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Assessment and Model of Green Jobs Potential in India

THE GREEN JOBS PROGRAMME

NCAER

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Assessment and Model of Green Jobs Potential in India

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Study Team

Project Leader

Anushree Sinha

Senior Consultant

A C Kulshreshtha

Core Research Team

Rajesh Jaiswal
Avantika
Prabhakar
Kalicharan Shukla
Yashpal

Technical Support

Poonam Dhawan

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Abbreviations

CIS *Change in Stocks*

CSO *Central Statistics Office*

DDP *Desert Development Programme*

DMRC *Delhi Metro Rail Corporation*

DPAP *Drought Prone Areas Programme*

EXP *Exports*

GDP *Gross Domestic Product*

GFCE *Government Final Consumption Expenditure*

GFCF *Gross Fixed Capital Formation*

GOI *Government of India*

GVA *Gross Value Added*

HFCE *Household Final Consumption Expenditures*

IMP *Imports*

IO *Input-Output*

IOT *Input-Output Table*

IOTT *Input-Output Transactions Table*

IWDP *Integrated Wasteland Development programme*

IWMP *Integrated Watershed Management Programme*

KMRC *Kolkata Metro Rail Corporation*

MW *Megawatt*

NAS *National Accounts Statistics*

NIC *National Industrial Classification*

NIT *Net Indirect Tax*

NSSO *National Sample Survey Office*

PFCE *Private Final Consumption Expenditure*

PS *Principal Status*

R&D *Research and Development*

RGI *Registrar General of India*

SNA *System of National Accounts*

SS *Subsidiary Status*

WPR *Work Participation Rate*

WTGs *Wind Turbine Generators*

Abstract

The key purpose of this study is to understand the prevalence of green jobs in India by developing a national-level green input-output (IO) table. Six sectors are specifically analysed: the four green sectors of forestry and logging, watershed development, wind energy, and metro transport services, and the two related sectors of wind turbine generator (WTG) manufacturing and rail transport services (other than metro). An IO table with the "new" green sectors is obtained through a hybrid method that uses various sources of data: primary-level data collected for the new green sectors, published and unpublished secondary data, and other information gathered from experts and specialists. This new IO table is used as the base table for developing a green-sector-aware IO model. The output and employment multipliers of the relevant sectors are obtained using the input-output model constructed by introducing the "new" green sectors (disaggregated from existing relevant 'mother' sectors of the national IO table). The model so developed is used to explore the issue of investment in green sectors and the resulting employment and growth effects. The study examines the employment generation potential of the green and related sectors, as well as the structure of such employment, in terms of shares of informal and formal employment and gender distribution.

1. Introduction

1.1 Background

The present concerns about climate change have resulted in the issue of "green growth" becoming increasingly integrated with the overall growth and development objective of the world economy. There is an urgent requirement to invest in a greener development path and consequently promote green jobs, especially in developing economies. According to the United Nations Environment Programme, green jobs (or green-collar jobs) are "work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute(s) substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution".

In developing economies like India, which largely depend on imported fossil fuels to meet energy requirements, industries will soon face mounting pressures to move towards less fossil-fuel intensive production processes through the development of energy-efficient technology and sustainable practices. Since the growth trajectories of such economies are heavily dependent on stable energy supply, this shift in the system will have major consequences for all other pillars of development, including employment, livelihoods and social progress. The promotion of green jobs tackles the twin problems of poverty and the adverse consequences of climate change and natural resource depletion. "Green jobs are diverse as they can be created in all sectors of economic activity, in urban and rural areas and all segments of the labour force. Therefore, promoting green jobs means addressing issues at different areas both nationally and internationally" (ILO 2011).

The Ministry of Labour and Employment, Government of India (GOI), has been leading a "Multi-stakeholder Taskforce on Climate Change and Green Jobs" since 2009. The core aim of this taskforce is to manage the labour-market elements of the nation's transition to a greener economy. This is of high importance. Accomplishing this will be a complex task since the Quick Estimates released by the Central Statistics Office (CSO) show only 4.5 per cent growth in Gross Domestic Product (GDP) at constant (2004-05) prices for the year 2012-13, against growth of 6.7 per cent in 2011-12. In light of this, the energy needs of industry and the household sector will grow each year. Thus, the transition to a greener economy has vast implications for green jobs.

Through the backward linkage of certain sectors with other sectors, the input-output analysis in the present study will assist in understanding the number of direct and indirect jobs involved in the different industrial activities. If a certain sector which is perceived to be green is promoted by way of investment, say, by the government, then not only will there be growth in output and employment in that particular sector, there will also be indirect effects on other linked

sectors. These will be key inputs for the sector which is receiving the investment. Also, due to the growth in output and employment caused by this investment, households will earn more and, as a result, demand more goods. This feedback is also captured in the IO analysis as the induced effect of households and will cause even more growth and employment in the focus sector and other linked sectors. The potential of green jobs is therefore immense.

1.2 Objective

Given this background, the major purpose of the present study is to develop a "green" input-output (IO) table for India for the year 2009-10, then use this table to develop the green sector IO model or multipliers. The focus is on sectoral job creation, which is estimated through the multiplier analysis. Six sectors are analysed in this study: the four green sectors of forestry and logging, watershed development, wind energy and metro services, and the two related sectors WTG manufacturing and rail transport services. As it is important to look at the major input sectors for these focus sectors, we have also included in the IO table such sectors as bricks and tiles as inputs to watershed development; iron and steel and rail and other transport equipment as inputs to metro and railways; and WTG manufacturing as an input sector to the wind energy sector. WTG manufacturing has been retained as a focus sector in this study, as a specialized sector catering exclusively to the wind energy generation sector. Job creation and growth potential for the open and closed IO models are estimated using output and employment multiplier analysis. These sectors have been included so that different impacts due to investment could be examined in terms of changes in output and employment. This analysis thus assists in determining the employment and growth effects of environment-related policies, especially those endorsing green sectors.

This report starts with 20 sectors from the all-India input-output table for the year 2009-10, to which we have added five of the six new focus sectors specifically developed for this study by disaggregating them from the existing all-India IO sectors specified by the Central Statistics Office (CSO), Government of India. Hence, the 'mother' table for this IO analysis is the latest national IO table for India developed by CSO for 2007-08, which includes 130 sectors. This all-India IO table has then been updated by the NCAER to 2009-10, maintaining consistency with the published estimates of sectoral gross value added, GDP and estimates of final expenditure for consumption, capital formation and net exports published by the CSO in its National Accounts Statistics (NAS) publication. The updated IO table for 2009-10 has been used for the analysis presented in this paper.

1.3 Sectors in focus

The sectors selected for analysis in this study are the following:

1. Forestry and logging
2. Watershed development
3. Wind energy
4. WTGs manufacturing
5. Metro transport services
6. Railway transport services

To aid understanding of these sectors in the Indian context, brief descriptions are given below.

1.3.1 Forestry and logging

The recorded forest area in India is 76.95 million hectares, which works out to around 23.41 per cent of the geographical area of the country (328.73 million hectares). Of the recorded forest area, 42.25 million hectares (54.91 per cent) are Reserved Forests, 21.40 million hectares (27.81 per cent) are Protected Forests, and 13.30 million hectares (17.28 per cent) are Unclassed Forests (SFR, 2011). The per-capita forest figure is 0.064 ha. Forest area refers to all lands recorded as forest in government records. Forest cover includes all lands with a tree canopy density of more than 10 per cent with a minimum areal extent of 1 hectare and includes all types of land, irrespective of ownership, land use and legal status (SFR, 2011). Forests in India cover 69.20 million hectares, which works out to 21.05 per cent of the total geographical area.

Forests contribute 1.7 per cent to India's GDP (FAO 2002). Forestry is a major environmental concern and provides livelihoods in many rural areas. Important forest products are: paper, plywood, timber, poles, pulp and matchwood, fuel wood, sal (an Indian tree which yields teak-like timber and dammar resin), seeds, tendu leaves (leaves of an Asian ebony tree, gathered in India as a cheap tobacco substitute), gums and resins, cane and rattan, bamboo, grass and fodder, drugs, spices and condiments. The paper industry uses over 3 million tonnes of wood pulp annually. India is also the largest consumer of fuel wood in the world. About 70 per cent of this fuel wood is consumed by households. Sale of non-timber forest products (NTFPs) such as latex, gums, resins, essential oils, flavours, fragrances and aroma chemicals, thatching materials and medicinal plants account for nearly 50 per cent of total revenue from the forestry and logging sector (FAO 2002). The forestry and logging sector exists as a separate sector in the national IO table. Primary surveys validate the existing coefficients for this sector and, in some cases, field coefficients have been used to make adjustments to the forestry and logging sector data in the national IO table. The activity or output of this sector is the revenue generated by sales of wood and non-timber products. The environmental aspects, such as conservation, cannot be measured within the scope of the current research and are therefore not shown in the IO table.

1.3.2 Watershed development

A watershed is an area from which water drains to a common point, making it an "attractive unit for technical efforts to manage water and soil resources for production and conservation" (John Kerr, 2002). These structures are mostly kutcha (non-concrete) constructions undertaken by users themselves, who are paid to carry out such work. If the task is not undertaken by users, a committee is formed at the local panchayat level to carry out the construction work. Watershed development is in fact a construction activity undertaken with the main objective of restoring the ecological balance by harnessing, conserving and developing degraded natural resources, such as soil, vegetative cover and water. The outcomes are prevention of soil erosion, regeneration of natural vegetation, rainwater harvesting and recharging of the ground water table. This enables multi-cropping and the introduction of diverse agro-based activities, which help to provide sustainable livelihoods for the people residing in the surrounding area. Since 2009, watershed development activity has been undertaken on behalf of the Department of Land Resources under the Integrated Watershed Management Programme (IWMP), which is a modified version of the erstwhile Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) of the Department of Land Resources. The programme is being implemented as per the Common Guidelines for Watershed Development Projects, 2008. It has a uniform pattern of funding, whereby a ratio of 90:10 between central government and states is maintained. The kind of construction activities undertaken under the programme (as funded projects, using the local labour of farmers and largely local materials such as stones, cement, boulders, etc.) are field bunds, farm ponds, boulder checks, rubble checks, waterways, diversion channels, ravine reclamation structures, gokatte (ponds), mini percolation tanks, check dams, percolation tanks, land reclamation structures, nala (waterway) revetments and nala bunds (waterway embankments). The programme also includes horticulture and forestry-related activities. Since the main activity in this sector is the construction of watershed structures, this sector had to be disaggregated from the construction sector of the all-India IO table.

1.3.3 Wind energy

Wind today competes as not only a cost-effective energy source but as a sustainable, environmentally friendly and long-term energy solution. The green wind energy sector is therefore treated as a separate sector in the present study. In the national IO table, wind energy is included in the electricity sector. India has the fifth largest installed wind power capacity in the world (WWEA 2009)[1]. In 2009-10, India's growth rate in wind power was higher

1 Expansion of the wind energy sector depends primarily on energy requirements, state government policies and initiatives, requisite wind speed, and corporate investment. India has a strong domestic manufacturing base and provides positive regulatory support. However, suitable measures for connectivity with the electricity grid need to be ensured. The major concern is in terms of seasonality. Wind energy production peaks during the monsoon season (because wind power density is at its peak then), when demand for energy is relatively lower. But the wind energy produced can neither be stored nor transmitted into the grid, since the grid already has the requisite capacity from conventional sources (and, for technical reasons, this conventionally generated electricity cannot be altered to accommodate absorption of wind energy). Due to this limitation, production of wind energy cannot be increased beyond a certain limit.

than that of the top four countries. According to the Ministry of New and Renewable Energy, Government of India, the country's total installed wind-energy capacity, as of 31 July 2013, was 19,661.15 MW. Wind power accounts for 8.5 per cent of India's total installed power capacity, and generates 1.6 per cent of the country's power. The main activity of the wind-energy sector is electricity generation and this sector had to be disaggregated from the electricity sector in the national IO table.

1.3.4 Wind turbine generator manufacturing

The WTG sector provides the machinery and equipment for generating wind energy. Wind energy is generated when WTGs are in operation. As with any other manufacturing sector, there is a cost to the environment in producing WTGs, as the production process requires a substantial array of raw material and energy inputs[2]. A WTG unit has three basic components: the generator, the rotor blades, and the tower, which are manufactured at a manufacturing plant and assembled at the wind-farm site. The manufactured components require inputs of steel, rubber, etc. As the rotor blades move with the wind flow, electricity is produced in the generator and transmitted down via the tower to the transmission lines. As the WTG sector is basically a manufacturing sector, it has been disaggregated from the "Other manufacturing" sector of the all-India IO table. WTGs are used by the wind energy sector to produce wind energy, as explained above, which is a major green sector of the economy.

1.3.5 Metro rail services

The first "rapid transit" system in India was the Kolkata Metro. The Delhi Metro was the first modern metro system, with approximately 190 km of lines. Currently, three major cities have metro rail services: Delhi, Kolkata and Bangalore. Meanwhile, metro rail systems are under construction in Mumbai, Jaipur, Hyderabad and Chennai, and more are planned. The development of metro lines in India is governed by the Metro Railways (Construction of Works) Act, 1978. Since the main activity of metro rail systems is to provide rail transport services, this sector will be disaggregated from the "rail transport" sector.

2 To understand whether the environmental impact of manufacturing the components of WTGs is overridden by the use of WTGs over their lifespan, all WTG manufacturers should be encouraged to undertake a life-cycle assessment of their turbines. A life-cycle assessment is both a mapping and an evaluation of the potential impact of the wind turbine on the external environment throughout its lifespan, i.e. the operation and maintenance throughout the 20-year design lifetime of the wind turbine, as well as its disposal. The long term impact of a WTG is better than its impact in the short term. A study by the global wind company, Vestas Wind Systems states... "If installed on a good site, the V90-3.0 MW wind turbine will generate approximately 280,000 MWh in 20 years - thus sparing the environment the impact of a net volume of approximately 230,000 tons of CO2, as compared to the figures for energy generated by a coal-fired power station." So, the long-term impact of such processes is important, and short-term assessments would not capture such aspects.

1.3.6 Railway transport services (except metro)

Founded 160 years ago on April 16 1853, Indian Railways is now one of the world's largest rail networks, comprising around 115,000 kilometres of track and 7,500 stations. The first train ran from Bombay to Thane in 1853. In 2011-12, Indian Railways earned revenues of approximately 1,060 million Indian rupees (INR 1,060 million). It is a state-owned enterprise under the Ministry of Railways and is the world's ninth largest commercial or utility employer by number of employees, with a workforce of over 1.4 million. The services the railways provide include passenger transport, freight services, parcel carriage and catering. In August 2013, Indian Railways entered into a partnership with the Indian Institute of Technology (Madras) to develop technology to tap solar energy for the lighting and air-conditioning of its coaches. The railways sector is already treated independently in the national IO table for India. The metro transport sector need to be disaggregated from this sector.

1.4 Use of input-output models

There are many methods for estimating economic multipliers in order to measure impacts. The generally preferred technique is the IO model (provided that sufficient resources are available). This is the approach used to estimate output and employment multipliers in this study. We have tried to gauge the quantum of green jobs that can be generated by the key study sectors. The employment multiplier analysis is therefore very significant. An IO table is a detailed depiction of sales and purchases of goods and services among producers and final users, as well as income generated for owners of resources, in an economy over a specific time period (usually, a year). The IO model, which is derived from the IO table, has an accounting framework in which the total receipts of sellers must balance the total expenditures of buyers. Since the IO model is based on technology coefficients, it is a viable technique for carrying out simulations and for forecasting output and employment impacts over a short time period (up to five years). This is because production technology does not change significantly over short time periods. Moreover, this approach facilitates the analysis of the impacts of policy changes on a large number of sectors of the economy, and the impact of external shocks on individual sectors. This is done through multiplier analyses.

2. Input-output models

2.1 Background

The input-output model was developed by W. Leontief, who derived it from a system of equations expressing the equivalence relationships in the supply and use of goods and services in an economy in a state of general equilibrium, assuming homogeneity (constant technology), proportionality and additivity in the production process of various products. If X_{ij} is the output of the i^{th} product used as an input in the j^{th} industry, and X_i and F_i are the total output and final use (sum of final consumption expenditure, gross capital formation and net exports) of the i^{th} product respectively, the input-output system as a set of "n" balance equations is:

$$Xi_1 + Xi_2 + \ldots\ldots + X_{ij} + \ldots + X_{in} + F_i = X_i \quad , \qquad i = 1, 2, \ldots, n$$

For a given final demand (F), assuming constant technology, the unknowns in the equations can be reduced to just n and the model can be formulated using n sectors. Thus, if $a_{ij} = X_{ij} / X_j$ is the input-output coefficient representing the output of sector "i" absorbed by sector "j" per unit of output of sector "j", and assuming it to be constant, we get

$$X_i = \sum_{j=1}^{n} X_{ij} + F_i = \sum_{j=1}^{n} a_{ij} X j + F_i, \quad (1< i <n)$$

These equations can conveniently be written in matrix notation as:

$$X = AX + F,$$

or

$$(I-A) X = F$$

to obtain the Leontief input-output open model as

$$X = (I-A)^{-1} F$$

where A is the matrix of input-output coefficients and I the identity matrix (for details of the building of IO models, see Appendix I).

The IO model is derived from the IO table. IO tables are developed by the national statistical offices of various countries. These tables show inter-sectoral relationships across a number of industry sectors covering the entire economy (in India, for example, IO sectors are aggregates of a number of industries, coded according to a five-digit National Industrial Classification which includes various agricultural producers, to form 130 homogenous industry groups).

2.2 Multiplier analysis

Multiplier analyses are carried out using both the open and closed input-output models. The concept of a multiplier is that it measures the difference between the initial effect of exogenous (final demand) changes in any sector and the economy-wide effects of that change. The economy-wide or total effect of the open input-output model is due to direct and indirect effects (i.e. those transmitted from one sector to others through elements in the Leontief inverse matrix, which is open with respect to household consumption). In the case of the closed model, direct, indirect and induced effects (through elements of an augmented Leontief inverse matrix, which is closed with respect to household consumption) are taken into account. Multipliers therefore measure the impact of any change in final demand originating from a sector of the economy over short periods of time using the input-output models. When IO models are used to trace the outcome of such changes, they are also called impact models or multiplier models. It is important to understand the analysis behind these models, which is based on three major tables: the transactions table, the direct requirements table and the total requirements table.

A transactions table shows the monetary flows of goods and services in a local economy and represents monetary flows for a given time period, usually one year. Transactions table flows depict the total outlay, which is equal to total output. Intermediate purchases are goods and services purchased and used in the national production process. Final demands are purchases made for final consumption, and final payments are payments for factors or primary inputs outside the intermediate production process. The following table shows the basic sectors of the Indian economy for 2009-10. The column of a specific sector depicts the monetary values of the inputs required to produce the final output of the sector. The cell formed by the first row and first column shows that INR 2,579 billion worth of agricultural output is returned to the agriculture sector itself. To take another example, the cell formed by the fifth row and first column shows that INR 1,357 billion worth of output from the services sector is inputted into the agriculture sector. The row shows the uses made of the output of the specific sector. Apart from intermediate uses, INR 7,303 billion worth of agricultural output is demanded for consumption by households (first row). The sum of the values in the row will match the sum of the values in the column for each sector.

Table 1: Transactions table for India, 2009-10

(Rs. Billion)

Sector		1	2	3	4	5	Household Consumption	Other Final Demand	Total Output
1	Agriculture and Allied Activities	2579	0	3244	560	1605	7303	373	15665
2	Mining	0	15	6257	236	354	16	-4755	2123
3	Manufacturing	1018	219	16625	4160	4988	9871	7992	44873
4	Construction	83	37	377	1540	645	60	12162	14903
5	Services	1357	230	8384	2612	7531	19519	11152	50785
	Gross Value Added + NIT	10628	1623	9985	5795	35662	311	1108	65113
	Gross Output	15665	2123	44873	14903	50785	37080	28032	193462

The direct requirements table traces purchases of resources (inputs) by a sector from all sectors in order to produce 1 rupee's worth of output and thereby creates a production procedure.

Table 2: "A" matrix: Direct requirements table (coefficient matrix) for India, 2009-10

(Rs. Billion)

Sector		1	2	3	4	5
1	Agriculture and Allied Activities	0.1646	0.0000	0.0723	0.0376	0.0316
2	Mining	0.0000	0.0071	0.1394	0.0158	0.0070
3	Manufacturing	0.0650	0.1029	0.3705	0.2791	0.0982
4	Construction	0.0053	0.0173	0.0084	0.1033	0.0127
5	Services	0.0866	0.1082	0.1868	0.1753	0.1483
	Gross Value Added + NIT	0.6785	0.7644	0.2225	0.3889	0.7022
	Gross Output	1.0000	1.0000	1.0000	1.0000	1.0000

The values in the above table are obtained by dividing each corresponding cell in Table 1 by its column total, i.e. the gross output. So, in order to produce one unit of agricultural output, 0.1646 units of agricultural sector output are needed as an input.

Before we describe the total requirements table, some mention of multipliers is needed. Multipliers measure total change throughout the economy resulting from a unit change in a given sector. Two types of multipliers are generally used: open (Type I) and closed (Type II). An open multiplier is the outcome of direct or initial spending and indirect spending due to intermediate buying and selling. A multiplier of this kind is obtained by dividing the sum of the direct and indirect effects by the direct effect. Open multipliers are derived from the total requirements table. In algebraic form this is $X = (1-A)^{-1} Y$, where X is the total output vector, $(1-A)^{-1}$ is the inverse matrix of the total requirements table and Y is the total final demand vector of the economy (please refer to Appendix I for details of IO tables). The table below shows that for a 1-rupee rise in final demand in the agricultural sector, the total direct and indirect effect on the economy is INR 1.578, meaning that the total output of the economy would increase by an amount of INR 1.58.

Table 3: Total requirements table (inverse matrix) for India, 2009-10

(Rs. Billion)

Sector		1	2	3	4	5
1	Agriculture and Allied Activities	1.218	0.027	0.167	0.116	0.066
2	Mining	0.024	1.039	0.246	0.104	0.039
3	Manufacturing	0.160	0.213	1.726	0.590	0.216
4	Construction	0.011	0.025	0.028	1.129	0.021
5	Services	0.164	0.186	0.433	0.387	1.237
	Gross Value Added + NIT	1.578	1.489	2.599	2.326	1.579
	Gross Output	1.0000	1.0000	1.0000	1.0000	1.0000

The closed multiplier includes open multiplier effects and, in addition, takes into account household spending based on income earned which is called indirect effects, i.e. induced effects. The coefficients of household spending are obtained by dividing household final consumption expenditure by total final demand or GDP.

Table 4: "B" matrix: Augmented coefficient matrix (households included) for India, 2009-10

(Rs. Billion)

Sector		1	2	3	4	5	6 (PFCE/ GVA)
1	Agriculture and Allied Activities	0.165	0.000	0.072	0.038	0.032	0.112
2	Mining	0.000	0.007	0.139	0.016	0.007	0.000
3	Manufacturing	0.065	0.103	0.370	0.279	0.098	0.152
4	Construction	0.005	0.017	0.008	0.103	0.013	0.001
5	Services	0.087	0.108	0.187	0.175	0.148	0.300
	Gross Value Added + NIT	0.678	0.764	0.223	0.389	0.702	
	Gross Output	1.000	1.000	1.000	1.000	1.000	0.569

Including households as a sector within the A matrix augments it to form a B matrix (see Table 4). This includes a row vector of value added to output ratio and a column vector of private final consumption to total value added ratio. This means that the exogenous final demand vectors does not include private final consumption expenditure, as it has been endogenized. However, most of the instruments that would shock the economy remain exogenous to the study, as we calculate two kinds of multipliers, i.e. the output and the employment multipliers using both open and closed models.

2.2.1 Output multiplier

The output multiplier for a sector, say manufacturing, is defined as the total value of production by all sectors of the economy required to satisfy one extra rupee's worth of final demand for that sector's output. On top of this, inputs from other sectors, such as mining and services, are required, as well as inputs from the manufacturing sector itself. The demand for the extra rupee's worth of manufacturing output is regarded as having caused the production of these additional outputs. The manufacturing sector is said to have "backwards linkages" to the sectors supplying inputs and "forward linkages" to sectors to which this sector supplies its output and intermediate goods and services.

In calculating the simple (open) multipliers, we effectively assume that household spending takes place outside the model and there is no feedback interconnecting the household sector and other sectors. This is calculated by using an open model. However, in calculating the total (closed) multipliers, we do take into account feedback from household demand, and the model is said to be closed with respect to household consumption. The total requirements table above (Table 3) gives the output multipliers as the column sums of $(I- A)^{-1}$. The output multiplier for agriculture is 1.578 (as mentioned earlier), for the mining sector 1.489, for the manufacturing sector 2.599, and so on. So, if the expected increase in final demand is INR 1 for the agricultural sector, the total effects from this requirement of an additional INR 1's worth of agricultural output is INR 1.578 worth of total output for the entire economy.

2.2.2 Employment multiplier

When dealing with employment, we treat units somewhat differently. We denominate the ratio in employees per INR 100 thousand of output to keep the numbers reasonable. Total employment multipliers for an industry are computed by multiplying the row vector of direct employment multipliers (which are the employment/output ratios) by the appropriate column vector in the inverse matrix (total requirements table). This multiplier provides an estimate of the direct and indirect employment changes resulting from the change in output per INR 100 thousand. The employment per unit output of a sector is called the employment coefficient of the sector. This coefficient for the i^{th} sector measures the direct employment effect of a unit increase in final demand in sector "i". The direct and indirect employment change per INR 1 change in final demand in sector "i" is estimated by multiplying each figure of the i^{th} row of the inverse matrix by the employment coefficients and then summing the product. To understand direct employment and total employment needs arising from a sector's production, we provide the employment coefficients and multipliers for all major sectors in Table 5 below:

Table 5: Employment coefficients and employment multipliers for main sectors in India, 2009-10

Sector	Employment coefficient	Employment multiplier
Agriculture and Allied Activities	2.389	2.998
Mining	0.207	0.385
Manufacturing	0.164	0.883
Construction	0.491	1.073
Services	0.316	0.603

A coefficient of 2.389 for the agricultural sector means that employment of 2.389 person-years3[3] is generated in this sector in order to produce INR 100 thousand of this sector's output. Furthermore, 2.998 person-years of employment are generated by an increase in final demand for the agricultural sector's products, taking into account both the direct and the indirect effects. Similarly, a coefficient of 0.164 for the manufacturing sector means that employment of 0.164 person-years is generated in this sector in order to produce INR 100 thousand of this sector's output. Furthermore, 0.883 person-years of employment are generated by an increase in final demand for the products of the manufacturing sector, taking into account both the direct and the indirect effects.

3 Work carried out by one person in one year consisting of a standard number of person-days.

3. Methodology and data sources

3.1 Indian input-output (IO) table

The Central Statistics Office (CSO) prepares an IO table every five years. This practice was started in the year 1968-69, when the first national input-output transaction table (IOTT) for India was prepared jointly by the Planning Commission and the CSO. It was published in the "National Accounts Statistics (NAS), 1978" and adopted a 60-sector classification. The latest national IO table, for 2007-08, adopts a 130-sector classification, as did the table for 2003-04. The first 37 sectors represent primary production, the next 68 manufacturing sectors, and the remaining 25 sectors tertiary activities. The final uses are distinguished under six categories: (i) private final consumption expenditure (PFCE), (ii) government final consumption expenditure (GFCE), (iii) gross fixed capital formation (GFCF), (iv) change in stocks (CIS), (v) exports of goods and services (EXP) and (vi) imports of goods and services (IMP), which is taken as a negative entry in the final uses.

3.2 Aggregation of national level IO table

In the 130-sector classification adopted for the national Input-Output Table (IOT) constructed by the CSO, the critical sectors identified were those that are important for the purpose of the present study, i.e. sectors that supply critical inputs to the key "green" sectors (e.g. cement, iron and steel, bricks and tiles, petroleum products). we devised a 16-sector classification To have the above-identified products and related services as individual sectors, while aggregating the remaining sectors into 'other manufacturing products' and 'other services',. We therefore needed a national-level aggregated IO table with a 16-sector classification for the year 2009-10, the year chosen for the study. The sixteen sectors are: (i) Agriculture and allied activities (except forestry), (ii) forestry and logging, (iii) Mining, (iv) Petroleum products, (v) Bricks and tiles, (vi) Cement, (vii) Non-metallic mineral products, (viii) Iron and steel, (ix) Rail and other (metro) equipment, (x) Other manufacturing, (xi) Construction, (xii) Electricity, (xiii) Rail transport services, (xiv) Other transport services, (xv) Other services, (xvi) Public administration and defence. The mapping of the 130 national IO sectors to these 16 sectors is shown in Table 6.

Table 6: Mapping of the 130 sectors of the national IO table to 16 sectors

S. No.	National IO sector codes	National IO sector
1	1-24, 26	Agriculture and allied activities (except forestry)
2	25	Forestry and logging
3	27-37	Mining
4	63	Petroleum products
5	74	Bricks and tiles (structural clay products)
6	75	Cement
7	76	Non-metallic mineral products
8	77-78	Iron & steel (Ferro alloys and casting & forging)
9	96, 100	Rail and other transport equipment
10	38-62, 64-73, 79-95, 97-99, 101-105	Other manufacturing
11	106	Construction
12	107	Electricity
13	109	Rail transport services
14	110-113	Other transport services
15	108, 114-129	Other services
16	130	Public administration and defence

As mentioned above, the latest IO table for India is for the year 2007-08. The NCAER updated this table to the year 2009-10, and it is this table that is used for our study. Actual information for the year 2009-10 in respect of private final consumption expenditure, government final consumption expenditure, gross fixed capital formation, exports and imports, and GVA (Gross Value Added) was used and kept consistent with that published at aggregated level in the National Accounts Statistics, 2012. Technology coefficients were assumed to have remained constant between 2007-08 and 2009-10. For the purpose of IO modelling, the commodity x commodity matrix is also required, and it is this matrix (at factor cost, using the industry technology assumption) that has been used to evaluate the findings of the study. The 2009-10 flow table (transactions table) with 20 sectors (16 with four new disaggregated sectors) is given in Appendix II.

3.3 Secondary data

The secondary data used for this study are elaborated below:

3.3.1 All-India Input-Output Table for 2007-08 (CSO)

This table was further updated to 2009-10 for the purpose of this study.

3.3.2 The 2009-10 Employment-Unemployment Survey published by the National Sample Survey Organization

This data was used to estimate employment shares by sector of the economy by type (formal, informal) and gender.

3.3.3 Population projections from the Registrar General of India to estimate the size of the workforce

Profit and Loss statements from the annual reports of the Delhi Metro Rail Corporation (DMRC), the Kolkata Metro Rail Corporation (KMRC) and various other companies to obtain input structures for certain sectors.

3.4 Primary surveys for the new sectors

This section explains the scope and method of the field observations undertaken by NCAER's trained field consultants, who are especially trained for key observation and data- gathering at various levels. They include government officials from various departments/ministries, forest rangers, wind-energy developers, farmers, enterprises and contractors. Separate structured proformas were prepared for forest rangers (for the forestry and logging sector), wind-energy developers and turbine manufacturers (for the wind energy sector), metro rail corporations and metro contractors (for the metro rail sector) and watershed contractors and farmers (for the watershed development sector). For the railways sector, secondary data was used.

In addition, a list of relevant issues was prepared for semi-structured interviews with state government officials, including policy-makers. The trained field consultants personally visited selected government departments with a specific focus on the green sectors chosen for analysis in this study. In order to cross-check the data/information, various sources were consulted, as and when necessary. Subsequently, if necessary, specific indicators were verified over the telephone with the offices concerned.

3.4.1 Sample design and coverage

In order to gather data on the selected sectors, and to gauge their input costs, outputs, employment, and sectoral contributions, the NCAER, in consultation with the International Labour Organization, decided to undertake surveys in eleven representative states of India, including New Delhi. Table 7 below shows the sectors surveyed in specific states:

Table 7: Geographic coverage of primary surveys by sector

S. No.	Sector	State
1	Forestry and logging	Madhya Pradesh, Assam, Meghalaya, Tripura, Arunachal Pradesh
2	Watershed development	Andhra Pradesh, Karnataka
3	Wind energy and wind turbine generator manufacturing	Gujarat, Maharashtra
4	Metro transport services	NCR Delhi, Kolkata (West Bengal)
5	Rail transport services (except metro)	All-India (secondary data only)

For the surveys of the forestry and logging sector, questionnaires were prepared for state government officials of the forestry departments concerned. Four forest rangers from each state also completed the questionnaires. For the watershed development sector, the stakeholders interviewed included state government officials from the relevant watershed development departments, local contractors for watershed structures and 32 farmers of various strata from each state. Stakeholders interviewed for the wind energy sector were wind energy department officials from the respective states, as well as four wind energy developers and three turbine manufacturers from each state. Lastly, for the metro rail sector, metro rail corporation officials were interviewed along with metro rail contractors. Appendix III gives details of the data gathered by sector and the reconciliation of this data with secondary data to determine input structures.

