Socio-economic Impact of National Highway on Rural Population

ASIAN INSTITUTE OF TRANSPORT DEVELOPMENT

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Study conducted by AITD
for
National Highways Authority of India

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Concepts and Definitions

The concepts and definitions of some of the important terms used in the baseline survey schedules or referred to in the present report are explained below. The technical terms have been explained, only with a view to enabling the lay reader to understand the context of the narration.

Access: It is the ability to reach, visit, or use a service, and encompasses two factors of mobility and proximity.

Accessibility: It is a term often used in transport and land use planning and is generally understood to mean 'ease of reaching' (Jones, 1981).

Acre: A unit of surface area (equivalent to 4047 sq.m.)

Agricultural Labour: A person is considered as agricultural labour, if he/she follows one or more of the following agricultural occupations in the capacity of a wage-paid manual labour, whether paid in cash or kind or both: (i) farming, (ii) dairy farming, (iii) production of any horticultural commodity, (iv) raising of livestock, bee-keeping or poultry farming, (v) any practice performed on a farm as incidental to or in conjunction with farm operations (including forestry and timbering), preparation for market and delivery to storage or to market or to carriage for transportation to market of farm produce. Working in fisheries is excluded from agricultural labour. Further, 'carriage for transportation' refers only to the first stage of transport from farm to the first place of disposal. *(Source: NSSO)*

Agricultural Marketing Societies: These societies are formed by groups of farmers with the objective of getting better prices for their products. Their activities include collection, processing, selling, and transporting the products of their members.

Agricultural Production: An occupation category which includes growing of (i) cereal crops (paddy, wheat, jowar, bajra, maize, ragi, barley, etc.), (ii) pulses (arhar, gram, moong, urad, etc.), (iii) cotton, (iv) jute, mesta, sann hemp or other kindred fibres, (v) oilseeds, (vi) sugarcane or sugar beet, (vii) roots and tubers, vegetables, singharas, chillies and spices (other than pepper and cardamom), (viii) fodder crops; floriculture and horticulture including tree nurseries; and agricultural production not elsewhere classified. *(Source: Census of India)*

Agro-climatic Zone: A division of the country based on physical and climatic considerations for an optimum farming system of crop production. The agro-climatic division (zoning) broadly takes into account the soil characteristics, climate, rainfall, and water availability. The country has been divided into 15 zones for the purposes of national agricultural economy:

(i) Western Himalayan	(ii) Eastern Himalayan	(iii) Lower Gangetic Plains
(iv) Middle Gangetic Plains	(v) Upper Gangetic Plains	(vi) Trans- Gangetic Plains
(vii) Eastern Plateau and Hills	(viii) Central Plateau and Hills	(ix) Western Plateau and Hills
(x) Southern Plateau and Hills	(xi) East Coast Plains and Hills	(xii) West Coast Plains and Ghats
(xiii) Gujarat Plains and Hills	(xiv) Western Dry	(xv) Islands

(Source: Planning Commission)

Arithmetic Mean or ***Mean:*** It is the sum of a set of numbers divided by the number of cases in the set. It is denoted as $\overline{X} = (\sum X)/N$.

Artisans: An occupation category which includes (i) sculptors, painters and related artists; (ii) commercial artists, interior decorators and designers; (iii) movie camera operators; (iv) photographers; (v) composers, musicians and singers; (vi) choreographers; (vii) actors; (viii) stage and film directors and producers (performing arts); (ix) circus performers (excluding rope dancers and acrobats); (x) dancers; (xi) rope dancers; (xii) acrobats; and (xiii) snake charmers. *(Source: Census of India)*

Attached Labour: Contract labour for a specified period of agricultural season.

Average: It denotes, among other things, the arithmetic mean, the median, the mode, the geometric mean, and weighted means.

Average Cost: Cost per unit of output, where the costs of all inputs (factors of production) are included. Thus, the average cost (AC) may be written as: AC = (TC/X), where X is output and TC is the total cost. Average cost comprises average fixed cost (AFC) and average variable cost (AVC).

Average Daily Traffic (ADT): Average number of vehicles that pass a specified point during a 24-hour period.

Average Travel Cost: It is the average cost of travel taking all trips into account; also expressed as a ratio of total trips to total cost.

Average Travel Time: It is the average time of travel taking all trips into account; also expressed as the ratio of total trips to total travel time.

Average Trip Length*:* It is the average distance of travel taking all trips into account.

Bias: It may be said to exist when the value of a sample statistics shows a persistent tendency to deviate in one direction from the value of the parameter.

Big Business (Organised Sector Enterprise): It refers to those enterprises which are registered under the Factory Act, 1948, and have 10 or more employees, using power for their operations; or have 20 or more employees and carry out their operations without power *(Source: CSO).*

Bigha: One fifth of an acre (equivalent to 809 sq.m.)

