	**57.5**	**72.4**	**85.9**	**100.1**	**114.1**	**127.3**	**144.4**	**162.1**	**187.0**	**224.6**	**275.0**	**383.5**	**154.0**

Source: Estimated as explained in the text

Table A2.5: Incidence of commodity taxes by NSS commodity groups and expenditure fractile classes in India (urban)

ITEMS	Fractile class of MPCE(URP)												All Classes
	1	2	3	4	5	6	7	8	9	10	11	12	
Cereal	1.7	2.0	2.1	2.3	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.5	2.6
Gram	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Cereal products	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1
Pulses & Pulse Products	2.8	3.4	3.8	4.2	4.6	5.0	5.3	5.6	5.9	6.6	6.9	7.5	5.1
Milk & milk products	6.7	11.3	15.2	19.4	23.4	26.8	32.2	36.4	41.1	50.9	60.7	73.2	32.1
Sugar	2.6	3.4	3.8	4.2	4.7	4.8	5.1	5.4	5.7	6.1	6.5	7.3	5.0
Salt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oil	3.7	4.5	5.0	5.7	6.2	6.8	7.0	7.6	8.1	8.7	8.9	9.7	6.8
Egg, fish & meat	2.2	3.1	4.1	5.0	5.7	6.3	6.9	7.0	8.9	9.5	11.4	12.9	6.8
Vegetables	3.6	4.1	4.8	5.3	5.8	6.4	6.9	7.5	8.0	9.0	9.6	10.4	6.8
Fruits (fresh)	0.4	0.7	1.1	1.6	1.9	2.4	2.7	3.4	4.2	5.6	7.5	10.2	3.2
Fruits (dry)	0.2	0.4	0.5	0.7	0.9	1.1	1.4	1.7	2.1	3.0	4.2	6.9	1.7
Spices	0.9	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.1	2.3	2.4	2.5	1.8
Beverages etc.	9.0	10.6	13.7	17.5	20.0	23.6	28.2	34.5	47.9	61.6	89.8	179.5	39.2
Pan	2.9	4.3	3.8	4.7	3.9	4.8	6.0	6.7	7.0	6.0	5.0	4.9	5.1
Tobacco	5.1	6.4	6.8	8.2	8.6	9.6	9.3	12.2	11.6	13.8	14.2	16.0	10.1
Intoxicants	2.6	3.3	3.6	4.4	5.9	6.9	7.1	9.3	10.2	14.0	16.3	22.7	8.4
Fuel and light	19.8	24.1	27.5	30.7	34.1	37.5	41.1	44.8	50.7	60.9	73.3	98.3	43.5
Clothing	3.6	4.7	6.5	8.7	10.3	12.5	17.3	21.2	29.0	38.3	54.2	91.7	22.1
Footwear	1.0	1.3	1.8	2.3	2.7	3.5	4.4	5.4	7.0	9.0	12.9	18.7	5.3
Education	0.9	1.2	1.6	2.3	3.2	4.1	5.1	6.6	8.4	12.0	22.8	49.2	8.0
Medical (non- inst.)	2.3	3.2	3.9	5.1	6.5	7.4	9.6	10.8	13.4	17.4	23.9	38.7	10.8
Minor durable- type goods	0.2	0.3	0.4	0.6	0.7	0.7	1.2	1.3	1.9	2.9	4.3	7.8	1.6
Toilet articles	3.6	4.5	5.5	6.6	7.8	8.8	10.0	11.3	12.9	15.7	19.9	27.6	10.6
Other Consumables	2.8	3.6	4.6	5.5	6.4	7.6	8.5	9.9	11.5	13.9	17.5	23.5	9.2
TAX INCIDENCE	**78.5**	**101.3**	**121.3**	**146.2**	**167.4**	**190.9**	**219.8**	**253.6**	**300.5**	**370.6**	**475.8**	**722.8**	**246.0**

Source: Estimated as explained in the text

Table A2.6: Incidence of excise duties by NSS commodity groups and fractile expenditure classes in India (rural)

ITEMS	Fractile class of MPCE(URP)												All Classes
	1	2	3	4	5	6	7	8	9	10	11	12	
Cereal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gram	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cereal products	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Pulses & Pulse Products	1.4	1.6	1.7	2.0	2.2	2.3	2.4	2.6	2.8	3.0	3.3	3.8	2.4
Milk & milk products	1.9	3.8	5.3	7.0	9.5	11.0	13.9	16.6	19.3	24.8	30.9	39.2	14.5
Sugar	1.3	1.5	1.9	2.1	2.5	2.7	2.9	3.2	3.6	4.1	4.8	5.5	3.0
Salt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oil	1.6	1.9	2.2	2.4	2.6	2.8	2.9	3.2	3.4	3.6	3.9	4.4	2.9
Egg, fish & meat	0.7	1.1	1.5	1.9	2.0	2.3	2.5	3.0	3.3	4.1	5.1	6.7	2.7
Vegetables	2.3	2.6	2.9	3.2	3.4	3.5	3.6	3.9	4.3	4.6	5.1	5.6	3.7
Fruits (fresh)	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.2	1.5	2.0	2.8	3.9	1.2
Fruits (dry)	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.8	1.2	0.3
Spices	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beverages etc.	4.0	4.5	5.5	6.4	7.0	7.8	8.5	9.1	10.6	12.4	15.3	28.5	9.3
Pan	1.2	1.9	2.6	2.8	3.1	3.6	3.7	4.1	4.5	4.7	4.5	4.8	3.5
Tobacco	2.0	2.6	3.1	3.8	4.2	4.6	5.6	5.9	6.7	7.4	8.2	8.5	5.2
Intoxicants	0.5	0.5	0.6	0.7	0.8	0.9	1.2	1.2	1.7	2.1	2.9	4.0	1.3
Fuel and light	6.9	8.0	8.5	9.4	10.2	10.8	11.5	12.7	13.8	15.3	17.2	20.2	11.8
Clothing	1.4	2.6	3.4	4.4	5.3	6.9	8.5	10.0	12.2	17.2	23.4	38.1	10.0
Footwear	0.5	0.5	0.8	1.0	1.2	1.6	1.9	2.1	2.6	3.6	4.7	6.9	2.1
Education	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.6	1.0	2.6	0.4
Medical (non- inst.)	0.8	1.3	1.6	1.9	2.2	2.6	3.1	3.6	4.7	6.3	8.6	14.9	3.9
Minor durable- type goods	0.1	0.3	0.3	0.3	0.3	0.5	0.5	0.6	0.6	0.8	1.1	1.7	0.5
Toilet articles	1.7	2.0	2.4	2.6	3.0	3.3	3.7	4.1	4.7	5.4	6.4	7.9	3.8
Other Consumables	1.4	1.7	2.0	2.3	2.6	2.9	3.3	3.8	4.4	5.2	6.4	8.4	3.5
TAX INCIDENCE	**29.9**	**38.6**	**46.6**	**54.9**	**63.1**	**71.1**	**81.0**	**91.5**	**105.6**	**127.6**	**156.4**	**216.7**	**86.2**

Source: Estimated as explained in the text

Table A2.7 Incidence of excise duties by NSS commodity groups and fractile expenditure classes in India (urban)

ITEMS	Fractile class of MPCE(URP)												All Classes
	1	2	3	4	5	6	7	8	9	10	11	12	
Cereal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gram	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cereal products	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pulses & Pulse Products	1.7	2.1	2.3	2.5	2.8	3.0	3.2	3.4	3.5	4.0	4.1	4.5	3.1
Milk & milk products	4.8	8.2	11.0	14.1	17.0	19.4	23.4	26.4	29.8	36.9	44.1	53.1	23.3
Sugar	1.8	2.3	2.6	2.9	3.3	3.4	3.5	3.8	4.0	4.3	4.5	5.1	3.5
Salt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oil	2.1	2.5	2.8	3.2	3.5	3.8	3.9	4.2	4.5	4.9	5.0	5.4	3.8
Egg, fish & meat	1.3	1.8	2.4	3.0	3.4	3.7	4.0	4.2	5.2	5.6	6.8	7.6	4.0
Vegetables	2.6	2.9	3.4	3.9	4.2	4.6	5.0	5.5	5.8	6.5	7.0	7.5	4.9
Fruits (fresh)	0.3	0.5	0.8	1.2	1.5	1.9	2.1	2.6	3.3	4.4	5.9	8.0	2.5
Fruits (dry)	0.1	0.2	0.3	0.3	0.4	0.6	0.7	0.8	1.0	1.5	2.1	3.3	0.8
Spices	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beverages etc.	4.9	5.8	7.5	9.5	10.9	12.8	15.3	18.7	26.0	33.4	48.7	97.4	21.2
Pan	2.1	3.2	2.8	3.4	2.9	3.5	4.4	4.9	5.2	4.4	3.7	3.6	3.8
Tobacco	2.7	3.4	3.6	4.3	4.5	5.0	4.9	6.4	6.1	7.2	7.4	8.4	5.3
Intoxicants	0.5	0.7	0.7	0.9	1.2	1.4	1.4	1.9	2.0	2.8	3.3	4.5	1.7
Fuel and light	8.3	10.1	11.5	12.9	14.3	15.8	17.2	18.8	21.3	25.6	30.8	41.3	18.3
Clothing	2.6	3.4	4.7	6.3	7.5	9.0	12.5	15.3	20.9	27.6	39.1	66.2	15.9
Footwear	0.7	0.9	1.2	1.6	1.9	2.4	3.0	3.7	4.8	6.2	8.9	12.8	3.6
Education	0.2	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.4	2.0	3.8	8.3	1.4
Medical (non- inst.)	1.3	1.7	2.2	2.8	3.6	4.1	5.2	5.9	7.4	9.5	13.1	21.2	5.9
Minor durable- type goods	0.1	0.2	0.3	0.4	0.5	0.5	0.8	0.9	1.2	1.9	2.8	5.1	1.1
Toilet articles	2.4	3.0	3.7	4.4	5.2	5.9	6.7	7.5	8.7	10.5	13.3	18.5	7.1
Other Consumables	1.9	2.4	3.1	3.7	4.3	5.1	5.7	6.6	7.7	9.3	11.7	15.6	6.1
TAX INCIDENCE	**42.3**	**55.5**	**67.0**	**81.5**	**93.1**	**106.5**	**123.9**	**142.7**	**169.8**	**208.6**	**266.0**	**397.5**	**137.4**

Source: Estimated as explained in the text

Table A2.8: Incidence of GST based taxes by NSS commodity groups and fractile expenditure classes in India (rural)

ITEMS	Fractile class of MPCE(URP)												All Classes
	1	2	3	4	5	6	7	8	9	10	11	12	
Cereal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gram	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cereal products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0
Pulses & Pulse Products	1.1	1.3	1.4	1.6	1.8	1.9	2.0	2.1	2.4	2.5	2.7	3.2	2.0
Milk & milk products	1.8	3.6	5.1	6.7	9.1	10.5	13.4	15.9	18.5	23.8	29.7	37.6	13.9
Sugar	1.2	1.5	1.8	2.1	2.4	2.6	2.8	3.1	3.5	3.9	4.6	5.3	2.8
Salt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oil	1.3	1.6	1.8	2.0	2.2	2.3	2.4	2.6	2.9	3.0	3.3	3.6	2.4
Egg, fish & meat	0.6	0.9	1.2	1.6	1.7	1.9	2.1	2.5	2.7	3.4	4.2	5.5	2.3
Vegetables	1.9	2.2	2.4	2.7	2.8	2.9	3.0	3.3	3.6	3.8	4.3	4.7	3.1
Fruits (fresh)	0.2	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.3	1.7	2.3	3.3	1.0
Fruits (dry)	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.7	1.0	0.3
Spices	1.8	2.1	2.4	2.7	2.9	3.2	3.4	3.8	4.2	4.6	5.2	6.0	3.5
Beverages etc.	8.9	10.1	12.4	14.2	15.6	17.5	18.9	20.3	23.6	27.8	34.2	63.8	20.9
Pan	1.7	2.6	3.5	3.7	4.2	4.9	5.1	5.6	6.1	6.4	6.2	6.5	4.8
Tobacco	3.8	5.0	6.0	7.3	8.0	8.7	10.6	11.3	12.7	14.2	15.6	16.3	9.9
Intoxicants	2.7	2.7	3.0	3.4	4.2	4.3	5.8	6.1	8.3	10.6	14.7	19.9	6.6
Fuel and light	8.2	9.5	10.2	11.3	12.3	12.9	13.8	15.2	16.6	18.3	20.6	24.2	14.2
Clothing	1.3	2.5	3.2	4.2	5.1	6.6	8.1	9.6	11.7	16.5	22.4	36.5	9.6
Footwear	0.4	0.5	0.8	1.0	1.1	1.5	1.8	2.1	2.5	3.4	4.5	6.6	2.0
Education	0.7	1.0	1.4	1.6	2.0	2.4	2.9	3.5	4.6	7.6	11.5	30.7	4.8
Medical (non- inst.)	1.6	2.6	3.1	3.8	4.4	5.2	6.1	7.2	9.5	12.5	17.3	29.7	7.7
Minor durable- type goods	0.3	0.6	0.6	0.6	0.7	1.0	1.0	1.3	1.4	1.8	2.5	3.9	1.2
Toilet articles	2.5	2.9	3.4	3.8	4.4	4.8	5.3	6.0	6.8	7.7	9.2	11.4	5.5
Other Consumables	3.1	3.7	4.4	5.0	5.8	6.5	7.3	8.4	9.9	11.6	14.4	18.7	7.9
TAX INCIDENCE	**45.1**	**57.0**	**68.4**	**79.8**	**91.4**	**102.6**	**117.0**	**131.2**	**153.0**	**185.7**	**230.2**	**338.6**	**126.5**

Source: Estimated as explained in the text

Table A2.9: Incidence of GST based taxes by NSS commodity groups and fractile expenditure classes in India (urban)

ITEMS	Fractile class of MPCE(URP)												All Classes
	1	2	3	4	5	6	7	8	9	10	11	12	
Cereal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gram	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cereal products	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pulses & Pulse Products	1.4	1.7	1.9	2.1	2.3	2.5	2.7	2.8	2.9	3.3	3.5	3.8	2.6
Milk & milk products	4.6	7.9	10.6	13.5	16.3	18.6	22.4	25.4	28.7	35.5	42.3	51.0	22.4
Sugar	1.8	2.3	2.5	2.8	3.1	3.2	3.4	3.6	3.8	4.1	4.3	4.9	3.3
Salt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oil	1.7	2.1	2.3	2.6	2.9	3.1	3.3	3.5	3.8	4.0	4.2	4.5	3.2
Egg, fish & meat	1.1	1.5	2.0	2.5	2.8	3.1	3.4	3.5	4.4	4.7	5.6	6.3	3.4
Vegetables	2.2	2.5	2.9	3.2	3.5	3.9	4.2	4.6	4.8	5.4	5.8	6.3	4.1
Fruits (fresh)	0.3	0.4	0.7	1.0	1.2	1.6	1.8	2.2	2.8	3.6	4.9	6.7	2.1
Fruits (dry)	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.2	1.7	2.8	0.7
Spices	2.2	2.8	3.3	3.6	4.0	4.3	4.7	5.0	5.2	5.7	6.0	6.3	4.4
Beverages etc.	10.9	12.9	16.7	21.2	24.4	28.7	34.2	42.0	58.2	74.9	109.1	218.2	47.6
Pan	2.9	4.3	3.8	4.7	3.9	4.8	6.0	6.7	7.0	6.0	5.0	4.9	5.1
Tobacco	5.1	6.4	6.8	8.2	8.6	9.6	9.3	12.2	11.6	13.8	14.2	16.0	10.1
Intoxicants	2.6	3.3	3.6	4.4	5.9	6.9	7.1	9.3	10.2	14.0	16.3	22.7	8.4
Fuel and light	10.0	12.1	13.8	15.5	17.2	18.9	20.7	22.6	25.5	30.7	36.9	49.5	21.9
Clothing	2.5	3.3	4.5	6.0	7.2	8.7	12.0	14.7	20.1	26.5	37.5	63.5	15.3
Footwear	0.6	0.9	1.2	1.5	1.8	2.3	2.9	3.5	4.6	6.0	8.5	12.3	3.5
Education	1.8	2.3	3.3	4.7	6.6	8.3	10.4	13.4	17.0	24.3	46.1	99.8	16.3
Medical (non- inst.)	2.5	3.5	4.3	5.6	7.2	8.2	10.5	11.9	14.7	19.0	26.2	42.5	11.9
Minor durable- type goods	0.3	0.4	0.6	0.9	1.0	1.1	1.8	2.0	2.8	4.3	6.3	11.4	2.4
Toilet articles	3.4	4.3	5.3	6.3	7.5	8.5	9.6	10.9	12.5	15.2	19.1	26.6	10.2
Other Consumables	4.2	5.4	6.9	8.3	9.6	11.4	12.7	14.8	17.1	20.8	26.2	35.0	13.7
TAX INCIDENCE	**62.2**	**80.4**	**97.1**	**118.8**	**137.1**	**158.0**	**183.5**	**215.0**	**258.5**	**323.1**	**430.0**	**695.0**	**212.5**

Source: Estimated as explained in the text

Table A2.10a: Incidence of income tax on returned income (Assessment 2012-13)

Average Returned income	F(Y)	T(Y)	T'(Y)
83000	0.140	0	-
179000	0.358	0	0
222000	0.124	4200	0.1
294000	0.117	11400	0.1
374000	0.038	19400	0.1
424000	0.032	24400	0.1
475000	0.027	29500	0.1
523000	0.022	34300	0.1
703000	0.069	54600	0.1
975000	0.004	109000	0.2
1207000	0.022	160100	0.2
1721000	0.009	314300	0.3
2226000	0.005	465800	0.3
3394000	0.007	816200	0.3
6900000	0.003	1868000	0.3
19476000	0.002	5640800	0.3
69449000	0.000	20632700	0.3
153323000	0.000	45794900	0.3

Source: Estimated as explained in the text

Table A2.10b: Incidence of income tax on returned income (Assessment 2013-14)