The questionnaires were designed to cover a vast range of issues directly and indirectly linked with our major data needs. We also collected substantial amounts of data on peripheral aspects of a sector's production process so to check the reliability of the data concerned. It is obvious that we were dealing with very technical matters, and we needed to obtain information from our respondents to work out the necessary technical coefficients. No entity that we surveyed could provide us with the coefficients in the manner we use in an IO table. Hence, all the data gathered had to be validated and scrutinized to gauge its usability in the modelling framework. As described in Appendix III, relevant data were extracted and used to build technical coefficients, while other data helped us to gain insights into the sectors on which we were focusing. For this study, all the stakeholders in each sector were interviewed individually. Data gathered from wind developers validated insights gained from interviews with officials from the state wind energy departments. Data from metro construction contractors converged with the data from the DMRC and the KMRC. Finally, we discussed certain issues with various officials and experts. The forestry and logging sector is already present in the existing IO table for India, but the insights we gained through this survey were very useful. Furthermore, it is important to be aware of the livelihood aspect of forestry and logging. This work is an exercise in itself. Appendix IX provides some explanatory notes on the complexities of the forestry sector.

3.5 Developing the study sectors

3.5.1 Forestry and logging

The surveys conducted for the forestry and logging sector provided information on the major inputs used by this sector. This sector is treated separately, even within the national IO table provided by the CSO. However, the field survey data covered major inputs such as agriculture, manufacturing industries, electricity, petroleum, services, etc. and was then aggregated with the IO input sectors. This provided us with a clearer insight, and so we used the coefficients derived from the field surveys (Appendix III). These coefficients were then calibrated to the national level. The sectors for which we used field data were manufacturing, petroleum and the forestry and logging sector. We used the national coefficients for sectors such as agriculture, electricity and services, as the field data on these sectors were driven by the development of particular states and hence were not considered an accurate representation of the all-India situation.

3.5.2 Watershed development

Since watershed development is a construction activity undertaken under approved projects that are fully funded by the government (central government and states in a 90:10 ratio), its output was obtained by the input-cost method, which includes both labour and materials. The total funding provided by central government to states in 2009-10 is readily available on the website of the Department of Land Resources and was taken as the output of the activity during this period (Appendix III). Since the central government share is 90 per cent of the total, the state share can be easily calculated. We thus arrived at the total output of government-funded watershed development activity.

State funding is used mainly for the repair and maintenance of existing watershed structures and this fact was used to establish the state-share figure as representing the state-share component of watershed activity. In the IO table, this figure appears in the watershed construction row under the "Government final consumption expenditure" column heading. The central government share is shown under "Gross fixed capital formation" in the watershed development row, as this share is spent on new construction projects. It should also be mentioned that, over and above the government-funded projects, farmers also undertake watershed development activity (typically, bund-making) on their farms on their own account ("own account construction"). To estimate this own-account activity (which is purely labour, without any material inputs), farmers in the field study were asked a question relating to the number of days they spent in bund making. From the information gathered, we estimated that 5.3 per cent of man-days in farming are devoted to this own-account construction activity.

As per the 2008 SNA recommendations, this own account construction in agriculture is to be imputed and added to the output of agriculture as construction output. However, since we were using the pure product-by-product IO matrix, the above "own account construction" estimated by imputation was transferred to the construction sector and added to the existing total construction output. Since watershed development is a construction activity, its output, estimated as explained above (without the own account construction), was subtracted from the total output of the construction sector in the original IO table. The remaining output was taken as output of "Other construction" (construction other than watershed activity).

Regarding the input structure of watershed development, we have already noted that this is a labour-intense activity. During field visits, officials with expertise in the implementation of the IWMP programmes informed about the share of labour and materials for different kinds of activities. Data were also gathered on the kinds of inputs, other than labour, that were required to build the structures concerned. Information on expenditure by kind of watershed development construction is also available on the website of the Department of Land Resources, and this information, along with the information on shares of labour and materials as collected by the research team was used to obtain the primary inputs and shares of labour and materials relating to watershed development construction in the year 2009-10 (Appendix III).

3.5.3 Wind turbine generator manufacturing and wind energy sector

There are two important activities associated with wind energy generation. The first is the production of WTGs, which come under machinery manufacturing in the standard economic classification used in the IO tables. The second is the operation of wind turbines, which is considered here as the "wind energy sector" (geared to electricity generation). For the purpose of this study, we have disaggregated two sectors from the aggregated national IO table: "wind energy", from the electricity sector (leaving "electricity other than wind energy" as the residual sector); and "WTG manufacturing", from the manufacturing sector (leaving "Other manufacturing" as the residual sector).

The output of the wind energy sector has been estimated as the product of the quantity of wind energy produced in 2009-10 and its average price. Data on the wind energy produced and the prices charged were obtained from the Department of Renewable Energy. This data was cross-checked with the available information on the capacity of the wind energy providers, since generally 20 per cent of capacity is the production of energy in real time. The output of the WTG manufacturing sector has been estimated as the product of the total number of WTGs produced (in terms of megawatts) and the cost of producing one megawatt of WTG energy (obtained from the Indian Wind Turbine Manufacturer's Association, Chennai).

Wind turbines are operated only when a clear demand exists, and when the wind quality, its moisture component, etc., is suitable. This is why only 20 per cent of wind-turbine capacity

is used for the production of energy. In practice, the activities associated with wind energy mentioned above are all undertaken by the same company. The result is that the cost information in the company's profit and loss account provides mixed information on the three activities and it is difficult to arrive at a clear input structure for the wind energy sector (in terms of the electricity generated by the operation of WTGs as a discrete item) or the WTG manufacturing sector. To arrive at the input structure of the wind energy sector, we have used data provided by a cooperative company on the operation of a wind turbine to generate one MW of energy (Appendix III). The input structure of the WTG manufacturing sector has been obtained by using field-level coefficients, as well as certain all-India coefficients for the electrical industrial machinery sector.

Regarding the uses of wind energy, the energy produced is fed into the national grid and it is not possible to say which industries or final users receive this component of the energy mix. Generally, there would be no change in usage, whether the energy is generated by conventional methods or by wind. The demand structure is therefore assumed to be the same as for the electricity sector as a whole. For the WTG manufacturing sector, the output is distributed entirely as gross fixed capital formation (in the form of fully functional turbines), as WTGs are capital goods, and in the form of spare parts to the WTG manufacturing sector itself and to the wind energy sector.

3.5.4 Metro transport services

In the Indian IO table for the year 2009-10, metro transport services are included in the rail transport services sector. In 2009-10, only the Delhi Metro Rail Corporation (DMRC) and the Kolkata Metro Rail Corporation (KMRC) were in operation, while other metro systems were in the construction stage. Therefore, in the new green metro transport services sector, only the metro transport services provided by the DMRC and KMRC are considered. The information for the gross value added and total intermediate inputs of the DMRC and KMRC was obtained from the National Accounts Division of the Central Statistics Office, the official agency that compiles the nation's accounts. To obtain the input structure of the metro sector, we used details of itemized expenditure on material inputs made by the DMRC, to be found in the profit and loss account section of their annual report (Appendix III). Since the Kolkata metro was part of Indian Railways until 2009, details of the operational expenditure of the KMRC are not available in the KMRC's annual report (the company was incorporated in July 2008). We therefore assumed that the input structure of the KMRC was similar to that of the DMRC. Please note that the metro sector in our IO table has been disaggregated from the railway sector of the national IO table. The rail transport sector in our IO table therefore represents rail transport service other than metro.

Regarding the uses of metro transport services (which must appear as the row entries in the metro transport service sector), it should be mentioned that the metro systems provide only passenger transport and their services are used mainly by commuters (i.e. households).

However, some people working in the services sector also make use of the metro when visiting customers. Since no exact information is available regarding use of the metro by business service providers, we have assumed that 5 per cent of metro transport service output is used by business (services sector) and have classified this as an intermediate use of the services sector in the metro sector row. The remaining output of the metro transport service is classified as private final consumption expenditure.

3.5.5 Rail transport services (except metro)

In the Indian national accounts, rail transport services include metro services, and the two form one separate sector in the national IO table for India. To validate the coefficients, we looked at the budgetary documents of the rail services. These are an integral part of the central government budget and include allied activities which, according to standard industrial classification, should belong to their own sectors. Following this principle, railway workshops and railway manufacturing establishments such as the Chittaranjan Locomotive Works, the Integral Coach Factory, the Diesel Locomotive Works and the Wheel & Axle Plant were excluded from rail transport and included in the manufacturing sector. Railway construction activity was also excluded and taken into account in the construction sector. The principal sources of data for estimating the input structure (itemized inputs and gross value added) of rail transport services are: (i) the Annual Report & Accounts and Annual Statistical Statements published by the Ministry of Railways (Railways Board); and (ii) the central government budget documents relating to the railways. The former contain comprehensive statistics on all important aspects of the workings of government railways, and also some basic data on non-government railways' procurement. The central government documents contain the railways' budget: revenue and expenditure, requests for expenditure on railways, works, machinery and rolling stock, and an explanatory memorandum. From the input structure of the railways (which includes metro transportation services), the input structure of the rail transport sector was obtained by subtracting the material inputs that have gone into the production of metro transport services, as estimated above, from the inputs of the total rail transport sector of the national IO table. The flow of outputs from the rail transport sector to other sectors was similarly obtained by subtracting those of the metro transport sector from the railways sector total in the national IO table.

4. Analysis and findings

The IO multipliers for the various focus and other sectors in this study have been developed for the purpose of comparative analysis. IO multipliers are summary measures used for calculating the total impact of changes in the demand for the output of a particular sector on all industries and on the entire economy. The impact on private consumption can be gauged, with or without taking into account the responses of households, by examining changes in sectoral level output. The open system does not include private consumption changes, whereas the closed system includes the response of households to initial impulses that ripple through the entire economy. The details are explained in the following pages. One should also note that these multipliers describe average effects, not marginal effects, and thus do not take account of economies of technological change, nor of scale or unused capacity. As technology does not change very fast (at least not over 4 years or so), the various multipliers generally remain reasonably stable over time. There may, however, be some exceptions and researchers need to keep a note of such industries. Generally input-output multipliers are driven by demand for outputs. The model assumes that, in a particular year, fixed amounts of given inputs are required to produce a given output.

In this section, we discuss the findings of the analysis conducted using secondary and primary data gathered during the study. First, some basic analyses of secondary data are presented to show the shares of income and expenditure of various sectors of the economy. This provides perspective on the individual significance of each sector, especially the new "green" sectors. Employment data are then evaluated by sector, according to type of worker (formal, informal) and gender, to furnish a background understanding of where the economy currently stands with regard to the structure of the workforce. In calculating the simple multipliers, we effectively assume that the spending of households takes place outside the model, and there is no feedback between the household sector and the other sectors. We are then said to be using an open model. However, in calculating the total multipliers, we do allow for feedback, and the model is then said to be closed with respect to households. The computed multipliers (output and employment, open and closed) are presented against this background. Finally, the results of the simulations carried out using the open IO model are analysed for the new sectors.

4.1 Value added and final uses shares

The following table shows the percentage share of each sector's GVA, PFCE, GFCE and GFCF of the total for the Indian economy.

Table 8: Sector-related percentage shares of gross value added and final demand components

(% shares)

Sector	GVA	PFCE	GFCE	GFCF
Agriculture and allied activities (except forestry)	16.07	18.81	2.00	0.12
Forestry and logging	1.67	1.05	0.00	0.00
Mining	2.56	0.04	0.11	0.00
Petroleum products	0.66	2.74	1.54	0.00
Bricks and tiles (structural clay products)	0.33	0.00	0.00	0.00
Cement	0.41	0.00	0.00	0.00
Non-metallic mineral products	0.31	0.28	0.00	0.24
Iron and steel (ferro alloys and casting & forging)	1.10	0.00	0.00	1.49
Rail and other transport equipment	0.17	0.00	0.00	0.38
Wind turbine generator manufacturing	0.03	0.00	0.00	0.18
Other manufacturing	11.45	23.82	9.05	33.49
Watershed development	0.69	0.00	0.02	2.10
Other construction	8.16	0.16	1.16	56.18
Wind energy	0.02	0.02	0.04	0.00
Other electricity	1.47	0.81	1.61	0.00
Metro transport services	0.01	0.02	0.00	0.00
Rail transport services (except metro)	0.94	1.05	0.61	0.18
Other transport services	5.29	10.71	4.63	1.34
Other services	41.86	40.47	24.85	4.29
Public administration and defence	6.80	0.00	54.37	0.00
Total (%)	100	100	100	100
Total (INR billion)	61454	36769	7687	20664

Table 8 above shows that our study sectors are small in terms of their share of the total output of the economy. Clearly, this is relative to the other major sectors, such as agriculture, services and manufacturing. The highest share of GVA is in the aggregated "Other services" sector, which accounts for around 42 per cent of the total. We find that the agricultural sector accounts for around 16 per cent of the economy's GVA, while the forestry and logging sector accounts for nearly 1.7 per cent. Rail transport services contribute around 1 per cent of the output, while metro transport services account for as little as 0.01 per cent of GVA. This does not imply that the output or employment impacts of, say, the metro transport sector are insignificant (as will be shown through the multiplier analysis). It merely indicates that the size of these sectors is small relative to other sectors of the economy, especially since some of the other sectors are highly aggregated in this analysis, and the key sectors are purely disaggregated sectors.

As one examines the demand side, one finds that PFCE by all households is highest for the "Other services" sector, accounting for around 40 per cent of the total. Among the study sectors, forestry and logging, and rail transport services, each account for around 1 per cent of the total. GFCE is highest for public administration and defence (54 per cent) because these services, produced by the government, are conceived to be consumed by the government itself. GFCF is highest in construction and accounts for 56 per cent of the national total.

4.2 Employment structures

In India, as in other developing countries, the restructuring of the global economy, together with wide-ranging economic policy reforms, is swelling the size of the informal economy. It is widely recognized that a large section of the Indian work force is involved in informal activities/ processes. The third report of the National Commission for Enterprises in the Unorganized Sector (NCEUS), submitted in 2007, estimated the total number of unorganized/informal workers to be 423 million (92.6 per cent) in January 2005, of whom 395 million (93 per cent) were in the unorganized sector and the remaining 28 million (7 per cent) in the organized sector. This reveals the existence of a very large proportion of informal workers in the Indian economy, and it is widely acknowledged that such workers are likely to be living in poverty.

The liberalization policies adopted during the late 1980s and early 1990s have created incentives for registered firms in the corporate sector to cut costs. While the relatively low productivity of agriculture continues to generate seasonal and permanent movements of excess agricultural labour to non-farm activities that absorb low-skilled workers, the new technologies and market access created by global deregulation have also opened up opportunities for firms to respond to new demand. Informal activities that generally take place on makeshift sites have been integrated into global production process, because such activities can operate with low fixed costs.

Authors such as Sinha and Adam (2006), Unni (2001), Harriss-White (2003), Jhabwala (2003) and Harriss-White and Sinha (2007) have described the rapid expansion of this informal economy in India, which has confounded expectations that this phenomenon would be phased out as Third World countries followed the path of development. India, like other developing countries, has firms that can be termed informal, mostly operating with low capital intensity and hence lower productivity (officially termed "unregistered" enterprises). There is also a smaller capital-intensive formal sector (details available in the Annual Survey of Industries). However, registered firms also hire workers under different working conditions to reduce the risk of fluctuating market demand. These firms thus hire both types of workers, formal and informal. We can deduce from the Report of the National Commission for Enterprises in the Unorganised Sector (NCEUS), cited above, that about 83 per cent of the labour force in the organized sector was informal during the period June 2003 - July 2004. Moreover, a comparison with the 55th Round of the NSSO (providing information for July 1998-June 1999)

shows that the number of informal workers had increased by about 17 per cent, whereas the number of formal workers had marginally decreased. The economy therefore generates a large number of low-skilled informal workers earning relatively low incomes and having little access to education and training, which leads to lower productivity (Jutting and De Laiglesia, 2009). Such workers are generally available at lower wages and, under pressure to cut cost, many firms hire such workers.

For the purposes of this study, we focus on employment multipliers by type of employment (formal and informal) and also by gender. Using data from the Registrar General of India (RGI) to obtain population projections for the relevant year, as well as from the 66th round on employment and unemployment of the National Sample Survey Office (NSSO) on work participation rates, we have estimated employment by sector (by type and gender).

Projected population: The projected population for India was obtained from the Office of the RGI.

Work participation rate: To estimate total workers in India for 2009-10, we used the projected population from the RGI and work participation rates (WPR) from the NSSO 66th round Report. The WPR is calculated on the basis of different types of work and time. Using the annual principal status and subsidiary status (PS+SS) WPR ratio for India, we estimated the workforce to be 58.6 per cent of the projected population.

Distribution of workers: To distribute workers (by type and gender) by sector, we generated and applied sector-related ratios from the NSSO (66th round, unit-level data)(See Appendix IV for details of the mapping of NSSO sectors to the IO sectors). We have used NSSO terminologies and definitions of workers.

Formal workers: For the purpose of our study, formal workers are defined as those workers who reported that they worked as regular workers in registered firms or entities which employed 10 or more workers and also used electricity. Moreover, workers working in firms which employed more than 20 workers, even without using electricity, are classified as formal workers (the standard definitions used officially in India).

Informal workers: Both casual and regular workers who worked in firms which employed fewer than 10 workers were considered informal, even if they used electricity, as the firms in which they worked were informal (unregistered). Similarly, both casual and regular workers who worked in firms that had fewer than 20 workers, without using electricity, were considered informal. We also categorized as informal those workers who are defined in the NSSO as "own account workers", i.e. those who are self-employed and do not imply other workers; "causal workers", who did not have regular work; and "unpaid family workers", who work for family businesses but are not paid in money. Such work should not be confused with household chores which are for households' self-use and consumption. Unpaid family workers are market workers and help in the production of marketed products. The final category of market workers is "other types":

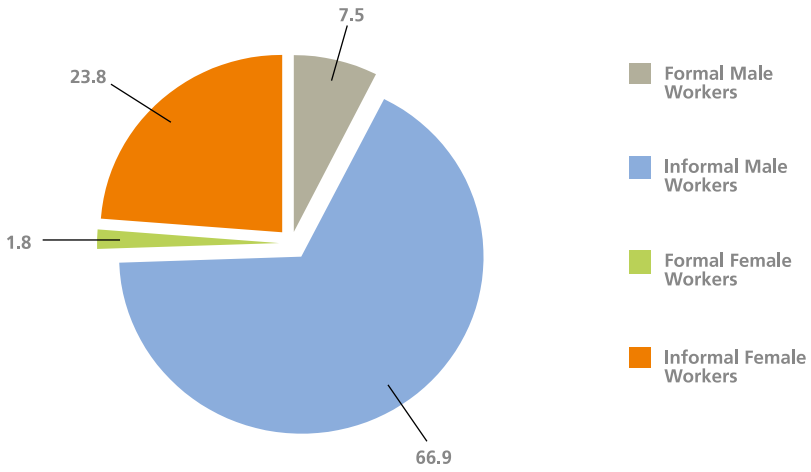
workers engaged in informal firms or casual miscellaneous work which cannot be ascribed to any other category by the statistical agencies.

Employers: Formal and informal employers are also market "workers". The former are defined as those who own firms, employ 10 or more workers and use electricity, or who employ 20 or more workers without using electricity. The latter are those who employ fewer than 10 workers, if they use electricity, or fewer than 20 workers, if they do not use electricity.

4.2.1 Workers by type and gender

The methodology described in the earlier section was used to estimate the percentages of workers in the economy according to type and gender. For all sectors of the economy, almost 91 per cent of the workforce is categorized as informal. If we consider gender, 74 per cent of the workforce is male. The figure below provides a breakdown of the total Indian workforce by both gender and type. The largest proportion of the workforce is made up of informal male workers, who account for 67 per cent of the total. The lowest share (1.8 per cent) consists of formal female workers. This clearly indicates that the workforce in India is largely informal and mostly male. Also, women are engaged on a massive scale in low-paid and informal work.

Figure 1: Percentage shares of total workforce by gender and type

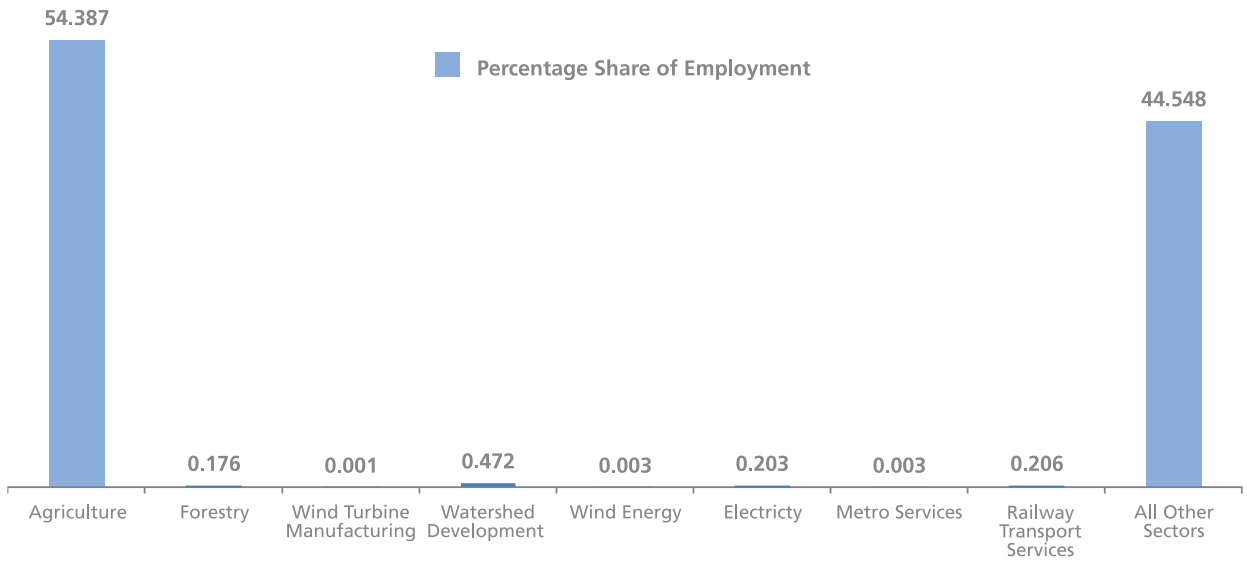


4.2.2 Sector-related employment structure

Approximately 1 per cent of the total Indian workforce is engaged in the new sectors investigated in this study. It is important to consider why, even when they account for such a small share of total output and/or employment, it is worth analysing these sectors separately. These are sectors that have "environmentally friendly" aspects and, as such, are identified as "green" sectors for this study. There are also "pure" sectors, i.e. not aggregated like most of the other sectors in our input-output table. Moreover, these are dynamic sectors that need

nurturing. The figure below shows percentage employment in the green study sectors, as well as in all other sectors:

Figure 2: Percentage shares of sectoral employment in the study sectors



Source: NCAER's Calculations using NSSO Data

Agriculture employs the vast majority of the Indian workforce (around 54 per cent). The remaining study sectors employ less than 1 per cent of the workforce. The traditional electricity sector employs around 0.2 per cent of the total workforce, while wind energy generation (electricity) employs much less (0.003 per cent). Similarly, rail transport services employ 0.21 per cent of the workforce, while metro transport, being a much smaller sector, employs only 0.003 per cent.

Finally, to understand the sectoral intensity of types of worker, shares of employment in each sector were mapped by gender and type (male and female, formal and informal). Table 9 below shows the percentage of workers by type and gender in each sector of the Indian economy (see Appendix V for a more detailed exploration of the employment structure of the various sectors). So, in agriculture, for example, the sum of the shares of formal and informal employment is 100 per cent. The last column shows the share of workers in the total workforce by the 20 sectors identified. The last row shows the total number of formal, informal, male and female workers, and the overall total.

The metro transport services sector comprises only formal employment. Public administration and defence has 80 per cent formal employment. The share of male employment is 100 per cent in the rail and transport equipment manufacturing sector and in the wind energy sector. The highest share of female employment (33 per cent) is in agriculture and allied activities. In general, the figure for informal employment is higher in all sectors except for metro transport services and public administration. As expected, the data also show that male employment

Table 9: Sector-related percentage shares of workers by type and gender

(% shares)

Sector	Type worker		Gender		Total %
	Formal %	Informal %	Male %	Female %	
Agriculture and allied activities (except Forestry)	1.86	98.14	66.61	33.39	1.86
Forestry and logging	8.63	91.37	82.95	17.05	8.63
Mining	10.78	89.22	88.98	11.02	10.78
Petroleum products	15.10	84.90	93.24	6.76	15.10
Bricks and tiles (structural clay products)	4.24	95.76	79.99	20.01	4.24
Cement	7.37	92.63	94.22	5.78	7.37
Non-metallic mineral products	3.16	96.84	84.23	15.77	3.16
Iron and steel (ferro alloys and casting & forging)	5.95	94.05	94.67	5.33	5.95
Rail and other transport equipment	19.13	80.87	100.00	0.00	19.13
Wind turbine generator manufacturing	71.80	28.20	85.00	15.00	71.80
Other manufacturing	6.35	93.65	73.55	26.45	6.35
Watershed development	0.00	100.00	66.01	33.99	0.00
Other construction	2.56	97.44	89.82	10.18	2.56
Wind energy	0.00	100.00	100.00	0.00	0.00
Other electricity	29.81	70.19	90.58	9.42	29.81
Metro transport services	100.00	0.00	75.49	24.51	100.00
Rail transport services (except metro)	43.89	56.11	94.41	5.59	43.89
Other transport services	23.86	76.14	98.95	1.05	23.86
Other services	26.75	73.25	83.55	16.45	26.75
Public administration and defence	80.07	19.93	86.47	13.53	80.07
Total (%)	9.27	90.73	74.44	25.56	100.00
Total (number)	6355220	622251874	51051768	175286396	685804078

is higher than female employment in all sectors, but the relative shares of female and male employment is of interest. Further scrutiny reveals that female workers form less than 15 per cent of the workforce in sectors such as mining, petroleum products, cement, iron and steel, rail and other transport equipment, other construction, wind energy, other electricity, rail and other transport services (except metro transport), as well as in public administration and defence. More strikingly, the most women-friendly of the study sectors is watershed development, where women account for 34 per cent of the workforce, as compared with 10 per cent in "Other construction". It is also interesting that metro transport services employ 24.5 per cent women, as compared to 6 per cent in the railways sector. The wind energy sector employs only males, while the wind turbine generator manufacturing sector is estimated to employ 15 per cent females. This makes our study sectors more interesting in terms of the effects on gender intensity in employment.

4.3 Output multiplier

The IO model developed for India with the green sectors disaggregated from their various "mother" sectors provides us with a tool for analysing the output and employment- generating potential of these sectors. Table 10 below gives the standard coefficient matrix or the direct requirements table for the closed model. As explained in section 3 on methodology, this matrix is then used to calculate the total requirements matrix or the (I-A)-1 (inverse) matrix, which gives the output multipliers. The coefficient matrix for the open model is the same as for the closed model, except for the 20th row and the 20th column, which provide the income and consumption coefficients of households. Since households are not endogenous in the open model, they are not shown in the open coefficient matrix. For the inverse matrices of both the open and closed models, see Appendix VI.

Table 10: Direct requirements table (coefficient matrix) for closed model, India, 2009-10

S. No.	Sector	1	2	3	4	5	6	7
1	Agriculture and allied activities (except forestry)	0.178	0.000	0.000	0.000	0.007	0.000	0.004
2	Forestry and logging	0.000	0.005	0.000	0.000	0.000	0.000	0.000
3	Mining	0.000	0.000	0.007	0.837	0.051	0.189	0.064
4	Petroleum products	0.010	0.035	0.020	0.017	0.072	0.061	0.074
5	Bricks and tiles (structural clay products)	0.000	0.000	0.000	0.000	0.038	0.024	0.002
6	Cement	0.000	0.000	0.000	0.000	0.025	0.017	0.019
7	Non-metallic mineral products	0.000	0.000	0.001	0.000	0.031	0.011	0.047
8	Iron and steel (ferro alloys and casting & forging)	0.000	0.000	0.000	0.000	0.001	0.000	0.014
9	Rail and other transport equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.001
10	Wind turbine generator manufacturing	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	Other manufacturing	0.057	0.059	0.082	0.010	0.089	0.100	0.179
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Other construction	0.005	0.008	0.017	0.000	0.006	0.003	0.088
14	Wind energy	0.000	0.000	0.000	0.000	0.001	0.001	0.001
15	Other electricity	0.007	0.001	0.018	0.003	0.027	0.039	0.026
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.003	0.002	0.006	0.001	0.006	0.006	0.006
18	Other transport services	0.019	0.038	0.016	0.006	0.051	0.052	0.050
19	Other services	0.058	0.046	0.068	0.015	0.102	0.124	0.106
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Households	0.683	0.843	0.742	0.080	0.452	0.339	0.274
	Gross output	1.000	1.000	1.000	1.000	1.000	1.000	1.000

(contd.)

S. No.	Sector	1	2	3	4	5	6	7
1	Agriculture and allied activities (except forestry)	0.000	0.005	0.000	0.084	0.000	0.007	0.000
2	Forestry and logging	0.000	0.001	0.000	0.011	0.000	0.032	0.000
3	Mining	0.163	0.014	0.001	0.035	0.000	0.016	0.000
4	Petroleum products	0.023	0.014	0.008	0.012	0.000	0.010	0.202
5	Bricks and tiles (structural clay products)	0.000	0.000	0.000	0.000	0.000	0.026	0.000
6	Cement	0.000	0.002	0.024	0.000	0.002	0.046	0.000
7	Non-metallic mineral products	0.001	0.007	0.002	0.001	0.008	0.026	0.000
8	Iron and steel (ferro alloys and casting & forging)	0.145	0.113	0.135	0.046	0.000	0.065	0.000
9	Rail and other transport equipment	0.000	0.121	0.002	0.003	0.000	0.000	0.000
10	Wind turbine generator manufacturing	0.000	0.000	0.307	0.000	0.000	0.000	0.347
11	Other manufacturing	0.200	0.235	0.000	0.365	0.000	0.113	0.000
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Other construction	0.001	0.013	0.021	0.009	0.000	0.106	0.000
14	Wind energy	0.001	0.000	0.000	0.000	0.000	0.001	0.000
15	Other electricity	0.026	0.016	0.000	0.017	0.000	0.021	0.000
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.007	0.003	0.003	0.005	0.000	0.005	0.001
18	Other transport services	0.056	0.027	0.031	0.044	0.000	0.037	0.011
19	Other services	0.136	0.086	0.208	0.140	0.007	0.118	0.177
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Households	0.193	0.302	0.216	0.207	0.982	0.347	0.215
	Gross output	1.000	1.000	1.000	1.000	1.000	1.000	1.000

(contd.)

S. No.	Sector	1	2	3	4	5	6	7
1	Agriculture and allied activities (except forestry)	0.001	0.000	0.000	0.052	0.033	0.000	0.113
2	Forestry and logging	0.000	0.000	0.000	0.000	0.000	0.000	0.006
3	Mining	0.137	0.000	0.001	0.000	0.000	0.000	0.000
4	Petroleum products	0.071	0.000	0.017	0.186	0.006	0.000	0.016
5	Bricks and tiles (structural clay products)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Cement	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Non-metallic mineral products	0.000	0.000	0.000	0.001	0.000	0.000	0.002
8	Iron and steel (ferro alloys and casting & forging)	0.001	0.000	0.000	0.000	0.001	0.000	0.000
9	Rail and other transport equipment	0.000	0.092	0.137	0.000	0.000	0.000	0.000
10	Wind turbine generator manufacturing	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	Other manufacturing	0.065	0.000	0.021	0.088	0.051	0.000	0.143
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000	0.000

13	Other construction	0.017	0.014	0.070	0.008	0.014	0.000	0.001
14	Wind energy	0.004	0.001	0.002	0.000	0.000	0.000	0.000
15	Other electricity	0.164	0.046	0.083	0.006	0.009	0.000	0.005
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.004	0.000	0.001	0.004	0.001	0.000	0.006
18	Other transport services	0.027	0.005	0.006	0.037	0.020	0.000	0.064
19	Other services	0.118	0.269	0.050	0.196	0.099	0.000	0.242
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Households	0.366	0.572	0.594	0.370	0.750	1.000	0.000
	Gross output	1.000	1.000	1.000	1.000	1.000	1.000	0.603

Open output multiplier: The output multiplier of a sector (for example, agriculture) is the total increase in production in all sectors of the economy required to satisfy a unit increase in the final demand of that sector (agriculture). The "backward linkages" of the agriculture sector will stimulate demand from other sectors when agricultural production rises. Output from sectors such as manufacturing and construction will have to increase to fulfil one unit of extra production of agricultural output. The agriculture sector will also draw on its own sector for the additional one unit of production, as a sector is mostly an aggregation of homogenous sub-sectors. These direct and indirect impacts of a unit increase in final demand for agricultural output make up the open output multiplier and are obtained from the Leontief $(I-A)^{-1}$ (inverse) matrix (see Appendix VI). In other words, the column sums of the open inverse matrix provide the open model output multipliers for each sector.