Average Returned Income	F(Y)	Tax Liability= T(Y)	T'(Y)
81000	0.10824	0	0.0
187000	0.26176	700	0.0
219000	0.19735	3900	0.1
294000	0.13820	11400	0.1
374000	0.04491	19400	0.1
424000	0.03741	24400	0.1
475000	0.03149	29500	0.1
524000	0.02364	34400	0.1
700000	0.07779	54000	0.1
975000	0.00457	109000	0.2
1209000	0.02483	160700	0.2
1718000	0.00994	313400	0.3
2227000	0.00501	466100	0.3
3388000	0.00770	814400	0.3
6887000	0.00290	1864100	0.3
19270000	0.00185	5579000	0.3
69039000	0.00019	20509700	0.3
153130000	0.00011	45737000	0.3
347728000	0.00004	104116400	0.3

Source: Estimated as explained in the text

Table A2.10c: Incidence of income tax on returned income (Assessment 2014-15)

Average Returned Income	F(Y)	Tax Liability= T(Y)	T'(Y)
80000	0.1290	0	0
184000	0.1673	400	0.00
222000	0.0102	4200	0.1
292000	0.2274	11200	0.1
374000	0.0679	19400	0.1
424000	0.0578	24400	0.1
476000	0.0532	29600	0.1
524000	0.0376	34400	0.1
701000	0.1272	54200	0.1
975000	0.0072	109000	0.2
1210000	0.0385	161000	0.22
1720000	0.0166	314000	0.3
2225000	0.0084	465500	0.3
3398000	0.0124	817400	0.3
6916000	0.0046	1872800	0.3
19351000	0.0026	5603300	0.3
69186000	0.0003	20553800	0.3
151785000	0.0002	45333500	0.3
345771000	0.0001	103529300	0.3

Source: Estimated as explained in the text

Table A2.11: Estimates of distribution of population by age group and survival probabilities (2010-14), All India

Age Group	All				Males				Females			
	Population	a	a*	P[1]	Population	a	a*	P[1]	Population	a	a*	P[1]
0—4	112806778	0.094	-	0.054	58632074	0.094	-	0.051	54174704	0.093	-	0.058
5—9	126928126	0.105	-	0.004	66300466	0.107	-	0.004	60627660	0.104	-	0.004
10—14	132709212	0.110	-	0.004	69418835	0.112	-	0.004	63290377	0.108	-	0.003
15—19	120526449	0.100	0.145	0.006	63982396	0.103	0.150	0.006	56544053	0.097	0.139	0.006
20—24	111424222	0.092	0.134	0.008	57584693	0.093	0.135	0.009	53839529	0.092	0.132	0.008
25—29	101413965	0.084	0.122	0.009	51344208	0.083	0.120	0.010	50069757	0.086	0.123	0.008
30—34	88594951	0.073	0.106	0.011	44660674	0.072	0.105	0.013	43934277	0.075	0.108	0.008
35—39	85140684	0.071	0.102	0.014	42919381	0.069	0.101	0.018	42221303	0.072	0.104	0.010
40—44	72438112	0.060	0.087	0.019	37545386	0.061	0.088	0.025	34892726	0.060	0.086	0.014
45—49	62318327	0.052	0.075	0.028	32138114	0.052	0.075	0.035	30180213	0.052	0.074	0.020
50—54	49069254	0.041	0.059	0.041	25843266	0.042	0.061	0.050	23225988	0.040	0.057	0.032
55—59	39146055	0.032	0.047	0.060	19456012	0.031	0.046	0.076	19690043	0.034	0.048	0.047
60—64	37663707	0.031	0.045	0.094	18701749	0.030	0.044	0.107	18961958	0.032	0.047	0.079
65—69	26454983	0.022	0.032	0.146	12944326	0.021	0.030	0.165	13510657	0.023	0.033	0.127
70+	39730350	0.033	0.048		19425797	0.031	0.046		20304553	0.035	0.050	

Source: SRS Based Abridged Life Tables, 2010-14, Registrar General, Census, Government of India

Notes: **a**: proportion population in i^{th} age group; **a***: proportion population of age above 15 years in i^{th} age group

CHAPTER III: RATE OF RETURN ON INVESTMENT AND SHADOW PRICE OF PUBLIC INVESTMENT

3.1. Introduction

3.1. In an economy with the optimal level of savings, the consumption rate of discount in Ramsey formula discussed in Chapter-II is equal to the rate of return on capital in financial markets or marginal productivity of capital[27]. However, if the economy is not on the optimal saving path which happens when there are distortions in the capital market, the rate of return on investment or the marginal productivity of capital will be higher than the social time preference rate. In this case, there is a social premium on investment vis-a-vis consumption.

3.2. The social cost of public sector investment depends upon the sources of funds, i.e. whether it displaces investment or consumption elsewhere in the economy or a combination of two. In calculating the social cost of capital, the crowded out investment has to be valued at the rate of return on investment in the economy and the forgone consumption has to be valued at the social time preference rate. Therefore, for the estimation of social cost or shadow price of public investment in India, we require the estimates of the rate of return on investment, social time preference rate and the proportion in which investment and consumption are displaced elsewhere in the economy due to public sector investment.

3.3. The rate of return on investment in the economy could be estimated as either marginal productivity or returns on capital invested in various production activities or rate of interest in the financial sector reflecting the marginal cost of capital. Rate of return on investment forgone due to public sector investment could be the rate of return earned in a displaced investment project in the economy. Therefore, it could be estimated as a weighted average of rates of return earned in the projects displaced by the public sector projects.

3.4. Alternatively, the rate of return on foregone investment could be obtained by looking at the sources of financing public sector investments. If public sector

[27]In Ramsey optimal growth model the consumption rate of interest will equal the marginal product of capital along optimal consumption path.

investments are made mainly through government borrowing, the long-term borrowing rate by the government may be taken as a proxy for the opportunity cost of funds to the public sector. However, the government may take recourse partly to borrowing and partly to taxes for financing the public sector investments and therefore the opportunity cost of funds for the public sector should be a weighted average of the long-term borrowing rate and the social cost of tax financing. The government-borrowing rate is governed more by the general monetary policy designed to account especially for international flows of capital and therefore directly linked to the interest rates of other countries.

3.5. The remaining chapter is planned as follows: Section 3.2 describes methods of estimating the marginal productivity of capital in India. Data of a very large sample of industries belonging to different industrial sectors of Indian economy is used for estimating the rate of return on investment. Section 3.3 describes a methodology for estimating shadow price of investment and provides an estimate of it for India. Section 3.4 provides an estimate of rate of rate return on investment evident from the financial sector of India. Section 3.5 provides conclusion.

3.2. Marginal Productivity of Capital for Different Industries

3.2.1. Methodology

3.6. Production functions considering capital and labor as inputs and value added as output at constant (2015-16) prices are estimated for a large sample of industries belonging to 14 sectors of Indian economy. Two production functions – Cobb-Douglas and Translog - are widely used in empirical research to estimate marginal productivity of capital. Cobb-Douglas production function provides for limited substitution possibility between capital and labour assuming unitary elasticity of substitution between the factors. Translog provides for more flexible substitution possibilities with variable elasticity of substitution among factors in the production process.

3.7. These two production functions are estimated to find out possible range of variability in estimates of productivity of capital with different production function specifications. These two production functions may be stated as:

Cob-Douglas production function:

$$ln\ V = \alpha + \beta_1 ln\ K + \beta_2 ln\ L + u$$

Translog production function:

$$ln\ V = \alpha + \beta 1\ ln\ K + \beta 2\ ln\ L\ +\ \beta 3\ \ lnK\ lnL\ +\ 1/2\beta 4\ (ln\ K)2\ +\ 1/2\beta 5\ (ln\ L)2 + u$$

Where,

V: Value-added obtained by deducting from total income, the value of raw materials, power and fuel and other manufacturing expenditures, selling and administrative expenses and miscellaneous expenses.

α : a constant.

K: Capital measured as gross block plus inventories.

L: Labor measured as wage bill.

u: Disturbance term

For the Cobb-Douglas production function, the value of marginal productivity of capital (R) is obtained as:

$$R = \beta_1 \frac{\overline{V}}{\overline{K}}$$

For the Translog production function, the value of marginal productivity of capital (R) is obtained as:

$$R = \beta_1 \frac{\overline{V}}{\overline{K}} + \beta_3 \frac{\overline{V}}{\overline{K}}(\ln L) + \beta_4 \frac{\overline{V}}{\overline{K}}$$

Where, R is the derivative of V with respect to K. Here, $\overline{V}$ and $\overline{K}$ are sample averages of companies in each sector.

3.8. We used time series of cross section firm level data which might incorporate firm specific and year specific effects. We chose panel fixed effects model for estimation to account for unobserved firm-specific and year-specific effects while estimating the parameters (Wooldridge 2010).

3.2.2. Estimates Based on Company Balance Sheet Data

3.9. The dataset used consists of balance sheet data for a large set of public and private limited companies for each industry in India. The data have been obtained from *Capitaline* for the financial years 2011-12 to 2015-16. In all, 261 industries belonging to 14 sectors are considered for estimation. Table A3.1 in Appendix A3 describes the sectors and industries considered for estimation. For estimation of the production function and the value of marginal productivity of capital for each sector, company level data for about 3962 companies has been used. The production function is estimated using the panel data of 3962 companies for five years period 2011-12 to 2015-16, all the variables are measured at 2015-16 prices.

Table 3.1: OLS estimates for Cobb-Douglas production function

Year	N	Constant		Log of capital		Log of wage		R^2
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
2011-12	2535	-0.49	0.446	0.36***	0.026	0.68***	0.041	0.73
2012-13	2552	-0.56	0.461	0.40***	0.032	0.64***	0.033	0.75
2013-14	2541	0.19	0.187	0.39***	0.017	0.62***	0.018	0.86
2014-15	2833	-0.14	0.284	0.36***	0.018	0.66***	0.028	0.80
2015-16	2810	0.23	0.165	0.38***	0.016	0.61***	0.019	0.86

***significant at 1 per cent level of significance

Table 3.2: Fixed-effects estimates for Cobb-Douglas and Translog (Company data)

Variables	Cobb-Douglas		Translog	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Constant	-0.10	0.273	-0.74	1.491
Log of capital	0.37***	0.026	-0.12	0.133
Log of wage	0.65***	0.024	1.24***	0.179
Log of capital squared	-		0.11***	0.006
Log of wage bill squared	-		0.08***	0.015
Log capital x log wage bill	-		-0.10***	0.008
R^2	0.79		0.80	
N	13271		13271	

***Significant at 1 per cent level of significance

3.10. Table 3.1 provides estimates of production function obtained using ordinary least squares regression model respectively for Cobb-Douglas production functions

for each year. Table 3.2 provides estimates of both Cobb-Douglas and Translog production functions using time series cross section panel data for 9871 companies belonging to 14 industrial sectors considered in this study and fixed-effects regression model. Table 3.3 reports estimates of marginal productivity of capital or rate of return of capital in different industries for each year.

Table 3.3: OLS estimates for rate of return on investment in 14 sectors, (Cobb-Douglas)

Sector	2011-12	2012-13	2013-14	2014-15	2015-16
Agro Based Industries	6.7	8.9	8	7.7	7.8
Chemicals & Pharmaceuticals	14	14.7	10.8	14.9	13.2
Consumer Goods	19.4	19.5	20.1	20.3	18.9
Contract & Construction	5	7	7.4	5.3	5.8
Fertilizers	9.7	10.6	6.2	5.5	3.2
Heavy Engineering	14.6	15.9	14	11.1	12.3
Medium & Light Engineering	16.1	9.6	13.1	13.8	13.7
Minerals and Metals	29	36.7	28.8	13.6	22.2
Miscellaneous & Diversified	7.1	11.1	8	9.9	12.1
Petroleum	14.1	8.7	13.6	16.5	18.7
Power	7.2	5.5	6.9	5.7	6.1
Steel	15.5	16.1	11.4	5.2	8.2
Tourist Services	6.6	7.9	4.8	5.1	4.7
Transportation Equipment Services	11.6	12.6	8.6	8.4	8.5
Pooled Estimates	**10.6**	**11**	**10.2**	**9.5**	**9.8**

Table 3.4: Fixed-effects estimates for rate of return on investment (Company data)

Model	Observations	Rate of return on Capital
Cobb-Douglas production function	13271	9.7
Translog production function	13271	11.1

3.11. The last row of Table 3.3 reports estimates of rate of return of capital at 2015-16 prices using pooled data of industries for each year. These estimates form a range of 9.5 to 11 per cent. Table 3.4 reports estimates of rate of return on capital estimated using panel data and fixed-effects model for the years 2011-16. The estimate based on Cobb-Douglas model is 9.7 per cent while that is based on Translog model is 11.1 per cent. These two estimates also form a range of 9.7 to 11.1 per cent.

3.2.3. Estimates Based on ASI Data

3.12. Annual Survey of Industries (ASI) is another important data for the production accounts of various industries in India. Unlike company level data from *Capitaline*, RBI, used in the earlier section, ASI gives industry-level data. The ASI four-digit classification reported in Table A3.2 gives production accounts data for 150 industry categories. The data for five year period 2009-14 is used in this Section for estimating production functions and rate of return on capital for the Indian economy. The data set used is thus a panel data consisting of 150 industries and five years, providing 750 observations.

Table 3.5: Fixed-effects estimates for Cobb-Douglas and Translog (ASI data)

Variables	Cobb-Douglas		Translog	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Constant	10.384	1.482	5.420	10.41
Log of capital	0.243	0.076	0.724	1.456
Log of workers	0.743	0.133	0.796	1.583
Log of capital squared	-		-0.025	0.107
Log of workers squared	-		-0.036	0.135
Log capital x log workers	-		0.008	0.118
R^2	0.90		0.90	
N	750		750	

Table 3.6: Fixed-effects estimates for rate of return on investment, ASI data

Model	Observations	Rate of return on Capital
Cobb-Douglas production function	750	11.4
Translog production function	750	9.6

3.13. Table 3.5 provides estimates of Cobb-Douglas and Translog production functions using this data. Table 3.6 provides the estimates of rate of return on capital based on ASI data. They form a range of 9.60 per cent to 11.4 per cent which is comparable to the estimated range of 9.7 per cent to 11.1 per cent using *Capitaline* data in the previous section. Therefore, based on both these estimates from two different sets of data made in this study, the rate of return of capital in the Indian economy could be considered as approximately 10 per cent at 2015-16 prices.

3.3. Estimation of Shadow Price of Investment

3.14. In a situation in which the social time preference rate is lower than the rate of return on investment in the economy (that may be due to various reasons explained in Chapter-II), a formula for estimating the shadow price of investment (P_I) based on the UNIDO method of investment project appraisal is given as:

$$P_I = [(1-Q)R] / [r - QR]$$

Where, r, R, and Q are respectively the social time preference rate, rate of return on investment, and rate of savings in the economy.

3.15. Chapter II and Section 3.2 of this chapter above provide estimates of social time preference rate (r) and rate of return on investment (R) in the Indian economy. Estimates of r and R are made as 8 and 10 per cent respectively. Table 3.7 provides estimates of rate of savings (savings as per cent of GDP) for different sectors of Indian economy as reported in the Economic Survey of India for recent years. The estimates of rate of savings for the Indian economy (Q) during recent years have happened to be higher than 33 per cent. However the average rate of savings for the household sector is around 20 per cent while that of corporate sector is about 10 per cent. Therefore savings of household sector and corporate sector together form 30 per cent of GDP.

3.16. Table 3.8 provides the information about the sensitivity of estimates of shadow price of investment with respect to rate of savings Q and social time preference rate r for the Indian economy. It is found that shadow price of investment is highly sensitive to social time preference rate, r. When the social rate of time preference is low (e.g., 0.4 or 0.6), the values are very sensitive to savings rate; but, not so sensitive to savings rate for higher values of social time preference (e.g., 0.8 or above).

3.17. In the case of social time preference rate falling from 8 per cent to 4 per cent, the shadow price of investment has increased from 1.40 to 7.00. This is the likely scenario for the investment projects with long gestation period such as environmental management projects like river cleaning and climate change mitigation projects with the recommended 4 per cent rate of discount. That means for this type of projects with a recommended lower social discount rare for their economic evaluation, the

social cost of initial investments are higher while the benefits in the distant future are also higher. For example, the climate change mitigation investment projects which normally having very long gestation periods and very low rates of discount for their evaluation will have very high initial social cost of investment and more than compensating very high future benefits.

Table 3.7: Gross domestic savings as percentage of GDP, 1990-91 to 2014-15

Year	Household Sector	Private Corporate Sector	Public Sector	Total Savings
1990-91	18.5	2.6	1.8	22.9
1991-92	15.7	3.0	2.6	21.3
1992-93	16.5	2.6	2.2	21.3
1993-94	17.0	3.4	1.3	21.7
1994-95	17.9	3.4	2.3	23.6
1995-96	16.2	4.8	2.6	23.6
1996-97	15.8	4.4	2.2	22.4
1997-98	18.1	4.2	1.9	24.2
1998-99	19.5	3.8	-0.2	23.2
1999-00	21.7	4.3	-0.5	25.5
2000-01	21.3	3.7	-1.3	23.7
2001-02	23.1	3.3	-1.6	24.8
2002-03	22.2	3.9	-0.3	25.9
2003-04	23.1	4.6	1.3	29.0
2004-05	23.6	6.6	2.3	32.4
2005-06	23.5	7.5	2.4	33.4
2006-07	23.2	7.9	3.6	34.6
2007-08	22.4	9.4	5.0	36.8
2008-09	23.6	7.4	1.0	32.0
2009-10	25.2	8.4	0.2	33.7
2010-11	23.1	8.0	2.6	33.7
2011-12	22.8	7.3	1.2	31.3
2011-12	23.6	9.5	1.5	34.6
2012-13	22.5	10.0	1.4	33.9
2013-14	20.3	10.7	1.0	32.1
2014-15	20.5	11.7	0.9	33.1
2015-16	19.2	11.9	1.3	32.3

Source: Economic Survey 2016-17

3.18. In case of environmental management projects and projects for climate change mitigation, we may adopt a savings rate of 30 per cent, a social time

preference rate of 6 per cent and a rate of return on investment of 10 per cent as plausible scenarios for the medium run in the Indian economy. For the long-run investment projects in environmental management and climate change mitigation, the social time preference rate of 4 per cent is recommended. Given the two scenarios of medium-run and long-run project investments, the shadow price of investment in this scenario turns out to be 1.40. Note further that in case the savings rate increases to 35% as for some years in the last decade, shadow price of investment would be 1.44. On the basis of these considerations, we recommend a social premium of 40 per cent on investment made in public sector projects in India.

Table 3.8: Sensitivity of shadow price of investment (P_I) with respect to social time preference rate (r) and savings (Q)

Social time preference rate, r	Savings rate, Q		
	0.25	**0.30**	**0.35**
0.04	5.00	7.00	13.00
0.06	2.14	2.33	2.6
0.08	1.36	1.40	1.44
0.10	1.00	1.00	1.00
0.12	0.79	0.78	0.76

3.19. By adopting 30 per cent, 8 per cent and 10 per cent as estimates respectively of rate of savings of private sector, social time preference rate and rate of return on investment, the shadow price of investment is estimated at 1.40 for the Indian economy. Therefore, in this scenario there is social premium of 40 per cent on investment made in public sector projects in India. However, given an estimate of Q as 0.30, in the scenarios of 6 and 4 per cent social time preference rate, the shadow price of investment is 2.33 and 7.00, respectively.

3.20. It is found that shadow price of investment is highly sensitive to social time preference rate, r. In the case of social time preference rate falling from 8 per cent to 4 per cent, the shadow price of investment has increased from 1.40 to 7.00. This is the likely scenario for the investment projects with long gestation period such as environmental management projects like river cleaning and climate change mitigation projects with the recommended 4 per cent rate of discount. That means for this type of projects with a recommended lower social discount rare for their economic evaluation, the social cost of initial investments are higher while the benefits

in the distant future are also higher. For example, the climate change mitigation investment projects which normally having very long gestation periods and very low rates of discount for their evaluation will have very high initial social cost of investment and more than compensating very high future benefits.

3.4. Financial Rate of Return on Investments

3.21. A distinction has to be made between the cost of investment to the economy and to the individual or an agency undertaking the public and private investments. The economic rate of return and shadow price of investment discussed in Sections 3.2 and 3.3 above refer to the cost to the economy due to public investment. In contrast, the financial cost refers to the cost to an agency making the investment and it represents the minimum expected financial rate of return on investment. The financial rate of return is computed by the analysis of cash flows of revenues and costs to the agency making the investment. Whereas, the economic rate of return is computed by the economic evaluation of benefit and costs to the economy from the project. The incremental economic benefits of the project are computed by comparing the two scenarios, the economy with the project and the economy without the project.

3.22. If the agency making the investment borrows from the market, the market rate of interest is the minimum expected financial rate of return on the project. What is the relevant rate to be used for investment done by the government or public sector units? Two approaches can be taken to address this issue. The first approach is based on the concept of 'competitive interest rate in the market' for which one may use the prime lending rate by commercial banks and term lending institutions.

3.23. The alternate approach is to consider the borrowings done by the government and try to ascertain the rate of interest that the government has to pay at the margin. To derive the minimum expected financial rate of return based on the second approach, one has to consider the interest rates applicable on different instruments of government borrowing and take a weighted average and then make some further adjustments for administrative costs of borrowing.

3.24. The prime-lending rate is taken up first for discussion. One could observe a wide variation in the interest rates charged by different lending institutions in India. The prime-lending rate of commercial banks as reported in Table 3.9 was as high as 10 per

cent in recent years and has been fluctuating between 12 and 9 per cent during the last 10 years. The lending rates of term-lending institutions as given in Table 3.10 have been recently in the range of 9 to12 per cent as per the data available.

3.25. The prime-lending rate of commercial banks of about 10 per cent in recent years may be taken as the minimum expected financial rate of return for public investment going by the first approach. Indeed, for certain categories of public investments, for example, investment done by a public sector undertaking out of its own resources, the prime lending rate is the correct minimum financial rate of return to be used for project evaluation.

Table 3.9: Prime lending rates of scheduled commercial banks, 2002-03 to 2016-17

Year	Lending Rates* (in per cent)
2002-03	10.75-11.50
2003-04	10.25-11.00
2004-05	10.25-11.00
2005-06	10.25-12.75
2006-07	12.25-14.75
2007-08	12.25-15.75
2008-09	11.50-16.75
2009-10	11.00-15.75
2010-11	8.25-9.50
2011-12	10.00-10.75
2012-13	9.70-10.25
2013-14	10.00-10.25
2014-15	10.00-10.25
2015-16	9.30-9.70
2016-17 @	8.90-9.15

Source: Scheduled Commercial Banks (Excluding RRBs) and the Reserve Bank of India

*Data on deposit and lending rates relate to five major Public Sector Banks up to 2003-04. While for the subsequent years, they relate to five major banks.

#: Savings deposit rate from 2011-12 onwards relates to balance up to Rs. 1 lakh. Savings deposit rate was deregulated with effect from October 25, 2011.

@: As on July 15, 2016.

Notes:
1. Data on lending rates relate to Prime Lending Rate (PLR) or Benchmark Prime Lending Rate (BPLR), Base Rate or Marginal Cost of Funds Based Lending Rate (MCLR) (overnight) as the case may be for the relevant year.

2. BPLR system effective November 2003 was replaced by the Base Rate System effective from July 1, 2010. Base Rate System effective from July 1, 2010 was replaced by the MCLR System effective from April 1, 2016.

3.26. As mentioned above, an alternative approach for finding the minimum expected financial rate of return on investment projects in India is to base it on the interest payments that the government has to make for borrowing from market and public. Here there are two possibilities: (a) the possibility of borrowing from international markets as a source of funding of public projects, and (b) financing the project out of government borrowing from domestic market.

Table 3.10: Prime lending rates of term lending institutions, 1991-92 to 2007-08

Year	IDBI	IFCI	ICICI	IIBI / IRBI	SFCs
1991-92	18.00-20.00	18.00-20.00	18.00-20.00	18.00-20.00	9.00-20.00
1992-93	17.00-19.00	17.00-19.00	17.00-19.00	18.50-21.00	(11.50-20.00)
1993-94	14.50-17.50	14.50-17.50	14.50-17.50	14.50-17.50	(11.50-20.00)
1994-95	15.00	14.50-18.50	14.00-17.50	14.50-17.50	(12.00-13.50)
1995-96	16.00-19.00	16.00-20.00	14.00	15.50-18.50	(12.00-13.50)
1996-97	16.20	15.00-19.50	16.50	17	(12.00-27.50)
1997-98	13.30	14.50-18.00	14.00-14.50	12.50-13.50	(12.00-18.00)
1998-99	13.50	13.50-17.00	13.00	-	12.00-18.50
1999-00	13.60-17.10	13.50-17.00	12.50	14	12.00-18.00
2000-01	14.00	13.00	12.50	13.25	9.75-17.00
2001-02	11.50	12.50	12.50	11.5	9.50-16.75
2002-03	10.20	12.50	-	11	9.50-14.50
2003-04	8.90	12.50	-	8.5	9.50-14.51
2004-05	-	12.50	-	8.5	9.50-14.51
2005-06	-	12.50	-	8.5	9.50-13.00
2006-07	-	-	-	-	9.50-14.50
2007-08	-	-	-	-	9.50-15.00

Source: Respective Financial Institutions and Reserve Bank of India

Notes:
1. Data on prime lending rates for IDBI, IFCI and ICICI for the year 1999-00 relates to long-term prime lending rates in January 2000.

2. Data on prime lending rates for State Financial Corporation for all the years and for other term lending institutions from 2002-03 onwards relate to long-term (over 36-month) PLR.

3. Data on prime lending rate of IIBI/ IRBI from 2003-04 onwards relate to single PLR effective July 31, 2003.

4. IDBI ceased to be term lending institution on its conversion into a banking entity effective October 11, 2004. ICICI ceased to be a term-lending institution after its merger with ICICI Bank. IFCI has become a non-bank financial company and IIBI is in the process of voluntary winding up.

5. Figures in brackets indicate lending rate charged to small-scale industries.

3.27. Apart from being a possibly cheaper source of funds, government borrowings from international markets would have an added advantage in that public

investments will then displace neither domestic private consumption nor investment. The effective rate of interest paid by the government on these borrowings has to account for the risk of foreign exchange rate depreciation by the time the loan is repaid by the government in dollars. The effective rate of interest on foreign commercial borrowings is estimated as explained below.

Table 3.11: Foreign commercial borrowings and interest paid by government, 2004-14

Year	Interest paid (USD mn)	Debt outstanding (USD mn)	Rate of interest (in %)	Market exchange rate (Rs/USD)	Rate of appreciation of exchange rate	Implicit rate of interest
2004-05	959	31595	3.00	44.93	0.03	0.08
2005-06	2996	32371	9.00	44.27	0.04	0.14
2006-07	1709	48459	4.00	45.28	0.04	0.09
2007-08	2630	71051	4.00	40.24	0.06	0.09
2008-09	2702	77862	3.00	45.92	0.05	0.08
2009-10	2397	82518	3.00	47.44	0.05	0.08
2010-11	2584	108328	2.00	45.56	0.07	0.07
2011-12	4326	126288	3.00	47.92	0.08	0.08
2012-13	4990	138735	4.00	54.41	0.05	0.09
2013-14	4739	149146	3.00	60.5	0.00	0.08
Average					**0.05**	**0.09**

Source: India's External Debt: A Status Report 2015-16, Ministry of Finance, Government of India.
Note: For details, see appendix A3.7

3.28. Table 3.11 reports that the interest amount paid, foreign commercial borrowings, and the average interest paid by Government of India during the years 2004-05 and 2013-14 ranges from 2 per cent to 9 per cent. The average interest paid by the government during recent financial years is around 3 per cent. However, debt service payments are typically made over an extended period of time and are usually made in dollars. Hence, this figure needs to be further adjusted for the risk of foreign exchange rate depreciation during the interim period of borrowing and repayment of loan. For the loan repayment after very long period of borrowing, the effective rate of interest on long-term borrowing has to be computed by considering the trend rate of depreciation of foreign exchange rate. The trend rate of depreciation is computed as 5 per cent during the period 2004-05 to 2013-14 for the Indian economy. Therefore, the implicit rate of interest paid by Indian government on foreign commercial borrowing is estimated as 9 per cent. Table A3.7 in the Appendix reports the implicit interest paid for the long term period (1990-91 to 2013-14).

3.29. Table 3.12 presents interest rates on domestic borrowings (small savings, PPF and market borrowing through government securities) of the government from 2000-01 to 2015-16. The average of interest rates on different components of government borrowing had come down from about 10.32 per cent in 2000-01 to about 8.36 per cent in 2015-16. Therefore, current rate of interest is estimated as 8 per cent.

Table 3.12: Interest on government borrowings in domestic market, 2000-16

Year	Post Office 5 Year Deposit	Public Provident Fund	Central Government securities
2000-01	9.0	11.0	10.95
2001-02	8.5	9.5	9.44
2002-03	7.5	9.0	7.34
2003-04	7.5	8.0	5.71
2004-05	7.5	8.0	6.11
2005-06	7.5	8.0	7.34
2006-07	7.5	8.0	7.89
2007-08	7.5	8.0	8.12
2008-09	7.5	8.0	7.69
2009-10	7.5	8.0	7.23
2010-11	7.5	8.0	7.92
2011-12	8.3	8.6	8.52
2012-13	8.5	8.8	8.36
2013-14	8.4	8.7	8.45
2014-15	8.5	8.7	8.51
2015-16	8.5	8.7	7.89

Source: Reserve Bank of India Handbook of Statistics, Table 124

3.30. To this should be added, the administrative cost of borrowing and channeling the funds to investment projects. No estimates of administrative costs of borrowing are readily available, but it seems reasonable to assume that by adding 100 basis points to the average interest rate it should be possible to take care of the administrative cost. Accordingly, the minimum expected financial rate of return may be taken as 9 per cent for the investments made by government out of domestic borrowing.

3.31. Therefore, the appropriate cut off rate of return for the financial evaluation of investment projects in India could be the maximum of interest rates paid for different sources of borrowing. This happens to be 10 per cent rate of discount. This rate should apply also for the projects wholly or partly funded from the foreign borrowings if the latter is not earmarked for investments in any specific sector or project. But in case of

projects funded by foreign borrowings specifically earmarked for them, the financial cut off rate of return for them will be the actual interest paid by the Government on such loans.

Table 3.13: Sources of fund and estimated cost of capital in private sector, 2014-15

Sector	Proportion of debt in total capital	Proportion of equity in total capital	Average rate of interest	Rate of return, production method	Weighted average of interest and value added
Agro-based Industries	0.46	0.54	0.11	0.08	0.09
Chemicals & Pharma	0.27	0.73	0.09	0.15	0.13
Consumer Goods	0.35	0.65	0.09	0.20	0.16
Contract, Construction	0.52	0.48	0.11	0.05	0.08
Fertilizers	0.48	0.52	0.07	0.06	0.06
Heavy Engineering	0.27	0.73	0.11	0.11	0.11
Medium & Light Engg.	0.39	0.61	0.11	0.14	0.13
Minerals and Metals	0.28	0.72	0.07	0.14	0.12
Misc. & Diversified	0.39	0.61	0.09	0.10	0.10
Petroleum	0.39	0.61	0.05	0.17	0.12
Power	0.55	0.45	0.06	0.06	0.06
Steel	0.56	0.44	0.08	0.05	0.07
Tourist Services	0.47	0.53	0.09	0.05	0.07
Transport Equip Service	0.39	0.61	0.06	0.08	0.07
Overall					**0.10**

3.5. Conclusion

3.32. There are two views in investment planning about the choice of social rate of discount, one suggesting social time preference rate, and another prescribing the rate of return on private investment. If savings level is sub-optimal level, these two rates differ with the social time preference rate being lower than the rate of return on investment. In this case if the investment in public sector projects is at the cost of private sector investment, there could a social premium on public sector investments. It implies that the social cost (shadow price) of a rupee investment in public sector is more than one rupee. Therefore, based on the estimates in this chapter:

- The recommended rate of return estimated as marginal value productivity of capital in the private sector in the Indian economy is **10 per cent.**

- The recommended rate of return based on the prime lending rates of commercial banks and maximum of interest rates paid by government for different sources of borrowing is also **10 per cent.**

3.33. We may note that for appraisal of projects which have an identifiable stream of financial returns, Government of India has advised the use of a hurdle rate of 10% for financial internal rate of return (FIRR). This study thus provides confirmation for continuation of this rate in project appraisal.

Appendix A3

Table A3.1: Capital-line data: list of sectors and industries

S.No.	Sector	Industry
1	Agro Based Industries	Floriculture/Tissue
2	Agro Based Industries	Food Dai -I-MNC
3	Agro Based Industries	Food Dai-I-IRG
4	Agro Based Industries	FOOD Dai-I-m/s
5	Agro Based Industries	Food Product- Atta/Rav
6	Agro Based Industries	Food Product-Fruit Pros.
7	Agro Based Industries	Food Product-Mushroom
8	Agro Based Industries	Food Product-OTHERS
9	Agro Based Industries	Food Product-Rice
10	Agro Based Industries	Food Product-Spi/Pkl
11	Agro Based Industries	Hatcheries
12	Agro Based Industries	Large Solvent Extraction
13	Agro Based Industries	Solvent Extraction Med/Small
14	Agro Based Industries	Starch
15	Agro Based Industries	Sugar Integrated
16	Agro Based Industries	Sugar Other
17	Agro Based Industries	Tea Indian Med/Small
18	Agro Based Industries	Tea-Foreign
19	Agro Based Industries	Tea-Indian Large
20	Agro Based Industries	Tea-Process & Trading
21	Agro Based Industries	Vanaspati Large
22	Agro Based Industries	Vanaspati Med/Small
23	Chemicals & Pharmaceuticals	Biotechnology
24	Chemicals & Pharmaceuticals	Chem-caco3
25	Chemicals & Pharmaceuticals	Chem-Gelatin
26	Chemicals & Pharmaceuticals	Chemical-alcohol
27	Chemicals & Pharmaceuticals	Chemical-Benzene
28	Chemicals & Pharmaceuticals	Chem-Inorg-Large
29	Chemicals & Pharmaceuticals	Chem-MA/PTH
30	Chemicals & Pharmaceuticals	Chem-Pente/Forma
31	Chemicals & Pharmaceuticals	Chem-Plasticizer
32	Chemicals & Pharmaceuticals	Chem-Spalty-M/Small
33	Chemicals & Pharmaceuticals	Chem-Splty-Large
34	Chemicals & Pharmaceuticals	Chlor Akali
35	Chemicals & Pharmaceuticals	Dyes & Pigmentation Large
36	Chemicals & Pharmaceuticals	Dyes & Pigmentation Small/Med
37	Chemicals & Pharmaceuticals	Dyes React/Direct
38	Chemicals & Pharmaceuticals	Dyes-Intermediate
39	Chemicals & Pharmaceuticals	Gelatin Capsules
40	Chemicals & Pharmaceuticals	Leather Chemicals
41	Chemicals & Pharmaceuticals	Medical Accessories/Disposable
42	Chemicals & Pharmaceuticals	Medical Equipment
43	Chemicals & Pharmaceuticals	Pharm-I-BD-M/S
44	Chemicals & Pharmaceuticals	Pharm-I-B-Drug
45	Chemicals & Pharmaceuticals	Pharm-I-Bulk Drugs/Large
46	Chemicals & Pharmaceuticals	Pharm-I-Form
47	Chemicals & Pharmaceuticals	Pharm-iv Fluids
48	Chemicals & Pharmaceuticals	Pharm-Mnc
49	Consumer Goods	Breweries
50	Consumer Goods	Cement - Major - North India Industry
51	Consumer Goods	Cement - Major - South India Industry
52	Consumer Goods	Cement - Mini - North India Industry
53	Consumer Goods	Cement - Mini - South India Industry
54	Consumer Goods	Cement Products
55	Consumer Goods	Ceramics - Sanitary ware / Others Industry