Closed multiplier: Given a change in final demand, the open system is capable of evaluating only direct and indirect effects on output requirements. But changes in output levels will lead to changes in income, which in turn will induce changes in consumption. Therefore, only part of the overall impact of a given change in final demand can be evaluated using an open system. We must therefore rely on the closed system for an evaluation of the overall effect of a given change in final demand. As explained above, the closed model includes, in addition to the direct and indirect impacts mentioned above, the induced impacts of the secondary round of consumption stimulated by households' additional income resulting from the first round of production. The direct, indirect and induced impacts together make up the closed output multiplier. The column sums of the inverse matrix of the closed model give the closed output multipliers of each sector. The following table shows the open and closed output multipliers for all the sectors of the economy:

Table 11: Sector-related open and closed output multipliers

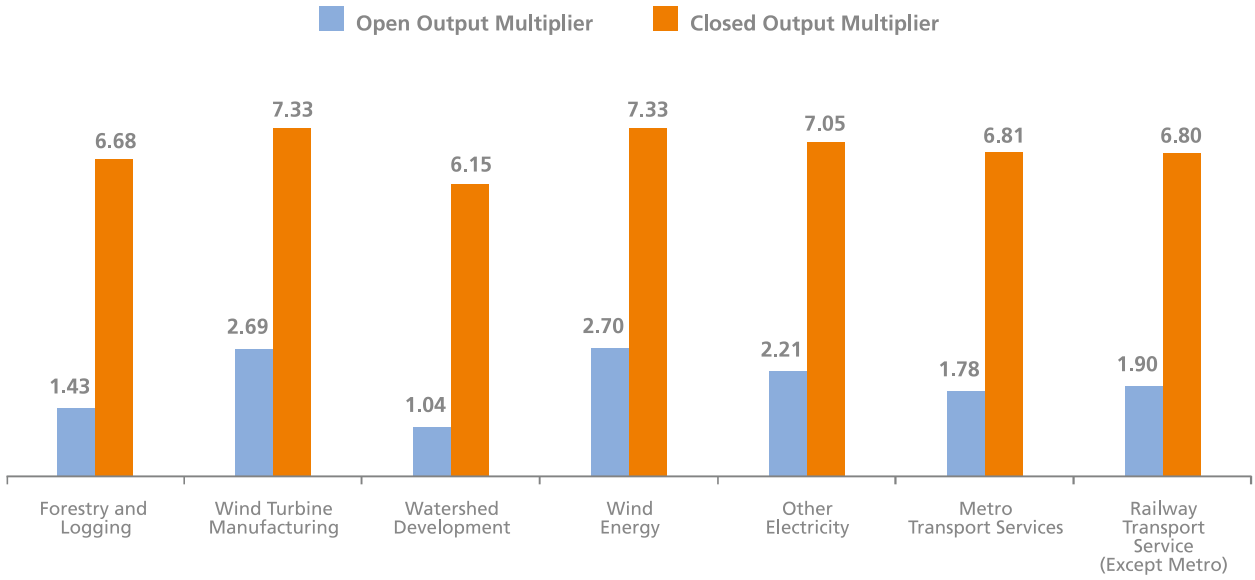
S. No.	Sector	Open multiplier	Closed multiplier	Induced impact = closed-open	Induced % of closed multiplier
1	Agriculture and allied activities (except forestry)	1.63	6.82	5.19	76.2
2	Forestry and logging	1.43	6.68	5.25	78.7
3	Mining	1.51	6.46	4.95	76.6
4	Petroleum products	2.38	7.18	4.80	66.9
5	Bricks and tiles (structural clay products)	2.07	6.85	4.78	69.8
6	Cement	2.22	7.02	4.80	68.4
7	Non-metallic mineral products	2.52	7.23	4.71	65.2
8	Iron and steel (ferro alloys and casting & forging)	2.62	7.29	4.67	64.0
9	Rail and other transport equipment	2.60	7.31	4.71	64.5
10	Wind turbine generator manufacturing	2.69	7.33	4.64	63.3
11	Other manufacturing	2.73	7.58	4.85	64.0
12	Watershed development	1.04	6.15	5.11	83.1
13	Other construction	2.37	7.20	4.83	67.1
14	Wind energy	2.70	7.33	4.63	63.2
15	Other electricity	2.21	7.05	4.84	68.7
16	Metro transport services	1.78	6.81	5.03	73.8
17	Rail transport services (except metro)	1.90	6.80	4.90	72.1
18	Other transport services	2.18	6.91	4.74	68.5
19	Other services	1.46	6.47	5.01	77.4
20	Public administration and defence	1.00	6.12	5.12	83.7

The highest open multiplier in the Indian economy is for the aggregated "Other manufacturing" sector (INR 2.73 worth of output generated in the entire economy due to a INR 1 increase in final demand for other manufacturing output). This highly aggregated sector is interlinked with many other sectors of the economy (Table 10: coefficient matrix). So, to produce an extra unit of this sector's output, many other sectors of the economy are stimulated and have to increase their outputs. It not only takes inputs from, but also provides inputs to, almost all other sectors in the economy. The next highest open output multiplier is for the wind energy sector, at INR 2.71, followed by iron and steel at INR 2.62. Introducing the effect of households into the model, the output multiplier (closed in this case) is again highest for "Other manufacturing" (7.57), followed by the wind energy sector (7.4). A large input of the wind energy sector is its consumption of spare parts. These are products of manufacturing, which in turn is interlinked with many other sectors. The third highest closed output multiplier is for rail and other transport equipment (7.31). If we look at just the induced impact obtained by endogenizing households into the model (which is the difference between the closed and the open multiplier), we find that, in terms of number values, the highest induced impact is in the forestry and logging

sector (5.25). Another way of analyzing this, though, is by looking at the share of the induced impact in the total (i.e. closed) multiplier. Public administration has the highest share of induced impact in the total multiplier (around 84 per cent). This implies that of the total impact, 84 per cent is due to the additional workers' income generated by the initial change in final demand, i.e. to what we call the 'induced' effects.

The figure below shows the study-sector-related multipliers for each model. Among the green sectors, the open output multiplier of the wind energy sector is 2.7, which is higher than the corresponding multiplier for "Other electricity" (2.21). Moreover, the total (i.e. closed) multiplier is higher (7.33 versus 7.05). This is a striking result because, in terms of GDP shares, the wind energy sector's share is 0.02 per cent, implying that wind energy generation is more productive than conventional sources of electricity. Metro transport services provide a lower open output multiplier (1.78) than rail services (1.9) and an almost equal total output multiplier (6.81 for metro services and 6.80 for railways). The national coverage of metro services is low, which is why the open output multiplier is lower. But the induced impact of metro services is higher (5.03 versus 4.90). This highlights the structural difference in employment in these two sectors. While metro services provide only formal employment, railways employ 56 per cent informal labour (Table 9). The induced income effect of formally employed households generates more output for metro services.

Figure 3: Open and closed output multipliers



The watershed development sector's open output multiplier is 1.04, which is to be expected as this sector is less productive. The open output multiplier of the wind turbine generator manufacturing sector is as high as 2.69. This highly specialized sector uses vast capital inputs, which mostly stimulates the manufacturing industry. The strong backward linkages of this sector lead to further stimulation of related sectors. For example, the various components used

in constructing a wind turbine generator include rotor blades, electronic controls, the tower, etc. Any demand for a wind turbine will stimulate each of these industries: the electronic equipment industry for the controls, the plastic/cement industry for towers, and so on. As a result, sectors related to these various industries are also stimulated. These being manufacturing industries, the backward linkages are wide-ranging. This results in higher output. The closed output multipliers for wind turbine generator manufacturing and wind energy are each 7.33, showing the interconnectedness of these activities. The turbine manufacturing industry caters exclusively to the wind energy generation industry and most companies involved in wind energy activities are engaged in both activities. An industry of this kind therefore operates in both the services and the manufacturing sectors.

The induced effect of households' additional income (the difference between the open and closed multipliers) is highest for the forestry and logging sector (5.25), showing that this sector experiences major feedback effects from the inclusion of households. The open output multiplier for this sector is the lowest in the economy (1.43), followed closely by the watershed development sector. The development of the forestry and logging sector relies on fewer inputs and more labour: 84.3 per cent of the input is labour (coefficient matrix), and around 91 per cent of this labour is informal (Table 9). Since this sector does not significantly stimulate other sectors, its open output multiplier is low. But since the major input is labour, the induced income effect is significant.

In terms of the percentage share of induced impact in the total (closed) multiplier, the watershed development sector has the second highest share (83 per cent) in the economy as a whole. This shows that, despite being a small sector, it has vast potential as a result of the extra demand created by households. Firstly, it is interlinked with many other sectors, such as cement, bricks and tiles, non-metallic mineral products and services (please refer to Table 10 for the coefficient matrix), and therefore output and employment are generated in these other sectors as a result of watershed construction. Secondly, it caters to the agricultural sector, especially in rural areas. The IWDP employs local labour (including farmers) for watershed construction activities and therefore the feedback effect of households is very significant (the work is also very labour-intensive and most of this labour is informal). This generates additional income for workers, which further induces a rise in consumption, which in turn leads to an additional increase in output. It is this feedback effect that is captured in the closed multiplier, specifically in the induced impact component.

4.4 Employment coefficients and multipliers

Open: The employment coefficient of a sector is expressed as its employment per unit of output. It is the direct employment requirement of any specific sector. The open employment multiplier of a sector (say, agriculture) is the direct and indirect change in employment in the economy as a whole due to a unit change in the agricultural sector's output. This first results in the generation of additional employment in the sector itself, then employment in all other sectors in the economy due to one extra person being employed in agriculture. The multiplier is estimated by multiplying each figure in the i^{th} row of the inverse matrix with the employment coefficients, then summing the products. The open employment multiplier is the sum of the employment coefficient and the indirect employment effects. Here, the multiplier is measured in terms of person-years generated to fulfil a INR 100 thousand increase in a sector's output.

Closed: As noted above, the inclusion of households in the endogenous component of the model takes into account successive rounds of consumption and subsequent employment creation stimulated by additional workers' incomes from the first round of expansion of the economy. The difference between the closed and open employment multipliers is the effect induced by the inclusion of households in the model. The direct, indirect and induced impacts therefore make up the closed (total) employment multiplier. This closed system resembles the Walrasian system, in that both seek to solve a system of equations involving all prices and all quantities in an economy.

The following table shows the open and closed total employment multipliers for the Indian economy, obtained from the open and closed models respectively. Further analysis shows the employment effects disaggregated according to type (formal, informal) and gender.

Table 12: Sector-related open and closed employment multipliers

S. No.	Sector	Open	Closed	Induced impact = closed – open	Induced as % of closed multiplier
1	Agriculture and allied activities (except forestry)	3.28	7.75	4.46	57.6
2	Forestry and logging	0.24	4.75	4.52	95.0
3	Mining	0.38	4.63	4.25	91.8
4	Petroleum products	0.35	4.48	4.13	92.09
5	Bricks and tiles (structural clay products)	1.18	5.29	4.11	77.7
6	Cement	0.42	4.54	4.12	90.8
7	Non-metallic mineral products	0.87	4.91	4.05	82.4
8	Iron and steel (ferro alloys and casting & forging)	0.53	4.54	4.01	88.4
9	Rail and other transport equipment	0.53	4.59	4.05	88.4
10	Wind turbine generator manufacturing	0.39	4.38	3.99	91.0
11	Other manufacturing	1.02	5.20	4.17	80.3

12	Watershed development	0.76	5.15	4.39	85.3
13	Other construction	0.96	5.11	4.15	81.3
14	Wind energy	0.34	4.32	3.98	92.0
15	Other electricity	0.38	4.54	4.16	91.7
16	Metro transport services	0.54	4.86	4.32	88.9
17	Rail transport services (except metro)	0.38	4.60	4.22	91.7
18	Other transport services	0.67	4.74	4.07	85.9
19	Other services	0.63	4.94	4.30	87.2
20	Public administration and defence	0.31	4.71	4.40	93.41

The highest employment multiplier (open) is 3.28, for agriculture and allied activities. This means that, in India, 3.28 person-years of employment are generated by an increase in agricultural output of INR 100 thousand. Agriculture and other allied primary activities provide 54 per cent of employment in the Indian economy (Table 9). The labour intensity of this sector is very high: its labour-output ratio (or labour coefficient) is 2.58. It is logical to expect that the employment multipliers here will be high. The total (closed) employment multiplier for agriculture is also the highest, at 7.75.

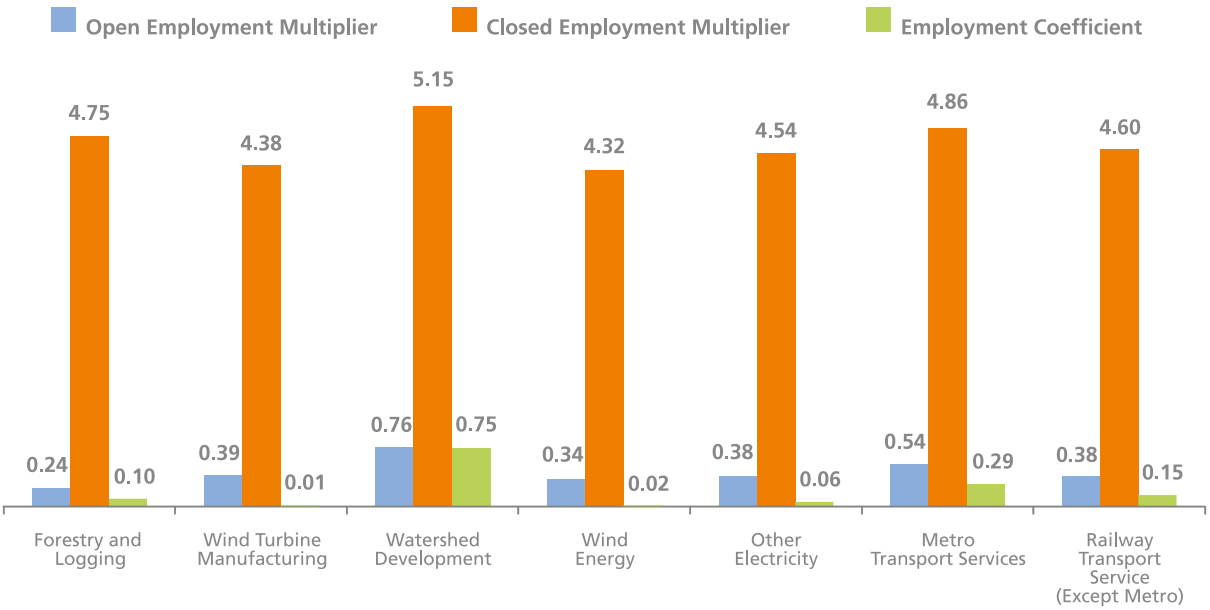
This means that 4.46 person-years (7.74 minus 3.28) of extra employment is generated as a result of the induced effects of households' feedback. These results show that, due to the labour-intense nature of this sector, agricultural production generates the most employment. However, the concern remains that the multipliers (open and closed) are also high for manufacturing sectors such as bricks and tiles and the aggregated "Other manufacturing" sector. The induced impact, in absolute numbers, is highest for the forestry and logging sector (4.52), as is the sector's percentage share of the induced impact as a part of the total closed multiplier: 95 per cent of the total employment impact (closed multiplier) is due to the induced effects of households' extra income. The induced impact, in absolute numbers, is second highest for the agriculture sector (4.46), followed by public administration (4.4).

Among the study sectors, the watershed development sector, as expected, has the highest open and total (closed) employment multipliers (0.76 and 5.15 respectively). This is a very labour-intensive sector, but generally tends to engage workers who are low-skilled. Hence, most of this labour is informal.

The employment multipliers (open and closed) for the wind energy sector are slightly lower than for the conventional electricity sector. This is explained by the labour–output ratios of these sectors, shows direct employment effect (Figure 4). Wind energy generation employs less labour per unit of production (0.02) than the "Other electricity" sector (0.06), but the indirect effect is higher (0.32 as opposed to 0.25). Taking the net result, however, the wind energy sector employs comparatively less labour than the conventional energy sector, because it is more capital intensive. This lower employment intensity is driven mainly by the direct

employment generated by this sector, which itself is very low. The bulk of the employment generated is due to the indirect effect stimulated by this sector, affecting interlinked sectors which themselves are capital intensive. The "Other electricity" sector, a major part of which is conventional electricity, is more labour-intensive and is also interlinked with other labour-intensive sectors, such as mining (the coefficient matrix shows that 13.7 per cent of the "Other electricity" sector's inputs are from the mining industry).

Figure 4: Employment coefficients and open and closed total employment multipliers



Metro transport services, on the other hand, employ more labour per unit of output than railways. As a result, the open (0.54) and closed (4.86) employment multipliers for the metro transport services sector are higher than for the railways (0.38 and 4.6 respectively). The watershed development sector has one of the highest labour-output ratios (0.75). It is also interlinked with various other sectors (mentioned above). This can be seen in the coefficient matrix (Table 10).

4.4.1 Employment effects by type of worker and gender

The disaggregation of employment multipliers by type of employment (formal, informal) and gender are detailed here. The methodology used to estimate numbers of workers was discussed earlier. The multiplier effects for male, female, formal and informal workers were determined using this procedure. The employment coefficient indicates the direct employment required in a particular sector to produce one unit value of output. The indirect impact is the employment generated in all sectors of the economy due to a one-unit value increase in output in a particular sector. The induced impact is the additional employment generated due to the feedback effects resulting from a change in households' final private consumption expenditure. The total employment requirement (which is the total impact of the closed model) is the sum

of the direct, indirect and induced requirements. The following table shows the percentage shares of these three impacts in the total or closed multiplier for all sectors of the economy by type of worker. The total of the three impacts for, say, formal workers in agriculture indicates the total (closed) employment multiplier for formal workers in that sector. The total of these three components will be 100 per cent. Thus, in Table 13 below, the total of 10.4, 6 and 83.6 is 100. The percentage shares of formal and informal employment are shown by sector in the following table.

Table 13: Sector-related percentage shares of direct, indirect and induced employment requirements by type of worker

S. No.	Sectors	Formal employment			Informal employment		
		Direct	Indirect	Induced	Direct	Indirect	Induced
1	Agriculture and allied activities (except forestry)	10.4	6.0	83.6	34.8	9.3	56.0
2	Forestry and logging	2.1	3.7	94.2	2.1	2.8	95.1
3	Mining	5.4	4.8	89.8	4.4	3.7	92.0
4	Petroleum products	0.1	9.8	90.1	0.0	7.7	92.3
5	Bricks and tiles (structural clay products)	8.1	8.8	83.1	16.2	6.6	77.2
6	Cement	0.8	10.8	88.4	1.0	8.0	91.0
7	Non-metallic mineral products	2.8	11.8	85.4	7.8	10.1	82.1
8	Iron and steel (ferro alloys and casting & forging)	0.6	13.5	85.9	0.9	10.5	88.6
9	Rail and other transport equipment	2.0	11.7	86.3	0.8	10.6	88.6
10	Wind turbine generator manufacturing	1.9	14.5	83.6	0.1	8.1	91.8
11	Other manufacturing	2.8	14.1	83.1	3.8	16.2	80.0
12	Watershed development	0.0	0.4	99.6	15.6	0.2	84.1
13	Other construction	3.0	10.9	86.1	10.0	9.1	80.8
14	Wind energy	3.7	13.1	83.2	0.0	7.0	93.0
15	Other electricity	4.0	9.9	86.1	1.0	6.8	92.3
16	Metro transport services	40.6	6.0	53.4	0.0	5.1	94.9
17	Rail transport services (except metro)	14.0	5.6	80.3	2.0	5.1	93.0
18	Other transport services	9.7	10.5	79.8	3.2	10.3	86.5
19	Other services	20.3	4.4	75.3	6.2	5.3	88.5
20	Public administration and defence	39.5	0.0	60.5	1.5	0.0	98.5

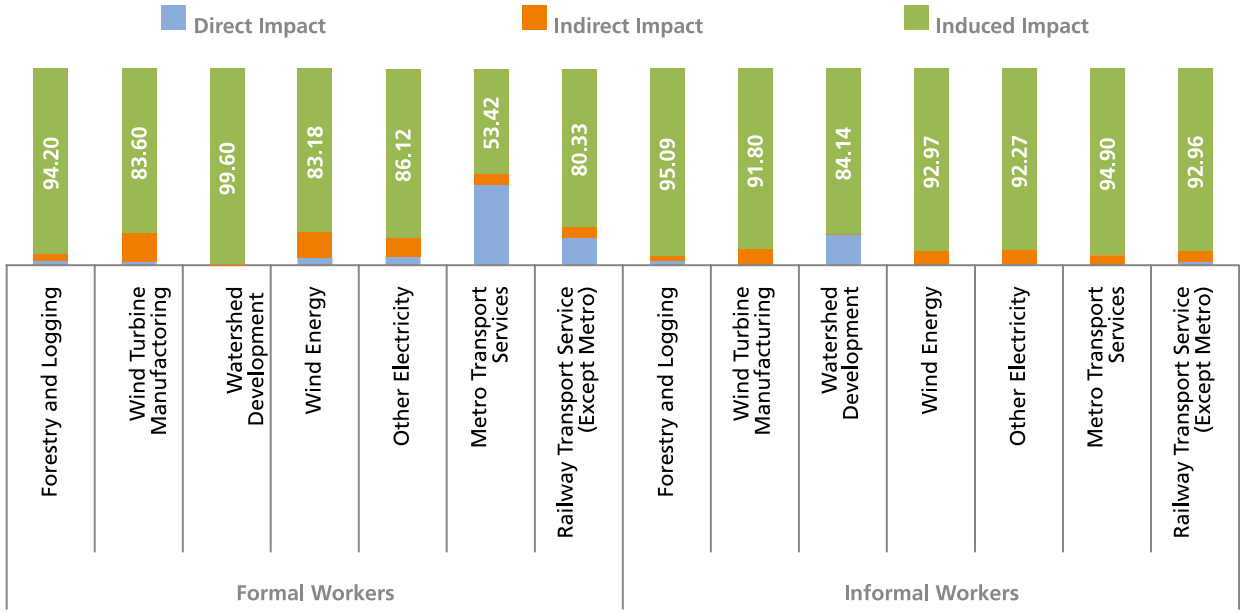
Formal workers: The percentage share of the direct employment impact in the closed employment multiplier for formal workers is highest in the metro transport services sector (around 41 per cent), followed by public administration (around 40 per cent). Table 9 shows that all employment in metro services and 80 per cent of employment in public administration is classified as formal. These are also the only two sectors that generate more formal than informal employment (Table 9). It follows that the formal employment impacts in these sectors will be high. In terms of multipliers, 0.285 person-years of formal employment need to be generated in the metro transport sector to produce INR 100 thousand worth of extra output (for direct, indirect and induced employment multipliers, see Appendix VII). This is the highest direct employment impact in the whole economy. The percentage share of the indirect employment effect in the total (closed) multiplier is highest in WTG manufacturing, at 14.5 per cent, while the wind energy sector has an indirect employment effect of 1.54. In an earlier study (NCAER, 2012), it was observed that the wind energy sector has very little direct impact on employment. This study also found that the shares of indirect impact and induced impact in the total impact were 13 and 83 per cent of employment generation respectively. The highest induced-income impact for formal workers (0.392) is in the forestry and logging sector (see Appendix VII). The feedback effects of households' additional income signify that 0.392 person-years of employment are generated through the closed system to produce one unit value of output in the forestry and logging sector.

Informal workers: The three types of impact (direct, indirect and induced) are much higher for informal workers than for formal workers (except for the impacts on direct employment generated in public administration and metro transport services). The direct employment impact for informal workers is highest in agriculture, where 2.53 person-years of informal employment are generated to produce extra output of INR 100 thousand. As a percentage share of the total impact, the highest direct employment impact share is also in agriculture (35 per cent). This is followed by bricks and tiles (16 per cent) (Table 13). The share of the indirect impact is highest in "Other manufacturing" (16 per cent). As mentioned earlier, this aggregated sector's vast backward linkages contribute to the large amount of informal employment generated in all other sectors of the economy. Finally, the induced impact is highest for forestry and logging (4.13). The inclusion of households in the endogenous section of the model generates 4.13 person-years of employment. As a percentage share of the total closed multiplier, the highest induced employment impact is in public administration (98.5 per cent). Since most of the employment in this sector is formal, the direct employment generated for formal workers in the sector is high (0.25). The second and third highest percentage shares of the induced impact is in the forestry and logging and metro transport services sectors, at 95 and 94.9 per cent respectively.

Study sectors

The following figure shows the percentage breakdown of direct, indirect and induced employment effects out of the total (closed) multipliers for the green sectors. The percentage shares of the induced impacts have been highlighted.

Figure 5: Percentage shares of direct, indirect and induced employment multipliers by type of worker for green sectors



Formal workers: Among the study sectors, the direct employment share of the total impact for formal workers is highest in the metro transport services sector (41 per cent) (Table 13). As mentioned above, it is also highest for the economy as a whole. The railways sector has a much lower share of formal employment (44 per cent). The direct effect is also much lower (14 per cent). Most of the employment generated in the formal railway sector is induced. In the case of metro services, the induced impact share is much lower (53 per cent). The share of the indirect employment impact is highest in the wind energy sector, at around 14 per cent. This sector has high indirect employment impacts as it requires various other inputs and only low employment directly in the sector itself. For "Other electricity", the share of the indirect effect is slightly lower, at around 10 per cent. For both sectors, the induced income effect on employment is quite high (between 80 and 90 per cent). As mentioned above, the percentage share of this indirect effect on employment generation in the total (closed) multiplier is second highest for the wind energy sector. The indirect requirements of this sector are very high (NCAER, 2012), as the inter-sectoral linkages are quite strong. The share of formal employment in the WTG manufacturing sector is nearly 72 per cent. This sector also has interlinkages with other specialized manufacturing sectors, such as iron and steel, cement and other manufacturing. Thus, the share of the indirect impact in the total (closed) multiplier for formal employment is close to 15 per cent, while the bulk of the remainder forms the induced impact. The share of

induced employment generated in the total employment impact is highest in the watershed development sector (99.6 per cent), which is also highest for the economy as a whole. Almost all the formal employment generated in this sector is a result of the impact induced by additional household income and the resulting demand for consumption. This is because, as Table 13 shows, this sector does not employ formal labour. Any formal employment generated in this sector is through indirect linkages to other sectors, such as cement and stone aggregates (non-metallic mineral products).

Informal workers: The direct employment share of the total employment impact for informal workers in the watershed development sector is around 16 per cent (Table 13). This sector has high employment multipliers but employs only informal workers. If we examine it closely, the direct impact for formal workers for this sector is zero, while the direct impact for informal workers is the highest in all the study sectors and third highest in the economy as a whole. The indirect share is high in the case of the wind energy sector (12 per cent). The forestry and logging sector has the highest share of induced effect on employment generation, at around 95 per cent. Since the metro sector does not employ informal labour, the share of direct employment of informal workers is zero. But indirect informal employment generated in other sectors contributes 5 per cent of the share of the closed employment multiplier. In addition, in both the metro and rail transport sectors, more than 90 per cent of the share of the total (closed) multiplier is attributed to the induced income effect. This shows that, where informal labour is concerned, the feedback effect is very high, indicating that income from informal employment induces much higher consumption, leading to still further income and rounds of consumption, output and employment.

Two major points need to be noted:

- The induced impacts arising from the closed model are very large, as compared with the employment generated under the open model (which takes into account only direct and indirect employment generation). This reflects the fact that including households in the endogenous system leads to major feedback effects, and this should be borne in mind when making policy decisions regarding investment in any particular sector.
- Informal employment generation is much more significant than formal employment generation in almost all sectors. This raises questions about the massive amount of informal labour in the Indian economy, the need for greater formalization and related policies.

Employment effects by gender

It is very important to differentiate the effects on employment by gender if we are to account for all differences in outcomes. The following table shows the shares of the direct, indirect and induced impacts on employment by gender. The total of the three effects for, say, male workers in agriculture gives the total (closed) employment multiplier for male workers in that sector. The total of these shares will be 100 per cent. In Table 14 below, we can see that the total of 31.4, 8.8 and 59.8 is in fact 100. Shares of male and female employment by sector are also shown.

Table 14: Sector-related percentage shares of direct, indirect and induced employment requirements by gender

S. No.	Sectors	Male employment			Female employment		
		Direct	Indirect	Induced	Direct	Indirect	Induced
1	Agriculture and allied activities (except forestry)	31.4	8.8	59.8	38	9.7	52.3
2	Forestry and logging	2.3	3	94.6	1.4	2.5	96.1
3	Mining	5.4	3.9	90.7	1.9	3.3	94.7
4	Petroleum products	0.1	8.8	91.1	0	5.2	94.8
5	Bricks and tiles (structural clay products)	16.6	7.1	76.3	12.3	6	81.7
6	Cement	1.3	8.8	90	0.2	6.7	93.1
7	Non-metallic mineral products	8.3	10.7	81	4.6	8.9	86.5
8	Iron and steel (ferro alloys and casting & forging)	1.1	11.2	87.7	0.2	9.5	90.4
9	Rail and other transport equipment	1.2	11	87.8	0	10	90
10	Wind turbine generator manufacturing	0.3	9.4	90.3	0.1	6.8	93.1
11	Other manufacturing	3.7	15.8	80.5	3.7	16.5	79.8
12	Watershed development	13.2	0.3	86.5	17.8	0.2	82
13	Other construction	11.3	9.7	79.1	3.9	8.2	87.9
14	Wind energy	0.5	8.2	91.3	0	5.7	94.3
15	Other electricity	1.5	7.6	90.9	0.5	5.6	94
16	Metro transport services	6	5.6	88.4	5.5	4.1	90.4
17	Rail transport services (except metro)	4	5.5	90.5	0.7	4	95.3
18	Other transport services	5.1	10.3	84.6	0.2	10.3	89.5
19	Other services	8.6	5.1	86.3	4.9	5.4	89.7
20	Public administration and defence	7.7	0	92.3	3.5	0	96.5

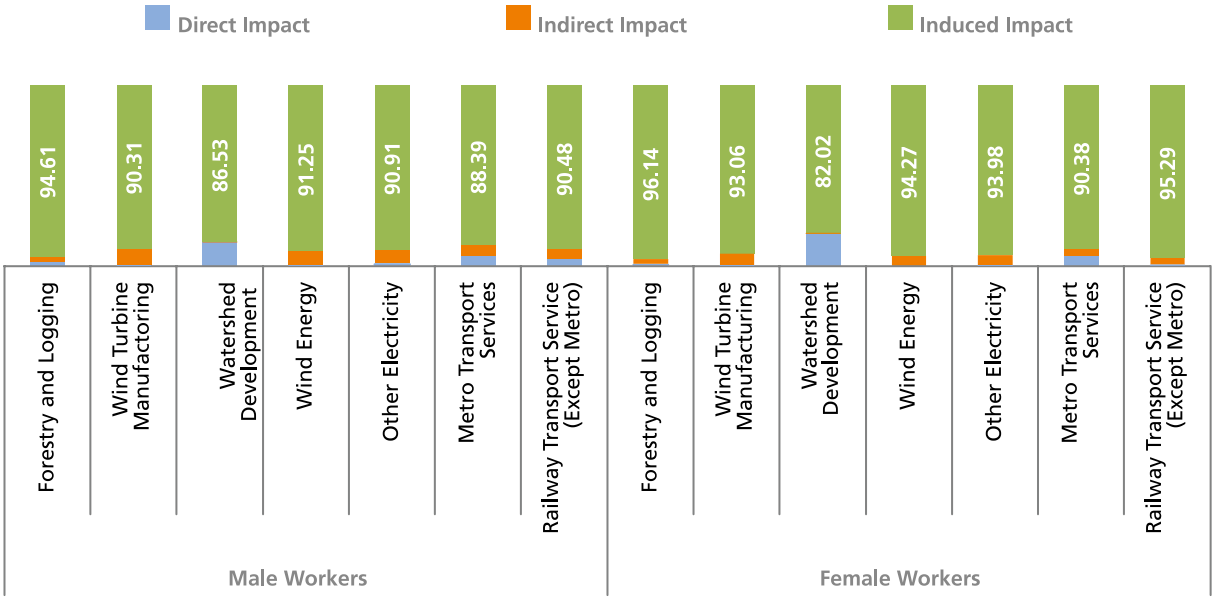
Male workers: The highest direct generation of employment for male workers is in agriculture (1.719), followed by bricks and tiles (0.656) (refer to Appendix VII). This means that 1.72 and 0.66 person-years of employment respectively are generated in these two sectors to produce INR 100 thousand worth of extra output. The share of direct employment impact in the total (closed) multiplier is also highest in agriculture (31 per cent), again followed by bricks and tiles (17 per cent). Indirect employment is highest in "Other manufacturing" (0.603). This indicates that 0.603 person-years of employment are generated in all other sectors of the economy to produce INR 100.000 worth of extra output in the aggregated "Other manufacturing" sector. The percentage share of the indirect employment generated for male workers is also highest in this sector (about 16 per cent). The induced effect is highest for the forestry and logging sector (3.317), followed by agriculture (3.279). In terms of percentage shares of the total multiplier, the impact on induced employment is highest in forestry and logging (95 per cent). Such consistently high impacts on induced employment in the forestry and logging sector reflect the fact that the feedback effect of households' additional income affects this sector the most. The forestry and logging sector requires inputs from various sectors, such as manufacturing, services, agriculture, and forestry and logging itself. These sectors are also relatively labour-intensive, so more employment leads to higher consumption. This in turn leads to greater demand and hence, more induced employment.