S.No.	Sector	Industry
56	Consumer Goods	Ceramics - Tiles Industry
57	Consumer Goods	Cigarettes
58	Consumer Goods	Coffee
59	Consumer Goods	Contraceptive/Protection
60	Consumer Goods	Decoratives Wood
61	Consumer Goods	Detergent/Intermediates
62	Consumer Goods	Diamond Cutting/Jewellery Large
63	Consumer Goods	Diamond Cutting/Jewellery-Medium
64	Consumer Goods	Distilleries
65	Consumer Goods	Domestic Appliances-Cookers
66	Consumer Goods	Food Product-Egg Powder
67	Consumer Goods	Hospitals/Medical Services
68	Consumer Goods	Lthr Products & Garments
69	Consumer Goods	Lthr Products -Integr
70	Consumer Goods	Lthr Products Others
71	Consumer Goods	Lthr-Synft -W-M/S
72	Consumer Goods	Lthr-Synft-W-Lar
73	Consumer Goods	Moulded Luggage
74	Consumer Goods	Packg-Printing Ink
75	Consumer Goods	Paint/Varnishes
76	Consumer Goods	Paper Large
77	Consumer Goods	Paper M/Small
78	Consumer Goods	Per Care Ind Large
79	Consumer Goods	Per Care- MNC
80	Consumer Goods	Personal Care-Ind M/S
81	Consumer Goods	Plastic Flooring
82	Consumer Goods	Plastic Furniture
83	Consumer Goods	Plastic-PU/PU Leather
84	Consumer Goods	Plastc-Thermo ware
85	Consumer Goods	Printing Stationary
86	Consumer Goods	Rubber Retreading
87	Consumer Goods	Rubber Synthetic
88	Consumer Goods	Tyres Cycle
89	Consumer Goods	Tyres Large
90	Consumer Goods	Tyres-Med/Small
91	Contract & Construction	Construction Civil/Large
92	Contract & Construction	Construction Civil/M/S
93	Contract & Construction	Construction Housing Large
94	Contract & Construction	Construction Housing-Medium/Small
95	Contract & Construction	Construction-Fac/Off/Co.
96	Fertilizers	Fert SSP
97	Fertilizers	Fert-Nitro/Phasp
98	Fertilizers	Industrial Explosive
99	Fertilizers	Pest/Agr-Ind-Lrg
100	Fertilizers	Pest/Agr-Ind-M/S
101	Fertilizers	Pest/AGR-mnc
102	Fertilizers	Soda Ash
103	Heavy Engineering	Compress/Drill Equipment
104	Heavy Engineering	Electric Equipment Gensets
105	Heavy Engineering	Electrode Welding Equipment
106	Heavy Engineering	Electrodes Graphite's
107	Heavy Engineering	Electronic Equip-Gen-Large
108	Heavy Engineering	Electronic Equip-Transformer
109	Heavy Engineering	Electronic-Soft-Ferrites
110	Heavy Engineering	Eng. -Engines
111	Heavy Engineering	Eng. Heavy-Material Handling
112	Heavy Engineering	Eng. Turnkey Services
113	Heavy Engineering	Eng. Heavy-Glass-Lined Equipment
114	Heavy Engineering	Engg.-Heavy-Gen-Lrg
115	Heavy Engineering	Engg-Heavy--Gen-M/S

S.No.	Sector	Industry
116	Heavy Engineering	Fasteners
117	Heavy Engineering	Medium & Small Electric Equipment
118	Heavy Engineering	Refractories/Intermediate
119	Heavy Engineering	Transmission Line Equipment
120	Medium & Light Engineering	Aluminum - Extrusions
121	Medium & Light Engineering	Aluminum - Sheets / Coils / Wires
122	Medium & Light Engineering	Analy Lab Equip
123	Medium & Light Engineering	Auto Ancillaries - Axles / Shafts
124	Medium & Light Engineering	Auto Ancillaries - Batteries
125	Medium & Light Engineering	Auto Ancillaries - Brakes
126	Medium & Light Engineering	Auto Ancillaries - Clutches
127	Medium & Light Engineering	Auto Ancillaries - Electrical
128	Medium & Light Engineering	Auto Ancillaries - Engineering part
129	Medium & Light Engineering	Auto Ancillaries - Friction Materials
130	Medium & Light Engineering	Auto Ancillaries - Gears
131	Medium & Light Engineering	Auto Ancillaries - Instruments
132	Medium & Light Engineering	Auto Ancillaries - Lamps
133	Medium & Light Engineering	Auto Ancillaries - Others
134	Medium & Light Engineering	Auto Ancillaries - Sheet Metal
135	Medium & Light Engineering	Auto Ancillaries - Shock Absorbers
136	Medium & Light Engineering	Auto Ancillaries - Springs Industry
137	Medium & Light Engineering	Auto Ancillaries - Wheels
138	Medium & Light Engineering	Automobiles - Tractors
139	Medium & Light Engineering	Bearing Large
140	Medium & Light Engineering	Bearing Small
141	Medium & Light Engineering	Cables - Power - Large
142	Medium & Light Engineering	Cables - Power - Medium / Small
143	Medium & Light Engineering	Cable-Telephone
144	Medium & Light Engineering	Carbon Black
145	Medium & Light Engineering	Dry Cells
146	Medium & Light Engineering	Electronic Audio/Video
147	Medium & Light Engineering	Electronic B/W Picture Tube
148	Medium & Light Engineering	Electronic Capacitors
149	Medium & Light Engineering	Electronic Color Picture Tube
150	Medium & Light Engineering	Electronic Equipment Switch gears
151	Medium & Light Engineering	Electronic -Ferrites -Hard
152	Medium & Light Engineering	Electronic-Power Device/Equipment
153	Medium & Light Engineering	Eng. Heavy-Plastic Machine
154	Medium & Light Engineering	Eng. Light Gears
155	Medium & Light Engineering	Eng.-Light-General-Large
156	Medium & Light Engineering	Eng-Light-General-M/S
157	Medium & Light Engineering	Eng-Light-Tools/Moulds
158	Medium & Light Engineering	Fire-Protection Equipment
159	Medium & Light Engineering	Glass Containers/Others
160	Medium & Light Engineering	Glass Safety
161	Medium & Light Engineering	Glass Sheet/Float
162	Medium & Light Engineering	Hydraulics
163	Medium & Light Engineering	Laminates
164	Medium & Light Engineering	Lighting System
165	Medium & Light Engineering	LPG Bottling
166	Medium & Light Engineering	M/C Tool-Tungcarb
167	Medium & Light Engineering	Machine/Tools Others
168	Medium & Light Engineering	Medium-Small Forging
169	Medium & Light Engineering	Office Equipment
170	Medium & Light Engineering	Others Electronic
171	Medium & Light Engineering	Packaging- Polyester Film
172	Medium & Light Engineering	Packaging BOPP Adhesive Tape
173	Medium & Light Engineering	Packaging BOPP Films
174	Medium & Light Engineering	Packaging Plastic Containers
175	Medium & Light Engineering	Packaging -Lamination/Processors

S.No.	Sector	Industry
176	Medium & Light Engineering	Packaging -Lamination/Processors M/s
177	Medium & Light Engineering	Packaging-Metallic
178	Medium & Light Engineering	Packaging-Others
179	Medium & Light Engineering	Photographic & Allied Prod.
180	Medium & Light Engineering	Plastic Others
181	Medium & Light Engineering	Plastic Papers
182	Medium & Light Engineering	Plastic Bottles /Jars
183	Medium & Light Engineering	Plastic Drip Irrigation
184	Medium & Light Engineering	Pollution Control Equipment/Distillation Plant
185	Medium & Light Engineering	Pumps
186	Medium & Light Engineering	Telecom Large Equipment
187	Medium & Light Engineering	Telecom-Med/Small
188	Medium & Light Engineering	Textile Machinery
189	Medium & Light Engineering	Watch & Access
190	Minerals and Metals	Aluminum
191	Minerals and Metals	Ferro Alloys
192	Minerals and Metals	Large-Granite-Marble
193	Minerals and Metals	Metal Copper Alloy Products
194	Minerals and Metals	Metal Others
195	Minerals and Metals	Metal Zinc
196	Minerals and Metals	Mining/Minerals
197	Miscellaneous & Diversified	Couriers
198	Miscellaneous & Diversified	Diversify Large
199	Miscellaneous & Diversified	Diversify med/small
200	Miscellaneous & Diversified	Diversify mega
201	Miscellaneous & Diversified	Miscellaneous large
202	Miscellaneous & Diversified	Miscellaneous-med/small
203	Petroleum	Gas Distribution
204	Petroleum	Industrial Gas
205	Petroleum	Lubricants
206	Petroleum	Oil Drilling
207	Petroleum	Oil Explr/Allied
208	Petroleum	Others-Petrochemicals
209	Petroleum	Petrochem-Poly-Large
210	Petroleum	Petrochem-Poly-M/S
211	Petroleum	Refineries
212	Power	Power Generation
213	Steel	Castings - Grey Iron Industry
214	Steel	Castings - Steel / Alloy Industry
215	Steel	Forging Large
216	Steel	Steel Large
217	Steel	Steel Medium Small
218	Steel	Steel Seamle Tube
219	Steel	Steel Sponge Iron
220	Steel	Steel Wires
221	Steel	Steel-Pig-Iron
222	Steel	Steel-Tube/Pipe-WLD
223	Textiles	Textile Company Large
224	Textiles	Textile Company Med/Small
225	Textiles	Textile Cotton Yarn 100% EOU
226	Textiles	Textile Others
227	Textiles	Textile Processing
228	Textiles	Textile Readymade Appa
229	Textiles	Textile Silk
230	Textiles	Textile Spg Cot/Bl.Yrn
231	Textiles	Textile Woolen Processing
232	Textiles	Textile-Socks
233	Textiles	Textile-Weaving
234	Textiles	Textile-Worsted Fabric
235	Textiles	Txt Cot Yarn-OESPG

S.No.	Sector	Industry
236	Textiles	Txt -Man Made Nylon
237	Textiles	Txt Manmade PSF/PFY CH
238	Textiles	Txt-Den, FABC
239	Textiles	Txt-EMB,Fabric
240	Textiles	Txt-Hos/Kntwer
241	Textiles	Txt-JuteYarn Prod
242	Textiles	Txt-Manmade-PPFY
243	Textiles	Txt-Man-Pfy/Psf
244	Textiles	Txt-Terry Towel
245	Textiles	Txt-Texturising
246	Tourist Services	Hotels Large
247	Tourist Services	Hotels Medium
248	Tourist Services	Hotel-Small
249	Tourist Services	Hotels-Resorts
250	Tourist Services	Recreation/Amusement Park
251	Tourist Services	Travel Agency
252	Transportation Equipment Services	Automobiles - LCVs/HCVs Industry
253	Transportation Equipment Services	Automobiles - Motorcycles / Mopeds
254	Transportation Equipment Services	Automobiles - passenger cars
255	Transportation Equipment Services	Automobiles - Scooters and 3-Wheelers
256	Transportation Equipment Services	Cycle & Access
257	Transportation Equipment Services	Ship-Breaking/Repair
258	Transportation Equipment Services	Shipping Large
259	Transportation Equipment Services	Shipping Med/Small
260	Transportation Equipment Services	Transport/Air
261	Transportation Equipment Services	Transport/Road

Table A3.2: Annual Survey of Industry (ASI) Data: 4-Digit Industry Code

S.No.	Industry Code- Industry Name
1	0163 - Post-harvest crop activities
2	0164 - Seed processing for propagation
3	0893 - Extraction of salt
4	1010 - Processing and preserving of meat
5	1020 - Processing and preserving of fish, crustaceans and molluscs
6	1030 - Processing and preserving of fruit and vegetables
7	1040 - Manufacture of vegetable and animal oils and fats
8	1050 - Manufacture of dairy products
9	1061 - Manufacture of grain mill products
10	1062 - Manufacture of starches and starch products
11	1071 - Manufacture of bakery products
12	1072 - Manufacture of sugar
13	1073 - Manufacture of cocoa, chocolate and sugar confectionery
14	1074 - Manufacture of macaroni, noodles, couscous and similar farinaceous products
15	1075 - Manufacture of prepared meals and dishes
16	1079 - Manufacture of other food products n.e.c.
17	1080 - Manufacture of prepared animal feeds
18	1101 - Distilling, rectifying and blending of spirits
19	1102 - Manufacture of wines
20	1103 - Manufacture of malt liquors and malt
21	1104 - Manufacture of soft drinks; production of mineral waters and other bottled waters
22	1200 - Manufacture of tobacco products
23	1311 - Preparation and spinning of textile fibres
24	1312 - Weaving of textiles
25	1313 - Finishing of textiles
26	1391 - Manufacture of knitted and crocheted fabrics
27	1392 - Manufacture of made-up textile articles, except apparel
28	1393 - Manufacture of carpets and rugs
29	1394 - Manufacture of cordage, rope, twine and netting
30	1399 - Manufacture of other textiles n.e.c.
31	1410 - Manufacture of wearing apparel, except fur apparel
32	1420 - Manufacture of articles of fur
33	1430 - Manufacture of knitted and crocheted apparel
34	1511 - Tanning and dressing of leather; dressing and dyeing of fur
35	1512 - Manufacture of luggage, handbags and the like, saddlery and harness
36	1520 - Manufacture of footwear
37	1610 - Sawmilling and planing of wood
38	1621 - Manufacture of veneer sheets and wood-based panels
39	1622 - Manufacture of builders' carpentry and joinery
40	1623 - Manufacture of wooden containers
41	1629 - Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
42	1701 - Manufacture of pulp, paper and paperboard
43	1702 - Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
44	1709 - Manufacture of other articles of paper and paperboard
45	1811 - Printing
46	1812 - Service activities related to printing
47	1820 - Reproduction of recorded media
48	1910 - Manufacture of coke oven products
49	1920 - Manufacture of refined petroleum products
50	2011 - Manufacture of basic chemicals
51	2012 - Manufacture of fertilizers and nitrogen compounds
52	2013 - Manufacture of plastics and synthetic rubber in primary forms
53	2021 - Manufacture of pesticides and other agrochemical products
54	2022 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics
55	2023 - Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
56	2029 - Manufacture of other chemical products n.e.c.

S.No.	Industry Code- Industry Name
57	2030 - Manufacture of man-made fibres
58	2100 - Manufacture of pharmaceuticals, medicinal chemical and botanical products
59	2211 - Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres
60	2219 - Manufacture of other rubber products
61	2220 - Manufacture of plastics products
62	2310 - Manufacture of glass and glass products
63	2391 - Manufacture of refractory products
64	2392 - Manufacture of clay building materials
65	2393 - Manufacture of other porcelain and ceramic products
66	2394 - Manufacture of cement, lime and plaster
67	2395 - Manufacture of articles of concrete, cement and plaster
68	2396 - Cutting, shaping and finishing of stone
69	2399 - Manufacture of other non-metallic mineral products n.e.c.
70	2410 - Manufacture of basic iron and steel
71	2420 - Manufacture of basic precious and other non-ferrous metals
72	2431 - Casting of iron and steel
73	2432 - Casting of non-ferrous metals
74	2511 - Manufacture of structural metal products
75	2512 - Manufacture of tanks, reservoirs and containers of metal
76	2513 - Manufacture of steam generators, except central heating hot water boilers
77	2520 - Manufacture of weapons and ammunition
78	2591 - Forging, pressing, stamping and roll-forming of metal; powder metallurgy
79	2592 - Treatment and coating of metals; machining
80	2593 - Manufacture of cutlery, hand tools and general hardware
81	2599 - Manufacture of other fabricated metal products n.e.c.
82	2610 - Manufacture of electronic components and boards
83	2620 - Manufacture of computers and peripheral equipment
84	2630 - Manufacture of communication equipment
85	2640 - Manufacture of consumer electronics
86	2651 - Manufacture of measuring, testing, navigating and control equipment
87	2652 - Manufacture of watches and clocks
88	2660 - Manufacture of irradiation, electromedical and electrotherapeutic equipment
89	2670 - Manufacture of optical instruments and photographic equipment
90	2680 - Manufacture of magnetic and optical media
91	2710 - Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
92	2720 - Manufacture of batteries and accumulators
93	2731 - Manufacture of fibre optic cables
94	2732 - Manufacture of other electronic and electric wires and cables
95	2733 - Manufacture of wiring devices
96	2740 - Manufacture of electric lighting equipment
97	2750 - Manufacture of domestic appliances
98	2790 - Manufacture of other electrical equipment
99	2811 - Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
100	2812 - Manufacture of fluid power equipment
101	2813 - Manufacture of other pumps, compressors, taps and valves
102	2814 - Manufacture of bearings, gears, gearing and driving elements
103	2815 - Manufacture of ovens, furnaces and furnace burners
104	2816 - Manufacture of lifting and handling equipment
105	2817 - Manufacture of office machinery and equipment (except computers and peripheral equipment)
106	2818 - Manufacture of power-driven hand tools
107	2819 - Manufacture of other general-purpose machinery
108	2821 - Manufacture of agricultural and forestry machinery
109	2822 - Manufacture of metal-forming machinery and machine tools
110	2823 - Manufacture of machinery for metallurgy
111	2824 - Manufacture of machinery for mining, quarrying and construction
112	2825 - Manufacture of machinery for food, beverage and tobacco processing
113	2826 - Manufacture of machinery for textile, apparel and leather production
114	2829 - Manufacture of other special-purpose machinery
115	2910 - Manufacture of motor vehicles

S.No.	Industry Code- Industry Name
116	2920 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
117	2930 - Manufacture of parts and accessories for motor vehicles
118	3011 - Building of ships and floating structures
119	3012 - Building of pleasure and sporting boats
120	3020 - Manufacture of railway locomotives and rolling stock
121	3030 - Manufacture of air and spacecraft and related machinery
122	3040 - Manufacture of military fighting vehicles
123	3091 - Manufacture of motorcycles
124	3092 - Manufacture of bicycles and invalid carriages
125	3099 - Manufacture of other transport equipment n.e.c.
126	3100 - Manufacture of furniture
127	3211 - Manufacture of jewellery and related articles
128	3212 - Manufacture of imitation jewellery and related articles
129	3220 - Manufacture of musical instruments
130	3230 - Manufacture of sports goods
131	3240 - Manufacture of games and toys
132	3250 - Manufacture of medical and dental instruments and supplies
133	3290 - Other manufacturing n.e.c.
134	3311 - Repair of fabricated metal products
135	3312 - Repair of machinery
136	3313 - Repair of electronic and optical equipment
137	3314 - Repair of electrical equipment
138	3315 - Repair of transport equipment, except motor vehicles
139	3319 - Repair of other equipment
140	3320 - Installation of industrial machinery and equipment
141	3811 - Collection of non-hazardous waste
142	3812 - Collection of hazardous waste
143	3821 - Treatment and disposal of non-hazardous waste
144	3822 - Treatment and disposal of hazardous waste
145	3830 - Materials recovery
146	5811 - Book publishing
147	5812 - Publishing of directories and mailing lists
148	5813 - Publishing of newspapers, journals and periodicals
149	5819 - Other publishing activities
150	Others