Female workers: For women workers, the agriculture sector generates the highest direct employment, with a multiplier of 0.862 (Appendix VII). The percentage share of direct impact as part of total impact is also the highest in agriculture, at 38 per cent (and higher than the 31 per cent for men). This highlights the continuing dominance of agriculture as a source of employment, as well as the high presence of females in this sector. The aggregated "Other manufacturing" sector has the highest indirect employment impact for female employment (0.229), followed by agriculture (0.220). The percentage share of indirect employment generated in the total (closed) multiplier is highest for the aggregated "Other manufacturing" sector (16.5 per cent), followed by "Other transport services" (10.3 per cent). As in the case of male workers, the forestry and logging sector shows the highest induced impact, as well as the highest percentage share of induced impact as part of the total (closed) multiplier (1.199 and 96 per cent respectively). This means that the employment generated in the forestry and logging sector is mostly induced by the second round of household consumption resulting from additional income.

The following figure shows the shares of the three impacts as part of the total impact for the study sectors, i.e. the percentage shares of the direct, indirect and induced impacts of the total (closed) impact.

Male workers: Among the study sectors, watershed development shows the highest direct employment impact (0.492) (Appendix VII). This is attributable to the labour-intensive nature of this sector. Moreover, 66 per cent of employment in this sector is male. All employment generated here is informal, as mentioned previously, and the strong feedback effects of this informal labour on consumption also leads to a high induced impact on employment (around 87 per cent of

Figure 6: Percentage shares of direct, indirect and induced employment multipliers by gender for green sectors



the closed employment multiplier). In terms of percentage shares, the watershed development sector shows the highest share of direct employment generation (in the total/closed multiplier) for male workers (around 13 per cent) (Table 14). On the other hand, the highest indirect male employment multiplier is found in the WTG manufacturing sector (0.305). This sector also has the highest share of indirect employment generation (around 9.4 per cent). Compared with the wind energy sector, the "Other electricity" sector shows a similar breakdown of employment effects, with the share of direct employment slightly higher (1.5 per cent versus 0.5 per cent) and the share of indirect employment slightly lower (7.6 per cent versus 8.2 per cent). The gender-based breakdown of this sector is similar, and therefore the multiplier effects are similar, too. Finally, as already mentioned, the forestry and logging sector shows the highest induced employment effect for the economy as a whole (around 95 per cent).

Female workers: For women workers, the relative positioning of the various sectors with regard to the multipliers and percentage shares of the impacts in the total (closed) multiplier is similar to those of male workers. The direct and indirect employment generation impacts are highest in the watershed development and WTG manufacturing sectors (0.253 and 0.077 respectively). Moreover, the induced employment effect is highest in the forestry and logging sector (1.199). Similarly, in terms of percentage shares, direct employment in the total (closed) impact is highest in the watershed sector (about 18 per cent), the indirect employment effect is highest in the WTG manufacturing sector (6.8 per cent) and the induced employment impact in the total multiplier is highest in forestry and logging (96 per cent) (Table 14).

Two points need to be noted:

- The employment generated as a result of induced income effects in the closed model is much greater than the employment generated under the open model (which takes into account only direct and indirect employment effects).
- The employment multipliers (direct, indirect and induced, see Appendix VII) for all sectors are greater for male workers. Despite recent developments in female workforce participation, the proportion of women in the Indian workforce remains very low. Figure 1 shows their participation to be around 26 per cent.

Employment effects by type and gender

The following table shows the formal and informal employment multipliers, as well as the shares of male and female employment generated as a result (male figure in parentheses). The table shows, for example, that the open formal employment multiplier for Agriculture and allied activities is 0.076, of which the male employment share is 80.7 per cent, and consequently the female share is 19.3 per cent.

Table 15: Formal and informal employment multipliers and gender percentage shares

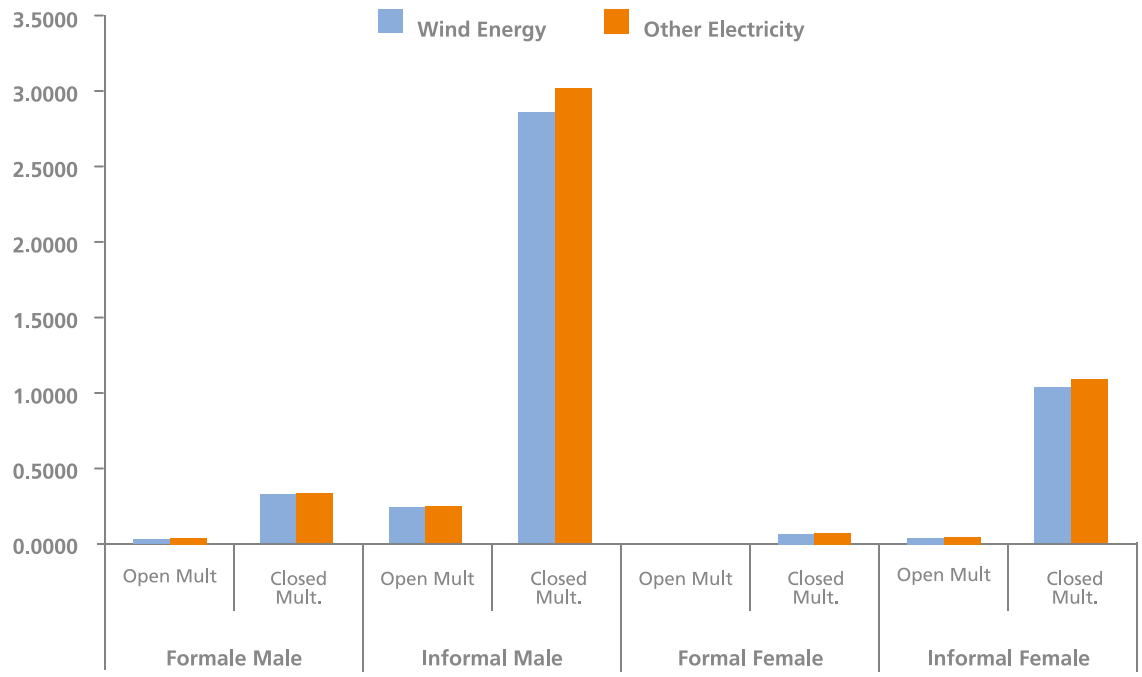
Sector	Formal employment		Informal employment	
	Open multiplier	Closed multiplier	Open multiplier	Closed multiplier
Agriculture and allied activities (except forestry)	0.076 (80.7)	0.463 (80.4)	3.208 (66.7)	7.285 (70.1)
Forestry and logging	0.024 (82)	0.416 (80.5)	0.213 (79.4)	4.338 (73.1)
Mining	0.042 (88.6)	0.411 (81.2)	0.340 (82.9)	4.223 (73.6)
Petroleum products	0.039 (87.9)	0.398 (81.1)	0.315 (82.5)	4.086 (73.5)
Bricks and tiles (structural clay products)	0.072 (83)	0.429 (80.8)	1.108 (79.1)	4.861 (74.2)
Cement	0.047 (83.6)	0.405 (80.8)	0.372 (80.2)	4.137 (73.4)
Non-metallic mineral products	0.060 (79.9)	0.411 (80.3)	0.806 (80.7)	4.503 (74.2)
Iron and steel (ferro alloys and casting & forging)	0.057 (82.6)	0.405 (80.7)	0.470 (78)	4.133 (73.4)
Rail and other transport equipment	0.056 (84.3)	0.407 (80.9)	0.478 (76.8)	4.180 (73.2)
Wind turbine manufacturing	0.068 (79.6)	0.414 (80.3)	0.326 (80)	3.970 (73.4)
Other manufacturing	0.074 (81.9)	0.435 (80.6)	0.951 (72)	4.761 (72.6)
Watershed development	0.002 (77.9)	0.382 (80.4)	0.756 (66.2)	4.769 (71.7)

Other construction	0.058 (84.6)	0.418 (81)	0.901 (84.2)	4.695 (75)
Wind energy	0.070 (79.5)	0.415 (81)	0.274 (82.4)	3.907 (73.3)
Other electricity	0.058 (83.8)	0.419 (80.9)	0.318 (80.7)	4.120 (73.4)
Metro transport services	0.327 (75.8)	0.702 (78.2)	0.212 (79.8)	4.162 (73.1)
Rail transport services (except metro)	0.090 (89.2)	0.455 (82.1)	0.292 (84.3)	4.142 (73.6)
Other transport services	0.089 (89.5)	0.443 (82.2)	0.580 (79.8)	4.299 (73.7)
Other services	0.123 (75.9)	0.496 (79.3)	0.510 (80.2)	4.441 (73.6)
Public administration and defence	0.249 (86.1)	0.630 (82.6)	0.062 (88)	4.079 (73)

Within formal employment, the percentage share of male employment is relatively high in all sectors for both the open and closed multipliers (as high as 89 per cent in the rail transport sector and 88.6 per cent in the mining sector, in the case of the open multipliers). For informal employment as well, the male employment share is higher than the female, though women are comparatively more involved as informal workers than as formal workers.

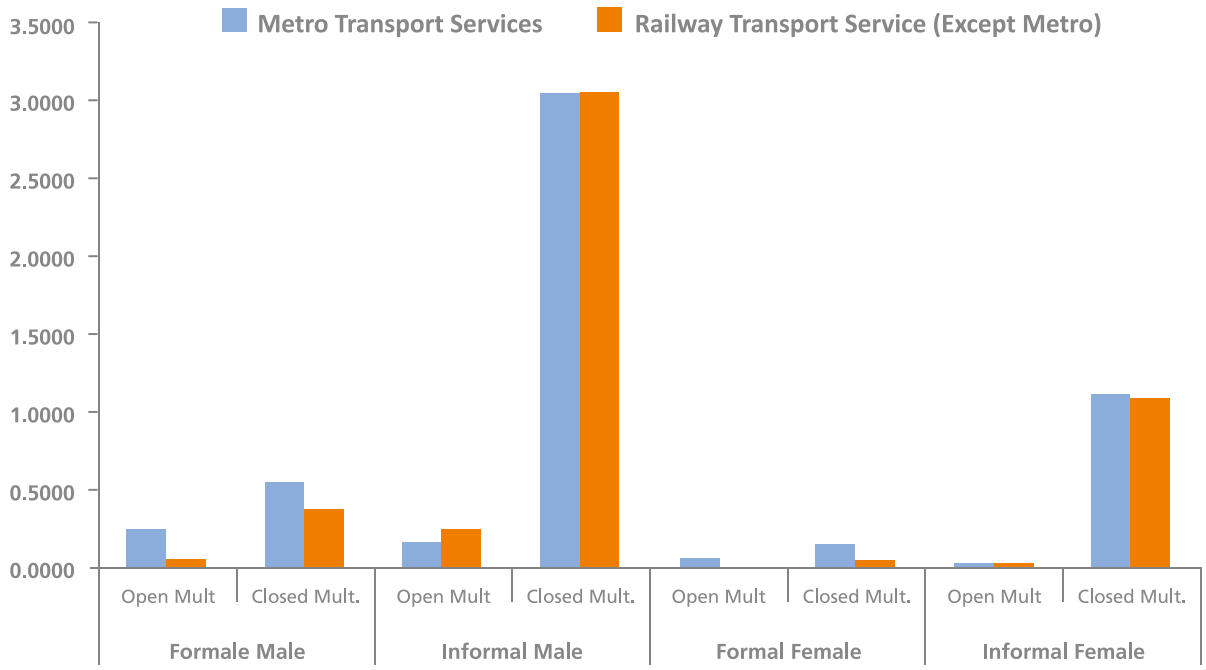
The figures below show the differences in employment structure for the green and conventional energy sectors:

Figure 7: Employment multipliers by type of employment and gender for the wind and "other electricity" sectors



The open and closed multipliers for informal male workers are the highest, followed by those for informal females. In both cases, the multipliers are slightly higher for the "Other electricity" sector than for the wind energy sector. As explained earlier, the wind energy sector is more capital-intensive and less labour-intensive.

Figure 8: Employment multipliers by type of employment and gender for the metro and rail transport sectors



4.5 Simulations

Multipliers show changes in the whole economy due to a unit change in demand for the output of any particular sector. The above discussion exhaustively sets out the open and closed multiplier analyses, and the difference between the two. In the following section, we use simulations to answer some of the questions often asked by policy-makers. These queries tend to arise because of the kinds of "what if?" analysis for which input-output tables can be used (e.g. What would be the impact on employment of a percentage change in the output generated by the wind energy sector?). Taking this further, simulations were carried out to gauge the impact of shocks on green sectors as a result of exogenous changes and to examine the effect on the economy in terms of output and employment. In this section, we present the findings of five simulation exercises, one for each of the green sectors, using open multiplier analysis. The simulations were carried out by positing a shock to total final demand (which remains exogenous to the model) in the sector concerned, expressed as a percentage change. This change could be the

result of any event, for instance government consumption or capital formation. Any exogenous shock to the IO model works through total final demand. The relevant equation here is:

$$X = (I - A)^{-1} * F$$

where X is the vector of sectoral outputs and F the vector of sectoral final demands. So any change resulting from government consumption or investment will lead to a change in the sector's total final demand (as these are components of final demand). For the purposes of our analysis, we therefore simulated a shock to the economy, expressed as a change in a sector's total final demand. The research question here is:

"For a 10 per cent increase in the final demand of a green sector, what is the change in the total output and total employment of the Indian economy by type and gender?"

Therefore, for each green sector we analysed the changes in the economy resulting from a 10 per cent rise in final demand for that sector's output. This operation was performed using the open model, for which private final consumption expenditure is a part of final demand, resulting in a greater volume of final demand. Multiplier analysis had already shown the relative positioning of open and closed model impacts.

The following table shows the results of the simulations for the five sectors using the open model.

Table 16: Results of simulations in green sectors

Sector	Increase in output (INR billion)	Increase in employment (numbers)								
		Formal		Total formal	Informal		Total in-formal	Total male	Total female	Total
		Male	Female		Male	Female				
Forestry and logging	49.9	8860	2097	10956	79152	28122	107275	88012	30219	118231
WTG manufacturing	10.0	2938	695	3633	26244	9324	35569	29182	10020	39202
Watershed development	45.1	25607	6060	31668	228780	81284	310064	254388	87344	341732
Wind energy	3.0	783	185	968	6993	2485	9477	7776	2670	10445
Other electricity	93.1	26267	6216	32484	234674	83378	318052	260942	89594	350536
Metro transport Services	1.4	577	136	713	5152	1831	6983	5729	1967	7696
Rail transport services (except metro)	100.8	28784	6812	35596	257164	91368	348532	285948	98180	384128

The rail transport services sector has the highest impact on the economy in terms of value of output and employment. An INR 53.2 billion increase (the equivalent of a 10 per cent rise) in final demand for this sector's output leads to an increase in output of around INR 101 billion in the economy as a whole, effectively doubling the volume of final demand, while total

employment in the economy increases by 384 thousand workers. Table 16 gives a breakdown of this employment by type and gender. In comparison, a 10 per cent shock to final demand for metro transport services leads to an increase in output of INR 1.4 billion, while a similar shock to the watershed development sector, equal to INR 43.5 billion, results in an increase of approximately INR 45 billion in total economic output and additional employment of 341 thousand workers. A 10 per cent shock to the forestry and logging sector (INR 35 billion) leads to a rise of around INR 50 billion in terms of output, and additional employment of around 120 thousand workers. The inter-sectoral linkages of each of these sectors is the factor that plays the major role in generating employment throughout the economy. In volume terms, a large sector has a larger impact. For example, the railway sector contributes nearly 1 per cent of the economy's GVA and therefore has a much bigger effect in volume terms than the metro services sector, which contributes only around 0.01 per cent to national GVA. Moreover, the railway sector is interlinked with many more sectors than the metro services sector. A shock to the railway sector therefore stimulates more industries than does a shock to the metro sector. As a result, the impact of the railway sector on output and employment is higher than that of the metro sector.

Caveat

The utility of the input-output model as a tool for empirical analysis depends on the dependability of the "A" matrix of technical coefficients. In such analysis, there is a basic assumption that the IO coefficients are constant, in other words that over short periods of time (two to four years) there is no technological change in sectoral production processes. This drawback can be overcome by carrying out surveys for specific dynamic sectors (such as IT) in order to modify their coefficients. In the case of new sectors, the coefficients are calculated in specific industry surveys and thus are more current.

There is also a strong assumption of a single production process in each sector.

We also need to bear in mind that input-output tables aggregate different-sized firms into a single industry, and this may introduce variations in the technology adopted in a particular sector.

It is also necessary to bear in mind the size of the various sectors in making employment projections, as we have done in this study, because the size of a sector can be critical in determining whether an increase in output will have a major or only a minor effect on job creation in the economy as a whole.

5. Conclusions

Under the pressure of climate change, the global development agenda is gradually adopting a greener approach, with the focus on "decent" green jobs. The transition will require cooperation between employers, employees and policy-makers, especially in developing countries. This being the case, the ILO commissioned a study from the NCAER to evaluate the social dimensions (growth and employment) of certain "green" sectors of the Indian economy. The objective of this study was to investigate sectoral job creation, using two types of multiplier analysis, namely the open and closed multipliers. Six sectors were analysed: the four green sectors of forestry and logging, watershed development, wind energy and metro services, and the two related sectors of WTG manufacturing and rail transport services. The methodology adopted was the input-output model. The latest all-India input-output table for 2007-08, published by the CSO, was updated to the year 2009-10 (keeping technical coefficients constant) and the IO model was derived from it (using the commodity x commodity matrix).

For the purposes of this study, four "new" sectors were disaggregated from existing sectors of the IO table: watershed development, wind energy, WTG manufacturing and metro transport services (forestry and logging and rail transport sectors were already classified separately in the national IO table). The forestry and logging sector was adjusted to incorporate field-level data. Using primary and secondary data, the IO table, initially comprising 16 sectors, was disaggregated to include the four new sectors, thus consisting of 20 sectors in all. Output and employment multipliers were then calculated to gauge the growth and job creation potential of these sectors. These multipliers were derived using an open and a closed model. The closed model includes household expenditure as endogenous and treats households as a separate sector. If there is an increase in the output of any sector, the incomes of workers in that sector and other interlinked sectors will increase. This will stimulate demand and lead to a further round of consumption, which in turn will lead to a increases in output and employment, until the economy reaches a new equilibrium. This system is said to be "closed" with respect to households, and increases in output and employment due to their inclusion in the system are referred to as "induced" effects. Closed multipliers therefore include the induced effects (as well as the direct and indirect effects captured in the open multipliers). However, a time series study would be necessary to fully capture the dynamic nature of these new sectors.

The baseline analysis reveals that agriculture accounts for around 16 per cent of the economy's GVA, while the forestry and logging sector accounts for 1.7 per cent. This simply indicates that the sectors we are studying are small in size relative to other sectors of the economy, especially since some of the other sectors are highly aggregated, while our key sectors have been disaggregated from their "mother" sectors. Moreover, these are dynamic sectors that need nurturing. The share of the study sectors is also low with respect to employment: they employ less than 1 per cent of the Indian workforce. Whereas the traditional electricity sector employs around 0.2 per cent of the total workforce, wind energy generation (electricity) employs far less (0.003 per cent). The metro transport services sector employs only formal

workers. In general, informal employment is higher than formal employment in all sectors, except for metro transport services and public administration. As expected, the data also show that male employment is higher than female employment in all sectors. More strikingly, the most women-friendly of the study sectors is watershed development, where women constitute 34 per cent of the labour force, as compared with 10 per cent in "Other construction". It is also noteworthy that metro transport services employ 24.5 per cent women, as compared with 6 per cent in the railways sector. The wind energy sector employs only males, while the WTG manufacturing sector is estimated to employ 15 per cent females.

The IO model developed for India, with the green sectors disaggregated from their various mother sectors, provides us with a tool for analysing the output and employment-generating potential of these sectors of the economy. The output multiplier of a sector (for example, agriculture) is the total increase in production in all sectors of the economy required to satisfy a unit increase in the final demand of the sector concerned (in this case agriculture). The "backward linkages" of the agricultural sector will stimulate demand for the products of other sectors when agricultural production rises. The agricultural sector will also draw on itself for the additional one unit of production, as a sector is generally an aggregation of homogenous sub-sectors. The direct, indirect and induced impacts together make up the closed output multiplier. The column sums of the inverse matrix of the closed model give the closed output multipliers of each sector.

It is revealing that wind energy generation employs less labour per unit of production than the "Other electricity" sector. But the indirect effect of the wind energy sector is higher than that of the "Other electricity" sector. Viewing the net result, however, the wind energy sector employs comparatively less labour than the conventional energy sector. The lower employment intensity in the wind energy sector is due to the low level of direct employment it generates. The bulk of the employment it generates is due to its indirect effects on interlinked sectors. The "Other electricity" sector, a major part of which is conventional electricity, is more labour-intensive and is also interlinked with other labour-intensive sectors, such as mining. The study shows that the percentage share of the indirect employment effect in the total (closed) multiplier is highest for WTG manufacturing. We find that the three types of impacts (direct, indirect and induced) are much higher in the case of informal workers than of formal workers (except for the impacts of direct employment generation in public administration and metro transport services). The direct employment impact for informal workers is highest in agriculture.

The gender analysis part of the study also produced interesting findings. Among the study sectors, the watershed development sector has the highest direct employment impact, and roughly one third of new employment in this sector involves male workers. The employment multipliers are greater for male workers in all sectors. Within formal employment, the percentage share of male employment is much higher in all sectors, as calculated by both the open and the closed multipliers. In informal employment, too, the male share is higher than the female, but women are comparatively more involved than they are in the formal sector.

5.1 Simulations

5.1.1 Multipliers

Output Multipliers

- The output multiplier (open) of the wind energy sector is 2.7, which is higher than the figure for "Other electricity" (2.21). The total (closed) multiplier is also higher (7.33 as against 7.05). This is striking because, in terms of GDP share, the wind energy accounts for 0.02 per cent. This indicates that wind energy generation is more productive than other conventional sources of electricity.
- The WTG manufacturing sector has a high output multiplier (open) of 2.69. This highly specialized sector requires massive capital inputs, which mostly stimulates manufacturing industry. This sector's strong backward linkages lead to the further stimulation of related sectors. The total (closed) output multiplier for WTG manufacturing is as high as 7.33. The turbine manufacturing industry caters exclusively to the wind energy generation industry and is highly capital intensive. Its interlinkages are with manufacturing industries and the endogenization of households therefore results in large feedback effects, as various sectors are stimulated.
- Metro transport services have a lower open output multiplier (1.78) than rail services (1.9) and an almost equal closed output multiplier (6.81 and 6.80 respectively). This indicates that, though in the open model the metro transport service sector may be less productive than the railways sector, when households are endogenized the formal labour employed in metro services induces more demand and consumption, and thus output.
- The watershed development sector's output multiplier (open) is 1.04, which is to be expected, as this sector is less productive and very labour-intensive.

Employment Multipliers

- As anticipated, watershed development is the study sector with the highest open and closed employment multipliers (0.76 and 5.15 respectively), as it is very labour-intensive. However, most of this labour is informal.
- The employment multipliers (open and closed) for the wind energy sector are slightly lower than those of the "Other electricity" sector. This is explained by the labour–output ratios of these sectors, in other words their direct effects. Wind energy generation employs less labour per unit of production (0.02) than the "Other electricity" sector (0.06). But the indirect effect of wind energy (0.32) is higher than that of the "Other electricity" sector (0.25). This, coupled with the output multiplier results (the output multipliers for the wind energy sector are higher than those for "Other electricity"), indicates that the wind energy sector employs comparatively less labour to generate output. The "Other electricity" sector, a major part of which is accounted for by conventional electricity, is more labour-intensive and is also interlinked with other labour-intensive sectors, such as mining.

- Metro transport services, on the other hand, employ more labour per unit of output than railways. As a result, the open (0.54) and closed (4.86) employment multipliers for the metro transport services sector are higher than those for railways (0.38 and 4.6 respectively).
- The watershed development sector has one of the highest labour-output ratios of all the sectors of the economy (0.75). It is also interlinked with various other sectors (as mentioned above). This can be seen in the coefficient matrix (Table 10).
- Among the study sectors, the share of direct employment generation as part of the total impact for formal workers is highest in the metro transport services sector (41 per cent). The railways sector has a much lower share of formal employment (44 per cent). Direct employment generation is also much lower (14 per cent) in the case of formal employment. Most of the employment generated in the formal railway sector is due to the induced income effect. In the case of metro services, the induced impact share is much lower (53 per cent). Since the metro sector does not employ informal labour, its direct effect share of informal employment is zero. But indirect informal employment generated in other sectors accounts for 5 per cent of the closed multiplier. In the case of both the metro and rail transport sectors, more than 90 per cent of the closed multiplier for informal employment is attributed to the induced effect. This shows that, where informal labour is concerned, the feedback effect is very high, indicating that income from informal labour induces much higher consumption, resulting in additional income and further rounds of consumption, output and employment.
- In the case of "Other electricity", the share of indirect formal employment generated is slightly lower (around 10 per cent). For both the "Other electricity" and wind energy sectors, employment generated by the induced income effect is quite high (between 80 and 90 per cent). Where the percentage of this indirect effect as part of the total impact is concerned, the wind energy sector has the second highest share in the economy as a whole. The indirect requirements of this sector are very high (NCAER, 2012), as the inter-sectoral linkages are very strong.
- The share of formal employment in the WTG manufacturing sector is nearly 72 per cent. This sector also has interlinkages with other specialized manufacturing sectors. Its share of the indirect impact in the total multiplier for formal employment is therefore close to 15 per cent, while the bulk of the remainder counts towards induced impact.
- The share of the induced employment impact as part of the total impact on formal employment is highest in the watershed development sector (99.6 per cent), which is also the highest figure for the economy as a whole. Almost all of the formal employment effects of this sector are a result of the induced impact arising from additional household income and the resulting consumer demand. This is because this sector does not employ formal labour. Any formal employment generated by this sector is via indirect linkages to other industries, such as cement and stone aggregates (non-metallic mineral products). The share of direct employment generated as part of the total employment impact for informal workers in watershed development is around 16 per cent. If we examine this closely, direct employment of formal workers in this sector is zero, while the figure for the direct employment of informal workers is the highest for all the study sectors, and third highest in the economy as a whole.

- Among the study sectors, watershed development has the highest direct employment effect (0.492) where male employment is concerned. This is attributable to the labour-intensive nature of this sector. Moreover, 66 per cent of employment in this sector is male. In terms of percentage shares, the watershed development sector accounts for the highest share of the direct employment effect (in the total/closed multiplier) for male workers (around 13 per cent).
- On the other hand, the highest indirect male employment multiplier is found in the WTG manufacturing sector (0.305). This sector also has the highest share of the indirect effect for all employment (around 9.4 per cent). Compared with the wind energy sector, the breakdown of the various effects in the "Other electricity" sector is similar, with the share of the direct effect slightly higher (1.5 per cent as against 0.5 per cent), and the share of the indirect effect slightly lower (7.6 per cent as against 8.2 per cent). The gender-based breakdown of this sector is similar, which is why the multiplier effects are also similar. Finally, as mentioned earlier, the forestry and logging sector has the highest induced employment effect in the whole economy (around 95 per cent).
- The direct and indirect employment impacts for female employment are highest in the watershed development and WTG manufacturing sectors (0.253 and 0.077 respectively). Induced employment generation is also highest in the forestry and logging sector (1.199). Similarly, in terms of percentage shares, direct employment as part of the total (closed) impact is highest in the watershed sector (about 18 per cent), indirect employment is highest in the WTG manufacturing sector (6.8 per cent), and induced employment is highest in forestry and logging (96 per cent).

5.1.2 Simulations

Simulations were carried out for the study sectors using the open model, which, unlike the closed model, does not include households. The final demand component was raised by 10 per cent to gauge the effects of a shock of this kind on growth and employment. We obtained the following results:

- The rail transport services sector had the highest impact on the economy as a whole in terms of output and employment. A 10 per cent increase in final demand for this sector's output led to an increase in output of around INR 101 billion and an increase in total employment of 38 thousand workers. In terms of the mass of final demand, this is a large sector, so the shock to final demand resulted in larger changes. In comparison, a 10 per cent shock to final demand in the metro transport services sector increased output by INR 1.4 billion and employment by 7,700 workers.
- A 10 per cent shock to final demand in the forestry and logging sector led to an increase in output in the economy as a whole of about INR 50 billion, which is higher than the corresponding figure for the watershed development sector (INR 45 billion). However, employment generation as a result of the shock was higher in watershed development (34 thousand workers) than in the forestry and logging sector (11,800 workers).

- The shock to the wind energy sector had a much lower impact on total economic output (INR 3 billion) and total employment (10 thousand workers) than on the "Other electricity sector" (INR 93 billion and 35 thousand workers).
- The shock to the WTG manufacturing sector resulted in an increase in output of INR 10 billion and an increase in employment of 39 thousand workers.

5.2 Data limitations and the way forward

We encountered a number of data gap problems in the course of this study, as detailed below:

- The sample surveys for the watershed development sector were carried out in two states. The data related to the use of various inputs for different types of construction activities, but the input structure for each state was slightly different hence one to one comparison was not possible. Hence, it was finally decided to use the data from both states.
- A larger sample would have accounted for regional differences in the input make-up of watershed structures.
- The companies surveyed for the wind energy sector could not give very specific data on the operation of wind turbines (to generate electricity), which is the relevant green activity for this study. Their accounts usually contain combined data for various activities that form part of the companies' operations. The survey team therefore encountered problems in trying to dissociate the inputs for the operation of the wind turbines from those required for manufacturing the turbines.
- The issue of whether or not to invest in green sectors of the kinds covered in this study depends on cost-effectiveness assessments. In the short term, investing in a green sector, for example the wind energy sector, is expensive, due to the costs involved in the construction of turbines and other infrastructure. In the long term, however, the operations become cost-effective. But the time-lag in transitioning from the short to the long term also plays a role. The issue therefore becomes one of the motivation required to invest in a green sector and, hence, the need for a policy that would encourage such investment.
- In addition, the transition from short term to long term in the case of the WTG manufacturing sector needs to be evaluated to gauge whether the environmental impact of manufacturing the various components is more than compensated for by the operation of WTGs over their lifespans. We would suggest that all WTG manufacturers should undertake a life-cycle assessment of their turbines. A life-cycle assessment is both a mapping and an evaluation of the potential impact of a wind turbine on the external environment throughout its 20-year lifespan, taking into account its operation, maintenance and eventual disposal. The long-term impact of a WTG is, of course, better than the short term.
- The study also reflects the need for policy decisions regarding employment structures in various sectors (and not only the green sectors) of the economy. The massive presence of informal labour, as well as the dominance of male workers, needs to be tackled immediately so that India can benefit from the major untapped employment potential.

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Appendix I

Conceptual framework of an input-output table

1. What is an IO table?

An input-output table gives a comprehensive and detailed account of sales and purchases of goods and services among the producing sectors, final consumers (households, exports and government), and resource owners (generally labour, capital and land) of a specific economy or state during a particular time period (usually one year). The information from an IO model is presented in a format called an IO table (IOT). This framework was developed by Wassily Leontief in the 1930s, for which he was awarded the 1973 Nobel Prize in Economics. A very general and simplified sector-by-sector overview of an IOT is presented here. A standard IOT can be viewed as consisting of three major components (also known as blocks or quadrants): inter-sectoral transactions (block A), final demand (block B), and value added (block C). Each of these blocks consists of a series of rows and columns. The producing or selling sectors are shown in rows and they are often referred to "row" sectors. Similarly, the purchasing or buying sectors are shown in columns and hence they are known as "column" sectors.

Block A, the inter-sectoral transactions portion of the table accounts for intermediate sales and purchases of goods and services among the producing sectors of the economy. Reading across a row of the transactions table, we see the inter-sectoral sales made by the row sector to the various column sectors. Similarly, reading down a column, we see the inter-sectoral purchases made by the column sectors from the various row sectors.

Block B shows the sales of goods and services made by each row sector to final users. These include households (household final consumption expenditure (HFCE), or PFCE if the final consumption expenditure of non-profit institutions serving households is merged with HFCE); central, state and local government units (government final consumption expenditure); investment (gross capital formation, comprising gross fixed capital formation, changes in stocks and commodities); and net exports. The elements of Block B are final demands for goods and services produced within the economy that are available from domestic production and stocks, and also imports.

Block C shows primary inputs, i.e. payments to the owners of resources (the primary factors of production). These include human resources (labour), natural resources (land, mines), produced resources (fixed capital formation), financial resources, and also taxes (minus subsidies) on product-related payments to government.

2. Components of the input-output table

The components of an IOT are described below:

Intermediate demand

Intermediate demand is the inter-sectoral transactions block of an IOT. Estimated figures in this block show the flow of goods and services that are both produced and consumed among the sectors. In other words, intermediate demand refers to the inputs that different sectors purchase for the purpose of transforming them into a different product for subsequent sale.

Final demand

Final demand refers to purchases of products for final consumption or use, i.e. not for further production or resale. The components of final demand, or the final users, are classified into the following six categories:

2.1 Private final consumption expenditure (PFCE)

PFCE refers to household final consumption expenditure and the final consumption expenditure of non-profit institutions serving households. This expenditure relates to purchases (minus disposals) of durables (except for residential dwellings or land), as well as non-durable goods and services. There are two concepts of household final consumption expenditure: final consumption expenditure in the domestic market and final consumption expenditure of resident households. The former concerns the expenditure of resident and non-resident households in the domestic market. The PFCE of resident households is estimated by adding resident households' direct purchases from abroad and deducting direct purchases in the domestic market made by non-resident households. Consumption expenditure also includes the imputed gross rent of owner-occupied dwellings, consumption of own account production evaluated at producers' prices, payments in kind (valued at cost) of wages and salaries for domestic help, and indirectly measured financial intermediary services (FISIM) allocated to households.

2.2 Government final consumption expenditure (GFCE)

GFCE represents the current consumption expenditure of government in general. This expenditure comprises the remuneration of employees, consumption of fixed capital (CFC) and final consumption of products (purchases of goods and services, including repair and maintenance, less sales) by all administrative departments at all levels of the government. The total GFCE is divided on the basis of economic classification into the sectors of education, medical and health, construction, public administration and defence, and others. All relevant

expenditure is allocated to its respective sector, except in the case of public administration and defence, where only the remuneration of employees and CFC are so allocated.

2.3 Gross fixed capital formation (GFCF)

GFCF refers to the acquisition, less disposals, of fixed assets. It is a form of investment generated from the total output of the various sectors, as well as from imports of capital goods. Fixed assets comprise buildings, machinery and equipment (including transport equipment and additions to breeding stock, draught animals, dairy cattle and the like). Construction activity covers all new constructions, alterations to buildings, highways, streets, bridges, culverts, railroad beds, railroads, subways, airports, parking areas, dams, drainage systems, wells and other irrigation sources, water and power projects, communication systems such as telephone and telegraph lines, land reclamation, land improvements, the planting and cultivation of new orchards, tea, coffee and rubber plantations, afforestation projects and all other types of heavy construction. GFCF also includes the acquisition, less disposals, of intellectual property (the results of mineral exploration, software, data bases) and, as per the 2008 SNA, expenditure on research and development. Valuables, as per 2008 SNA, are kept apart from GFCF as a separate category but are part of gross capital formation.

2.4 Change in stocks (CIS)

CIS refers to increases/decreases in inventories during a period of account. It is the difference between the market/book values of stocks at the beginning and end of the year. CIS can be held by either a producer or a trader. This is a part of gross capital formation (investment).

2.5 Exports (E) and Imports (M)

Exports refer to sales of commodities to non-resident entities. In practice, exports of goods consist of the outward movement of merchandise across the customs frontier of a country and of other goods across the economic boundaries of its domestic territory, including direct purchases made within the country by extra-territorial organizations and non-resident persons. Exporting is defined as the supply of products by resident entities to non-resident entities.

Importing, on the other and, refers to purchases from non-resident entities. Imports of goods and services consist of the inward movement of merchandise, goods and services across the customs frontier of a country and of other goods across the economic boundaries. Importing is defined as the supply of products by a non-resident entity to a resident entity.

Other components of an IOT are:

Gross value added (GVA)

The GVA of a sector is the gross output valued at factor cost (at basic prices, as per 2008 SNA) less the price paid by the purchaser for intermediate inputs. if we take an income approach, it also equals the sum of the remuneration paid to employees, the combined income of the self-employed, the consumption of fixed capital and the operating surplus. The value added or total income is distributed between two factor inputs, namely labour and capital. In other words, income is distributed in the form of remuneration to employees, or wages to the labour employed, and an operating surplus (the income of the owner of resources, other than human labour). GDP is the of GVA from all sectors of the economy and taxes, minus subsidies on products.

Gross value of output

The value of all the goods and services produced during the period of account, including the net increase in work-in-progress and products for use or capital formation on own account, is called gross value of output. It is usually valued at basic prices, i.e. without including taxes or subsidies.

Indirect taxes

Indirect taxes are taxes assessed in respect of the production, sale, purchase or use of goods and services, which producers charge to expenses. Indirect taxes may be either commodity taxes or other indirect taxes. Commodity taxes include union and state excise duties, sales taxes, customs duties (on imports and exports) and various other duties and cesses. Other indirect taxes include such levies as electricity duty, motor vehicle tax, entertainment tax, stamp duty and so on. Their effect is to make the price paid in a transaction higher than the actual receipts of the factors of production involved. Direct taxes do not have the same effect, since they do not impinge directly on transactions but are levied directly on income. Indirect taxes, on the other hand, need to be added to obtain market price figures as opposed to figures at factor cost.

Subsidies

Subsidies are grants made on a current account basis by government to private-sector and public companies, and grants made by public authorities to enterprises, in compensation for operating losses, when such losses are clearly the consequence of a government policy to maintain prices at a level below the cost of production. In the case of government-operated irrigation schemes, operating losses are classified as subsidies.

3. Construction of an input-output transactions table (IOTT)

An IOTT can be constructed, whether on a product-group or industry-group basis, by making use of two basic matrices, namely the "absorption" matrix and the "make" matrix. These matrices furnish the basic information on the uses and supply of products in the economy.

In the following section, we shall use the following notations:

X = (X_{ij}): Absorption matrix , **Xij**: i^{th} product use by industry j for its production,

M = (m_{ij}): Make matrix, **mij** : i^{th} industry produced output of j^{th} product,

f: Final use of products, **y**: Primary incomes,

q : Outputs of products, **g**: Outputs of industries

B : Product x Industry coefficient matrix, **<I**: Final use of the industry output mix

A : Product x Products coefficient matrix, **W**: Products x Products flow matrix

E : Industry x Industry coefficient matrix, **Z** : Industry x Industry flow matrix

An absorption matrix consists of three main parts: (i) a products analysis of purchases of intermediate goods and services by industry groups, i.e. input flow; (ii) a products analysis of purchases by final users, i.e. final use or demand and (iii) an analysis of primary inputs into the industry, consisting of wage and non-wage income, i.e. the gross value added in the industry.

Absorption matrix

To	Industries								Final use	Product output
Products	1	2	.	.	j	.	.	n		
1	X_{11}	X_{12}	.	.	X_{1j}	.	.	X_{1n}	f_1	q_1
2	X_{21}	X_{22}	.	.	X_{2j}	.	.	X_{2n}	f_2	q_2
.	.	.	.	.	.	.	.	.	.	.
i	X_{i1}	X_{i2}	.	.	X_{ij}	.	.	X_{in}	f_i	q_i
.	.	.	.	.		.	.	.	.	.
n	X_{n1}	X_{n2}	.	.	X_{nj}	.	.	X_{nn}	f_n	q_n
Primary inputs	y_1	y_2	.	.	y_j	.	.	y_n		
Industry output	g_1	g_2			g_j			g_n	F	X

It should be noted that industries produce both products and by-products. Therefore the output of industry i (g_i) will not be equal to i^{th} product output in the economy as a whole (q_i). However, the total output from all industries (Zg_i 's) will be equal to the total output of all products (Zq_i 's). The absorption matrix is a product x industry matrix.

A make matrix is an output matrix of products and by-products (at basic prices). The rows here represent industry groups and the columns product groups.

Make matrix

To	Products								Industries output
from Industries	1	2	.	.	j	.	.	n	
1	m_{11}	m_{12}	.	.	m_{1j}	.	.	m_{1n}	g_1
2	m_{21}	m_{22}	.	.	m_{2j}	.	.	m_{2n}	g_2
.	.	.	.	.	.	.	.	.	.
i	m_{i1}	m_{i2}	.	.	m_{ij}	.	.	m_{in}	g_i
.	.	.	.	.		.	.	.	.
n	m_{n1}	m_{n2}	.	.	m_{nj}	.	.	m_{nn}	g_n
Primary inputs	q_1	q_2	.	.	q_j	.	.	q_n	

It is the make matrix that provides the outputs of products in an economy where industries produce both products and by-products. A make matrix is an industry x product matrix.

The accounting framework underlying the input-output system is therefore the following:

Accounting framework

	Products	Industry	Final use	Total
Products		X	f	q
Industry	M			g
Primary input		y'		
Total	q'	g'		

The notations f, q and g are for column vectors of final uses of products, product outputs and industry outputs, while y', q' and g' are the row vectors of GVA, product outputs and industry outputs.

Whereas the basic IO table, which is in the form of an absorption matrix, is a product x industry table, for modelling purposes pure matrices are preferred, i.e. a product x product table that is suitable for product planning and an industry x industry table that is suitable for industry planning. The pure matrices (product x product and industry x industry) can be obtained by matrix operations under certain assumptions: (a) an industry technology assumption, (b) a product / commodity technology assumption or (c) a mixture of the two. The technology assumptions, used for transferring the outputs of secondary products, are described below.

An industry technology assumption is one whereby the input structure of a secondary product is considered to be similar to that of the industry that produced it.

A commodity (product) technology assumption is one whereby the input structure of the secondary product is assumed to be similar to that of the industry in which it is primarily produced.

Working with either of these assumptions, the pure matrices can be obtained by making use of the basic matrices and the derived matrices of the make matrix, namely the "product mix" and "market share" matrices, C and D.

C: Product mix matrix. The columns show the proportions in which a particular industry produces various products: $C = M' g^{*-1}$

D: Market share matrix. The columns show the proportions in which various industries produce the total output of a particular product: $D = M q^{*-1}$ where q* and g* are diagonal matrices and so are their inverse.

The pure matrices, obtained under both assumptions, are summarized in the following table:

Symmetrical or pure matrices

	Products	Industry	Final demand
Product	$A=BC^{-1}$ (Product tech. ass.)	$B=Xg^{*-1}$	f
	=BD (Ind.tech. ass.)		
	$W=Aq^{*}$		
Industry	Product mix matrix $C=M' g^{*-1}$	$E= C^{-1} B$ (Product.tech.ass.)	$<I=C^{-1} f$ (Product.tech. sss)
	Market share matrix $D=M q^{*-1}$	= DB (Ind.tech. ass.)	$<I=D^{f}$ (Ind.tech. ass.)
		$Z=Eg^{*}$	

In the present study, the national-level IOT taken into consideration is a poduct x product matrix, working with the industry technology assumption. This pure matrix is a square matrix, in which the row totals and column totals are equal. This matrix is then converted into the multiplier matrix or the IO model.

Input-output table at factor cost prices

The IOT, compiled from the basic data for input flow and final uses, is expressed at purchasers' prices, since all the material inputs purchased by the various industries are at purchasers' prices, as are all the final use items of expenditure. In the columns, industry output is expressed at basic prices and the difference between an industry's output (at basic prices) and the sum of its intermediate inputs (at purchasers' prices) is the GVA at basic prices (or at factor cost prices if taxes on production are excluded). The make matrix gives the product outputs at basic prices.

The outputs at basic prices are converted to purchasers' prices by marking them up by trade and transport margins, as well as by taxes (minus subsidies) on products. The IOT at purchasers' prices is then balanced to match each of the product row sums and the product outputs at purchasers' prices derived from the make matrix. The balanced IOT at purchasers' prices is converted to basic prices in two steps. First, it is converted to producers' prices by removing trade and transport margins on products from each of the entries and placing the margins so deducted from the various column entries against the respective trade and transport product sectors in the same column. The IOT at factor cost prices (basic prices) is obtained from the IOT expressed at producer's prices by removing the indirect taxes and subsidies (taxes on products minus subsidies on products) from each of the entries and placing the net taxes so deducted from the various column entries at the bottom, against a new row of net indirect taxes (taxes on products minus subsidies on products) on intermediate inputs.

Overview of an input-output symmetric matrix

	Sectors (Inputs)	Final Uses Vectors	Total
Sectors Supply	**Block A** Intersectoral transactions	**Block B** Final demand (sales to households, government, gross capital formation, and net exports)	Total sector output (sales)
Primary income payments	**Block C** Primary payments (payments for labour, capital, land, subsidies, taxes on products)		Total primary payments
Total	Total sector input (purchases)	Total final expenditures	

The IO table is based on an accounting framework in which the total receipts of sellers must balance the total expenditure of buyers. By this convention, total output (sales, including final demand) is equal to total input (purchases, including final payments to owners of resources) for each producing sector of the economy.

Schematic structure of an input-output table

The economy is divided into a number of homogeneous sectors, each of which is represented in the table by a row and a column. The row corresponding to a particular sector shows the usage pattern of the total supply of the sector, while the column provides details of the inputs absorbed by the sector. The entry in the cell formed by the i^{th} row and j^{th} column is the value of the output of sector i consumed as input by sector j and is generally denoted by X_{ij}. The output of sector j is denoted as X_j.

The IOT provides a detailed description of the production side of the economy. For the sake of simplicity, we have divided the whole economy into four sectors[4].

- Agriculture: agricultural products
- Mining: mineral products
- Manufacturing: manufactured products
- Services: service sector output

These four sectors use inputs from two main sources:

- Domestically produced commodities from the four sectors (intermediate inputs),
- Other inputs, such as imports, labour, and capital.

The outputs of these four sectors have two broad uses or destinations:

- Inputs to the four sectors for use in production (intermediate inputs),
- Final demand (private final consumption expenditure, government final consumption expenditure, investment (gross fixed capital formation and CIS), exports and imports). The imports are shown as negative entries under final demand.

The following is a schematic description of an IO table in which the economy has been broken down into four broad sectors: agriculture, mining, manufacturing and services.

Table A.I.1: Schematization of input-output table

Sectors	Intermediate demand				Final demand					Total
	Agriculture	Mning	Manufacturing	Services	Household consumption	Investment	Government consumption	Exports	Imports	
Agriculture	X_{11}	X_{12}	X_{13}	X_{14}	C_1	I_1	G_1	E_1	M_1	X_1
Mining	X_{21}	X_{22}	X_{23}	X_{24}	C_2	I_2	G_2	E_2	M_2	X_2
Manufacturing	X_{31}	X_{32}	X_{33}	X_{34}	C_3	I_3	G_3	E_3	M_3	X_3
Services	X_{41}	X_{42}	X_{43}	X_{44}	C_4	I_4	G_4	E_4	M_4	X_4
Net indirect Taxes	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	0	T
Total value added (distributed to labour and capital)	V_1	V_2	V_3	V_4	0	0	0	0	0	V
Wages to labour	wL_1	wL_2	wL_3	wL_4	0	0	0	0	0	W

4 This is a simplistic classification. In real-life applications, one generally uses the classification used in the standard state accounts.

Capital	K_1	K_2	K_3	K_4	0	0	0	0	0	K
Total	X_1	X_2	X_3	X_4	C	I	G	E	M	X

Glossary of terms

X_1 = the output of sector 1,

Similarly X_i = the output of any sector i, where i can be sector 1 to sector 4 in our example. $X_{1,1}$ = the output of agriculture (i.e. sector 1) utilized as input for its own production (sector 1).

$X_{1,2}$ = the output of agriculture (i.e. sector 1) utilized as input for mining production (i.e. sector 2)

$X_{1,3}$ = the output of agriculture (i.e. sector 1) utilized as input for manufacturing production (i.e. sector 3)

$X_{1,4}$ = the output of agriculture (i.e. sector 1) utilized as input for the production of services (i.e. sector 4)

We can define other terms in the same way, e.g. $X_{2,1}$, $X_{3,1}$, etc.

C_1 = the output of the agricultural sector consumed by households

I_1 = the output of the agricultural sector utilized for investment

G_1 = the output of the agricultural sector consumed by government

E_1 = the output of the agricultural sector exported across the economic boundary of a state/country

M_1 = agricultural imports

T_1 = total net indirect taxes paid (total indirect taxes paid minus total subsidies received) on the inputs purchased by the agricultural sector.

T_i = total net indirect taxes paid (total indirect taxes paid minus total subsidies received) on the inputs purchased by the four sectors and by final users (recipients of final demand).

V_1 = gross value added of the agricultural sector.

We can define other such terms for sectors 2, 3 and 4, for all the variables mentioned, above using similar notation.

We can incorporate information about workers in each sector into an IO table. Value added is a composite of wage and capital components.

The wage component of value added in any sector is equal to the wages (remuneration of employees) paid to workers in that sector.

We can thus report value added in sector 1 as: $V_1 = w_1 L_1 + K_1$

where

L_1 = labour required in sector 1

K_1 = capital required in sector 1

$W_1 = L_1 w_1$ = wages generated in sector 1, i.e. wages multiplied by the total number of workers in sector 1.

or, $W_i = L_{iwi}$

In general, we have

L_i = labour required in sector i

$W_i = L_{iwi}$ = total wage component of total value added in sector I, and

K_i = capital income generated in sector i (this is the operating surplus computed as gross value added minus remuneration of employees, the wage component of value added).

In practice, all IO tables are expressed in value terms, rather than quantity terms. This is for two main reasons. Firstly, the output of a number of sectors is not available in quantity terms, e.g. the service sector. Secondly, it would be difficult to sum all inputs in terms of quantity, as inputs are expressed in different units. Generally, therefore, input-output tables and related transactions are expressed in value terms by defining the units appropriately, e.g. one rupee's worth of the product as the unit of the product. Quantities are thus converted into monetary values without any loss of generality.

We will now explain the flow of products from a sector using the schematic table.

Flow of output from the agricultural sector

$$X_1 = X_{11} + X_{12} + X_{13} + X_{14} + C_1 + I_1 + G_1 + E_1 - M_1$$

That is

- Total agricultural output fulfils the total output demanded from agriculture = agricultural demand for agricultural products + mining demand for agricultural products + manufacturing demand for agricultural products + service sector demand for agricultural products + final demand ($C_1 + I_1 + G_1 + E_1 - M_1$) for agricultural products.

Flow of output from the mining sector

$$X_2 = X_{21} + X_{22} + X_{23} + X_{24} + C_2 + I_2 + G_2 + E_2 - M_2$$

That is

- Total mining output fulfils the total demand for mining output = agricultural demand for mining output + mining demand for mining output + manufacturing demand for mining output + service sector demand for mining output + final demand for mining output.

Flow of output from the manufacturing sector:

$$X_3 = X_{31} + X_{32} + X_{33} + X_{34} + C_3 + I_3 + G_3 + E_3 - M_3$$

That is

- Total manufacturing output fulfils the total demand for manufacturing output = agricultural demand for manufacturing output + mining demand for manufacturing output + manufacturing demand for manufacturing output + service sector demand for manufacturing output + final demand for manufacturing output.

Flow of output from the services sector:

$$X_4 = X_{41} + X_{42} + X_{43} + X_{44} + C_4 + I_4 + G_4 + E_4 - M_4$$

That is

- The total output of the services sector fulfils the total demand for services = agricultural demand for services + mining demand for services + manufacturing demand for services + service sector demand for services + final demand for services.

In general terms:

$$Xi = Xi1 + Xi2 + Xi3 + Xi4 + Ci + Ii + Gi + Ei - Mi$$

We can therefore write:

$$F_i = C_i + I_i + G_i + E_i - M_i$$

where F is an aggregate of all components of final demand of sector i, i = 1 to 4.

Input-output coefficients

When the IO table is converted into a input-output coefficient matrix, it can be used as an IO model. The entries in this matrix are also referred to as Leontief input-output coefficients, i.e. aij indicates that to produce one unit of output in sector j, which could be any of the four sectors mentioned, aij units of output are required from sector i, where both i and j represent sector 1, 2, 3 or 4. Also please note that i is an alias of j.

The input-output coefficients aij are computed as shown below in Block A.

Block A

$a_{11} = X_{11} / X_1$, or $X_{11} = a_{11} X_1$

$a_{12} = X_{12} / X_2$, or $X_{12} = a_{12} X_2$

$a_{13} = X_{13} / X_3$ or $X_{13} = a_{13} X_3$

$a_{14} = X_{14} / X_4$, or $X_{14} = a_{14} X_4$

So, in general we have:

$a_{ij} = X_{ij} / X_j$ or $X_{ij} = a_{ij} X_j$

Similarly, we obtain the value added coefficient v_j

$v_j = V_j/X_j$; and the indirect tax coefficient

t_j $t_j = T_j/X_j$

where, v_j is the value added generated in producing one unit of output in sector j, and t_j is the net indirect tax on the inputs of sector j for producing one unit of output.

The taxes shown below each of the columns are taxes on products, i.e. the sum of excise duty, sales tax, customs duties on imports, etc. collected by the government, minus the subsidies paid by the government on the various items that have gone into the relevant sector as inputs. When shown below the intermediate (intersectoral) part of the IO table, these taxes are the overall tax burden on the sector on purchase of inputs for production, as intersectoral transactions are expressed in factor cost prices (not at purchasers' prices).

The input-output coefficients of the four sectors can be written in a tabular format, referred to as an A matrix

Matrix A: Input-output coefficients matrix

Sectors / Sectors	Intermediate demand			
	Agriculture	Mining	Manufacturing	Services
Agriculture	a_{11}	a_{12}	a_{13}	a_{14}
Mining	a_{21}	a_{22}	a_{23}	a_{24}
Manufacturing	a_{31}	a_{32}	a_{33}	a_{34}
Services	a_{41}	a_{42}	a_{43}	a_{44}

The Flow of X_i for any sector I, which may be sector 1,...4, can be expressed as:

$$X_i = X_{i1} + X_{i2} + X_{i3} + X_{i4} + C_i + I_i + G_i + E_i - M_i = X_{i1} + X_{i2} + X_{i3} + X_{i4} + F_i$$

because we have:

$a_{ij} = X_{ij} / X_j$, as explained above, where i,j = 1, . . 4.

Using the 'A' matrix and information from Block A, we can write this as:

$$X_{11} + X_{12} + X_{13} + X_{14} + F_1 = X_1$$

$$X_{21} + X_{22} + X_{23} + X_{24} + F_2 = X_2$$

$$X_{31} + X_{32} + X_{33} + X_{34} + F_3 = X_3$$

$$X_{41} + X_{42} + X_{43} + X_{44} + F_4 = X_4$$

or

$$a_{11} X_1 + a_{12} X_2 + a_{13} X_3 + a_{14} X_4 + F_1 = X_1$$

$$a_{21} X_1 + a_{22} X_2 + a_{23} X_3 + a_{24} X_4 + F_2 = X_2$$

$$a_{31} X_1 + a_{32} X_2 + a_{33} X_3 + a_{34} X_4 + F_3 = X_3$$

$$a_{41} X_1 + a_{42} X_2 + a_{43} X_3 + a_{44} X_4 + F_4 = X_4$$

Or we can use matrix algebra symbols:

$$AX + F = X$$

or $$F = X - AX$$

or $$F = (I - A) X$$

This can also be written as:

$$X = (I-A)^{-1} F$$

where X is a vector and can be written as:

$$X = \begin{pmatrix} X_1 \\ X_2 \\ X \end{pmatrix}$$

$$F = \begin{pmatrix} F_1 \\ F_2 \\ F \end{pmatrix}$$

The coefficient Matrix A is:

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix}$$

and the identity matrix for the four sectors:

$$I = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

In an Identity matrix, the off-diagonal values are all zeros, while the diagonal values of the matrix are all ones.

The 'A' matrix needs to be subtracted from the 'I' matrix to get the (I-A) matrix. We therefore need to get $(I-A)^{-1}$ to obtain X as explained below:

$$X = (I-A)^{-1} \zeta F$$

An inverse matrix is obtained by subtracting elements of the A matrix from corresponding elements of the I matrix and inverting the matrix. We can write this as:

$$(I-A)^{-1} = \begin{pmatrix} 1-a_{11} & -a_{12} & -a_{13} & -a_{14} \\ -a_{21} & 1-a_{22} & -a_{23} & -a_{24} \\ -a_{31} & -a_{32} & 1-a_{33} & -a_{34} \\ -a_{41} & -a_{42} & -a_{43} & 1-a_{44} \end{pmatrix}^{-1}$$

Now, by solving the $(I-A)^{-1}$ matrix, we get the Leontief inverse matrix, which provides the direct and indirect effects of a one rupee change in final demand:

$$(I-A)^{-1} = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \\ b_{41} & b_{42} & b_{43} & b_{44} \end{pmatrix}$$

The elements of the above matrix are represented by b_{ij}s.

So, multiplying by the 'F' column vector, using the above matrix, we get the total output values (X_1, X_2, X_3 and X_4) of the four sectors:

$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \\ b_{41} & b_{42} & b_{43} & b_{44} \end{pmatrix} \zeta \begin{pmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{pmatrix}$$

Appendix II

Table A.II.1: Transactions table (IO flow table) for India, 2009-10

(INR 100 thousand)

Sector		1	2	3	4	5	6	7	8
1	Agriculture and allied activities (except forestry)	25659012	3066	194	24175	33222	421	29382	646
2	Forestry and logging	11441	58826	9	502	1409	18	1864	179
3	Mining	2495	1	151641	42844859	230708	1384550	440195	5712393
4	Petroleum products	1390018	424058	417694	877230	322345	450203	512995	803505
5	Bricks and tiles (structural clay products)	0	30	766	0	168871	172906	12317	1101
6	Cement	0	20	656	1921	111765	122241	129865	1182
7	Non-metallic mineral products	6250	6	24414	597	138595	79924	324669	34034
8	Iron and steel (ferro alloys and casting & forging)	1970	53	147	880	4874	588	97065	5073075
9	Rail and other transport equipment	28487	0	13	0	531	37	8553	10234
10	Wind turbine generator manufacturing	0	0	0	0	0	0	0	0
11	Other manufacturing	8191140	716971	1741393	510684	401395	735146	1240780	7016729
12	Watershed development	0	0	0	0	0	0	0	0
13	Other construction	733698	95451	367469	19183	25175	21150	611088	27167
14	Wind energy	25060	310	10100	4499	3266	7676	4836	24372
15	Other electricity	940657	11643	379119	168857	122580	288124	181540	914814
16	Metro transport services	0	0	0	0	0	0	0	0
17	Rail transport services (except metro)	366155	21203	128638	30538	27822	45833	42922	236755
18	Other transport services	2750055	466186	338757	300198	228997	380714	343168	1953512
19	Other services	8431100	552991	1440617	761414	457906	909838	736893	4782580
20	Public administration and defence	0	0	0	0	0	0	0	0
	Net indirect taxes	-2787360	-440714	478897	1581000	181745	255253	310990	1733218
	Gross value added	98744418	10242102	15751097	4073253	2030050	2489946	1894541	6764948
	Gross output at factor cost	144494601	12152201	21231623	51199790	4491256	7344567	6923663	35090443

(Contd.)

(INR 100 thousand)

Sector		9	10	11	12	13	14	15	16	17
1	Agriculture and allied activities (except forestry)	17587	292	28476482	0	1028414	0	23319	0	0
2	Forestry and logging	4866	61	3853717	1991	4568601	0	9242	0	48
3	Mining	47659	1036	11911370	0	2360244	0	3378787	0	12452
4	Petroleum products	49888	7137	3914508	0	1491278	133092	1747349	0	163783
5	Bricks and tiles (structural clay products)	20	256	10773	995	3815163	0	128	0	0
6	Cement	8598	20762	14899	6692	6658664	0	413	0	0
7	Non-metallic mineral products	24843	1586	396123	36827	3822753	0	1446	0	545
8	Iron and steel (ferro alloys and casting & forging)	393803	116728	15514529	0	9399824	0	20578	0	203
9	Rail and other transport equipment	423277	1762	890920	0	619	0	58	7776	1332189
10	Wind turbine generator manufacturing	393803		0	0	0	228801	0	0	0
11	Other manufacturing	116728		124004970	0	16367506	0	1596507	0	201283
12	Watershed development	15514529		0	0	0	0	0	0	0
13	Other construction	0		3002521	0	15399247	0	408766	1183	676745
14	Wind energy	9399824		154633	0	80655	0	107822	104	21412
15	Other electricity	0		5804273	0	3027483	0	4047208	3905	803738
16	Metro transport services	20578		0	0	0	0	0	0	0
17	Rail transport services (except metro)	0		1856922	112	663707	955	91264	0	9673
18	Other transport services	203	26646	14784876	895	5297789	7021	670831	444	58657
19	Other services	301132	179690	47609693	31379	17021237	116550	2920881	22697	480961
20	Public administration and defence	0	0	0	0	0	0	0	0	0
	Net indirect taxes	138173	36283	6782914	736	3540109	30611	657209	0	179331
	Gross value added	1055379	186558	70335697	4269163	50142459	141545	9038527	48167	5773433
	Gross output at factor cost	3497683	864350	339319811	4348790	144685751	658575	24720333	84275	9714453

(Contd.)

(INR 100 thousand)

Sector		18	19	20	PFCE	GFCE	GFCF	CIS + Val	Net exports	Total
1	Agriculture and allied activities (except forestry)	4605257	11271773	0	69160660	1536253	255741	1429397	939306	144494601
2	Forestry and logging	0	140195	0	3873894	60	0	92605	-467326	12152201
3	Mining	14	147887	0	160144	87619	0	-2028959	-45613474	21231623
4	Petroleum products	16345342	2133865	0	10076189	1182394	0	2944122	5812796	51199790
5	Bricks and tiles (structural clay products)	0	1246	0	0	0	0	182339	124344	4491256
6	Cement	0	2020	0	0	0	0	284213	-19343	7344567
7	Non-metallic mineral products	58191	21860	0	1031074	296	492180	556141	-128692	6923663
8	Iron and steel (ferro alloys and casting & forging)	523	491634	0	0	0	3085845	3129664	-2241540	35090443
9	Rail and other transport equipment	2013	152880	0	0	0	777590	56957	-196211	3497683
10	Wind turbine generator manufacturing	0	0	0	0	0	370333	0	0	864350
11	Other manufacturing	7679488	17561689	0	87601215	6955718	69210371	21675971	-34910855	339319811
12	Watershed development	0	0	0	0	19195	4329595	0	0	4348790
13	Other construction	704036	4657294	0	597271	891631	116099025	0	283391	144685751
14	Wind energy	14192	85718	0	79363	33053	0	0	1	658575
15	Other electricity	532728	3217530	0	2978972	1240694	0	0	23	24720333
16	Metro transport services	0	4214	0	80061	0	0	0	0	84275
17	Rail transport services (except metro)	374597	486108	0	3872159	469984	368497	24012	583153	9714453
18	Other transport services	3234895	6855816	0	39375653	3558230	2776058	180895	4060818	87746541
19	Other services	17207661	33927812	0	148802681	19103262	8872234	452233	28002236	343125678
20	Public administration and defence	0	0	0	0	41796500	0	0	0	41796500
	Net indirect taxes	4478703	4714073	0	3111564	552309	4824172	1316011	4911372	36586600
	Gross value added	32508900	257252059	41796500	0	0	0	0	0	614538742
	Gross output at factor cost	87746541	343125678	41796500	370800900	77427200	211461641	30295599	-38860000	1934616225

Appendix III

Reconciliation of primary and secondary data for the new sectors

This appendix presents the data gathered and explains how the data were used to determine the input structures of the new green sectors: forestry and logging, watershed development, wind energy and metro (mass rapid transport services)[5].

1. Forestry and Logging

The forestry and logging sector already exists as a separate sector in the national IO table. Field work was carried out to validate the coefficients for the major inputs used in the forestry

Table A.III.1: Value of inputs in forestry and logging (field-level data)

Input	INR
Spraying materials (pesticides)	1025650
Bamboos	30747350
Netting	6528600
Seeds/seedlings	1655181000
Equipment for beating	105800
Plants for restocking	179042350
Fuel	221649389
Office stationery	138334129
Nursery materials (poly-bags)	699080
Uniforms	13847850
Others (specify)-1	183635000
Others (specify)-2	4541873
Others (specify)-3	26033000
Insurance premiums	233975
Legal Costs	214800
Repairs & Maintenance: machines	24443450
Repairs & Maintenance: vehicles	16844952
Repairs & Maintenance: construction works	395799658
Electricity	152356216
Postage	6110099
Telephone/telecoms	32681731
Others (specify)	3147018005
Awareness-raising	114719229
Total	6351793186

5 The primary data itself is provided separately in an Excel file: "Green Sectors Primary Data_NCAER-ILO".

and logging sector, such as plants, fuel, electricity, manufacturing products and services. The coefficients derived from the field data were validated using the coefficients in the CSO IO table, and it was finally decided to use field coefficients for the petroleum, manufacturing and forestry and logging inputs. The technology used in the forestry and logging sector does not vary much from region to region and the use of petroleum is driven by activities common to most regions. The coefficients of the remaining input sectors were taken from the IO table for India for 2009-10, as the field-level data for these sectors (agriculture, electricity and services) were unduly influenced by the level of development of a particular state/region and hence were not considered representative of India as a whole. These are pervasive sectors and using the field coefficients would make the IO table regionally biased. The above table gives values for the inputs used in the forestry and logging sector, as gathered from the sample states (the values are the sum of the data collected from the sample states).

The above inputs were calibrated to the sectors of the national IO table used in the study, and the relevant coefficients were adjusted accordingly. Table 2 below shows the aggregation of the above input sectors to the IO sectors, the coefficients of the field-level inputs and the IO coefficients for the same sectors from the IO table 2009-10.