Table A3.3: OLS estimates of Cobb-Douglas production function using company balance sheet, 2011-12

Sectors	N	Constant		Log of capital		Log of wage		R^2
		Coeff.	SE	Coeff.	SE	Coeff.	SE	
Agro Based Industries	223	0.47	0.948	0.33***	0.067	0.66***	0.054	0.800
Chemicals & Pharmaceuticals	266	-0.49	0.470	0.39***	0.060	0.64***	0.060	0.870
Consumer Goods	334	-0.97*	0.493	0.48***	0.046	0.57***	0.048	0.880
Contract & Construction	184	-3.17	3.656	0.21	0.144	1.01***	0.282	0.370
Fertilizers	53	1.98*	0.780	0.39***	0.075	0.52***	0.086	0.910
Heavy Engineering	215	-0.67	0.580	0.29***	0.047	0.77***	0.055	0.880
Medium & Light Engineering	530	-0.92*	0.408	0.49***	0.048	0.56***	0.046	0.880
Minerals and Metals	80	-0.79	1.041	0.49***	0.107	0.55***	0.087	0.900
Miscellaneous & Diversified	184	1.29*	0.535	0.22***	0.038	0.74***	0.048	0.860
Petroleum	61	-3.62***	1.014	0.52***	0.148	0.68***	0.174	0.920
Power	56	4.24**	1.273	0.43***	0.088	0.38***	0.073	0.810
Steel	169	-0.38	0.808	0.64***	0.073	0.36***	0.070	0.840
Tourist Services	85	0.46	1.169	0.33***	0.090	0.65***	0.127	0.880
Transport Equipment Services	95	0.03	0.909	0.39***	0.095	0.61***	0.110	0.880
Overall	**2535**	**-0.49**	**0.446**	**0.36*** **	**0.026**	**0.68*** **	**0.041**	**0.730**

Table A3.4: OLS estimates of Cobb-Douglas production function using company balance sheet, 2012-13

Sectors	N	Constant		Log of capital		Log of wage		R^2
		Coeff.	SE	Coeff.	SE	Coeff.	SE	
Agro Based Industries	226	0.77	0.887	0.42***	0.061	0.52***	0.059	0.790
Chemicals & Pharmaceuticals	265	-0.7	0.550	0.41***	0.069	0.63***	0.069	0.870
Consumer Goods	335	-0.82	0.451	0.44***	0.049	0.61***	0.054	0.880
Contract & Construction	171	1.09	0.652	0.34***	0.050	0.62***	0.059	0.820
Fertilizers	58	0.79	1.227	0.48***	0.090	0.47***	0.093	0.830
Heavy Engineering	224	-0.74	0.583	0.35***	0.055	0.71***	0.066	0.840
Medium & Light Engineering	532	-2.64	2.076	0.31***	0.063	0.85***	0.162	0.630
Minerals and Metals	84	-1.27	0.975	0.57***	0.094	0.49***	0.078	0.910
Miscellaneous & Diversified	195	-0.44	2.017	0.32**	0.119	0.72***	0.050	0.440
Petroleum	61	-1.97	1.063	0.40*	0.168	0.73**	0.217	0.890
Power	54	4.68**	1.413	0.34***	0.087	0.46***	0.075	0.810
Steel	166	-0.81	0.856	0.72***	0.101	0.29**	0.110	0.830
Tourist Services	86	-0.39	1.345	0.37***	0.106	0.64***	0.157	0.860
Transport Equipment Services	95	0.1	0.588	0.49***	0.072	0.49***	0.081	0.930
Overall	**2552**	**-0.56**	**0.461**	**0.40*** **	**0.032**	**0.64*** **	**0.033**	**0.750**

Table A3.5: OLS estimates of Cobb-Douglas production function using company balance sheet, 2013-14

Sectors	N	Constant		Log of capital		Log of wage		R^2
		Coeff.	SE	Coeff.	SE	Coeff.	SE	
Agro Based Industries	229	0.26	0.813	0.34***	0.070	0.65***	0.078	0.820
Chemicals & Pharmaceuticals	265	-0.11	0.707	0.33***	0.079	0.69***	0.070	0.880
Consumer Goods	325	-0.18	0.518	0.45***	0.051	0.57***	0.053	0.840
Contract & Construction	182	1.64**	0.604	0.41***	0.046	0.52***	0.053	0.850
Fertilizers	59	0.39	1.621	0.28*	0.113	0.72***	0.128	0.830
Heavy Engineering	218	-0.2	0.444	0.34***	0.047	0.69***	0.053	0.880
Medium & Light Engineering	529	-0.47	0.684	0.44***	0.065	0.59***	0.052	0.850
Minerals and Metals	80	-0.87	0.837	0.47***	0.088	0.58***	0.070	0.940
Miscellaneous & Diversified	189	0.25	0.534	0.22***	0.040	0.80***	0.046	0.860
Petroleum	59	-0.93	0.942	0.64***	0.086	0.40**	0.118	0.930
Power	57	1.63	2.183	0.47**	0.144	0.45***	0.096	0.850
Steel	168	0.67	0.586	0.54***	0.084	0.42***	0.094	0.850
Tourist Services	86	2.32	1.252	0.29***	0.079	0.59***	0.124	0.830
Transport Equipment Services	95	0.39	0.776	0.33***	0.081	0.66***	0.103	0.880
Overall	**2541**	**0.19**	**0.187**	**0.39*** **	**0.017**	**0.62*** **	**0.018**	**0.860**

Table A3.6: OLS estimates of Cobb-Douglas production function using company balance sheet, 2014-15

Sectors	N	Constant		Log of capital		Log of wage		R^2
		Coeff.	SE	Coeff.	SE	Coeff.	SE	
Agro Based Industries	272	0.69	0.545	0.34***	0.049	0.62***	0.053	0.820
Chemicals & Pharmaceuticals	280	-0.71	0.521	0.41***	0.043	0.64***	0.040	0.890
Consumer Goods	350	-1.08*	0.483	0.47***	0.048	0.59***	0.058	0.870
Contract & Construction	203	2.76***	0.707	0.35***	0.052	0.51***	0.057	0.760
Fertilizers	55	2.28*	1.133	0.25*	0.108	0.66***	0.120	0.840
Heavy Engineering	237	-0.98	0.566	0.31***	0.050	0.75***	0.050	0.850
Medium & Light Engineering	588	-0.43	0.360	0.39***	0.039	0.63***	0.041	0.890
Minerals and Metals	81	-0.52	0.778	0.28*	0.109	0.76***	0.110	0.890
Miscellaneous & Diversified	265	0.53	0.506	0.24***	0.045	0.75***	0.052	0.830
Petroleum	60	-3.43**	1.227	0.67***	0.087	0.49***	0.095	0.930
Power	67	3.45*	1.366	0.42***	0.083	0.42***	0.072	0.860
Steel	172	-4.28	3.768	0.25	0.269	1.02*	0.500	0.480
Tourist Services	91	1.42	1.023	0.33***	0.083	0.58***	0.123	0.870
Transport Equipment Services	112	0.57	0.733	0.31***	0.074	0.68***	0.100	0.880
Overall	**2833**	**-0.14**	**0.284**	**0.36*** **	**0.018**	**0.66*** **	**0.028**	**0.800**

Table A3.7: OLS estimates of Cobb-Douglas production function using company balance sheet, 2015-16

Sectors	N	Constant		Log of capital		Log of wage		R^2
		Coeff.	SE	Coeff.	SE	Coeff.	SE	
Agro Based Industries	267	0.4	0.545	0.33***	0.059	0.65***	0.058	0.840
Chemicals & Pharmaceuticals	277	-0.64	0.515	0.37***	0.046	0.67***	0.044	0.910
Consumer Goods	344	-1.42**	0.453	0.43***	0.051	0.65***	0.057	0.880
Contract & Construction	210	2.70***	0.646	0.44***	0.047	0.41***	0.058	0.770
Fertilizers	58	2.85*	1.350	0.17	0.135	0.72***	0.146	0.800
Heavy Engineering	230	-0.72	0.479	0.37***	0.046	0.67***	0.052	0.860
Medium & Light Engineering	574	-0.38	0.410	0.40***	0.053	0.62***	0.057	0.860
Minerals and Metals	76	-0.94	1.357	0.47***	0.112	0.58***	0.076	0.890
Miscellaneous & Diversified	271	1.06*	0.461	0.28***	0.041	0.69***	0.044	0.840
Petroleum	57	-2.42**	0.906	0.67***	0.093	0.44***	0.112	0.940
Power	73	2.13	1.519	0.47***	0.112	0.41***	0.098	0.800
Steel	174	-0.15	0.672	0.51***	0.078	0.49***	0.087	0.860
Tourist Services	94	1.53	1.147	0.28***	0.072	0.63***	0.119	0.850
Transport Equipment Services	105	0.22	0.650	0.32***	0.059	0.68***	0.072	0.920
Overall	**2810**	**0.23**	**0.165**	**0.38*** **	**0.016**	**0.61*** **	**0.019**	**0.860**

Table A3.8: Foreign commercial borrowings and average interest paid by government, 1990-91 to 2013-14

Year	Interest (USD Million)	Debt Outstanding (US $ Million)	Rate of Interest	Market Exchange Rate (Rupee/Dollar)	Rate of Appreciation of Exchange Rate[a]	Implicit Rate of Interest[b]
1990-91	1042	13909	0.07	17.94	0.05	0.10
1991-92	994	15557	0.06	24.47	0.04	0.09
1992-93	917	15818	0.06	30.65	0.03	0.09
1993-94	896	16650	0.05	31.37	0.03	0.08
1994-95	1091	18037	0.06	31.4	0.03	0.09
1995-96	1162	19024	0.06	33.45	0.03	0.09
1996-97	1177	20261	0.06	35.5	0.03	0.09
1997-98	1406	23946	0.06	37.16	0.03	0.09
1998-99	1575	28182	0.06	42.07	0.02	0.08
1999-00	1635	27530	0.06	43.33	0.02	0.09
2000-01	1683	30922	0.05	45.68	0.02	0.08
2001-02	1534	29579	0.05	47.69	0.02	0.08
2002-03	1180	28074	0.04	48.4	0.02	0.07
2003-04	2031	25809	0.08	45.95	0.03	0.11
2004-05	959	31595	0.03	44.93	0.03	0.06
2005-06	2996	32371	0.09	44.27	0.02	0.12
2006-07	1709	48459	0.04	45.28	0.04	0.06
2007-08	2630	71051	0.04	40.24	0.06	0.07
2008-09	2702	77862	0.03	45.92	0.05	0.06
2009-10	2397	82518	0.03	47.44	0.05	0.06
2010-11	2584	108328	0.02	45.56	0.06	0.05
2011-12	4326	126288	0.03	47.92	0.06	0.06
2012-13	4990	138735	0.04	54.41	0.05	0.06
2013-14	4739	149146	0.03	60.5	0.03	0.06
Average					**0.03**	**0.08**

Notes:

a: Rate of Appreciation of Exchange Rate is calculated w.r.t. the market exchange rate of 2013-14

b: Implicit rate if return is calculated by adding the average rate of appreciation of exchange rate to Rate of Return

CHAPTER IV: SHADOW EXCHANGE RATE

4.1. Introduction

4.1. Shadow price of foreign exchange represents the contribution of a unit of foreign exchange to the societal welfare. In an economy with perfect competition and free trade and no externalities, the market price of foreign exchange represents its social value. However, normally, there are distortions in the foreign exchange market at different levels, which are either directly introduced through trade policies or indirectly through other domestic economic policies of the government. The presence of these distortions makes shadow exchange rate (SER) higher than market exchange rate.

4.2. The methods to estimate SER are classified as (a) revealed preference methods and (b) equilibrium exchange rate method. The revealed preference method analyzes the trade policies or public expenditure policies for investing in import substituting and export promoting projects for estimating SER. The equilibrium exchange rate (EER) method analyzes the supply and demand of tradable commodities in the economy in the context of trade reforms and finds out exchange rate that would restore the current balance of trade after all trade distortions are removed. This exchange rate is considered as SER for the economy.

4.3. The SER estimated using either of these methods is used in two contexts for making investment decisions for public sector projects. In the first context, it is used to estimate the social benefits of earning foreign exchange and the social cost of using foreign exchange by a general investment project. Secondly, it could be used as a cut-off rate for the domestic resource cost of earning a dollar by import substituting and export promoting projects in a country.

4.4. The report of IEG 2007 provides estimates of SER for India using some of these methods. It provides estimates of SER implicit in trade policies and the choices of export promoting and import substituting public investment projects in India. It also provides estimate of SER using EER method and recommends it as more appropriate method of estimation of SER for India in the current situation.

4.5. The rest of this chapter is organized as follows: Section 4.2 provides a review of revealed preference methods for estimating SER. Section 4.3 describes the methodology for estimating EER. Section 4.4 reviews available estimates of import demand and supply functions and export demand and supply functions for the Indian economy including the estimates made in the earlier IEG report. It also provides the new estimates of these functions. Section 4.5 provides the estimates of shadow exchange rate using some of the methods of estimation described above using the most recent data of trade statistics for India. Section 4.6 provides the conclusions and recommendations.

4.2. Review of Revealed Preferences Methods

4.6. There are two distinct methods of estimating the shadow price of foreign exchange using revealed preference approach. One method considers that shadow price of foreign exchange (say, US dollar) should reflect the social welfare value of an additional dollar while the other method considers that it should reflect the opportunity cost of earning a dollar in the economy. These two methods could be regarded as demand and supply price based methods respectively.

4.7. The demand price or consumer surplus based methods are originally given by Harberger (1968), Harberger and Schydlowsky (1968), and Dasgupta, Sen and Marglin (1972) or UNIDO method. The methods based on supply price of a dollar or domestic resource cost of supplying a dollar are originally due to Bruno (1967), Kruger (1966), and Balassa and Schydlowsky (1968). These methods help one find the shadow exchange rate implicit in the investment decisions of government by estimating the domestic resource cost of earning a dollar through various projects undertaken in public sector.

4.8. The UNIDO method prescribes valuation of benefits and costs at domestic market prices and suggests the valuation of specific inputs like unskilled labor, capital and foreign exchange at their shadow prices. According to this method, the values of imports and exports due to a project at official rate of exchange have to be corrected with social premium on foreign exchange. The premium is to be derived in the following way.

$$P_F = \sum_{i=1}^{n} F_i \frac{P_i^D}{P_i^{cif}} + \sum_{i=n+1}^{n+h} X_i \frac{P_i^D}{P_i^{fob}}$$

with $\sum_{i=1}^{n} F_i + \sum_{i=n+1}^{n+h} X_i = 1$

Where,

F_i : the fraction of foreign exchange available to i^{th} import at margin $i = 1.....n$

X_i: the fraction of foreign exchange available to reduce i^{th} export at margin $i = n+1... n+h$

P_i^D : Domestic market price of i^{th} commodity in rupees, $i = 1... n+h$

P_i^{cif} : cif prices of i^{th} import in dollars, $i=1,...n$

P_i^{fob}: fob prices of i^{th} export in dollars, $i=n+1 ... n+h$

Given the import tariffs or duties and export taxes or subsidies, the domestic market prices of tradable are defined as follows.

$P_i^D = RP_i^{cif}(1+t_i+a_i)$ for imports, $i = 1,2,...n$

$P_i^D = RP_i^{fob}(1-t_i-a_i)$ for exports, $i = n+1,...n+h$

Where,

t_i : import tariff and $t_i < 0$ if it is an export subsidy.

R: market exchange rate

a_i: transport cost of i^{th} tradable commodity as a fraction of world price. It is the cost for transporting imports from port to the user and exports from factory to the port.

Using the above equations, the SER can be computed as

$$P_F = R\left[\sum_{i=1}^{n} F_i(1+t_i+a_i) + \sum_{i=n+1}^{n+h} X_i(1-t_i-a_i)\right]$$

4.9. Methodologically, the welfare based revealed preference methods were first found in Harberger (1968) and Schydlowsky (1968), and the UNIDO method described above complements them. As explained in Jenkins and Harberger (1997), these models focus on distortions that exist in the external trade sector by accounting for the effects of import tariffs and export subsidies on incremental changes in

consumption. Using these models, the shadow exchange rate in the aggregate form[28] could be computed as follows:

$$P_F = \frac{R(\varepsilon^x(1+K) - \eta^M(Q^M/Q^X)(1+T))}{\varepsilon^x - \eta^M(Q^M/Q^X)}$$

Where,

P_F = Shadow price of foreign exchange

R = Market exchange rate

K = Rate of subsidy (exports)

T = Rate of import tariff

ε^X = Price elasticity of supply of exports

η^M = Price elasticity of demand for imports

Q^M = Quantity of foreign exchange required to pay for imports

Q^X = Quantity of foreign exchange earned from exports

4.10. The cost based revealed preferences method considers that the choice of export promoting and import substituting projects in public sector could be made by ranking the projects on the basis of the domestic cost of earning a dollar through each project. The analysis of this ranking of projects could help one to know the shadow exchange rate implicit in the government's choice of investment projects. In an ex post analysis of import substituting and export promoting projects chosen by the government, the domestic cost of earning a dollar by the marginal project i.e. the project with the highest cost of supplying a dollar could be regarded as the shadow exchange rate. To explain the rationale, the fact that the government has already chosen this project implies that it places as much high value on a dollar as the supply cost of this project. The cost of supplying dollars could be computed either as the domestic cost or cost at domestic prices (Bruno, 1967 and Kruger, 1966) or as the cost measured in terms of world prices (Balassa and Schydlowsky, 1968 and Little and Mirrlees, 1969).

4.11. The Bruno-Kruger exchange rate or domestic resource cost of supplying a dollar can be used to rank investment projects based on exchange rates that result from existing industries and recent investment projects (both in export oriented and import substitution oriented). The exchange rate of the costliest project in principle is

[28] See Bacha and Taylor, 1971 for a disaggregated version of this formula.

regarded as a "planners" exchange rate used for valuing foreign exchange flows in benefit cost calculations (Bacha and Taylor, 1971). The effective protection rate of Balassa and Schydlowsky, defined as the ratio of the value added at domestic market prices to the value added at world prices of an investment project, could be used to rank the projects according to their probable changes in value added after trade liberalization. According to this criterion, a project is better; the lower is its effective protection rate. Using a variant of these methods, the social cost of earning a dollar through an investment project can be estimated (Planning Commission, and Murty et al. 1992):

4.12. The net present social benefits (NSPB) of investment project 'i' could be estimated as:

$$NPSB^i = P_F \sum_{t=1}^{T} (B_{Ft}^i - C_{Ft}^i)/(1+r)^t \; - \; \sum_{t=1}^{T} (P_L L_t^i + P_K K_t^i + D_t^i)/(1+r)^t$$

Where,

P_F: Shadow price of a dollar of foreign exchange in rupees

B_{Ft}^i : Value of foreign exchange benefits in dollars at boarder prices of ith project in the year t

C_{Ft}^i : Value of foreign exchange cost in dollars at boarder prices of ith project in the year t

D_t^i: Domestic material input cost of ith project in the year t

K_t^i: Capital investment of ithproject in the year t

L_t^i: Unskilled labour cost of ith project in the year t

r : Social rate of discount P_K : Shadow price of investment as a ratio of its market price

P_L: Shadow price of unskilled labour as a ratio of its market price.

Given r, B_{Ft}^i , C_{Ft}^i , D_t^i, K_t^i, L_t^i, P_K , and P_L for project *i*, one can find out the exchange rate at which this project breaks even or that makes $NPSB^i$ zero. Then this exchange rate could be defined as the own rate of exchange of project *i* (P_F^i).

$$P_F^i = \frac{\sum_{t=1}^{T} (P_L L_t^i + P_K K_t^i + D_t^i)/(1+r)^t}{\sum_{t=1}^{T} (B_{Ft}^i - C_{Ft}^i)/(1+r)^t}$$

4.13. In PC 2007, own rate of exchange is estimated for some export promoting projects chosen by the Government in recent years using data from the Project Appraisal Division of Planning Commission, Government of India.

4.3. OECD or World Price Method and Shadow Exchange Rate

4.14. In OECD method (Little and Mirrlees, 1974) the benefits and cost of a project are estimated in terms of uncommitted foreign exchange or at the world prices of goods and services. Given initially the estimates of values of commodities produced and commodities used as inputs by the project at domestic market prices, it requires that these values be converted into their equivalents at world market prices. For doing this, one needs the estimates of accounting ratios for tradable and non-tradable commodities. The estimation of accounting ratios in OECD method is described as follows:

$P_i^S = P_i^{cif}(a + a_i)$; for imports, $i = 1, 2 \ldots n$

$P_j^S = P_j^{fob}(a + a_j)$; for exports, $j = 1, 2 \ldots n$

Where, P_i^s, P_j^s, a_i, a_j represent shadow prices or world prices and transport margins of imports and exports respectively. Given the domestic market prices as defined above in equations, the ratios are computed as

P_i^s / P_i^D; for imports, $i = 1, 2 \ldots n$

P_j^s / P_j^D; for exports, $j = 1, 2 \ldots n$

4.15. These accounting ratios could be computed for all the tradable commodities for which there are world market prices. However, there are no world market prices for non-tradable commodities like electricity, transport, irrigation etc. For these commodities, standard conversion factors (SCF) for computing foreign exchange equivalents of domestic market prices have to be estimated. These have to be estimated by working through the production structure of the economy as depicted, for example, by an input-output table and finding out the cost of producing a unit of non-tradable commodity in terms of tradable inputs used in its production. For example, electricity is not tradable commodity but the foreign exchange cost of

supplying it could be estimated as the foreign exchange cost of coal used in its production along with other inputs. The SCF as one could see is the reciprocal of SER.

4.4. Equilibrium Exchange Rate Method

4.16. The project ranking rules based on the cost of earning a dollar or rules based on Bruno-Krueger domestic resource cost and effective rate of protection require a cut-off exchange rate. Taylor and Bacha (1971) have argued that the equilibrium or free trade exchange rate is an appropriate cut-off rate for the choice of export-promoting and import-substituting projects in the public sector. The equilibrium exchange rate (EER) is defined as the rate of exchange that prevails in a floating exchange rate market when all import tariffs and export subsidies, and quantitative restrictions on imports/exports are removed. It is also defined as the exchange rate needed to re-establish the pre-existent balance of trade when all trade restrictions, tariff and non-tariff, are removed.

4.17. Given that the Indian economy has been witnessing a gradual reduction in foreign trade restrictions since the early 1990s due to trade reforms, EER could be the appropriate method for estimating the shadow exchange rate for India. Derivation of the EER requires that the following assumptions be made about the trade sector: equality between export supply and export demand, equality between import supply and demand and balance of trade in foreign currency given by Exports + Δ = Imports where Δ is the current account balance or deficit of trade. The equilibrium exchange rate R^* is derived as follows (Bacha and Taylor, 1971):

$$R^* = R\,\tau^{1/1-q}$$

Where, $\tau = 1+t$

t: Equivalent ad valorem tariff (average of tariffs and tariff equivalents of trade restrictions and prohibitions)

R: Market exchange rate

$$q = D\,\psi$$

$$\psi = \frac{(1+\eta_x)\varepsilon_x(\varepsilon_m - \eta_m)}{(1+\varepsilon_m)\eta_m(\eta_x - \varepsilon_x)}$$

D = Ratio of volumes of exports and imports

η_x = Price elasticity of export demand

ε_x = Price elasticity of export supply

η_m = Price elasticity of import demand

ε_m = Price elasticity of import supply

Given the data on market exchange rate, export and import demand and supply price elasticities and volumes of exports and imports, one can estimate the equilibrium exchange rate by using the above formula.

4.5. Import Demand and Supply Functions and Export Demand and Supply Functions

4.5.1. Data Requirements

4.18. The main sources of data used for the estimation of export supply and demand and import supply and demand functions are the International Financial Statistics, International Monetary Fund, World Bank data base and the Hand Book of Statistics on Indian Economy, Reserve Bank of India. All unit value indices of annual exports and imports for the period 1991-2015 were obtained from the *International Financial Statistics,* International Monetary Fund. The definitions of variables used for estimating the models are given below.

P_X: Unit value of exports (2010=100) adjusted for export subsidies, the figures of export subsidies have been obtained from various issues of Economic Survey, Government of India.

P_W: Unit value of exports (2010=100) of the USA taken as a proxy for the world price for exports.

X: Volume of exports (in million dollars) deflated with the unit value of exports for the period 1991-2015, obtained from the Handbook of Statistics on Indian Economy, Reserve Bank of India.

Y: Real gross domestic product (in million dollars) for the period 1991-2015, figures have been obtained from World Development Indicators, World Bank.

W: World income (in million dollars), taken as an aggregate of the real gross domestic product of all countries other than OPEC (Organization of Petroleum Exporting Countries), figures have been obtained from World Development Indicators, World Bank.

P_D: Wholesale price index (2010=100) taken as a proxy for the domestic price for the period 1991-2015, figures have been obtained from the Handbook of Statistics on Indian Economy, Reserve Bank of India.

M: Volume of oil imports (in million dollars) deflated with unit value index of imports, figures have been obtained from the Handbook of Statistics on Indian Economy, Reserve Bank of India.

P_M: Unit value index of imports (2010=100) adjusted with tariff rate, figures of an average rate of tariff have been obtained from various issues of Economic Survey, Government of India.

$Price^D$: Relative price of export demand derived from the unit value index of exports adjusted for subsidies and deflated by the World Price (unit value index of US).

$Price^S$: Relative price of export supply derived from the unit value index of exports (based on unit values in US dollars), adjusted for export subsidies and deflated by Wholesale price index and exchange rate.

$Price^M$: Relative price of imports derived from the unit value index of imports (based on unit values in US dollars), adjusted for import tariff rate and deflated by Wholesale Price Index and exchange rate.

Table 4.1: Data sources and description

Variable	Base	Currency	Units	Source
1. Unit value of Exports India	2010	US Dollar	NA	International Financial Statistics
2. Unit value of Exports USA	2010	US Dollar	NA	International Financial Statistics
3. Unit value of Imports India	2010	US Dollar	NA	International Financial Statistics
4. Wholesale price index India	2010	NA	NA	RBI
5. Export Subsidy India				Union Budget documents
6. Revenue from custom duty India		Rupees	Crores	Economic Surveys
7. World income aggregate of real GDP other than OPEC	2010	US Dollar	-	World Development Indicators
8. Real GDP, India	2010	US Dollar	-	World Development Indicators
9. Volume of imports and exports	NA	US Dollar	Million	RBI
10. Exchange rate				RBI
11. Money supply		Rupees	Billion	RBI

Table 4.2: Descriptive statistics of variables used in the models

Variable	Description	Unit	Mean	SD
X(exports total)	Exports India	Million Dollars	121780	108939
M(imports total)	Imports India	Million Dollars	178499	171086
PX	Unit value of Exports India	Index (2010 =100)	73.4	23.4
PM	Unit value of Imports adjusted for tariff India	Index (2010 =100)	109.7	34.6
PD	Whole sale price index India	Index (2010 =100)	72.8	29.9
PW(export)	World price of exports	Index (2010 =100)	89.4	10.8
PW(import)	World price of imports	Index (2010 =100)	87.3	13.8
PriceS	Relative price of export supply		45.3	6.1
PriceD	Relative price of export demand		0.8	0.2
PriceM	Relative price of import demand tariff adjusted		68.8	14.2
Y	Real Gross domestic product of India	Million Dollars	1092323	529507
W	Real GDP of World	Million Dollars	52600000	11200000
Exchange rate	Nominal Exchange rate India		44	9.9

4.5.2. Price Elasticity of Demand and Supply of Exports and Imports: Review

4.19. IEG 2007 study provides a review of then available estimates of price elasticity of export supply and demand and import supply and demand. Tables 4.3 and 4.4 below report some of these earlier estimates. Tables 4.5 to 4.7 report estimates made in IEG 2007 study.

Table 4.3: Short run price elasticity of India's export demand and supply functions as derived in earlier studies

Study	Period	Export Demand	Export Supply
Khan (1974)	1951-1969	-2.19	Not estimated
Virmani (1991)	1970-1985	-1.32 to -1.8	14.28
Joshi and Little (1994)	1970-1990	-0.87 to -1.22	0.49 to 0.78
Krishnamurty and Pandit (1996)	1971-1991	-0.21 to -0.52	2.03 to ∞
Sharma (2000)	1970-1998	-1.01 to -1.16	0.85

Table 4.4: Short run price elasticity of India's import demand function from earlier studies

Study	Period	Import Demand	Import Supply
Khan (1974)	1951-69	-2.19	Not estimated
Virmani (1991)	1970-1985	-1.64	Assumed to be infinity
Krishnamurty and Pandit (1996)	1971-91	-0.11 to -1.38	Assumed to be infinity
Dutta and Ahmed (2001)	1971-95	-0.37	Not estimated

Table 4.5: Estimates of export demand and supply functions for India, PC 2007

			Model 1				**Model 2**
			Dependent Variable ln X				**Dependent Variable ln X**
Export Demand		**Export Supply**		**Export Demand**		**Export Supply**	
Constant	-60.09***	Constant	-22.89***	Constant	-26.81***	Constant	3.19*
	(14.1)		*(10.65)*		*(40.34)*		*(1.19)*
$Price^D$	-0.37***	$Price^S$	0.007*	$Price^D$	-0.85**	$Price^S$	0.27
	(3.09)		*(1.53)*		*(2.31)*		*(0.79)*
LnW	2.74***	LnY	1.75***	lnW	1.16**	lnDD(-1)	-0.07
	(20.2)		*(20.18)*		*(3.93)*		*(0.46)*
				lnX(-1)	0.54**	Trend	0.02**
					(3.85)		*(2.16)*
						LnX(-1)	0.81***
							(5.39)
Adj-R^2	0.98	Adj-R^2	0.95	Adj-R^2	0.99	Adj-R^2	0.98

Note: *** 1%, ** 5% and * 10% level of significance. Standard errors are reported in parenthesis.

Table 4.6: Estimate of import demand function, PC 2007

Import Demand: Dependent Variable ln M	
Constant	-13.59***
	(10.89)
$Price^M$	-0.88***
	(9.59)
LnY	1.38***
	(33.65)
Adj-R^2	0.989
DW	1.459

Note: *** 1%, ** 5% and * 10% level of significance. Standard errors are reported in parenthesis.

Table 4.7: ARDL estimates of export supply, export demand and import demand functions, PC 2007

Export Demand		Export Supply		Import Demand	
Price (PX/PW)	-0.891**	Price (PX/PD)	0.183***	Ln Price (PM/PW)	-0.477*
	(2.26)		(3.02)		(1.00)
World Income (W)	2.43***	Domestic Income(Y)	1.26***	Domestic Income (lnY)	1.33***
	(1.22)		(7.71)		(8.16)
Constant	6.14***	NEER	-0.195	Constant	-23.43***
	(8.34)		(1.29)		(4.59)
		Constant	-10.62**		
			(2.18)		
F statistics F(3,23)	3.85*	F statistics F(4,21)	5.63**	F-statistics F (3,23)	3.98*

Note: *** 1%, ** 5% and * 10% level of significance. Standard errors are reported in parenthesis.

4.20. Estimates of export demand and supply functions and import demand function for India are obtained using the following functional forms in this study. These are also functional forms used in IEG 2007 study.

Model 1

To estimate export demand and supply functions, the equations have been specified as:

$$XD_t = f(PX_t/PW_t, W_t)$$

$$XS_t = f(PX_t/PD_t, DD)$$

The above equations have been estimated independently by applying the Ordinary Least Squares (OLS) regression.

Model 2

Export demand is taken as a function of the relative price of exports, world income and lagged exports:

$$XD_t = f(PX_t/PW_t, W_t, XD_{t-1})$$

Where,

XD_t = total export volume of India in year t

PX_t = unit value index of exports in year t (Indian export prices)

PW_t = world price level in year t (represented by unit value index of exports of US in year t)

W_t = real world income in year t

Export supply is taken as a function of unit value of exports to the domestic price, domestic demand, trend and lagged exports:

$$XS_t = f(PX_t/PD_t, DD_t, X_{t-1})$$

Where,

XS_t = total export volume of India in year t

PX_t= unit value index of exports in year t

PD_t = domestic wholesale price index, which is multiplied by exchange rate

DD_t = domestic demand, which is measured by the change in the M3 to the GDP in year t

ED_t = domestic demand, which is measured as ratio of Gross Fiscal deficit to the GDP in year t

X_{t-1} = lagged effect of volume of the exports

Model 3

$$M = f(P^M, Y)$$

Where,

M = total import demand in India in year t

P^M = unit value of imports in year t

Y = real GDP income in year t

Tables 4.8 and 4.10 provide the estimates of these equations.

ARDL model and estimation of export and import functions

4.21. Even though the estimated equations of models presented in Tables 4.8 and 4.9 have a coefficient of appropriate signs, the Durbin-Watson (DW) test shows that the error term has a serial correlation. Also, before estimating the models, one should check the time series properties of the variables. If the variables in the model are non-stationary and become stationary only when their first difference is taken, this aspect needs to be taken into account in estimating the relationship among the variables. If this problem is ignored, one will get biased estimates. To correct for non-stationarity, the co-integration approach has been used, which gives the long run coefficients[29].

Table 4.8: New estimates of export demand and supply functions for India, 1991-2015

	Export demand			Export supply
	Model 1	**Model 2**		**Model 1**
Constant	-13.882	-59.66***	Constant	-7.484*
	(16.6)	(2.0)		(4.3)
$Price^D$	-0.397**	-0.5**	$Price^S$	3.063**
	(0.2)	(0.2)		(1.2)
lnW	0.867	3.75***	DD(-1)	0.132
	(1.0)	(0.1)		(0.2)
lnX(-1)	0.780**		lnED	-1.141**
	(0.3)			(0.4)

Note: *** 1%, ** 5% and * 10% level of significance. Standard errors are reported in parenthesis.

Table 4.9: New estimate of import demand function, 1991-2015

Import Demand (Dependent Variable ln M)	
Constant	-11.05***
	(1.28)
$Price^M$	-1.21***
	(0.13)
lnY	1.68***
	(.06)
R^2	0.9796

Note: *** 1%, ** 5% and * 10% level of significance. Standard errors are reported in parenthesis.