Table A.III.2: Comparison of national IOT and field coefficients for the forestry and logging sector

Sector	Field data (Total expenditure, INR 100 thousand)	Field coefficient (Expenditure on sector / Total expenditure)	National IO coefficient for same sector
Agriculture (Seeds/seedlings + plants for restocking: Table 1)	1834223350	0.288773	0.000252
Forestry and logging (Bamboos: Table 1)	30747350	0.004841	0.00948
Petroleum (Fuel: Table 1)	221649389	0.034896	0.014662
Manufacturing (Spraying materials + fertilizer + manure + nets + equipment for beating + herbicides + office stationery + polybags + uniforms + others: Table 1)	374750982	0.058999	0.03187
Electricity (Table 1)	152356216	0.023986	0.000984
Services (Insurance premiums + legal costs + rep & maint + postage + telephone + others + awareness-raising: Table 1)	3738065899	0.588506	0.085612
Total	6351793186		

The highlighted sectors (forestry and logging, petroleum and "Other manufacturing") had field coefficients closer to the IOT coefficients, as can be seen from the above table. As expected, the all-India coefficient for agriculture is significantly different, as Indian agriculture is very region-specific. The survey of the forestry and logging sector, conducted in only few states, therefore did not capture the country's agricultural input structure. Similarly, the electricity industry and especially the services sector vary from region to region. The final IO coefficients used for the analysis therefore included the coefficients derived from field-level data for petroleum, forestry and logging and manufacturing, whereas the remaining coefficients were taken from the IO table for 2009-10.

2. Watershed Development

The all-India IOT contains a "Construction Sector". Watershed development, being a construction activity, is a part of the construction sector. For the purpose of this study, we estimated values for the row and column of the watershed development sector, and then subtracted these from the corresponding row and column entries of the aggregate construction sector of the existing all-India IO table. This residual construction sector is the "Other Construction" sector (i.e. construction other than watershed development).

To begin with, it must be noted that the output value for the watershed development sector is the sum of all expenditure by the central and state governments on projects forming part of the Integrated Watershed Management Programme. The following table shows the amount spent by the central government:

Table A.III.3 (a): State-related release of funds (central government share) for all watershed development projects (2009-10), Non-North-Eastern States

(INR 100 thousand)

S. No.	State	DDP	DPAP	IWDP	Pre-IWMP	IWMP	Institutions	Grand total
(A)	(B)	(C)	(D)	(E)	(F=C+D+E)	(G)	(H)	(I=F+G+H)
1	Andhra Pradesh	868	3738	3435	8041	3068	344	11453
2	Bihar	0	0	571	571	0	0	571
3	Chhattisgarh	0	2076	1382	3458	1369	263	5091
4	Goa	0	0	0	0	0	0	0
5	Gujarat	11363	5131	2369	18864	5023	387	24274
6	Haryana	2722	0	384	3107	0	0	3107
7	Himachal Pradesh	0	404	1352	1755	1651	220	3627
8	Jammu And Kashmir	945	387	1121	2452	0	229	2681
9	Jharkhand	0	0	307	307	764	218	1288
10	Karnataka	4379	5406	3534	13319	8100	387	21806
11	Kerala	0	0	320	320	0	76	396
12	Madhya Pradesh	0	4756	2890	7646	4348	441	12435
13	Maharashtra	0	7979	3756	11735	6777	462	18974
14	Orissa	0	4330	2745	7075	2177	314	9566
15	Punjab	0	0	290	290	229	104	622
16	Rajasthan	10139	1871	2253	14262	6992	0	21254
17	Tamil Nadu	0	1448	1122	2570	1617	366	4552
18	Uttar Pradesh	0	2511	4638	7149	2268	527	9944
19	Uttaranchal	0	411	760	1171	0	168	1339
20	West Bengal	0	0	546	546	0	0	546
	Sub-total	30417	40447	33775	104639	44381	4505	153526

Table A.III.3 (b): State-related release of funds (central government share) for all watershed development projects (2009-10), North-Eastern States

(INR 100 thousand)

S. No.	State	DDP	DPAP	IWDP	Pre-IWMP	IWMP	Institutions	Grand total
(A)	(B)	(C)	(D)	(E)	(F=C+D+E)	(G)	(H)	(I=F+G+H)
1	Arunachal Pradesh	0	0	2668	2668	545	0	3213
2	Assam	0	0	2152	2152	3253	371	5775
3	Manipur	0	0	1097	1097	0	0	1097
4	Meghalaya	0	0	1595	1595	243	131	1969
5	Mizoram	0	0	3670	3670	506	68	4244
6	Nagaland	0	0	750	750	856	94	1699
7	Sikkim	0	0	845	845	117	114	1076
8	Tripura	0	0	39	39	2	114	156
	Sub-total for NE	0	0	12815	12815	5522	892	19229
	Grand total	30417	40447	46590	117454	49903	5397	172754

Website source: www.wmis.nic.in

It was also intimated by officials of the Department of Land Resources, Watershed Development, GoI that the central government share accounts for 90 per cent of all expenditure, and this amount is spent on "new construction". The state share (10 per cent of the total) is used for "repairs and maintenance". This enabled us to compute the total value of the output of watershed development construction activities: 90 per cent of total expenditure amounts to INR 172,754 hundred thousand. The total expenditure is therefore INR 191,949 hundred thousand and the state share (10 per cent) INR 19,195 hundred thousand.

The DSLW, GoI, also has structure-related expenditure targets, which we obtained through interviews. These were used to derive ratios for determining central and state expenditure by kind of watershed development structure. As mentioned above, the central share is taken as being applied to "new construction" and the state share to "repairs and maintenance". The table below shows how the ratios of the "new construction" targets (to the total target expenditure on new construction) were used to determine the central share by structure, and the ratios of the "repairs and maintenance" targets (to the total target expenditure on repairs and maintenance) to determine the state share by kind of structure.

Table A.III.4: Central and state expenditure targets by structure (2009-10)

(INR 100 thousand)

Type of structure	New construction		Repairs and maintenance		Central share	State share
	Target expenditure	Ratio to total	Target expenditure	Ratio to total		
Farm ponds	195	0.17	86	0.46	29895	8832
Check dams	261	0.23	30	0.16	39891	3090
Nallah bunds	105	0.09	5	0.02	16021	472
Percolation tanks	166	0.15	23	0.12	25364	2355
Groundwater recharge structures	72	0.06	3	0.01	11002	275
Others	331	0.29	40	0.22	50581	4171
Total	1129	1.00	186	1.00	172754	19195

Source: Department of Land Resources, Watershed Development, GoI

Next, interviews with experts in Karnataka and Andhra Pradesh provided a labour-materials breakdown of expenditure on various types of structures, as well as the inputs used to build the respective structures. Figures for these two components are required in order to break down the output into GVA (return on labour) and intermediate inputs.

Table A.III.5: Labour-materials breakdown of different watershed structures (field-level interview with expert from Karnataka state)

Type of structure	Labour (%)	Materials (%)
Field bund	95	5
Farm pond	80	20
Boulder check	40	60
Rubble check	40	60
Waterway (existing)	100	0
Waterway (proposed)	100	0
Diversion channel	100	0
Ravine reclamation structure (RRS)	40	60
Gokatte	80	20
Minor percolation tank (MPT)	80	20
Check dam	20	80
Percolation tank (PT)	60	40
Land reclamation structure (LRS)	60	40
Nallah revetment	60	40
Nallah bund	80	20
Horticulture	70	30
Forestry	60	40

Using tables 4 and 5, we were able to determine the labour-materials breakdown of the state and central government shares. Those shares for farm ponds, check dams, nallah bunds and percolation tanks were split into labour and materials using the respective ratios for each in Table 5 above. The remaining were lumped together as "others" and, with expert advice, it was decided to use a 65:35 ratio for this aggregated structure breakdown of output into GVA and intermediate input cost. The table below shows the labour and materials shares of state and central government expenditure by type of structure:

Table A.III.6: Labour-materials breakdown of central and state government expenditure (INR 100 thousand)

Type of structure	New construction (central share)		Repairs and maintenance (state share)		Labour-materials ratio used (Table 4)	Total labour costs	Total materials
	Labour costs	Materials	Labour costs	Materials			
Farm ponds	23916	5979	7066	1766	80:20	30982	7745
Check dams	7978	31913	618	2472	20:80	8596	34385
Nallah bunds	12817	3204	378	94	60:40	13195	3299
Percolation tanks	15218	10145	1413	942	80:20	16631	11088
Others	40029	21554	2890	1556	65:35	42919	23110
Total	99959	72796	12364	6831		112323	79627

Source: Authors' calculations

As previously mentioned, the total labour cost share (of central and state governments) is reckoned as the GVA (since watershed development activities are undertaken only with the involvement of local/hired labour, and not by contractors/enterprises), while the total materials cost share (of central and state governments) is reckoned as the intermediate input. From Table 6 above, we therefore find that the GVA is INR 112,323 hundred thousand and the intermediate input total INR 79,627 hundred thousand.

Conceptually, new construction is GFCF, while repairs and maintenance are part of GFCE.

Table A.III.7: Major inputs to the watershed development sector (interviews with experts at Andhra Pradesh State Department)

Input sectors	% share	% share (normalized to 80%)
Bricks	1	1.25
Cement	10	12.5
Concrete	15	18.75
Bamboo poles, brushwood	2	2.5
Stones (boulders)	22	27.5
Plants	10	0
R&M: Construction works	10	0
Hire of capital equipment	10	12.5
Other services	20	25
Total	100	100 (normalized to80)

The above table shows the various inputs required for watershed construction, as gathered from interviews with experts in Andhra Pradesh. The input-related expenditure items are determined by the ratios given in the table. The data we gathered in this way also yielded shares for two items which do not pertain to watershed structures. Plants are an input in horticultural activities, which do not fall within the ambit of our "watershed development" sector. Secondly, the repair and maintenance of construction works is accounted for in the state share. The values for the shares of the remaining inputs are therefore normalized to 80 per cent.

The intermediate total of INR 79,627 hundred thousand is distributed among the input sectors according to the ratios given in the above table. The column for the watershed development sector up to this point (before adjustments) is produced below:

Table A.III.8: Watershed development sector column in IO table (before adjustments)

Inputs according to I-O sector classification	% share (from Table 7)	Input distributed (INR 100 thousand)
Agriculture and allied activities (except forestry)		0
Forestry and logging (Bamboo poles, brushwood: Table 7)	2.5	1991
Mining		0
Petroleum products		0
Bricks and tiles (structural clay products) (Bricks: Table 7)	1.25	995
Cement (Cement: Table 6)	12.5	9953
Non-metallic mineral products (Concrete + stones, boulders: Table 7)	46.25	36827
Iron and steel (ferro alloys and casting& forging)		0
Rail and other transport equipment		0

Other manufacturing		0
Construction		0
Watershed development		0
Electricity		0
Wind energy		0
Rail transport services		0
Metro services		0
Other transport services		0
Other services (Hiring capital + other services: Table 7)	37.5	29860
Public administration and defence		0
Total Input		
100	79627 (Materials share total from Table 6)	
Net indirect taxes		
Gross value added		112323
Total Output		191949

The row will have only two entries, for GFCF and GFCE. As explained above, the total for new construction forms the GFCF. Table 4 in this section shows this to be INR 172,754 hundred thousand. The total for repairs and maintenance forms the GFCE, which is again shown to be INR 19,195 hundred thousand.

The first adjustment made was to the GVA of watershed development, to account for the time spent by farmers on 'bunding' (a type of watershed activity) for their own benefit. This is not accounted for in the published IOT. The farmers' survey conducted in Karnataka and Andhra Pradesh found that an estimated 5.6 per cent of farmers' total labour input was devoted to 'bunding', an activity which can be reckoned as own-account capital formation. The GVA of all crops in the national IOT for 2009-10 is therefore reduced to 94.4 per cent of the total GVA of all crops, and the remaining 5.6 per cent of the GVA of agricultural crops is considered as output for 'bunding' (watershed development). In the disaggregated 2009-10 IO table for India, this means that for sectors 1 to 20, which are all crop sectors, the GVA is 94.4 per cent of the total GVA of all crops. The table below shows the sector-related GVA for crops in the national IOT:

Table A.III.9: GVA of crops in national IO table, 2009-10

(INR 100 thousand)

IO sector No.	Sector	GVA
1	Paddy	11127880
2	Wheat	9134733
3	Jowar	425466
4	Bajra	676310
5	Maize	1277785
6	Gram	1294940
7	Pulses	2457218
8	Sugarcane	3944564
9	Groundnuts	1242086
10	Coconuts	829385
11	Other oilseeds	3941697
12	Jute	281071
13	Cotton	2686104
14	Tea	488733
15	Coffee	320528
16	Rubber	771332
17	Tobacco	680343
18	Fruits	7668846
19	Vegetables	9858738
20	Other crops	10964699
	Total	70072459

INR 70,072,459 hundred thousand is therefore reckoned as 94.4 per cent of the total GVA of the crops grown. Further calculation yields INR 74,229,300 hundred thousand as the total GVA and INR 4,156,841 hundred thousand as the GVA of 'bunding' work (5.6 per cent), which is actually output on fixed capital formation in the form of 'bunding'. This counts towards watershed development GVA and output, since the IO table used is the commodity x commodity (not commodity x industry) table. An amount of INR 4,156,841 hundred thousand has been added to the GVA and output column of the watershed development sector, and a corresponding value adjustment has been made to the watershed development row, under GFCF (as it is fixed capital formation). Since there have been additions to the row and the column, the total output of this sector increases by a corresponding amount.

A final adjustment was made to determine tax on inputs. For the watershed development sector, the tax in question was on cement. The following information was gathered from the CSO:

Since watershed development uses cement as an input, tax, trade and transport margins should be based on the input value of this sector: tax goes to "net indirect taxes"; trade margin goes to "other services"; transport margin goes to "transport services". Since the values we have are at purchasers' prices, we have to calculate backwards. Table 8 shows that, at purchasers' price, the input value of cement is INR 9,953 hundred thousand.

The basic tax rate is first applied to the basic price value, then the trade and transport margins are applied to the tax-adjusted value to determine the purchasers' price value. We therefore calculate backwards twice: first, to obtain the tax-adjusted value using trade and transport margin data from Table 10, then to obtain the basic price value using the tax rate as shown in the table.

Table A.III.10: Tax and margin rates on cement, 2009-10

Tax rate on cement	11%
Trade and transport margins on cement	34% (Trade: 60.14%, Transport: 39.96%)

In this way, we calculated the figure for net indirect tax to be INR 736 hundred thousand, for the trade margin to be INR 1,519 hundred thousand (added to "Other services") and for the transport margin to be INR 1,007 hundred thousand (added to "transport services" and split between "railways" and "Other transport" according to the ratio for these sectors, as shown in the "Total construction" column).

The final column of the watershed development sector after all adjustments is therefore as set out below (at basic prices):

Table A.III.11: Final IOT column for the watershed development sector (after adjustments)

(INR 100 thousand)

IOT sector	Value	
Agriculture and allied activities (except forestry)	0	
Forestry and logging	1991	
Mining	0	
Petroleum products	0	
Bricks and tiles (structural clay products)	995	
Cement	6692	(9953 minus all tax and margins: 9953 – 1007 – 1519 – 736)
Non-metallic mineral products	36827	
Iron and steel (ferro alloys and casting& forging)	0	
Rail and other transport equipment	0	
Other manufacturing	0	
Watershed development	0	
Other construction	0	
Wind energy	0	
Other electricity	0	
Metro services	0	
Rail transport services	112	1007 (Transport margin)
Other transport services	895	
Other services	31379	(29860 + 1519 (Trade margin))
Public administration and defence	0	
NIT	736	
GVA	4269163	112323 + 4156841
Total Output	4348790	

The values in this column (and the corresponding watershed development row) were subtracted from the respective entries in the "total construction" column (and row) and thus the separate "watershed development' and "Other construction" sectors were formed.

3. Wind Energy

The "Electricity Sector" is one of the sectors of the all-India IO table. Wind energy, being an electricity generation activity, is part of this sector. For the purpose of this study, we estimated figures for the row and column of the wind energy sector, subtracted them from the corresponding row and column entries of the aggregate electricity sector, and formed two separate sectors: "wind energy" and "Other electricity" ("other" meaning other than wind energy).

Firstly, we needed to determine the total output of wind energy for the whole of India. We therefore visited the Department of Renewable Energy, Government of India and obtained the following data on installed capacity, wind energy production and state-related tariffs. Multiplying the tariff with the actual production of wind energy gives the state-related output. Using this data, we reckoned the total value of the output of the wind energy sector to be INR 658,575 hundred thousand (see shaded cell in table below).

Table A.III.12: Wind energy: installed capacity and tariffs

S. No	State	Installed capacity (MW) as on March 2010	Installed capacity (MW) as on March 2009	Actual production (Billion KWH)	Tariff: INR/ KWH	Actual production(KW)	Tariff * Actual production (KW) (INR)
1	Tamil Nadu	4907	4304.5	8.146	3.4	8146000000	27614940000
2	Karnataka	1473	1327.4	2.895	3.7	2895000000	10711500000
3	Maharashtra	2078	1938.9	2.779	4.2	2779000000	11532850000
4	Rajasthan	1088	738.9	1.127	3.9	1127000000	4429110000
5	Andhra Pradesh	236	122.5	0.106	3.5	106000000	371000000
6	Madhya Pradesh	229	212.8	0.082	4.4	82000000	356700000
7	Kerala	28	27	0.065	3.1	65000000	204100000
8	Gujarat	1864	1566.5	2.988	3.6	2988000000	10637280000
9	Others	4	1.1	0	4.0	0	0
	All	11907	10239.6			18188000000	65857480000

Source: India Wind Energy Association (inwea.org/tariffs.htm)

The profit and loss accounts of wind energy producing companies provided mixed information on the three main activities of such companies (production of WTGs, construction of towers and operation of the WTGs). The relevant activity for our study is the operation of the WTGs, as this is what actually generates electricity. The companies concerned do not account separately for expenditure on each activity, but by interviewing experts we were able to gather the following information for the inputs required to generate one megawatt of wind energy electricity:

Table A.III.13: Input structure for wind energy electricity generation (1 MW) (field-level interview with experts)

Inputs	INR.
Consumption of materials (spare parts)	120619
Vehicle hire expenses	22097
Security costs	10904
Admin expenses	118946
Employee costs	74620
Total per MW O&M cost for 2009-10	347187

The data gathered from the wind energy generating companies provided figures for expenditure under various heads. But, as already mentioned, the companies do not report separate figures for the three activities. The following table shows figures for expenditure that was considered representative of the operation of WTGs alone (from interviews conducted in Gujarat and Maharashtra). These were taken to collectively represent the "Administrative expenses" referred to in the table above. The field interviews also provided values for wind energy generation. So, the expenditure figures were first weighted to take into account total energy generation in the respective states, then the shares were calculated.

Table A.III.14: Determination of percentage shares of admin expenses (field-level data)

	Gujarat	Maharashtra		
Energy generation (MW)	902.356	436.5		
	INR 100,000	INR 100,000	Weighted Sum (weighted to energy generation)	% Share
Fuel	59.45	126.45	108842.70	84
Repairs & Maintenance: Transport vehicles	11.73	17.19	18084.34	14
Telephone & postage	0	5.08	2218.36	2
Total	71.18	148.73	129145.41	100

The table below shows the percentage shares of the inputs for wind energy:

Table A.III.15: Percentage shares of expenditure on inputs for the wind energy sector (field-level data)

Inputs	INR.	%
Consumption of materials (spare parts)	120619	35
Vehicle hire expenses	22097	6
Security costs	10904	3
Admin expenses	118946	34
Fuel	99915	29
Repairs & Maintenance: Transport vehicles	16652	5
Telephone & postage	2379	1
Employees costs	74620	21
Total per MW O&M cost for 2009-10	347187	100

118946 is broken down among the 3 admin inputs in line with the shares determined in Table 14, so 84% of 118946 is 99915, and so on.

The resulting IOT column for the wind energy sector is reproduced below:

Table A.III.16: Wind energy sector column in IO table (before adjustments)

I-O Sectors	% Share	INR 100 thousand
Agriculture and allied activities (except forestry)		
Forestry and logging		
Mining		
Petroleum products **(Fuel: Table 15)**	29	190157
Bricks and tiles (structural clay products)		
Cement		
Non-metallic mineral products		
Iron and steel (ferro alloys and casting& forging)		
Rail and other transport equipment		
Other manufacturing **(Material cons-spare parts: Table 15)**	35	228801
Construction		
Watershed development		
Electricity		
Wind energy		
Rail transport services		
Metro services		
Other transport services		
Other services **(Vehicle hire + security costs + R&M transport vehicles + telephone & postage: Table 15)**	15	98071
Public administration and defence		
Value added **(Employee costs: Table 15)**	21	141545
Total Output	100	658575

Finally, the adjustment to take into account tax on products was estimated using data from the CSO. Tax in this sector was on the petroleum input. The following data was used to determine the basic price from the purchasers' price for petroleum, as well as the tax and margin (trade and transport) values.

Table A.III.17: Tax and margin rates on petroleum, 2009-10

Tax rate on petroleum	23%
Trade and transport margins on petroleum	16.16% (Trade: 69.85%, Transport: 30.15%)

The values were calculated in a similar manner as for the cement used in watershed development, i.e. by calculating backwards twice. The net indirect tax was thus found to be INR 30,611 hundred thousand, the trade margin value INR 18,478 hundred thousand and the transport margin value INR 7,976 hundred thousand.

The final column for the wind energy sector at basic prices is as follows:

Table A.III.18: Final IOT column for the wind energy sector (after adjustments)

(INR 100 thousand)

IOT sector	Value	
Agriculture and allied activities (except forestry)		
Forestry and logging		
Mining		
Petroleum products	133092	(190157 minus all tax and margins: 190157 – 30611 – 18478 – 7976)
Bricks and tiles (structural clay products)		
Cement		
Non-metallic mineral products		
Iron and steel (ferro alloys and casting& forging)		
Rail and other transport equipment		
Other manufacturing	228801	
Watershed development		
Other construction		
Wind energy		
Other electricity		
Metro services		
Rail transport services	955	7976 (Transport margin)
Other transport services	7021	
Other services	116550	(98071 + 18478 (Trade margin))
Public administration and defence		
NIT	30611	
GVA	141545	
Total Output	658575	

The figures in this column (and in the corresponding row for wind energy) were subtracted from the electricity column (and row) entries, thus forming the separate "wind energy" and "other electricity" sectors.

The new equipment and WTGs acquired by the wind energy producers would be reported as fixed capital formation under final use in the IO framework, which in our study is included in the "Other manufacturing" sector's fixed capital formation.

4. Metro (Mass Rapid) Transport Services

"Rail Transport" is one of the sectors of the all-India IO table. For the purpose of this study, we estimated figures for the row and column of the metro transport sector, subtracted them from the corresponding row and column entries of the aggregate rail transport sector, and thus formed two separate sectors: "metro transport services" and "rail transport services (other than metro)".

The metro transport services sector's total output was assumed to be the output of the Delhi Metro Rail Corporation plus that of the Kolkata Metro Rail Corporation, as only these two services were in operation during 2009-10. To obtain the input structure of the metro sector, we referred to the item-by-item expenditure on material inputs made by the DMRC, reported in their annual profit and loss account, and conducted interviews with experts. Since the Kolkata metro was part of Indian Railways until 2009, itemized information on its expenditure was not available in the annual report of the KMRC. The KMRC's share of the total is in any case relatively low. We therefore assumed the input structure (itemized shares of inputs to total input costs) of the KMRC to be similar to that of the DMRC in order to obtain the input structure for the whole metro sector (i.e. including both the DMRC and the KMRC). The CSO provided data on gross value added and intermediate expenditure for both the DMRC and the KMRC (Table 19). The overall input structure was therefore taken from the DMRC, while for the KMRC only the totals for input, GVA, and hence output, were included.

Table A.III.19: GVA and intermediate input figures for DMRC and KMRC

(INR 100 thousand)

	Gross value added	Intermediate input	Total output (GVA + intermediate input)
KMRC	152	259	411
DMRC	48015	35849	83864
Total	48167	36108	84275

The table below shows itemized expenditure for the DMRC, ratios of expenditure to total input and TOTAL (DMRC + KMRC) itemized expenditure.

Table A.III.20: Itemized distribution of expenditure (INR 100 thousand)

(INR 100 thousand)

Item	DMRC		Total (DMRC + KMRC)
	Values	Percentage share of input (to total input)	
Consultancy/Professional services	7659	21	7714
Conveyance	440	1	444
Stores/Traction expenses	5898	16	5940
R&M(plant & machinery)	1822	5	1836
R&M(buildings)	835	2	841
R&M(others)	339	1	341
House-keeping	1803	5	1816
Printing/Stationary	455	1	458
Electricity	3980	11	4009
Other services	12617	35	12708
Total inputs	35849	100	36108
GVA=output-inputs	48015		48167
Output	83864		84275

The column for the metro transport services sector, as obtained from Table 20, is shown below.

Table A.III.21: Final IOT column for the metro transport services sector

(INR 100 thousand)

IOT Sector	Value
Agriculture and allied activities (except forestry)	
Forestry and logging	
Mining	
Petroleum products	
Bricks and tiles (structural clay products)	
Cement	
Non-metallic mineral products	
Iron and steel (ferro alloys and casting& forging)	
Rail and other transport equipment **(Stores, traction expense + R&M plant & mach: Table 20)**	7776
Other manufacturing	
Watershed development	
Other construction **(R&M: buildings + R&M: others: Table 20)**	1183
Wind energy	
Electricity (Table 20)	4009

Metro services	
Rail transport services	
Other transport services (Conveyance: Table 20)	444
Other services **(Consultancy + housekeeping + printing/Stationery + other services: Table 20)**	22697
Public administration and defence	
GVA **(Table 20)**	48167
Total output	84275

The figures in this column were subtracted from the column entries of the all-India IO table's railways sector column in order to form two separate sectors: metro transport services and rail transport services (other than metro).

5. Wind Turbine Generator (WTG) Manufacturing

For this study, the WTG manufacturing sector was disaggregated from the "other manufacturing" sector. The output of this sector was estimated as the product of the megawatt value of total wind turbines manufactured during 2009-10 (1465 MW) and the cost of producing one megawatt of wind turbine energy (INR 59 million). This gave a total output of INR 864,350 hundred thousand.

Using the annual reports of Suzlon Energy Limited for the past four years, we were able to calculate average shares of inputs and GVA (Table 22):

Table A.III.22: Shares of inputs and GVA (INR 10 million)

Suzlon annual reports	2008	2009	2010	2011	Sum	Average
Output sales & service	6926.01	7,235.58	3488.68	4357.55	22007.82	5501.955
Intermediate inputs						
Consumption of raw materials	4226.99	4543.85	2517.49	2746.75	14035.08	3508.77
Operating and other expenses	644.55	951.19	659.35	770.28	3025.37	756.3425
Bank charges	14.27	53.85	78.31	50.86	197.29	49.3225
Total intermediate inputs	4885.81	5548.89	3255.15	3567.89	17257.74	4314.435
GVA	2040.2	1686.69	233.53	789.66	4750.08	1187.52
Input share (IO ratio)	0.7054	0.7669	0.9331	0.8188		0.7842
GVA share						0.2158

The input shares of this sector were taken as a combination of primary data coefficients and proxy coefficients from the "electrical industrial machinery" sector of the all-India IO table:

Table A.III.23: Input coefficients

1	Agriculture and allied activities (except forestry)	0.000
2	Forestry and logging	0.000
3	Mining	0.001
4	Petroleum products	0.008
5	Bricks and tiles (structural clay products)	0.000
6	Cement	0.024
7	Non-metallic mineral products	0.002
8	Iron and steel (ferro alloys and casting& forging)	0.135
9	Rail and other transport equipment	0.002
10	Wind turbine generator manufacturing	0.307
11	Other manufacturing	0.000
12	Watershed development	0.000
13	Other construction	0.021
14	Wind energy	0.000
15	Other electricity	0.000037
16	Metro transport services	0.000
17	Rail transport services (except metro)	0.003
18	Other transport services	0.031
19	Other services	0.208
20	Public administration and defence	0.000

The shaded coefficients were obtained from the primary survey and the remainder from the proxy sector of the national IO table. The coefficient for "Other services" was obtained from the annual reports of Suzlon Energy Limited.