[29] PC (2007) for details

Table 4.10: Unit root test for variables of export demand and supply models

Variables	ADF in Levels		ADF in differences	
	With trend	Without trend	With trend	Without trend
LnXt	0.052	-2.398	-2.234	-1.481
LnYt	-1.73	0.89	-3.607	-3.358
Ln(PX/PD)t	-1.338	-0.71	-4.547	-3.064
LnWt	-2.23	-0.656	-4.135	-4.089
Ln(PX/PW)t	-1.989	0.089	-3.697	-3.104
LnMt	-0.69	-1.883	-1.869	-1.535
Ln(PM/PD)t	-2.197	-2.581	-4.218	-3.784

Critical clue values at 5% = -2.95(without trend) and critical values at 5% = -3.55 (with trend)

Table 4.11: ARDL estimates of export supply, export demand and import demand functions, 1991-2015

Export Demand		Export Supply		Import Demand	
Price (PX/PW)	-0.41*	Price (PX/PD)	1.13	Ln Price (PM/PD)	-1.28***
	(0.20)		(1.43)		(0.19)
World Income (W)	3.78***	DD	-0.17	Domestic Income (lnY)	1.64***
	(0.17)		(0.12)		(0.04)
Constant	-60.25***	Xdd	-2.17**	Constant	-10.02***
	(3.04)		(0.17)		(1.00)
		Constant	-4.34		
			(6.17)		
F statistics F(5,19)	193.67***	F statistics F(6,18)	1.99	F-statistics F (3,21)	378***

Note:*** at 1% level of significance, ** at 5% and * at 10% level of significance

4.6. Estimates of Shadow Exchange Rate

4.6.1. Methodology

4.22. Estimates of shadow exchange rate for India are obtained using two of the methods described in earlier chapters. One method used for estimation is the revealed preference method of estimating SER implicit in trade policies of Indian government described by equation 4.4 of Section 4.2. Another is equilibrium exchange method described in Section 4.4. Section 4.5 above provides the review of some of the earlier estimates demand and supply function of exports and imports for India including the estimates made in PC 2007. It also provides newly made estimates of these functions using the up to date data of trade statistics for India. These estimates

are reported in tables 4.8-4.11 in Section 4.5. Table 4.12 provides a summary of price elasticity estimates newly obtained in this study for India. In many studies which provide estimates of import demand and supply functions, it is assumed that the price elasticity of import supply is very high or infinity implying that the world's supply of imports to India is perfectly elastic which is also maintained in this study. The estimates of price elasticity of export demand and export supply and import demand based on the estimated ARDL model for India are found to be -1.28, 1.13 and -0.41 respectively. This study has adopted these for estimation SER for India.

Table 4.12: New estimates of price elasticity of export supply, export demand and import demand, 1991-2015

Function	Model 1	Model 2	ARDL
Import Demand	-	-1.21	-1.28
Export Supply	3.063	-	1.13
Export Demand	-0.397	-0.5	-0.41

4.6.2. Shadow Exchange Rate Using EER Method

4.23. The value of 'ψ' based on price elasticity estimates of ARDL model given in Table 4.12 is computed as 0.344. The estimates of social premium based on EER method are presented in Table 4.13 for some recent years.

Table 4.13: Estimates of SER for India based on equilibrium exchange rate method

Year	Market Exchange Rate	Shadow Exchange Rate	Social Premium
1991-92	24.47	41.19	1.68
2001-02	47.69	63.10	1.32
2011-12	47.92	51.83	1.08
2012-13	54.41	58.56	1.08
2013-14	60.50	65.31	1.08
2014-15	61.14	67.10	1.10
2015-16	65.47	71.52	1.09

4.24. Economic reforms including trade reforms gradually resulting in steeply falling trade taxes and restrictions and partially market determined exchange rate (with partial convertibility on capital account) since then have seen a steeply falling social

premium on foreign exchange. There has been a reduction in the premium from 68 per cent in 1991-92 to 32 per cent in 2001-02. Further reduction in trade restrictions in successive budgets of the Union Government has resulted in a drop in the social premium on foreign exchange to 8 to 10 per cent during the decade starting from 2011-12.

4.25. Equilibrium exchange rate method is more suitable for the Indian economy. The premium is based on the results of table 4.13. The reason why the year till 2013-14 has been considered for calculating the premium using commodity taxes is the availability of revenue figures, which were available till 2013-14 only.

4.6.3. Shadow Exchange Rate Implicit in Trade and Domestic Tax Policies of Government or Revealed Preferences of Government

4.26. Revealed preference method could be used to estimate SER implicit in domestic fiscal and trade policies of the government. There have been some studies (NEDA, 2000) trying to decompose the shadow exchange rate into three components: effect of direct trade taxes and subsidies, effect of unsustainable current account balance, and indirect effects of domestic tax policies on trade. A methodology described by the equation 4.4 in Section 4.2 could be used to consider the effects of trade taxes and subsidies in estimating SER.

Table 4.14: Estimates of SER for India based on the revealed preferences method, 1991-92 to 2015-16

Year	Market Exchange Rate	Shadow Exchange Rate	Social Premium
1991-92	24.47	30.58	1.25
2001-02	47.69	53.59	1.12
2011-12	47.92	49.86	1.04
2012-13	54.41	56.50	1.04
2013-14	60.50	62.72	1.04
2014-15	61.14	63.90	1.05
2015-16	65.47	68.28	1.04

4.27. Table 4.14 provides the estimates of SER using these methods for recent years while Table A4.6 provides the estimates for a longer period of 1991-92 to 2015-16. These estimates are lower than those based on equilibrium exchange rate method given in the previous sub- section. The social premium on foreign exchange has gone down

from 25 per cent in the pre-reform period to 4 per cent in the year 2015-16 as per this method.

4.7. Conclusion

4.28. Estimates of the shadow exchange rate for the Indian economy obtained for different years show that the gradual reduction of trade taxes due to economic reforms had the effect of reducing the difference between the market and shadow exchange has rates, as expected. The equilibrium exchange rate as a percentage of the market exchange rate has fallen from 1.68 to 1.08 during 1991-2015. The average rate of import tariff has fallen from 43 per cent to 7 per cent during the same period.

4.29. The methodology of revealed preference predicts a lower social premium of foreign exchange in comparison to the one based on equilibrium exchange rate method. The estimates based on this method show that there is a fall in the social premium of foreign exchange from 25 per cent to 4 per cent during the same period. However, the social premium on foreign exchange implicit in trade taxes and domestic commodity taxes is found to be 12 per cent during recent years.

4.30. This study recommends **8 per cent** social premium on foreign exchange for the public investment project appraisal in India. This estimate is based on the equilibrium exchange method that is recommended as a relevant methodology for estimate shadow exchange rate for India.

Appendix A4

Table A4.1: Trade statistics for India for the period of 1991-92 to 2015-16 (USD million)

Year	Exports			Imports			Trade Balance		
	Oil	Non-Oil	Total	Oil	Non-Oil	Total	Oil	Non-Oil	Total
1991-92	414.7	17450.7	17865.4	5324.8	14085.7	19410.5	-4910.1	3365.0	-1545.1
1992-93	476.2	18061.0	18537.2	6100.0	15781.6	21881.6	-5623.8	2279.4	-3344.4
1993-94	397.8	21840.5	22238.3	5753.5	17552.7	23306.2	-5355.7	4287.8	-1067.9
1994-95	416.9	25913.6	26330.5	5927.8	22726.5	28654.4	-5510.9	3187.1	-2323.8
1995-96	453.7	31341.2	31794.9	7525.8	29149.5	36675.3	-7072.0	2191.7	-4880.4
1996-97	481.8	32987.9	33469.7	10036.2	29096.2	39132.4	-9554.4	3891.7	-5662.7
1997-98	352.8	34653.7	35006.4	8164.0	33320.5	41484.5	-7811.2	1333.1	-6478.1
1998-99	89.4	33129.3	33218.7	6398.6	35990.1	42388.7	-6309.2	-2860.8	-9170.0
1999-00	38.9	36783.5	36822.4	12611.4	37059.3	49670.7	-12572.5	-275.8	-12848.3
2000-01	1869.7	42690.6	44560.3	15650.1	34886.4	50536.5	-13780.4	7804.2	-5976.2
2001-02	2119.1	41707.6	43826.7	14000.3	37413.0	51413.3	-11881.2	4294.6	-7586.6
2002-03	2576.5	50142.9	52719.4	17639.5	43772.6	61412.1	-15063.0	6370.3	-8692.7
2003-04	3568.4	60274.1	63842.6	20569.5	57579.6	78149.1	-17001.1	2694.5	-14306.5
2004-05	6989.3	76546.6	83535.9	29844.1	81673.3	111517.4	-22854.8	-5126.7	-27981.5
2005-06	11639.6	91450.9	103090.5	43963.1	105202.6	149165.7	-32323.5	-13751.7	-46075.2
2006-07	18634.6	107779.5	126414.1	56945.3	128790.0	185735.2	-38310.7	-21010.5	-59321.2
2007-08	28363.1	134541.1	162904.2	79644.5	171794.7	251439.2	-51281.4	-37253.6	-88535.0
2008-09	27547.0	157748.0	185295.0	93671.7	210024.6	303696.3	-66124.8	-52276.6	-118401.3
2009-10	28192.0	150559.5	178751.4	87135.9	201237.0	288372.9	-58943.9	-50677.5	-109621.4
2010-11	41480.0	209656.2	251136.2	105964.4	263804.7	369769.1	-64484.4	-54148.5	-118632.9
2011-12	56038.5	249925.3	305963.9	154967.6	334352.0	489319.5	-98929.0	-84426.6	-183355.7
2012-13	60865.1	239535.5	300400.7	164040.6	326696.1	490736.7	-103175.5	-87160.6	-190336.0
2013-14	63179.4	251236.3	314415.7	164770.3	285443.3	450213.7	-101591.0	-34207.0	-135798.0
2014-15	56794.1	253557.9	310352.0	138325.5	309707.9	448033.4	-81531.4	-56150.0	-137681.4
2015-16	30423.5	231580.2	262003.7	82879.9	297476.4	380356.3	-52456.4	-65896.2	-118352.6

Table A4.2: Market exchange rate, tariff rate, broad money and subsidies in India for the period of 1991-92 to 2015-16

Year	Wholesale Price index	NEER	Broad Money (M3)	Tariff	Subsidy	Exchange rate ($ per ruppee)	Total imports
1991-92	31.24	143.87	129546.8	0.43	0.04	24.47	19410.5
1992-93	34.38	119.07	118770.1	0.33	0.014	30.65	21881.6
1993-94	37.25	122.44	137438.9	0.26	0.01	31.37	23306.2
1994-95	41.94	121.11	168031.7	0.24	0.008	31.40	28654.4
1995-96	45.30	112.09	179131.4	0.24	0.003	33.45	36675.3
1996-97	47.38	109.31	196060.3	0.25	0.003	35.50	39132.4
1997-98	49.47	112.7	220997.3	0.21	0.003	37.16	41484.5
1998-99	52.41	109.04	233170	0.20	0.004	42.07	42388.7
1999-00	54.13	111.45	259428.6	0.20	0.003	43.33	49670.7
2000-01	58.00	112.8	287451.3	0.18	0.003	45.68	50536.5
2001-02	60.09	112.13	314169.9	0.22	0.003	47.69	51413.3
2002-03	62.14	109.12	354979.9	0.15	0.002	48.40	61412.1
2003-04	65.52	106.7	436471	0.13	0.002	45.95	78149.1
2004-05	69.77	106.91	499794.8	0.11	0.002	44.93	111517.4
2005-06	72.89	109.3	614248.5	0.08	0.002	44.27	149165.7
2006-07	77.69	104.37	730936.4	0.09	0.001	45.28	185735.2
2007-08	81.37	111.98	998448.1	0.09	0.001	40.24	251439.2
2008-09	87.92	99.79	1044227	0.08	0.002	45.92	303696.3
2009-10	91.27	97.22	1180925	0.06	0.002	47.44	288372.9
2010-11	100.00	100	1427512	0.08	0.001	45.56	369769.1
2011-12	108.94	93.41	1540982	0.06	0.001	47.92	489319.5
2012-13	116.95	83.73	1541966	0.06	0.001	54.41	490736.7
2013-14	123.91	77.31	1573072	0.06	0.001	60.50	450213.7
2014-15	126.43	79.19	1725474	0.07	0.001	61.14	448033.4
2015-16	123.29	79.91	1780145	0.07	0.001	65.47	380356.3

Table A4.3: Unit values of exports and imports for India and the World for the period 1991-92 to 2015-16 (US $)

	Unit value export index		Unit value import index	
Year	**India**	**United States**	**India**	**United States**
1991-92	61.08	78.17	86.62	74.21
1992-93	61.12	78.25	81.91	74.81
1993-94	58.35	78.69	68.37	74.64
1994-95	59.23	80.36	66.04	75.89
1995-96	56.06	84.41	69.01	79.32
1996-97	53.47	84.87	71.94	80.12
1997-98	60.93	83.72	70.97	78.15
1998-99	55.66	80.95	63.01	73.43
1999-00	52.66	79.93	66.64	74.07
2000-01	52.12	81.22	69.09	78.87
2001-02	49.17	80.53	66.61	76.08
2002-03	47.88	79.74	71.61	74.20
2003-04	54.16	81.00	74.59	76.39
2004-05	60.64	84.12	93.28	80.69
2005-06	67.93	86.80	85.59	86.75
2006-07	71.51	89.90	85.56	90.98
2007-08	82.32	94.28	95.57	94.81
2008-09	91.44	99.96	103.37	105.72
2009-10	83.03	95.35	83.58	93.57
2010-11	100.00	100.00	100.00	100.00
2011-12	117.75	108.05	171.36	110.90
2012-13	108.98	108.44	161.63	111.21
2013-14	109.18	107.99	166.34	109.99
2014-15	100.79	107.44	159.71	108.81
2015-16	118.90	100.64	151.94	97.74

Table A4.4: Estimates of SER using EER method, 1991-92 to 2015-16

Year	Tariff	MER	Export	Import	Trade balance	elasticity*trade balance	1/1-q	SER	Premium
1991-92	0.43	24.5	17865.4	19410.5	0.92	0.31	1.46	41.19	1.68
1992-93	0.33	30.7	18537.2	21881.6	0.85	0.29	1.41	45.75	1.49
1993-94	0.26	31.4	22238.3	23306.2	0.95	0.32	1.48	44.16	1.41
1994-95	0.24	31.4	26330.5	28654.4	0.92	0.31	1.45	42.93	1.37
1995-96	0.24	33.5	31794.9	36675.3	0.87	0.30	1.42	45.38	1.36
1996-97	0.25	35.5	33469.7	39132.4	0.86	0.29	1.41	48.63	1.37
1997-98	0.21	37.2	35006.4	41484.5	0.84	0.29	1.40	48.55	1.31
1998-99	0.2	42.1	33218.7	42388.7	0.78	0.27	1.36	53.94	1.28
1999-00	0.2	43.3	36822.4	49670.7	0.74	0.25	1.34	55.29	1.28
2000-01	0.18	45.7	44560.3	50536.5	0.88	0.30	1.43	57.87	1.27
2001-02	0.22	47.7	43826.7	51413.3	0.85	0.29	1.41	63.10	1.32
2002-03	0.15	48.4	52719.4	61412.1	0.86	0.29	1.41	59.02	1.22
2003-04	0.13	46.0	63842.6	78149.1	0.82	0.28	1.39	54.42	1.18
2004-05	0.11	44.9	83535.9	111517.4	0.75	0.26	1.34	52.00	1.16
2005-06	0.08	44.3	103090.5	149165.7	0.69	0.24	1.31	48.96	1.11
2006-07	0.09	45.3	126414.1	185735.2	0.68	0.23	1.30	50.66	1.12
2007-08	0.09	40.2	162904.2	251439.2	0.65	0.22	1.28	44.94	1.12
2008-09	0.08	45.9	185295	303696.3	0.61	0.21	1.26	50.60	1.10
2009-10	0.06	47.4	178751.4	288372.9	0.62	0.21	1.27	51.13	1.08
2010-11	0.08	45.6	251136.2	369769.1	0.68	0.23	1.30	50.40	1.11
2011-12	0.06	47.9	305963.9	489319.5	0.63	0.21	1.27	51.83	1.08
2012-13	0.06	54.4	300400.7	490736.7	0.61	0.21	1.26	58.56	1.08
2013-14	0.06	60.5	314415.7	450213.7	0.70	0.24	1.31	65.31	1.08
2014-15	0.07	61.1	310352	448033.4	0.69	0.24	1.31	67.10	1.10
2015-16	0.07	65.5	262003.7	380356.3	0.69	0.23	1.31	71.52	1.09

Table A4.5: Estimates of SER using revealed preferences method, 1991-92 to 2015-16

Year	Tariff	MER	1+T	Exports	Imports	Qm/Qx	Subsidy	1+k	ex(1+k)	SER	Premium
1991-92	0.43	24.47	1.43	17865.4	19410.5	1.09	0.040	1.040	1.248	30.58	1.25
1992-93	0.33	30.65	1.33	18537.2	21881.6	1.18	0.014	1.014	1.217	36.48	1.19
1993-94	0.26	31.37	1.26	22238.3	23306.2	1.05	0.010	1.010	1.212	35.82	1.14
1994-95	0.24	31.40	1.24	26330.5	28654.4	1.09	0.008	1.008	1.210	35.56	1.13
1995-96	0.24	33.45	1.24	31794.9	36675.3	1.15	0.003	1.003	1.204	37.92	1.13
1996-97	0.25	35.50	1.25	33469.7	39132.4	1.17	0.003	1.003	1.204	40.47	1.14
1997-98	0.21	37.16	1.21	35006.4	41484.5	1.19	0.003	1.003	1.204	41.57	1.12
1998-99	0.20	42.07	1.20	33218.7	42388.7	1.28	0.004	1.004	1.205	46.99	1.12
1999-00	0.20	43.33	1.20	36822.4	49670.7	1.35	0.003	1.003	1.204	48.50	1.12
2000-01	0.18	45.68	1.18	44560.3	50536.5	1.13	0.003	1.003	1.204	50.25	1.10
2001-02	0.22	47.69	1.22	43826.7	51413.3	1.17	0.003	1.003	1.204	53.59	1.12
2002-03	0.15	48.40	1.15	52719.4	61412.1	1.16	0.002	1.002	1.202	52.49	1.08
2003-04	0.13	45.95	1.13	63842.6	78149.1	1.22	0.002	1.002	1.202	49.37	1.07
2004-05	0.11	44.93	1.11	83535.9	111517.4	1.33	0.002	1.002	1.202	48.00	1.07
2005-06	0.08	44.27	1.08	103090.5	149165.7	1.45	0.002	1.002	1.202	46.46	1.05
2006-07	0.09	45.28	1.09	126414.1	185735.2	1.47	0.001	1.001	1.201	47.79	1.06
2007-08	0.09	40.24	1.09	162904.2	251439.2	1.54	0.001	1.001	1.201	42.51	1.06
2008-09	0.08	45.92	1.08	185295	303696.3	1.64	0.002	1.002	1.202	48.29	1.05
2009-10	0.06	47.44	1.06	178751.4	288372.9	1.61	0.002	1.002	1.202	49.31	1.04
2010-11	0.08	45.56	1.08	251136.2	369769.1	1.47	0.001	1.001	1.201	47.82	1.05
2011-12	0.06	47.92	1.06	305963.9	489319.5	1.60	0.001	1.001	1.201	49.86	1.04
2012-13	0.06	54.41	1.06	300400.7	490736.7	1.63	0.001	1.001	1.201	56.50	1.04
2013-14	0.06	60.50	1.06	314415.7	450213.7	1.43	0.001	1.001	1.201	62.72	1.04
2014-15	0.07	61.14	1.07	310352	448033.4	1.44	0.001	1.001	1.201	63.90	1.05
2015-16	0.07	65.47	1.07	262003.7	380356.3	1.45	0.001	1.001	1.201	68.28	1.04

Table A4.6: SER in India implicit in indirect taxes, 1991-92 to 2015-16

Year	Tax revenue in Rs. 10 Million					Total consumption at current prices in Rs. Billion				Total tax revenue/ Total consumption
	Union excise duties	Sales tax	Others	Custom revenue	Total tax revenue	Gross Fixed Capital Formation	Private Final Consumption Expenditure	Government Final Consumption Expenditure	Total Expenditure	
	1	2	3	4	5=1+2+3+4	6	7	8	9=6+7+8	10
1991-92	28110	21552	16693	22257	88612	1524.66	4577.35	784.58	6886.59	0.13
1992-93	30831	24031	18733	23776	97371	1779.29	5161.18	888.46	7828.93	0.12
1993-94	31697	28140	20747	22193	102777	1914.56	5913.08	1030.66	8858.3	0.12
1994-95	37347	33226	24635	26789	121997	2284.42	6871.54	1146.72	10302.68	0.12
1995-96	40187	35693	31539	35757	143176	2950.46	7920.15	1358.83	12229.44	0.12
1996-97	45008	42226	33160	42851	163245	3280.46	9286.29	1540.89	14107.64	0.12
1997-98	47962	45540	42242	40139	175883	3724.01	10185.59	1822.45	15732.05	0.11
1998-99	53246	49438	44886	40668	188238	4270.69	11663	2257.16	18190.85	0.1
1999-00	61902	57811	50093	48420	218226	4846.66	13125.37	2588.68	20560.71	0.11
2000-01	68526	72874	48918	47542	237860	4951.96	14066.61	2734	21752.57	0.11
2001-02	90157	77308	55791	40268	263524	5902.4	15316.72	2911.89	24131.01	0.11
2002-03	82310	83768	81251	44852	292181	6011.2	16202.93	3015.73	25229.86	0.12
2003-04	90774	98001	71732	48629	309136	6974.78	17713.05	3247.83	27935.66	0.11
2004-05	99125	116234	89452	57611	362422	9310.28	19175.08	3545.18	32030.54	0.11
2005-06	111226	136500	112861	65067	425654	11202.92	21527.02	4016.19	36746.13	0.12
2006-07	117613	162297	145744	86327	511981	13437.74	24766.67	4434.77	42639.18	0.12
2007-08	123611	167731	170136	104119	565597	16416.73	28407.27	5130.21	49954.21	0.11
2008-09	108613	189754	197735	99879	595981	18210.99	32492.84	6153.33	56857.16	0.1
2009-10	102991	231461	215926	83324	633702	20557.72	37075.66	7711.51	65344.89	0.1
2010-11	137701	293256	267105	135813	833875	24070.69	43603.23	8901.36	76575.28	0.11
2011-12	144901	361332	324988	149328	980549	28610.62	51418.97	10258.95	90288.54	0.11
2012-13	171315	429977	401597	186694	1189583	33214.13	56709.29	10613.6	100537.02	0.12
2013-14	196805	503653	484281	187308	1372047	35643.2	65079.32	11529.93	112252.45	0.12

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

5.1. The Project Appraisal and Management Division (PAMD) in NITI Aayog undertakes comprehensive appraisal of public funded schemes/projects costing more than Rs. 500 crore for consideration by the Expenditure Finance Committee (EFC) or Public Investment Board (PIB). For projects of commercial nature, financial and economic viability analysis is done by calculating internal rate of return (IRR), net present value (NPV), benefit-cost ratio etc. The main tool being used in computation of these viability ratios is discount rate/hurdle rate.

5.2. The Indian economy has undergone significant economic and structural transformation since the implementation of the economic reforms in early 1990s. In view of this it is felt desirable to re-assess the national parameters of project appraisal with respect to the following:

d) Shadow price/discount rate of investment for financial viability analysis

e) Social rate of discount for economic viability analysis

f) Shadow price of foreign exchange rate

5.3. This study provides revised estimates of these parameters for India taking in to account the changes that have taken place in Indian economy in recent years, and also by using methodological improvements in the estimation. The major conclusions emerging from the review and analysis are as follows:

5.1.1. Social Time Preference Rate

5.4. Rate of discount used in social cost benefit analysis could be estimated as either consumption rate of discount or as rate of return on investment in the economy. But these two rates could differ if capital market is imperfect and the level savings in the economy is not optimum. This could be a situation in an emerging economy like India and requires estimation of social time preference rate as subjective or consumption rate of discount.

5.5. The Ramsey rule is commonly used to estimate this rate. The generalized Ramsey rule accounts for three components of social time preference rate: impatience effect, wealth effect and the effect of uncertainty of future state of the economy. These three components are identified and estimated for the Indian economy.

5.6. The impatience effect or pure rate of time discount (p) is estimated by using SRS Life Table data as the probability of a representative individual in India not to survive a year after. Using 2010-11 SRS data it is estimated as 2.34 per cent for India. The wealth effect is estimated by using taxation information of Indian government that affects distribution of consumption over time. Information related to commodity and income tax policies and various growth scenarios is used for this purpose.

5.7. Two estimates of elasticity of social marginal utility (ν), the crucial parameter determining wealth effect, are made. One is based on the incidence of commodity taxes by NSS consumer expenditure classes and another on the incidence of income taxes by income groups of tax payers in India. These estimates for ν form a range of 0.91 to 1.50 for India. An estimate of ν for India is also obtained using Ramsey growth model. Even though the assumption of perfect capital market in this model could not be valid for Indian economy, it provides a comparable estimate of ν as 0.87. The rate of growth of real per capita income which is another important parameter determining wealth effect is considered to be in the range of 5.0 - 6.5 per cent.

5.8. Estimation of precautionary effect requires information about the probability distribution of future rate of growth in India as per the extended Ramsey formula. One way is to assume that the probability distribution of historical growth rates in India could be an indicator of uncertainty of future growth rate. The frequency distribution of last 60 years growth rates of real per capita net national income in India is found to have mean 3.1 per cent and standard deviation 3.3 per cent.

5.9. Considering the current scenario of 5 per cent growth rate of real per capita income for India, this study recommends an estimate of 8 per cent for the rate of discount to be used for investment project appraisal in India. Given other things, the rate of discount used for making investment decisions depends upon the prevailing rate of growth of income during the year of making investment decisions.

5.10. The precautionary effect on the rate of discount estimated with the assumption that rates of growth are uncorrelated over time is found to be lower as expected. In a scenario of having ν as 1.2 and a probability distribution of historical growth rates of per capita income in India with mean growth rate 2.81 per cent and Standard Deviation, the discount rate is estimated as 5.64 per cent. Gollier has recommended 6.61 per cent rate of discount for India after accounting for precautionary effect of uncertain growth rate. However, Gollier used an estimate of ν as 2 and the utility rate of discount as 0 for all the countries for which he has provided estimates of social time preference rates.

5.11. The case for having declining discount rates over time is considered for a probable scenario of uncertain future growth rates which may be correlated over time. The current higher rates of growth may be cause of future lower rates of growth because of constraints on natural resources, climate change problems etc. Therefore, there is uncertainty and correlation between growth rates over time resulting in a precautionary effect of declining discount rates over time. Some developed countries like France and UK use declining term structure of discount rates. Literature suggests that rates of discount should be lower for assessing the investment projects meant for climate change mitigation and environmental management projects which have very long run beneficial effects.

5.12. Weitzman has recommended 4 and 2 per cent rates of discount for evaluating respectively projects for immediate future and median future. Currently the Government of UK uses declining discount rates varying from 3.5 per cent to projects with less than 30 years life time to 1 per cent discount rate to projects with more than 300 years life time.

5.13. Given that wealth effect could be high in a developing country a discount rate of 8 per cent is recommended for all general economic projects for India. In the case of environmental management projects and some infrastructure projects where the benefits may accrue for more than 50 years, the recommended rate of discount is 6 per cent. In case of climate change mitigation projects, the benefits of which may span over 100 years, the recommended discount rate can be lower than 6 per cent.

5.14. A lower discount rate for environmental management projects and climate change mitigation project is justified because a) the expansion of these services is

slower than general economic activities and b) there is more uncertainty around evolution of environmental quality in future than the uncertainty around economic growth itself. Empirical estimates suggest that the ecological discount rate can be lower than 2 ± 0.9 per cent of the general discount rate.

5.1.2. Rate of Return on Investment and Shadow Price of Public Investment

5.15. There are two views in investment planning about the choice of social rate of discount, one suggesting social time preference rate, and another prescribing the rate of return on private investment. If there is a sub-optimal level of savings in the economy, these two rates differ with the social time preference rate being lower than the rate of return on investment. In this case if the investment in public sector projects is at the cost of private sector investment, there could a social premium on public sector investments. It implies that the social cost (shadow price) of a rupee investment in public sector is more than one rupee.

5.16. The estimate of rate of return on investment in the private sector of India is obtained as the marginal value productivity of capital in the private sector of India. The rate of return of capital at 2015-16 prices based on estimated production functions form a range of 9.7 to 11 per cent. Therefore, the rate of return of capital in the Indian economy is recommended as 10 per cent at 2015-16 prices.

5.17. We may note that for appraisal of projects which have an identifiable stream of financial returns, Government of India has advised the use of a hurdle rate of 10% for financial internal rate of return (FIRR).This study thus provides confirmation for continuation of this rate in project appraisal.

5.18. By adopting 30 per cent, 8 per cent and 10 per cent as estimates respectively of rate of savings of private sector, social time preference rate and rate of return on investment, the shadow price of investment is estimated at 1.40. Therefore, in this scenario there is social premium of 40 per cent on investment made in public sector projects in India. However, in the scenarios of 6 and 4 per cent social time preference rate (r), shadow price of investment is 2.33 and 7.00 respectively, given an estimate of Q as 0.30.

5.19. Shadow price of investment is highly sensitive to social time preference rate, r. In the case of social time preference rate falling from 8 per cent to 4 per cent, the

shadow price of investment has increased from 1.40 to 7.00. This is the likely scenario for the investment projects with long gestation period such as environmental management projects like river cleaning and climate change mitigation projects and the recommended rate of discount can be even lower.

5.20. Such projects with a recommended lower social discount rare for their economic evaluation, the social cost of initial investments are higher while the benefits in the distant future are also higher. For example, the climate change mitigation investment projects which normally having very long gestation periods and very low rates of discount for their evaluation will have very high initial social cost of investment and more than compensating very high future benefits.

5.21. The cut off financial rate of return on investment for the financial analysis of projects depends on the market rate of interest for the borrowing in the economy. Two approaches are considered for deciding on the financial cut off rate of return of the investment projects. The first approach is based on the concept of competitive interest rate in the market for which one may use prime lending rate by the commercial banks. The alternative approach is to consider the sources of government borrowings and ascertain the rate of interest government pays at margin.

5.22. On the basis of these two approaches, the financial cut-off rate of return for public sector investments is estimated as the maximum of interest rates paid by government for different sources of borrowing. The appropriate cut-off rate of return for the financial evaluation of investment projects is recommended as 10 per cent.

5.1.3. Shadow Exchange Rate

5.23. Shadow exchange rate is estimated using both equilibrium exchange rate and revealed preferences methods. The equilibrium exchange method captures the effects of reducing tariffs on the exchange rate after keeping the pre-reform trade balance and equilibrium of import demand and supply and export demand and supply. It is an appropriate method for estimating the shadow exchange rate for the Indian economy, which has adopted substantial trade liberalization and reforms.

5.24. Revealed preference method focuses on distortions introduced in the external trade sector by trade policies of government (import tariffs and export subsidies) and accounts for their effects on incremental changes in consumption and welfare. Apart

from trade taxes, domestic commodity taxes also can indirectly contribute to distortions in the trade sector. The difference between domestic market prices and world prices of tradable goods can be partly explained by the domestic commodity taxes. Therefore, a generalized revealed preference method has to account for the effects of trade taxes and domestic commodity taxes on the social premium of foreign exchange.

5.25. The methods of estimation of shadow exchange rate used in this study show that there could be a social premium on foreign exchange so long as there are positive trade taxes. Trade taxes can never be reduced to zero given that they are also revenue-raising instruments for the government.

5.26. Trade reforms should have the effect of reducing the social premium on foreign exchange in India. Estimates of the shadow exchange rate show that the gradual reduction of trade taxes due to economic reforms had the effect of reducing the difference between the market and shadow exchange has rates. The equilibrium exchange rate as a percentage of the market exchange rate has declined from 1.68 to 1.08 during 1991-2015. The average rate of import tariff has fallen from 43 to 7 per cent during the same period.

5.27. The methodology of revealed preference predicts a lower social premium of foreign exchange in comparison to the one based on equilibrium exchange rate method. The estimates based on this method show that there is a fall in the social premium of foreign exchange from 25 to 4 percent during the same period. However, the social premium on foreign exchange implicit in trade taxes and domestic commodity taxes is found to be 12 percent during recent years.

5.28. This study recommends 8 per cent social premium on foreign exchange for the public investment project appraisal in India. This estimate is based on the equilibrium exchange method that is recommended as a relevant methodology for estimate shadow exchange rate for India.

5.2. Main Recommendations

The main recommendations of the study are as follows:

Social Time Preference Rate

Recommendation 1: For general economic projects, the recommended rate of discount is **8 per cent**.

Recommendation 2: For environmental management and infrastructure projects with over 50-year life, the recommended discount rate is **6 per cent**. For climate change mitigation projects with benefits accruing over 100 years, the rate of discount can be lower than 6 per cent. A detailed empirical assessment, however, is desirable in the context of environmental and climate change projects.

Rate of Return on Investment and Shadow Price of Public Investment

Recommendation 3: The recommended rate of return estimated as marginal value productivity of capital in the private sector in the Indian economy as well as based on the prime lending rates of commercial banks and maximum of interest rates paid by government for different sources of borrowing is **10 per cent.**

Recommendation 4: We may note that for appraisal of projects which have an identifiable stream of financial returns, Government of India has advised the use of a hurdle rate of **10 per cent** for financial internal rate of return (FIRR). This study thus recommends continuation of this rate in project appraisal.

Shadow Exchange Rate

Recommendation 5: Based on the equilibrium exchange method, this study recommends **8 per cent** social premium on foreign exchange for the public investment project appraisal in India.

Appendix B

A Note on Using Social Time Preference Rate and Shadow Prices of Public Investment and Foreign Exchange in Benefit Cost Analysis

This note explains in a simple way how to use the estimated social time preference rate and shadow prices of investment and foreign exchange in social cost benefit cost analysis (SBA) of any investment project. This analysis requires first estimation of time flows benefits and costs at market prices during the life time of the project. Next decomposition of these flows is required by various resource and commodity categories to estimate the flows of social benefits and social costs using shadow prices. Calculation of net present social benefits (NPSB), benefit cost ratio {BCR) and internal rate of return of the project requires the use of social time preference rate.

Time Flows of Benefits and Costs of a Project at Market Prices:

Cost Flows (C_t)

- **Investment Cost (I_t)**
- Domestic Materials: (I_t^d)
- Foreign Exchange: (I_t^f)
- **Operation and Maintenance Cost (O_t)**
- Domestic Materials: (O_t^d)
- Foreign Exchange: (O_t^f)

Benefit Flows (B_t)

- Domestic Consumption Benefits: (B_t^c)
- Domestic Savings Benefits: (B_t^s)
- Foreign Exchange Benefits: (B_t^f)

All the flows explained above are measured at domestic market prices. Flows of foreign exchange costs and benefits represent value of foreign exchange at market exchange rate.

Net Benefits at Market Price (NB_t): $NB_t = B_t - C_t$

Time Flows of Benefits and Costs of a Project at Shadow Prices

$$SB_t = B_t^c + P_l \cdot B_t^s + P_f \cdot B_t^f$$

$$SC_t = P_l \cdot I_t + (P_f - 1)I_t^f + O_t + (P_f - 1)O_t^f$$

Where, P_I and P_f are shadow prices of investment and foreign exchange as estimated in this study.

$NSB_t = SB_t - SC_t$

Net Present Social Benefits (Ns with PSB) = $\sum NSB_t / (1+r)^t$

Benefit Cost Ratio = $\sum SB_t / (1+r)^t / \sum SC_t / (1+r)^t$

Internal Rate of Return (r^*): $\sum NSB_t / (1+r^*)^t = 0$

In the benefit-cost calculations described above, higher discount rate implies that the benefits of a project in the near future are priced very high in comparison with the benefits in the distant future. Higher discount rate makes benefits in the distant future very insignificant resulting in the choice of projects with short gestation period. In contrast lower discount rate makes the benefits the of a project in the distant future significant and as a result ensuing benefit cost calculations to suggest the choice of projects with long gestation period. The case for having declining discount rates as the gestation period of the project increase discussed in this chapter is meant for facilitating the choice of projects with long gestation period which are generally meant for climate change mitigation, environmental management and technological innovations.

The shadow price of investment is very sensitive to discount rate used in cost-benefit calculations as shown in this chapter. It increases as discount rate declines. As shown in this note that the higher the shadow price of investment the higher the social cost of initial capital invested for the project and also higher the social benefits from the reinvested benefits of the project in future. Therefore, the investment projects with long gestation period deserving lower discount rate in benefit-cost calculations will have high social cost of initial investment which could be more than compensated by the re investible benefits they generate in the very long run.

As explained above, there could be foreign exchange costs and foreign exchange benefits of an investment project. Foreign exchange cost could be a part of investment cost and a part of operation and maintenance cost. Foreign exchange benefits are from direct exports or import substitution due to the project.

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