Appendix IV

Table A.IV.1: Mapping of NSSO sectors (NIC sectors) to IO sectors

S. No.	Sector	5-digit NIC (National Industrial Classification), 2004 Code
1	Agriculture and allied activities (except forestry)	01111, 01112, 01113, 01114, 01115, 01116, 01117, 01118, 01119, 01121, 01122, 01131, 01132, 01133, 01134, 01135, 01136, 01139, 01211, 01212, 01213, 01214, 01221, 01222, 01223, 01224, 01225, 01229, 01300, 01401, 01402, 01403, 01404, 01405, 01406, 01407, 01408, 01409, 01500, 05011, 05012, 05021, 05022, 05023
2	Forestry and logging	02001, 02002, 02003, 02004, 02005, 02006
3	Mining	10101, 10102, 10103, 10104, 10109, 10201, 10202, 10203, 10204, 10209, 10300, 11101, 11102, 11103, 11104, 11201, 11202, 11203, 11204, 12000, 13100, 13201, 13202, 13203, 13204, 13205, 13206, 13209, 14101, 14102, 14103, 14104, 14105, 14106, 14107, 14108, 14109, 14211, 14212, 14213, 14214, 14215, 14219, 14221, 14222, 14291, 14292, 14293, 14294, 14295, 14296, 14297, 14298, 14299
4	Petroleum products	23201, 23202, 23203, 23209
5	Bricks and tiles (structural clay products)	26921, 26931, 26939
6	Cement	26941, 26942
7	Non-metallic mineral products	26101, 26102, 26103, 26104, 26105, 26106, 26107, 26109, 26911, 26912, 26913, 26914, 26915, 26916, 26919, 26922, 26929, 26932, 26933, 26943, 26944, 26945, 26949, 26951, 26952, 26953, 26954, 26955, 26956, 26957, 26959, 26960, 26991, 26992, 26993, 26994, 26999
8	Iron and steel (ferro alloys and casting& forging)	27110, 27120, 27130, 27141, 27142, 27143, 27151, 27152, 27153, 27161, 27162, 27163, 27164, 27165, 27171, 27172, 27173, 27181, 27182, 27183, 27184, 27190, 27310
9	Rail and other (metro) equipment	35201, 35202, 35203, 35204, 35208, 35209
10	Other manufacturing	15111, 15112, 15113, 15114, 15115, 15116, 15117, 15118, 15119, 15121, 15122, 15123, 15124, 15125, 15126, 15127, 15129, 15131, 15132, 15133, 15134, 15135, 15136, 15137, 15138, 15139, 15141, 15142, 15143, 15144, 15145, 15146, 15147, 15149, 15201, 15202, 15203, 15204, 15205, 15209, 15311, 15312, 15313, 15314, 15315, 15316, 15317, 15318, 15319, 15321, 15322, 15323, 15324, 15325, 15326, 15329, 15331, 15332, 15339, 15411, 15412, 15419, 15421, 15422, 15423, 15424, 15425, 15426, 15427, 15428, 15429, 15431, 15432, 15433, 15434, 15435, 15439, 15440, 15491, 15492, 15493, 15494, 15495, 15496, 15497, 15499, 15511, 15519, 15520, 15531, 15532, 15533, 15539, 15541, 15542, 15543, 15544, 15545, 15549, 16001, 16002, 16003, 16004, 16005, 16006, 16007, 16008, 16009, 17111, 17112, 17113, 17114, 17115, 17116, 17117, 17118, 17119, 17121, 17122, 17123, 17124, 17125, 17126, 17129, 17131, 17132, 17133, 17134, 17135, 17136, 17137, 17139, 17141, 17142, 17143, 17144, 17145, 17149, 17211, 17212, 17213, 17214, 17215, 17219, 17221, 17222, 17223, 17224, 17225, 17226, 17229, 17231, 17232, 17233, 17234, 17235, 17236, 17239, 17241, 17242, 17243, 17249, 17251, 17252, 17253, 17254, 17255, 17259, 17291, 17292, 17293, 17294, 17295, 17296, 17297, 17298, 17299, 17301, 17302, 17303, 17309, 18101, 18102, 18103, 18104, 18105, 18109, 18201, 18202, 18203, 18204, 18205, 18209, 19111, 19112, 19113, 19114, 19115, 19116, 19119, 19121, 19122, 19123, 19129, 19201, 19202, 19209, 20101, 20102, 20103, 20109, 20211, 20212, 20213, 20219, 20221, 20222, 20229, 20231, 20232, 20233, 20239, 20291, 20292, 20293, 20294, 20295, 20296, 20297, 20298, 20299, 21011, 21012, 21013, 21014, 21015, 21016, 21017, 21019, 21021, 21022, 21023, 21024, 21029, 21091, 21092, 21093, 21094, 21095, 21096, 21097, 21098, 21099, 22110, 22121, 22122, 22130, 22190, 22211, 22212, 22213, 22219, 22221, 22222, 22229, 22300, 23101, 23109, 23300, 24111, 24112, 24113, 24114, 24115, 24116, 24117, 24118, 24119, 24121, 24122, 24123, 24124, 24129, 24131, 24132, 24133, 24134, 24139, 24211, 24219, 24221, 24222, 24223, 24224, 24229, 24231, 24232, 24233, 24234, 24235,

		24236, 24239, 24241, 24242, 24243, 24244, 24245, 24246, 24247, 24248, 24249, 24291, 24292, 24293, 24294, 24295, 24296, 24297, 24298, 24299, 24301, 24302, 24303, 24304, 24305, 24306, 24309, 25111, 25112, 25113, 25114, 25119, 25191, 25192, 25193, 25194, 25199, 25201, 25202, 25203, 25204, 25205, 25206, 25207, 25208, 25209, 27201, 27202, 27203, 27204, 27205, 27209, 27320, 28111, 28112, 28113, 28118, 28119, 28121, 28122, 28123, 28128, 28129, 28131, 28132, 28133, 28138, 28139, 28910, 28920, 28931, 28932, 28933, 28939, 28991, 28992, 28993, 28994, 28995, 28996, 28997, 28998, 28999, 29111, 29112, 29113, 29118, 29119, 29121, 29128, 29131, 29138, 29141, 29142, 29148, 29149, 29151, 29158, 29191, 29192, 29193, 29194, 29195, 29196, 29197, 29198, 29199, 29211, 29212, 29213, 29214, 29218, 29219, 29221, 29222, 29223, 29224, 29225, 29228, 29229, 29231, 29238, 29241, 29242, 29243, 29244, 29245, 29246, 29248, 29249, 29251, 29252, 29253, 29254, 29255, 29256, 29258, 29259, 29261, 29262, 29263, 29264, 29265, 29266, 29267, 29268, 29269, 29271, 29278, 29291, 29292, 29293, 29294, 29295, 29296, 29297, 29298, 29299, 29301, 29302, 29303, 29304, 29305, 29306, 29307, 29308, 29309, 30001, 30002, 30003, 30004, 30005, 30006, 30007, 30008, 30009, 31101, 31102, 31103, 31104, 31108, 31109, 31200, 31300, 31401, 31402, 31403, 31404, 31409, 31501, 31502, 31503, 31504, 31505, 31506, 31509, 31901, 31902, 31903, 31904, 31905, 31906, 31907, 31908, 31909, 32101, 32102, 32103, 32104, 32105, 32106, 32107, 32108, 32109, 32201, 32202, 32203, 32204, 32205, 32208, 32209, 32301, 32302, 32303, 32304, 32305, 32308, 32309, 33111, 33112, 33113, 33114, 33115, 33116, 33119, 33121, 33122, 33123, 33124, 33125, 33126, 33127, 33129, 33130, 33201, 33202, 33203, 33204, 33205, 33208, 33209, 33301, 33302, 33309, 34101, 34102, 34103, 34104, 34105, 34106, 34107, 34109, 34201, 34202, 34203, 34209, 34300, 35111, 35112, 35113, 35114, 35115, 35116, 35117, 35119, 35121, 35122, 35123, 35129, 35301, 35302, 35303, 35308, 35309, 35911, 35912, 35913, 35914, 35919, 35921, 35922, 35923, 35929, 35991, 35998, 35999, 36101, 36102, 36103, 36104, 36109, 36911, 36912, 36913, 36919, 36920, 36931, 36932, 36933, 36934, 36935, 36939, 36941, 36942, 36949, 36991, 36992, 36993, 36994, 36995, 36996, 36997, 36998, 36999
11	Construction	45101, 45102, 45201, 45202, 45203, 45204, 45205, 45206, 45207, 45208, 45209, 45301, 45302, 45303, 45309, 45401, 45402, 45403, 45500
12	Electricity	40101, 40102, 40103, 40104, 40105, 40106, 40107, 40109
13	Rail transport services	40108
14	Other transport services	60101, 60102, 60109
15	Other services	
16	Public administration and defence	60211, 60212, 60221, 60222, 60231, 60232, 60300, 61100, 61200, 62100, 62200

Appendix V

Table A.V.1: Employment structure of the Indian economy, 2009-10

(Fig: thousands)

S. No.	Sector	Formal workers		Total formal workers	Informal workers		Total informal workers	Total male workers	Total female workers	Total workers
		Male	Female		Male	Female				
1	Agriculture and allied activities (except forestry)	5605	1327	6931	242854	123206	366059	248458	124532	372991
2	Forestry and logging	85	19	104	915	187	1102	1000	206	1206
3	Mining	453	22	474	3463	463	3926	3916	485	4401
4	Petroleum products	17	1	18	95	7	103	113	8	121
5	Bricks and tiles (structural clay products)	132	25	156	2815	712	3527	2947	737	3684
6	Cement	24	0	24	285	19	304	309	19	328
7	Non-metallic mineral products	56	23	79	2055	372	2427	2111	395	2506
8	Iron and steel (ferro alloys and casting & forging)	78	0	78	1169	70	1239	1247	70	1318
9	Rail and other transport equipment	28	0	28	119	0	119	148	0	148
10	Wind turbine generator manufacturing	6	1	7	2	0	3	8	1	10
11	Other manufacturing	3591	558	4148	44463	16719	61182	48054	17277	65331
12	Watershed development	0	0	0	2138	1101	3239	2138	1101	3239
13	Other construction	1736	58	1794	61121	7065	68186	62857	7122	69980
14	Wind energy	0	0	0	18	0	18	18	0	18
15	Other electricity	365	49	414	894	82	976	1259	131	1390
16	Metro transport services	18	6	24	0	0	0	18	6	24
17	Rail transport services (except metro)	571	50	621	765	29	794	1336	79	1415
18	Other transport services	3757	26	3783	11932	141	12073	15689	166	15855
19	Other services	25924	8553	34477	81747	12641	94388	107671	21194	128865
20	Public administration and defence	8945	1444	10389	2275	311	2587	11220	1756	12976
	Total	51390	12162	63552	459127	163125	622252	510518	175286	685804

Table A.V.2: Percentage shares of workers by type and gender

(%)

S. No.	Sector	Total formal workers	Total informal workers	Total male workers	Total female workers
1	Agriculture and allied activities (except forestry)	10.91	58.83	48.67	71.05
2	Forestry and logging	0.16	0.18	0.20	0.12
3	Mining	0.75	0.63	0.77	0.28
4	Petroleum products	0.03	0.02	0.02	0.00
5	Bricks and tiles (structural clay products)	0.25	0.57	0.58	0.42
6	Cement	0.04	0.05	0.06	0.01
7	Non-metallic mineral products	0.12	0.39	0.41	0.23
8	Iron and steel (ferro alloys and casting & forging)	0.12	0.20	0.24	0.04
9	Rail and other transport equipment	0.04	0.02	0.03	0.00
10	Wind turbine generator manufacturing	0.01	0.00	0.00	0.00
11	Other manufacturing	6.53	9.83	9.41	9.86
12	Watershed development	0.00	0.52	0.42	0.63
13	Other construction	2.82	10.96	12.31	4.06
14	Wind energy	0.00	0.00	0.00	0.00
15	Other electricity	0.65	0.16	0.25	0.07
16	Metro transport services	0.04	0.00	0.00	0.00
17	Rail transport services (except metro)	0.98	0.13	0.26	0.05
18	Other transport services	5.95	1.94	3.07	0.09
19	Other services	54.25	15.17	21.09	12.09
20	Public administration and defence	16.35	0.42	2.20	1.00
	Total	100.00	100.00	100.00	100.00

Appendix VI

Table A.VI.1: Inverse matrix of open model for India, 2009-10

S. No.	Sector	1	2	3	4	5	6	7
1	Agriculture and allied activities (except forestry)	1.237	0.020	0.024	0.025	0.047	0.043	0.066
2	Forestry and logging	0.002	1.007	0.003	0.003	0.004	0.004	0.009
3	Mining	0.029	0.049	1.048	0.896	0.172	0.301	0.206
4	Petroleum products	0.024	0.050	0.033	1.048	0.109	0.100	0.119
5	Bricks and tiles (structural clay products)	0.000	0.000	0.001	0.001	1.040	0.026	0.006
6	Cement	0.001	0.001	0.001	0.001	0.028	1.019	0.026
7	Non-metallic mineral products	0.001	0.001	0.002	0.002	0.035	0.014	1.054
8	Iron and steel (ferro alloys and casting & forging)	0.009	0.008	0.011	0.011	0.017	0.017	0.050
9	Rail and other transport equipment	0.001	0.001	0.002	0.002	0.003	0.003	0.005
10	Wind turbine generator manufacturing	0.000	0.000	0.000	0.000	0.001	0.001	0.001
11	Other manufacturing	0.137	0.123	0.166	0.162	0.233	0.262	0.418
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Other construction	0.012	0.013	0.026	0.023	0.022	0.020	0.120
14	Wind energy	0.000	0.000	0.001	0.001	0.001	0.002	0.002
15	Other electricity	0.016	0.007	0.030	0.030	0.051	0.067	0.058
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.005	0.003	0.008	0.008	0.010	0.011	0.012
18	Other transport services	0.035	0.050	0.031	0.035	0.081	0.084	0.096
19	Other services	0.117	0.091	0.124	0.129	0.211	0.246	0.269
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Output multiplier	1.625	1.425	1.511	2.378	2.065	2.219	2.516

(Contd.)

S. No.	Sector	8	9	10	11	12	13	14
1	Agriculture and allied activities (except forestry)	0.068	0.080	0.041	0.193	0.001	0.059	0.031
2	Forestry and logging	0.006	0.009	0.004	0.020	0.001	0.040	0.002
3	Mining	0.279	0.119	0.098	0.128	0.002	0.113	0.222
4	Petroleum products	0.068	0.053	0.046	0.053	0.001	0.052	0.234
5	Bricks and tiles (structural clay products)	0.001	0.001	0.003	0.001	0.000	0.033	0.001
6	Cement	0.001	0.005	0.038	0.002	0.002	0.055	0.014
7	Non-metallic mineral products	0.003	0.011	0.005	0.003	0.009	0.034	0.002
8	Iron and steel (ferro alloys and casting & forging)	1.197	0.183	0.242	0.095	0.001	0.105	0.088
9	Rail and other transport equipment	0.004	1.141	0.006	0.007	0.000	0.003	0.003
10	Wind turbine generator manufacturing	0.001	0.001	1.443	0.001	0.000	0.001	0.501
11	Other manufacturing	0.474	0.552	0.161	1.698	0.005	0.323	0.112
12	Watershed development	0.000	0.000	0.000	0.000	1.000	0.000	0.000
13	Other construction	0.020	0.033	0.047	0.029	0.001	1.136	0.025
14	Wind energy	0.002	0.001	0.001	0.001	0.000	0.001	1.000
15	Other electricity	0.060	0.048	0.023	0.049	0.001	0.051	0.018
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.014	0.010	0.009	0.013	0.000	0.010	0.007
18	Other transport services	0.107	0.081	0.085	0.099	0.001	0.082	0.054
19	Other services	0.318	0.269	0.440	0.337	0.011	0.271	0.386
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Output multiplier	2.623	2.598	2.690	2.730	1.037	2.368	2.699

S. No.	Sector	15	16	17	18	19	20
1	Agriculture and allied activities (except forestry)	0.036	0.027	0.026	0.103	0.060	0.000
2	Forestry and logging	0.004	0.002	0.005	0.003	0.002	0.000
3	Mining	0.271	0.033	0.069	0.195	0.025	0.000
4	Petroleum products	0.110	0.017	0.042	0.214	0.018	0.000
5	Bricks and tiles (structural clay products)	0.001	0.001	0.003	0.001	0.001	0.000
6	Cement	0.002	0.002	0.005	0.001	0.001	0.000
7	Non-metallic mineral products	0.002	0.002	0.004	0.002	0.001	0.000
8	Iron and steel (ferro alloys and casting & forging)	0.016	0.022	0.037	0.014	0.010	0.000
9	Rail and other transport equipment	0.002	0.106	0.157	0.002	0.001	0.000
10	Wind turbine generator manufacturing	0.003	0.001	0.002	0.000	0.000	0.000
11	Other manufacturing	0.204	0.097	0.161	0.222	0.116	0.000
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000
13	Other construction	0.035	0.026	0.089	0.022	0.020	0.000
14	WindeEnergy	0.006	0.002	0.003	0.001	0.000	0.000
15	Other electricity	1.212	0.066	0.113	0.023	0.018	0.000
16	Metro transport services	0.000	1.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.008	0.002	1.004	0.008	0.003	0.000
18	Other transport services	0.057	0.026	0.033	1.064	0.033	0.000
19	Other services	0.238	0.351	0.144	0.301	1.148	0.000
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	1.000
	Output multiplier	2.206	1.783	1.896	2.176	1.458	1.000

Table A.VI.2: Inverse matrix of closed model for India, 2009-10

S. No.	Sector	1	2	3	4	5	6	7
1	Agriculture and allied activities (except forestry)	1.695	0.483	0.460	0.448	0.469	0.466	0.482
2	Forestry and logging	0.027	1.032	0.027	0.026	0.027	0.027	0.032
3	Mining	0.168	0.190	1.181	1.025	0.300	0.430	0.332
4	Petroleum products	0.137	0.165	0.142	1.153	0.213	0.205	0.222
5	Bricks and tiles (structural clay products)	0.001	0.001	0.002	0.002	1.041	0.026	0.007
6	Cement	0.002	0.003	0.003	0.003	0.030	1.021	0.028
7	Non-metallic mineral products	0.007	0.007	0.009	0.008	0.041	0.020	1.060
8	Iron and steel (ferro alloys and casting & forging)	0.054	0.053	0.054	0.053	0.058	0.058	0.091
9	Rail and other transport equipment	0.008	0.008	0.008	0.008	0.009	0.009	0.011
10	Wind turbine generator manufacturing	0.001	0.001	0.001	0.001	0.001	0.002	0.001
11	Other manufacturing	0.879	0.874	0.873	0.849	0.916	0.947	1.091
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Other construction	0.047	0.049	0.059	0.055	0.054	0.052	0.152
14	Wind energy	0.002	0.002	0.002	0.002	0.003	0.003	0.003
15	Other electricity	0.069	0.061	0.080	0.079	0.100	0.116	0.106
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.029	0.028	0.031	0.030	0.033	0.034	0.035
18	Other transport services	0.268	0.286	0.253	0.250	0.295	0.299	0.306
19	Other services	1.000	0.984	0.965	0.946	1.024	1.062	1.070
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Households	2.424	2.452	2.309	2.242	2.231	2.239	2.198
	Output multiplier	6.819	6.679	6.458	7.181	6.846	7.016	7.225

(Contd.)

S. No.	Sector	8	9	10	11	12	13	14
1	Agriculture and allied activities (except forestry)	0.480	0.496	0.450	0.622	0.452	0.486	0.439
2	Forestry and logging	0.029	0.032	0.026	0.044	0.026	0.063	0.025
3	Mining	0.405	0.246	0.223	0.259	0.140	0.242	0.346
4	Petroleum products	0.170	0.157	0.148	0.159	0.113	0.158	0.335
5	Bricks and tiles (structural clay products)	0.002	0.002	0.004	0.002	0.001	0.034	0.002
6	Cement	0.003	0.006	0.039	0.003	0.004	0.056	0.015
7	Non-metallic mineral products	0.009	0.017	0.011	0.010	0.016	0.040	0.008
8	Iron and steel (ferro alloys and casting & forging)	1.238	0.224	0.282	0.137	0.045	0.147	0.128
9	Rail and other transport equipment	0.010	1.147	0.011	0.014	0.007	0.009	0.009
10	Wind turbine generator manufacturing	0.001	0.001	1.444	0.001	0.001	0.001	0.502
11	Other manufacturing	1.141	1.226	0.825	2.392	0.735	1.013	0.773
12	Watershed development	0.000	0.000	0.000	0.000	1.000	0.000	0.000
13	Other construction	0.051	0.065	0.078	0.062	0.035	1.168	0.056
14	Wind energy	0.003	0.003	0.002	0.003	0.001	0.003	1.002
15	Other electricity	0.108	0.097	0.071	0.099	0.053	0.100	0.065
16	Metro transport services	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.036	0.032	0.031	0.035	0.024	0.033	0.029
18	Other transport services	0.316	0.292	0.292	0.317	0.230	0.299	0.261
19	Other services	1.111	1.071	1.229	1.162	0.880	1.092	1.172
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Households	2.178	2.200	2.167	2.266	2.385	2.256	2.160
	Output multiplier	7.289	7.313	7.333	7.585	6.148	7.201	7.326

(Contd.)

S. No.	Sector	15	16	17	18	19	20	21
1	Agriculture and allied activities (except forestry)	0.463	0.470	0.459	0.521	0.502	0.451	0.451
2	Forestry and logging	0.028	0.027	0.029	0.027	0.027	0.025	0.025
3	Mining	0.401	0.168	0.200	0.322	0.159	0.137	0.137
4	Petroleum products	0.216	0.127	0.149	0.318	0.128	0.112	0.112
5	Bricks and tiles (structural clay products)	0.002	0.002	0.004	0.002	0.002	0.001	0.001
6	Cement	0.004	0.003	0.007	0.003	0.003	0.002	0.002
7	Non-metallic mineral products	0.008	0.008	0.011	0.008	0.007	0.007	0.007
8	Iron and steel (ferro alloys and casting & forging)	0.058	0.065	0.079	0.055	0.053	0.044	0.044
9	Rail and other transport equipment	0.008	0.112	0.164	0.008	0.008	0.007	0.007
10	Wind turbine generator manufacturing	0.003	0.002	0.002	0.001	0.001	0.001	0.001
11	Other manufacturing	0.896	0.816	0.862	0.899	0.832	0.731	0.731
12	Watershed development	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Other construction	0.067	0.060	0.122	0.054	0.054	0.034	0.034
14	Wind energy	0.007	0.003	0.004	0.002	0.002	0.001	0.001
15	Other electricity	1.261	0.118	0.163	0.072	0.069	0.052	0.052
16	Metro transport services	0.000	1.000	0.000	0.000	0.000	0.000	0.000
17	Rail transport services (except metro)	0.031	0.026	1.027	0.030	0.027	0.024	0.024
18	Other transport services	0.274	0.251	0.252	1.276	0.257	0.229	0.229
19	Other services	1.061	1.206	0.978	1.106	1.999	0.870	0.870
20	Public administration and defence	0.000	0.000	0.000	0.000	0.000	1.000	0.000
21	Households	2.260	2.348	2.289	2.211	2.337	2.388	2.388
	Output multiplier	7.048	6.814	6.800	6.914	6.466	6.117	5.117

Appendix VII

Table A.VII.1: Sector-related direct, indirect and induced employment impacts by type of worker (formal, informal)

Multipliers	Formal employment			Informal employment		
	Direct impact	Indirect impact	Induced impact	Direct impact	Indirect impact	Induced impact
Agriculture and allied activities (except forestry)	0.048	0.028	0.387	2.533	0.675	4.077
Forestry and logging	0.009	0.016	0.392	0.091	0.122	4.125
Mining	0.022	0.020	0.369	0.185	0.155	3.884
Petroleum products	0.000	0.039	0.358	0.002	0.313	3.771
Bricks and tiles (structural clay products)	0.035	0.038	0.356	0.785	0.323	3.753
Cement	0.003	0.044	0.358	0.041	0.330	3.766
Non-metallic mineral products	0.011	0.049	0.351	0.351	0.456	3.697
Iron and steel (ferro alloys and casting & forging)	0.002	0.055	0.348	0.035	0.435	3.663
Rail and other transport equipment	0.008	0.048	0.351	0.034	0.444	3.701
Wind turbine generator manufacturing	0.008	0.060	0.346	0.003	0.323	3.644
Other manufacturing	0.012	0.061	0.362	0.180	0.770	3.811
Watershed development	0.000	0.002	0.381	0.745	0.012	4.012
Other construction	0.012	0.046	0.360	0.471	0.429	3.794
Wind energy	0.015	0.054	0.345	0.001	0.274	3.632
Other electricity	0.017	0.041	0.361	0.039	0.279	3.801
Metro transport services	0.285	0.042	0.375	0.000	0.212	3.949
Rail transport services (except metro)	0.064	0.026	0.366	0.082	0.210	3.850
Other transport services	0.043	0.046	0.353	0.138	0.443	3.719
Other services	0.100	0.022	0.373	0.275	0.235	3.931
Public administration and defence	0.249	0.000	0.381	0.062	0.000	4.017
Households			0.381			4.017

Table A.VII.2: Sector-related direct, indirect and induced impacts by gender

Multipliers	Male employment			Female employment		
	Direct impact	Indirect impact	Induced impact	Direct impact	Indirect impact	Induced impact
Agriculture and allied activities (except forestry)	1.719	0.483	3.279	0.862	0.220	1.185
Forestry and logging	0.082	0.107	3.317	0.017	0.031	1.199
Mining	0.184	0.134	3.123	0.023	0.040	1.129
Petroleum products	0.002	0.292	3.033	0.000	0.060	1.096
Bricks and tiles (structural clay products)	0.656	0.280	3.018	0.164	0.080	1.091
Cement	0.042	0.295	3.029	0.003	0.079	1.095
Non-metallic mineral products	0.305	0.394	2.973	0.057	0.111	1.075
Iron and steel (ferro alloys and casting & forging)	0.036	0.378	2.946	0.002	0.111	1.065
Rail and other transport equipment	0.042	0.372	2.977	0.000	0.120	1.076
Wind turbine generator manufacturing	0.009	0.305	2.931	0.002	0.077	1.060
Other manufacturing	0.142	0.603	3.065	0.051	0.229	1.108
Watershed development	0.492	0.010	3.227	0.253	0.003	1.166
Other construction	0.434	0.372	3.051	0.049	0.102	1.103
Wind energy	0.016	0.264	2.921	0.000	0.064	1.056
Other electricity	0.051	0.255	3.057	0.005	0.065	1.105
Metro transport services	0.215	0.202	3.176	0.070	0.052	1.148
Rail transport services (except metro)	0.137	0.188	3.096	0.008	0.047	1.119
Other transport services	0.179	0.364	2.991	0.002	0.125	1.081
Other services	0.314	0.188	3.161	0.062	0.069	1.143
Public administration and defence	0.268	0.000	3.230	0.042	0.000	1.168
Households			3.230			1.168

Appendix VIII

Sample questionnaire for the watershed development sector

NATIONAL COUNCIL OF APPLIED ECONOMIC RESEARCH
PARISILA BHAWAN, 11, I.P. ESTATE
NEW DELHI-110002

ASSESSMENT STUDY ON GREEN JOBS POTENTIAL IN INDIA
DEPARTMENT OF LAND RESOURCES (WATERSHED DEVELOPMENT)

Focus Year: 2009-10
Respondent: Principal Secretary.
Unit: mcft (1 mcft or 30 000 m^3)

I. Identification

S. No.	Particulars	Details
1	State	Andhra Pradesh/Karnataka
2	Focus Sector	Watershed
3	Name of the Respondent	
4	Designation of Respondent	
5	Contact Number of respondent	
6	Address of respondent	

II. Basic Details

S. No.	Particulars	Area
1	Total Geographical Area (Sq.Kms) 2009-10	
2	Total Area under Cultivation (Hectare): 2009-10	
3	Total Area under Watershed (Hectares)	
	TYPE OF Watersheds	**Number**
4	Watershed (50,000-2,00,000 hectare)	
5	Sub-watershed (10,000-50,000 hectare)	
6	Milli- watershed (1,000-10,000 hectare)	
7	Micro-watershed (100-1,000 hectare)	
8	Mini-watershed (10-100 hectare)	
	Others (specify)	
	Others (specify)	
	Others (specify)	
9	**TOTAL**	

III. Staff Employed

How many people were employed in the Department of Watershed Development in 2009- 10?

S. No.	Type of staff	Number
1	Gazetted Officers	
2	Staff in the Office of Principal Secretary	
3	Field staff	
4	Ministerial Staff	
5	Others (specify)	
	TOTAL	

IV. Total Expenditure

S. No.	Particulars	Amount (Rs. Lakhs)
Q.3	What is the total expenditure incurred on Salaries & Wages on the above staff in 2009-10?	

V. Details of Watershed

S. No.	Particulars	Number
1	How many watershed structures are created? Check Dams Nala Bunds Farm Ponds Others (Specify)	
2	Total expenditure incurred on watershed in 2009-10 (Rs per hectare)	
3	Employment Generated in 2009-10 (person days per hectare)	

VI. Expenditure on Material

Expenditure incurred on the following materials of watershed construction in 2009-10?

S. No.	Particulars	Value (Rs.)	Share (%)
A	MATERIALS		
1	Bricks		
2	Cement		
3	Concrete		
4	Bamboo Poles, Brushwood		
5	Ropes		
6	Saw		
7	Fine Thread		
8	Measuring Equipment (Consumables)		
9	Transparent Pipes		
10	Adhesive Tapes		
11	Stones (boulders etc)		
12	Wire Mesh, Binding Wires etc		
13	Fuel (Petrol, Diesel, Gas, Lubricant)		
14	Office Stationery		
15	Plants		
16	Others (specify)-1		
17	Others (specify)-2		
18	Others (specify)-3		
	SUB-TOTAL		
B	SERVICES		
1	Premium Paid for Insurance (Fire, Theft, Vehicles)		
2	Legal Cost		
5	Hiring Capital Equipments (Bulldozers etc)		
6	Repairs & Maintenance: Machines		
7	Repairs & Maintenance: Vehicles		
8	Repairs & Maintenance: Construction Works (plastering, pointing, and repairing to prevent cracks and leakages)		
9	Electricity		
10	Postage		
11	Telephone/Telecommunications		
12	Others (specify)		
	SUB-TOTAL		
C	OTHERS		

1	Posters, Banners (Awareness Creation)		
	SUB-TOTAL		
	GRAND TOTAL		

VII. Cost of Contractual Watershed Works

S. No.	Particulars	Cost (Rs)	Share (%)
1	Check dams Earth work Masonry Concrete		
2	Percolation Pond		
3	Irrigation Tank		

VIII. OUTCOMES of watershed Development (based on the Assessment Studies) (Please provide a copy of the report)

S. No.	Outcome Indicator	Details (%)
1	Increase in average yield of rainfed crops	
2	Increase in average yield of irrigated crops	
3	Increase in irrigated area	
4	Decrease in private cultivable land left fallow	
5	Increase in area devoted to horticulture	
6	Increase in milk yield, hybrid cattle	
7	Increase in household income	
8	Area in cash crops and oilseeds	
9	Groundwater recharged	
10	Others (specify)	

Name of Field Consultant	Date of Interview	Address & Contact Number

Appendix IX

Note on forestry and livelihoods

Background

The term 'forest' generally conjures up a vision of countryside covered with trees and undergrowth and inhabited by wild animals. The Food and Agricultural Organization (FAO) defines forest as land covering more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 per cent, or trees able to reach these thresholds in situ (http://www.fao.org/docrep/006/ad665e/ad665e06.htm). Forests have two components – the living and the non-living. The living component consists of trees and some or all of the following: shrubs, vines, herbs, grasses, mosses, algae, fungi, insects, mammals, birds, reptiles, amphibians and microorganisms. The living organisms interact amongst themselves and with the non-living elements such as soil and climate, leading to the formation and growth of forests of varied structures and compositions as dynamic systems. A forest can be of natural origin or planted; the definition excludes tree stands in orchards and agro-forestry. However, land classified as 'forest' under the law of the land will be 'forest' in legal parlance, irrespective of whether that land supports trees or not. The environment literally means everything that surrounds us. Its applied meaning, however, is restricted to the natural environment, viz. air, water, plants, animals and landscape. According to one formal definition, the environment includes "in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms." (Singh, 2006). Forest is a major component, as well as one of the key regulators, of the natural environment.

Focus on ecology, environment and livelihood

Advances in the study of ecology during the 1970s influenced forestry practitioners to expand their focus from the sustainable management of forests for the sake of a single product (timber) to a broader emphasis on ecosystems and social services, in addition to wood and non-wood products; and to pay increasing attention to the importance of forests in providing clean water and biodiversity. At the same time, the idea of 'putting the people first' was emerging in many developing nations, including India. The theme of the World Forestry Congress held in Indonesia in 1978 was "Forestry for People", and the Congress helped to provide impetus to a movement variously known as 'social forestry', 'community forestry' or 'participatory forestry'. This is now practised in India as 'joint forest management', with provision of usufructs to the forest-fringe community, who participate with the Forest Department in planning, managing and protecting a defined tract of government forest and receive a sustainable yield of a variety of forest products and services. The concept of sustainable yield was thus deepened and broadened to encompass the ecosystem and environmental services provided by forests and their critical role in sustaining life on earth. Thus arose the concept of sustainable forest management (SFM).

Box 1

Definition of sustainable forest management in the European Forest Convention:

"Sustainable forest management" means the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems.

http://www.forestindustries.eu/content/sustainable-forest-management-sfm

The ecological, economic and social functions of foresters are therefore the focus, and the role of the people directly dependent on forest ecosystem services, and their needs, are increasingly appreciated in forest management. Sustainable forest management thus recognizes the importance of a broad multi-disciplinary approach to managing forests in ways that sustain the flow of a variety of forest goods and services, while explicitly taking into account the role of forests in relation to other sectors, based on the three pillars of sustainable development: economy, society and environment (FAO, 2012).

Sustainable development though prudent use of renewable sources

Economic development can be sustained by exploiting renewable resources for both consumer products and energy commensurate with the sustainable yield from appropriately managed forests and from agriculture. It should be possible to source a major share of energy needs from the sun and wind, and the balance from wood. The consequent afforestation and promotion of wood and NTFP-based enterprises can generate livelihoods for millions of rural poor. Treated and processed wood/bamboo is a sound raw material for housing, furniture and other utility products. Its use, to the extent feasible, will reduce dependence on cement, sand, steel and other non-renewable products, ensuring environmental equilibrium and a green economy. Treated bamboo and wood so used can also be reused/recycled, further reducing the pressure on forests and plantations. Forest productivity in India is substantially lower than it could be, due to poor stocking (Refer to Table 3), and the challenge today is to find ways and means of rejuvenating the country's forests to boost production and so bridge the gap.

Forest in India

The recorded forest area in India is 76.95 million hectares, which accounts for 23.41 per cent of the geographical area of the country (328.73 million hectares). Of the recorded forest area, 42.25 million hectares (54.91 per cent) is "reserved" forest, 21.40 million hectares (27.81 per cent) is "protected" forest and 13.30 million hectares (17.28 per cent) is "unclassed" forest (SFR, 2011). The per capita forest area in India is 0.064 hectares.

Box 2	
1.	'Forest area' refers to all lands recorded as forest in Government records.
2.	'Tree canopy density' denotes the relative completeness of canopy, usually expressed as a percentage and taking closed canopy as one hundred.
3.	'Forest cover' includes all lands with a tree canopy density of more than 10 per cent with a 'minimum areal extent of one hectare'; and includes all types of 'lands irrespective of ownership, land use and legal status' (SFR, 2011).

For the different states and union territories, the total forest area breaks down as shown below:

Table A.IX.1: Recorded forest area in states and UTs (Square km)

State/UT	Geo. Area (G/A)	Recorded forest area			Total forest area	% of GA
		Reserved forests	Protected forests	Unclassed forests		
Andhra Pradesh	275069	50479	12365	970	63814	23.20
Arunachal Pradesh	83743	10546	9528	31466	51540	61.55
Assam	78438	17864	0	8968	26832	34.21
Bihar	94163	693	5779	1	6473	6.87
Chhattisgarh	135191	25782	24036	9954	59772	44.21
Delhi	1483	78	7	0	85	5.73
Goa	3702	253	845	126	1224	33.06
Gujarat	196022	14122	479	4326	18927	9.66
Haryna	44212	249	1158	152	1559	3.53
Himachal Pradesh	55673	1898	33130	2005	37033	66.52
Jammu & Kashmir	222236	17643	2551	36	20230	9.10
Jharkhand	79714	4387	19185	33	23605	29.61
Karnataka	191791	28690	3931	5663	38284	19.96
Kerala	38863	11123	142	0	11265	28.99
Madhya Pradesh	308245	61886	31098	1705	94689	30.72
Maharashtra	307713	49226	8195	4518	61939	20.13
Manipur	22327	1467	4171	11780	17418	78.01
Meghalaya	22429	1113	12	8371	9496	42.34
Mizoram	21081	7909	3568	5240	16717	79.30
Nagaland	16579	86	508	8628	9222	55.62
Orissa	155707	26329	15525	16282	58136	37.34
Punjab	50362	44	1137	1903	3084	6.12
Rajasthan	342239	12454	17416	2769	32639	9.54
Sikkim	7096	5452	389	0	5841	82.31
Tamil Nadu	130058	19388	2183	1306	22877	17.59
Tripura	10486	4175	2	2117	6294	60.02

Uttar Pradesh	240928	11660	1420	3503	16583	6.88
Uttarakhand	53483	24643	9885	123	34651	64.79
West Bengal	88752	7054	3772	1053	11879	13.38
A&N Islands	8249	5613	1558	0	7171	86.93
Chandigarh	114	31	0	3	34	29.82
Dadra&Nagar Haveli	491	199	5	0	204	41.55
Daman & Diu	112	0.24	0	8.03	8	7.38
Lakshadweep	32	0	0	0	0	0
Puducherry	480	0	2	11	13	2.71
Total	3287263	422536	213982	133020	769538	23.41

Source: SFR, 2011

The forest cover in India, on the other hand, is 69.20 million hectares, which works out at 21.05 per cent of the geographical area of the country.

Socio-economic contribution of forests in India

Enhanced focus on ecological concerns and livelihood since 1980s

Forest is the source of timber, small timber, firewood, bamboo, fodder and various non-timber forest products (NTFPs). Timber, small timber, firewood and bamboo are also available from trees outside forests. Employment is generated in the process of afforestation, planting and tending operations, the harvesting of trees – by thinning, clear-felling and logging –, and the transportation of logs to sales depots, especially for the rural poor. NTFPs, including edibles, are harvested by forest-fringe dwellers for domestic use and consumption, and for sale, with or without value addition. There are forests owned by local communities and forests owned by the state. In the case of state-owned forests, organized forest-fringe dwellers who sign a MoU with the state to participate in the protection and management of a defined tract of forest land are eligible for usufructs, as defined in the State Resolution for Joint Forest Management (JFM) and incorporated in the MoU. Benefits include access (regulated by JFM committee) to NTFPs free of charge and a share of the sale proceeds of the timber harvested/disposed of as per the management plan, in accordance with the policy of the states concerned. This practice began all over the country in the early 1990s in accordance with guidelines issued on 1 June 1990 by the Ministry of Environment and Forests, Government of India. The nature and extent of the usufructs accorded to JFM communities depends, however, on the policies of particular states.

As recently as three decades ago, most of the timber produced in the country was formerly drawn from forest areas. The volumes were in the order of 10 to 15 million cubic metres per annum, as compared with estimated production of 3.175 million cubic metres at present (SFR,

2011). As a result of growing awareness of the serious depletion and degradation of recorded forests, and the consequent adverse impact on ecological services and the livelihoods of forest-dependent communities, the regeneration and restocking of forests came to be seen as the primary challenge. The Forest (Conservation) Act, 1980 and the National Forest Policy (1988) were introduced during this period. The conservation of forests for ecological services and the provision of livelihoods for forest-dependent rural communities then became the major concern and priority, and the quantity of timber harvested from government forests was scaled down drastically to facilitate forest rejuvenation and restocking. Large-scale artificial planting and aided natural regeneration programmes were undertaken countrywide. The production of timber from recorded forest areas therefore declined gradually and, with the permissible harvest from recorded forests declining, the market relied increasingly on timber from trees outside of forests and on imports. The Social Forestry Programme, begun in the early 1980s, had promoted farm forestry on private land. This programme included the supply of planting stock and financial assistance for planting and maintenance. Agro-forestry, as it is known, was a huge success, and soon trees grown outside forests were contributing far more timber than was harvested from recorded forests. Marginal land not suitable for sustainable agriculture was made productive through tree-farming, thus providing regular income for rural people.

Forest area and type groups

Recorded forest in the state of Tripura covers 6,294 square kilometres, roughly 60 per cent of the geographical area. Of this total, reserved forests account for 4,175 square kilometres, protected forests for 2 square kilometres and unclassed forests for 2,117 square kilometres. The India State of Forest Report 2011 recognizes two forest type groups in Tripura: tropical semi-evergreen and tropical moist deciduous groups, accounting for around 11 per cent and 89 per cent of the forest area respectively.

NTFPs as food

Bamboo shoots are young culms (hollow stems), harvested when they first appear above the soil or shortly after. This is one of the favourite vegetables of the tribes living in Tripura, available in plenty from May to August. Sun-dried bamboo shoots are also popular in the off-season. There is significant demand for canned bamboo shoots in Japan, Singapore, China, Thailand, Hong Kong and the U.K (Sharma, 2009). A study conducted in 2008 revealed that at least 108 million tonnes of bamboo shoots are sold in the rainy season in various markets of the state for an estimated INR 11 hundred thousand, while an estimated 600 million tonnes are harvested for household consumption by locals practising shifting cultivation (calculated on the basis of 30,000 households consuming 200 grams per family per day for 100 days). This adds up to a total of 708 million tonnes of bamboo shoots valued (at the rate of INR 10 per kilogramme) at INR 71 hundred thousand (Sharma, 2009).

In addition to bamboo shoots, the tribal people consume other NTFPs, including a variety of forest herbs, tubers, fruits and flowers, and these play a vital role in their nutritional security, as

well as generating employment for harvesters and vendors (Sharma, 2009). Some of the more important edible wild plants are batema (Amorphophallus spp.), gandhroi or sugandhamantri (Homalomena aromatica), wild banana (Musa acuminate, M. paradisiacal), aonla (Emblica officinalis), dheki shak (Diplazium polypoides) and jalpai (Elaeocarpus floribundus). Particulars of sales of wild edibles during the rainy season, according to a market survey conducted in 2008, are listed in the table below (Sharma, 2009).

Table A.IX.2: Sales of edible NTFPs in the markets of Tripura

Types of Edible Forest Product	Estimated quantity of the product sold in the markets in 150 days (in Kg)					Total quantity sold in 150 days(kg.)	Weighted average rate of selling (INR/Kg)	Total amountin INR 100,000
	Agartala	Rest of West Tripura	South Tripura	North Tripura	Dhalai, Tripura			
Leafy vegetables	15729	4506	6532	814	1035	28616	28.70	8.2
Leafy-stem vegetables	4664	4676	1224	6128	1629	18321	14.09	2.6
Bamboo shoots for 100 days	38629	34900	14286	6557	14386	108758	10.00	11
Stem vegetables	2795	14555	3437	1607	546	22940	12.34	2.8
Root/ tuber vegetables	215	2567	7361	224	3704	14071	10.5	1.4
Flowers	4018	14569	15333	5948	6221	46089	5.05	2.3
Fruits	4848	5174	7030	2540	10739	30331	13.37	4.0
Seeds	86	280	-	-	-	366	15.00	0.05
Mushrooms	405	17	-	226	45	693	54.00	0.37
Aquatic animals	3201	2100	4546	5186	18332	33365	15.20	5.1
Total	74590	83344	59749	29230	56637	303550	12.45	37.82

Source: Sharma, 2009

Furthermore, consumption by forest dwellers practising shifting cultivation (about 30,000 households) at an estimated rate of 500 grams per household per day amounts to 2,250 million tonnes of edible NTFPs consumed over a period of 150 days. By adding together the figures for edible NTFPs directly consumed in this way and for those sold in markets, we get an estimated total of 2,553 million tonnes, which, at an average rate of INR 12.45 per kilogramme (see table above), would be worth INR 280.12 hundred thousand (Sharma, 2009).

(BRIEF) SURVEYORS' NOTES FOR INDIVIDUAL STATES

1. Assam

1.1 General information: Assam lies in the middle of the north-eastern part of India, sharing borders with West Bengal and six north-eastern states, as well as with Bangladesh and Bhutan. It is situated between 24°07'N-28°00'N latitude and 89°42'E-96°02'E longitude. Its geographical area is 78,438 square kilometres, which constitutes 2.39 per cent of the area of the country as a whole. The state can be divided into three parts topographically, viz. the Brahmaputra Valley, the Surma Valley and the mountainous Assam ranges. The state has a subtropical climate with temperatures ranging from 5°C to 32°C and mean annual rainfall of between 1,500 and 3,750 millimetres. The population of the state is 31.17 million, rural dwellers accounting for 85.92 per cent of this total, urban dwellers for 14.08 per cent (Census, 2011). The population density is 397 persons per square kilometre. The livestock population of the state is 17.23 million (Livestock Census 2007).

1.2 Recorded forest area and forest cover: The recorded forest area of the state is 26,832 square kilometres (34.21 per cent of its geographical area), of which 66.58 per cent is reserved forest and 33.42 per cent unclassed forest. The forest cover of the state, as per the India State of Forest Report 2011, is 27673 square kilometres (35.28 per cent of the state's geographical area). Details of the canopy density are given below:

a) Very dense forest (canopy density more than 70%): 1,444 square km

b) Moderately dense forest (canopy density 40% - 70%): 11,404 square km

c) Open forest (canopy density 10-40%): 14,825 square km

1.3 Tree cover: The tree cover of the state is estimated at 1,564 square kilometres (1.99 per cent of its geographical area). Its forest and tree cover status is shown below:

Category	Area in square km	% of geographical area
Tree cover	1564	1.99
Forest cover	27673	35.28
Forest & Tree cover	29237	37.27

1.4 Changes in forest cover: According to the India State of Forest Report 2011, there had been a net loss of 19 square kilometres of forest since the 2009 Report. Changes in canopy density are shown below:

a) Very dense forest (canopy density more than 70%): (-) 17 square km

b) Moderately dense forest (canopy density 40% - 70%): (-) 154 square km

c) Open forest (canopy density 10-40%): (+) 152 square km

1.5 Bamboo resources: The extent of the bamboo-bearing areas of the state forests is 7,238 square kilometres. According to the India State of Forest Report 2011, the density of the bamboo-bearing area of the recorded forests breaks down as follows (in square kilometres):

Recorded forest area	Pure bamboo	Dense bamboo	Scattered bamboo	Clumps hacked	Bamboo regeneration	No bamboo
26832	105	4049	2878	166	40	19594

The estimated number of bamboo culms and their equivalent "green weight", according to the India State of Forest Report 2011, are presented below:

Number of culms in million tonnes				Equivalent green weight in '000 tonnes		
Green	Dry	Decayed	Total	Green	Dry	Total
2046	201	94	2341	9985	2301	12286

1.6 Forest cover by different forest types: According to the latest assessment by the Forest Survey of India, as reported in the India State of Forest Report 2011, the state has 18 different forest types belonging to five forest-type groups, as per the Champion & Seth Classification. The percentage distribution of forest cover by forest type group, and also the percentage of plantations/trees outside forests (TOF), is shown below:

Sl. No.	Forest type group & Plantations/TOF	% of forest cover
1	Tropical wet evergreen	12.04
2	Tropical semi-evergreen	51.71
3	Tropical moist deciduous	25.64
4	Tropical dry deciduous	0.09
5	Subtropical pine forests	0.45
6	Plantations/TOF	10.07

1.7 Strict regulation of timber harvesting: In a judgment dated 12 December 1996, in response to a Civil Writ Petition (no. 202 of 1995) filed by T N Godavarman Thirumulpad, the Supreme Court imposed an interim ban on felling forest trees on account of the over-exploitation and degradation of forests in Jammu and Kashmir and Tamilnadu. The ban was subsequently extended to include the north-eastern states of India. The aforesaid order also stated that an expert committee must be constituted in each of these states to identify and study all forests and all sawmills, and veneer and plywood industries, to assess the sustainability of forests in relation to the demand/need for timber. At present, timber in these states may be harvested only in accordance with the prescriptions of working/management plans which have been approved by the Ministry of Environment and Forests (MoEF), Government of India. As a result of this strict regulation, timber is no longer the major source of revenue for the State Forest Department.

1.8 Focus on forest regeneration: The State Forest Department is focusing on large-scale forest regeneration through artificial planting and aided natural regeneration, with schematic support from the MoEF. However, the implementation of this afforestation/reforestation programme has not been very effective, and there is a need for more effective protection of forests and plantations through innovative approaches, rather than ill-considered reactive responses.

Studies of forests and forest resources: There have been hardly any studies of forests and forest resources by the State Forest Department worth mentioning, although such studies could lead to better management of forests and forest resources, as well as creating quality jobs for scholars and researchers.

1.9 Interaction between foresters and forest-fringe dwellers: It was noted during the study that interaction between frontline forest personnel and the forest-fringe population was relatively good. However, there was also plenty of scope for higher officials of the Department to engage more effectively with forest-fringe communities in order to build mutual trust, ensure proper listing of priority community needs and aspirations, and identify critical gaps in knowledge and skills for planning and implementing a training and capacity-building programme to enable such communities to utilize forest resources for income-generating activities.

1.10 Sensitization with regard to the forest ecosystem: The survey revealed a need for more concerted efforts by the State Forest Department to make forest-fringe communities aware of the value of the forest ecosystem for their livelihoods and its impact on the environment and clean water. The State Forest Department's awareness-raising programme was limited to occasional events and publicity using posters or banners; more participatory rural appraisal is required. There is scope for closer engagement with the forest-fringe population to raise awareness and build capacities.

2. Arunachal Pradesh

2.1 General information: Arunachal Pradesh is the largest state in the north-eastern region of India. The geographical area of the state is 83,743 square kilometres, which is 2.54 per cent of the country's total land mass. The state has international borders with Bhutan, China, Tibet and Myanmar and shares boundaries with the north-eastern states of Assam and Nagaland. It is situated between 26°28'N-29°30'N latitude and 91°30'E-97°30'E longitude. The main rivers are the Kameng, the Subansiri, the Siang, the Lohit and the Tirap, which flow down to the plains of Assam. The human population of the state is 1.38 million (Census 2011), representing just 0.11% of the country's population, with rural and urban dwellers accounting for 77.33 and 22.67 per cent respectively. The livestock population is 1.41 million (Livestock Census 2007). Some of the major mineral resources found in the state are limestone, dolomite, graphite, coal and oil, quartzite, brine oil, yellow ochre and marble. The state is rich in wildlife, having 11 wildlife sanctuaries, two national parks and one biosphere reserve.

2.2 Recorded forest area and forest cover: The recorded forest area of the state, according to the India State of Forest Report 2011, is 51,540 square kilometres, accounting for 61.55 per cent of its geographical area, of which 20.46 per cent is reserved forest, 18.49 per cent protected forest and 61.05 per cent unclassed forest. Of the total forest area, only 5,138 million hectares (India State of Forest Report 2011) is state owned, while the remainder is under private ownership. The forest cover of the state, according to the India State of Forest Report 2011, is 67,410 square kilometres, or 80.50 per cent of its geographical area. The canopy density of forest cover is shown below:

a) Very dense forest (canopy density more than 70%): 20,868 square km

b) Moderately dense forest (canopy density 40% - 70%): 31,519 square km

c) Open forest (canopy density 10-40%): 15,023 square km

2.3 Tree cover: The tree cover of the state is estimated at 549 square kilometres (0.66 per cent of its area). The forest and tree cover status of the state is shown below:

Category	Area in square km	% of geographical area
Tree cover	549	0.66
Forest cover	67410	80.50
Forest & Tree cover	67959	81.16

2.4 Changes in forest cover: According to the India State of Forest Report 2011, there has been a net increase in forest cover of 57 square kilometres, as compared with the previous assessment (2009). However, recent satellite imagery and high-resolution collateral data show that 131 square kilometres of forest cover remained undetected in the 2009 assessment, mainly due to snow cover. After making adjustments for the previously omitted forest cover, it emerges that there has in fact been a decrease of 74 square kilometres in the state's forest cover. Changes in canopy density are shown below:

a) Very dense forest (canopy density more than 70%): (-) 5 square km

b) Moderately dense forest (canopy density 40% - 70%): (-) 55 square km

c) Open forest (canopy density 10-40%): (-) 14 square km

2.5 Bamboo resources: The extent of bamboo bearing areas in the state's forests is 16,083 square kilometres. A breakdown of the bamboo-bearing areas, as per the India State of Forest Report 2011, is given below (in square kilometres):

Recorded forest area	Pure bamboo	Dense bamboo	Scattered bamboo	Clumps hacked	Bamboo regeneration	No bamboo
51540	217	8681	6953	144	88	35457

The number of bamboo culms and equivalent green weight, as estimated in the India State of Forest Report 2011, is presented below:

Number of culms in million tonnes				Equivalent green weight in '000 tonnes		
Green	Dry	Decayed	Total	Green	Dry	Total
2666	234	80	2980	12359	2072	14431

2.6 Forest cover in different forest types: According to the latest assessment by the Forest Survey of India, as reported in the India State of Forest Report 2011, the state has 16 different forest types belonging to 10 forest-type groups, as per the Champion & Seth classification. The percentage distribution of the various forest-type groups as part of the total forest cover, and also the percentage for plantations/trees outside forests (TOF), is shown below:

Sl. No.	Forest type group & plantations/TOF	% of forest cover
1	Tropical wet evergreen	1.48
2	Tropical semi- evergreen	68.75
3	Tropical moist deciduous	5.35
4	Subtropical broadleaved hill	3.35
5	Subtropical pine	0.84
6	Himalayan moist temperate	7.43
7	Himalayan dry temperate	1.51
8	Sub-Alpine	10.30
9	Moist Alpine scrub	0.92
10	Dry Alpine scrub	0.02
	Plantations/TOF	0.05

2.7 Revenue: The annual revenue from forests as a percentage of overall state revenue is presented below (INR in Lakh):

Year	State revenue	Forest revenue	Percentage of state revenue
2002-2003	11356	1560.83	13.74
2003-2004	157636	962.68	0.16
2004-2005	150183	1052.55	0.70
2005-2006	180940	1371.14	0.75
2006-2007	259217	866	0.35

(Source: Statistics Dept. Govt. of Arunachal Pradesh)

2.8 Expenditure: The annual expenditure of the State Forest Department on plan and non-plan blocks is shown below (INR in 100,000s):

Year	Plan	Non-plan
2002-2003	1235.87	2091.02
2003-2004	1148.73	2423.13
2004-2005	1170.15	2393.17
2005-2006	5412.17	2709.11
2006-2007	3356.26	2792.43
2009-2010	1523.63	6674.11

2.9 Forest Department manpower: The data gathered from the office of the Principal Chief Conservator of Forests (PCCF) revealed that the Arunachal Pradesh State Forest Department has 38 Indian Forest Service officers (IFS), 50 Arunachal Pradesh Forest Service officers (APFS) and 156 Forest Rangers, as well as a large number of forest field staff at the level of forester and below. There are 283 ministerial staff in the Arunachal Pradesh forest divisions and 59 in the office of the PCCF at Itanagar. A further 146 office staff are employed on a contractual basis.

2.10 Forest and livelihoods: The study revealed that the forest laws were in conflict with the age-old practice of shifting cultivation, while restrictions on harvesting and the use and sale of forest products, and bans of hunting are regarded as irritants by the forest-dwelling tribes. These issues will require thorough study and consideration by the government, and the direct involvement of the forest-dependent communities, in order to strike a balance and find ways of ensuring a sustainable flow of benefits from the forest to forest-dependent communities through appropriate value addition and marketing measures commensurate with the need for conservation of the forest ecosystem.

3. Meghalaya

3.1 General information: Meghalaya is one of the seven sister states in the north-eastern region of India, sharing borders with Assam and Bangladesh. It is situated between 24°58'N-26°07'N latitude and 89°48'E-92°51'E longitude. Its geographical area is 22,429 square kilometres. Most of the land hilly, interspersed with gorges and small valleys, with elevations ranging from 150 to 1,950 metres. The state has three distinct regions: the Garo Hills, the Khasi Hills and the Jaintia Hills. Cherrapunjee and Mawsynram, the places with the highest rainfall in the world, are located in the state. The western part of the state is warmer, with mean temperatures ranging from 12°C to 33°C. The central upland is relatively cooler (2°C to 24°C). Average annual rainfall varies from 4,000 to 11,436 millimetres. The population of the state is 2.96 million, with rural and urban dwellers accounting for 79.92 per cent and 20.08 per cent respectively (Census, 2011). The population density is 132 persons per square kilometre. The livestock population of the state is 1.82 million (Livestock Census 2007). The state is relatively

rich in mineral resources such as coal, limestone and uranium, and Meghalaya is the only state in the north-east of India which generates a surplus of power.

3.2 Recorded forest area and forest cover: The recorded forest area of the state, according to the India State of Forest Report 2011, is 9,496 square kilometres (42.34 per cent of its geographical area), of which 11.72 per cent is reserved forest, 0.13 per cent protected forest and 88.15 per cent unclassed forest. Forest cover, according to the India State of Forest Report 2011, is 17,275 square kilometres (77.02 per cent of the geographical area of the state). The figures for canopy density are shown below:

a) Very dense forest (canopy density more than 70%): 433 square km

b) Moderately dense forest (canopy density 40% - 70%): 9,775 square km

c) Open forest (canopy density 10-40%): 7,057 square km

3.3 Tree cover: Tree cover is estimated at 549 square kilometres (0.66 per cent of the area of the state). The forest and tree cover status of the state is shown below:

Category	Area in square km	% of geographical area
Tree cover	578	2.58
Forest cover	17275	77.02
Forest & Tree cover	17853	79.60

3.4 Changes in forest cover: According to the India State of Forest Report 2011, there has been a net loss of 46 square kilometres in forest cover as compared with the previous assessment (2009). The changes in canopy density are shown below:

3.5 Bamboo resources: The extent of the bamboo-bearing areas of the state's forests is 4,793 square kilometres. A breakdown of the bamboo-bearing areas, as per the India State of Forest Report 2011, is presented below (in square kilometres):

Recorded forest area	Pure bamboo	Dense bamboo	Scattered bamboo	Clumps hacked	Bamboo regeneration	No bamboo
9496	63	2815	1830	68	17	4703

Estimated figures for bamboo culms and equivalent green weight, according to the India State of Forest Report 2011, are presented below :

Number of culms in million tonnes				Equivalent green weight in '000 tonnes		
Green	Dry	Decayed	Total	Green	Dry	Total
1109	104	38	1251	6334	1157	7491

3.6 Forest cover in different forest types: According to the latest assessment by the Forest Survey of India, as reported in the India State of Forest Report 2011, the state has eight different forest types belonging to five forest-type groups, as per the Champion & Seth classification. The percentage distribution of the various forest-type groups is shown below:

Sl. No.	Forest type group & plantations/TOF	% of forest cover
1	Tropical wet evergreen	10.45
2	Tropical semi-evergreen	1.93
3	Tropical moist deciduous	61.62
4	Subtropical broadleaved hill	17.71
5	Subtropical pine	8.29

3.7 Jobs in the Forest Department: The Forest Department employs 2,634 people, according to the officers we interviewed. These include gazetted officers, front-line field staff, ministerial staff working at Forest HQ, circle offices and forest divisions, muster-roll workers and so on. The Department is also responsible for the work of constructing and repairing forest infrastructure, survey and project work, etc., thus creating temporary seasonal work for local people.

3.8 Sources of livelihood: The most important point that emerges from studying the livelihood patterns of the people of Meghalaya is that most occupations are based on the use of natural resources: land, forest and mineral resources. There is, however, no significant value addition to the state's natural resources. Some of these are discussed below.

3.8.1 Agriculture: Livelihoods in Meghalaya are mostly dependent on agriculture and the forest. Meghalaya is basically an agricultural state, with about 80 per cent of its population engaged in agriculture to earn a living. Nearly 10 per cent of the geographical area of Meghalaya is under cultivation. Agriculture is the single largest source of livelihood for the rural population and the mainstay of the state's economy. The major food crops are rice and maize. The State is also renowned for its horticultural crops: oranges, lemons, pineapples, guavas, litchis, bananas and jack fruit, as well as such temperate fruits as plums, pears and peaches. Potatoes, ginger, turmeric, black pepper, areca nuts, tezpatta, betelvine, short-staple cotton, jute, mesta, mustard and rapeseed are some of the state's other important cash crops. Agriculture, however, is characterized by limited use of modern techniques and low productivity. As a result, despite the fact that the vast majority of the population is engaged in agricultural activities, agriculture makes only a small contribution to the state's GDP, and most of those engaged in agriculture remain poor. A large majority of households are also partially dependent on NTFPs, including edibles, orchids, charcoal and a number of other forest products that are exploited for own-consumption or sold to generate income. Many people are also engaged in horticulture.

3.8.2 Nature tourism/ecotourism: There is also scope for promoting high-end nature tourism/ ecotourism, taking advantage of the favorable climate in the central uplands, the beauty of the forested hills and valleys, and the unique culture of the local tribes. There is great potential for job creation in this sector, especially for local people.

3.8.3 Mining: Coal and limestone-mining has become the principal occupation of landowners in some areas. This generates employment but also has adverse impact on forests and the livelihoods of forest-dependent communities.

4. Tripura

4.1 General information: The state of Tripura is situated in the north-eastern part of India. On three sides, it has an international border (856 km, 84 per cent of the state boundary) with Bangladesh, and also borders the two north-eastern Indian states of Assam and Mizoram. It is situated between 22°57'N-24°33'N latitude and 91°10'E-92°20'E longitude. Its geographical area is 10,486 square kilometres, which constitutes 0.32 per cent of the area of the country. Around 70 per cent of the landmass is hilly. Five principal ranges of hills traverse the state, running parallel to one another in a north-south direction, separated by narrow valleys. Undulating plateau land marks the western limits of the hilly region, gradually rising from west to east, with elevations ranging from 15 to 75 metres, and merging with the hilly eastern tract. This zone is characterized by medium and narrow valleys, streams and gullies. Low-lying alluvial lands are interspersed with hillocks and swamps, with elevations limited to 15 metres above MSL. Generally moist and humid, the state enjoys a typical monsoon climate with annual rainfall varying between 2,250 and 2,500 millimetres. Temperatures in winter range from 4°C to 33°C and in summer from 21oC to 38oC. The population of the state is 3.67 million, with rural and urban dwellers accounting for 73.82 per cent and 26.18 per cent of the total respectively (Census, 2011). The population density is 350 persons per square kilometre. Various tribal groups, 19 in all, represent around 30 per cent of the population of Tripura. The livestock population of the state is 1.87 million (Livestock Census 2007)

4.2 Recorded forest area and forest cover: The recorded forest area of the state is 6,294 square kilometres (60 per cent of its geographical area), of which 66.33 per cent is reserved forest, 0.33 per cent protected forest and 33,64 per cent unclassed forest. Forest cover, according to the India State of Forest Report 2011, is 7,977 square kilometres (76.04 per cent of the geographical area). The figures for canopy density are shown below:

a) Very dense forest (canopy density more than 70%): 109 square km

b) Moderately dense forest (canopy density 40% - 70%): 4,686 square km

c) Open forest (canopy density 10-40%): 3,182 square km

4.3 Tree cover: Tree cover is estimated at 184 square kilometres (1.75% per cent of the area of the state). The forest and tree cover status of the state is shown below:

Category	Area in square km	% of geographical area
Tree cover	184	1.75
Forest cover	7977	76.04
Forest & Tree cover	8161	77.79

4.4 Changes in forest cover: According to the India State of Forest Report 2011, there has been a net decrease in forest cover of eight square kilometres as compared with the previous assessment (2009). However, when combined with a negative interpretational change of 88 square kilometres, the net decrease in forest cover is in fact 96 square kilometres, again as compared with the 2009 assessment.

4.5 Bamboo resources: The extent of bamboo-bearing areas in the state's forests is 3,246 square kilometres. A breakdown of the bamboo-bearing areas, as per the India State of Forest Report 2011, is presented below :

Recorded forest area	Pure bamboo	Dense bamboo	Scattered bamboo	Clumps hacked	Bamboo regeneration	No bamboo
6294	67	2039	1079	43	18	3048

Estimated figures for bamboo culms and their equivalent green weight, according to the India State of Forest Report 2011, are presented below :

Number of culms in million tonnes				Equivalent green weight in '000 tonnes		
Green	Dry	Decayed	Total	Green	Dry	Total
735	70	25	830	4198	767	4965

4.6 Forest cover in different forest types: According to the most recent assessment by the Forest Survey of India, as reported in the India State of Forest Report 2011, the state has two forest-type groups, as per the Champion & Seth classification. The percentage distribution of these forest-type groups is shown below:

Sl. No.	Forest type group & plantations/TOF	% of forest cover
1	Tropical semi-evergreen	11.08
2	Tropical moist deciduous	88.94

4.7 Forest Products: Beside commercially valuable timber, such as teak (Tectona grandis), gamar (Gmelina arborea), chamal (Artocarpus chaplasha) and koroi (Albizzia procera), the state is very rich in bamboo forests and in NTFPs, including edible and medicinal plants.

4.8 Major objectives and activities of the State Forest Department:

4.81 Objectives: The feedback from the Forest Department revealed the following objectives:

Prevention of degradation of forest resources;

Restoration of degraded forests;

Ecological restoration and maintenance of the ecological balance;

Creation of livelihood opportunities through sustainable use of forest resources;

Other topical issues, such as climate change, and generation of synergies with other organs of government.

4.8.2 Activities: Activities undertaken by the Forest Department include forest protection, afforestation/reforestation, wildlife management, soil and moisture conservation, organization of the harvesting and marketing of forest products, development and management of ecotourism projects, research, extension and training.

4.9 The cost of regenerating forests: The different phases of the artificial and aided natural regeneration of forests are: (1) 'advance work' in the financial year prior to the year of creation, (2) 'creation' and (3) maintenance for a further two to three years. The costs of different models of artificial and aided natural regeneration of forests in Tripura during 2013-14, as approved under the National Afforestation Programme and based on a wage rate of INR 124 per man-day, are listed below:

	Models for induced forest regeneration	Number of years of maintenance after the year of creation	Cost per ha including advance action, creation & immature maintenance (INR)
1.	Aided natural regeneration	3	16120
2.	Artificial regeneration	2	28272
3.	Pasture development	2	18352
4.	Bamboo plantation	1	15376
5.	Planting of canes	2	18352
6.	Mixed plantations of trees having MFP & medicinal value	2	28272
7.	Regeneration of perennial herbs & shrubs of medicinal value	2	33728

4.10 Recognition of the forest rights of scheduled tribes & other traditional forest dwellers: Since 30 November 2012, a total of 120,418 forest-dwelling households have benefitted from recognition and have been vested with rights over 175,963.57 hectares of forest land (Source: Tripura Forest Department) in accordance with the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Right) Act, 2006 (FRA). The process is ongoing. Forest dwellers vested with rights under the FRA are entitled to hold and live in the vested forest land under individual or common occupation for habitation or self-cultivation purposes. They

are also entitled to own, access, collect, use and dispose of minor forest produce, which has traditionally been collected within or outside village boundaries. It should be pointed out that holders of forest rights under FRA do not have any rights to the timber in the vested forest land.

The north-eastern state of Tripura is the pioneer in recognizing and vesting forest rights under the FRA. Of the 120,418 tribal families benefitting in this way, 77,973 have been provided with various types of assistance to improve their livelihoods and INR 143,470 million have so far been spent for this purpose. The state government has also provided employment for these families under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and has extended the benefit of house construction under the Indira Awas Yojana programme (Source: North-East News, 2 May 2013).

Tripura Forest Environment Improvement & Poverty Alleviation Project (JICA Project): Major funding of this project has been provided in the form of a soft loan by the Japan International Cooperation Agency (JICA), while part of the funding has come from the State Government. The project was launched on the 19th November 2007. The objectives are to promote sustainable forest management by improving the density and quality of forests in the project area, to conserve soil and improve the water regime, to alleviate the poverty of local people who are heavily dependent on forests for their livelihood, and to conserve biodiversity. The project is being implemented in 40 forest ranges spread over seven territorial divisions and three wildlife sanctuaries. The project has achieved enormous success in improving forest density and livelihood options for forest dwellers. In its project area of 7,023 square kilometres, 39,403 hectares of forest plantations were created in the financial year 2012-13 and a target of 12,000 hectares was set for 2013-14. In order to improve the income of target households and their livelihood options, while conserving soil, improving the water regime and to conserving the Bio-diversity, the JICA project has established 460 Joint Forest Management Committees (JFMCs) and Eco-Development Committees (EDCs), including 16 JFMCs in re-grouped villages. The Tripura JICA project has so far formed 1,260 self-help groups (SHGs). These SHGs are engaging in income-generating activities such as pig-keeping, fish-farming, poultry-keeping, mushroom-growing, bee-keeping, duck-keeping, agarbati stick production, broomstick harvesting and value addition, the extraction of essential oil from sugandhamantri (gandhaki), and the marketing of jarul leaves and other NTFPs. A NTFP Centre of Excellence (NCE) has been formed to focus on the creation NTFP-based livelihoods in a comprehensive manner.

Some 1,000 check dams have been constructed so far to create a water area of 800 hectares, thus increasing annual fishery potential to 850 million tonnes. In the period to February 2013, training had been given to 2,264 persons. The main focus is on the awareness and empowerment of JFMC and SHG members, as well as skills development. In addition, three computerized facilities have been established to impart skills development training for unemployed young people in Kumarghat, Agartala and Kaladhepa. To March 2013, a total of 84 hundred thousand person-days of employment had been created as a result of the JICA project.

4.11 Indo-German development cooperation project: The Participatory Natural Resource Management in Tripura Project, funded by the German Development Cooperation (KfW), was also launched during 2008-09. The aim of the project is an 'equitable improvement in the general standard of living of all section of the population, especially Scheduled Tribes, Scheduled Castes, Minorities and Backward Classes, and ecological restoration through participatory management of Natural Resources'. The project is being implemented in 100 indicator villages across eight blocks of the Manu Forest Division, the Ambassa Forest Division and part of the Kanchanpur Forest Division. The programme supports land-based and non-land-based income-generating activities, both through Joint Forest Management Committees and outside Joint Forest Management areas.

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