Casual Wage Labour: A person who is casually engaged in others' farm or non-farm enterprises (both household and non-household) and, in return, receives wages according to the terms of the daily or periodic work contract. Usually, in the rural areas, a type of casual labourers can be seen who normally engage themselves in 'public works' activities. 'Public works' are those activities which are sponsored by the government or local bodies for constructing roads, bunds, digging ponds, etc. as 'test relief' measures (like flood relief, drought relief, or famine relief.) and also employment-generation schemes under poverty alleviation programmes (NREP, RLEGP, etc.). *(Source: NSSO)*

Co-efficient of Variation (CV): The coefficient of variation is defined as: $CV = \frac{\sigma}{\bar{x}} \times 100$, where σ is the standard deviation and $\bar{x}$ is the mean. It is used to compare two or more series where the means differ significantly and where the standard deviation is an inadequate measure of dispersion.

Community Health Centre: It is an upgraded primary health centre provided in each community development block, covering a population of one lakh. It has up to 30 beds and is equipped with X-ray and other laboratory facilities. The centre has a specialist each in surgery, medicine, obstetrics, gynaecology, and pediatrics.

Community Water Supply: Irrigated water supply for a group of people living in a particular area.

Community Wells: Wells dug for the purpose of providing drinking water to a group of people living in a particular area.

Confidence Interval: It is a random interval for a parameter constructed from data in such a way that the probability of that interval contains the true value of the parameter which can be specified before the data are collected.

Confidence Level: It is the chance that the interval which will result once data are collected will contain the corresponding parameter in a confidence interval. If one computes confidence intervals again and again from independent data, the long-term limit of the fraction of intervals that contain the parameter is the confidence level.

Construction Worker(s): Workers classified under this category are: (i) bricklayers, stone masons and tile-setters; (ii) reinforced concreters, cement finishers and terrazzo workers; (iii) roofers (iv) parquetry workers; (v) plasterers; (vi) insulators; (vii) glaziers; (viii) hut builders and thatchers; and (ix) well diggers. *(Source: Census of India)*

Consumer Price Index: A measurement of average changes in prices paid by consumers of a fixed basket of a wide variety of goods and services *(Source: CSO).*

Control Zone (Control Area): It is the area which will be least influenced by the impact of the project. The control zone enables comparison with the influence zone for the purpose of assessing the net socio-economic impact of the project. This comparison is done under two situations – before and after the implementation of the project – so as to isolate the effects of other simultaneous development initiatives or processes (for the current study, the control zone is the area extending beyond an approach distance of 5 km within the horizontal distance band of 7 km on either side of the national highway).

Co-operative: A business owned by people who use its services. Some cooperatives sell goods or services produced by their members. In the case of other cooperatives, farmers and other consumers as a group buy directly from suppliers. By reducing expenses, these organisations often provide lower costs for consumers and higher earnings for producers.

Correlation Coefficient: Given a pair of related measures (X and Y) on each of a set of items, the correlation coefficient (r) provides an index of the degree to which the paired measures co-vary in a linear fashion.

Cost-Benefit Analysis: The appraisal of an investment project which includes all social and financial costs and benefits accruing to the project. It is the technique adopted in investment appraisal in order to evaluate and decide whether a proposed project should proceed, i.e. its benefits would exceed its costs.

Cross-section Data: A set of data which are collected at one point of time.

Cultivation: All activities related to crop production including ancillary activities are considered as cultivation. Growing trees, plants, vegetables or of crops as plantation or orchards (such as rubber, cashew, coconut, pepper, coffee, tea, etc.) is not considered as cultivation activity. *(Source: NSSO)*

Cultivator: A cultivator is one engaged as employer, single worker or family worker in cultivation of crops on land owned or held from government or private persons for payments in money, kind or share. *(Source: Census of India)*

Database: Collection of data from which information is derived and on the basis of which decisions can be made.

Degrees of Freedom: This term is used to describe the number of values in the final calculation of a statistic that are free to vary.

Demand: It is the desire for a commodity backed by ability and willingness to pay.

Development Block: An administrative unit coterminous with the jurisdiction of Panchayat Samiti.

Dhaba: A small open eating place on the roadside, offering inexpensive eatables.

District Rural Development Agency: It is the government nodal agency at the district level which supports and finances micro development projects in the field of land and water resources.

Double Difference Method: A method of assessing the socio-economic impact of a project (Explained in detail in the text).

Drought: A situation when the deficiency of rainfall at a meteorological sub-division level is 25 percent or more of the long-term average of that sub-division for a given period. The drought is considered 'moderate', if the deficiency is between 26 and 50 percent, and 'severe' if it is more than 50 percent.

Dummy Variable: A binary (off-on) variable designed to take account of exogenous shifts (shift dummy) or changes of slope (slope dummy) in an econometric relationship. For instance, dummies can be used to account for seasonal influences in the data. By specifying a dummy to take on the value of unity of, say, winter months, and zero at other times, it will indicate the degree to which a relationship shifts during the winter, compared to other seasons, by augmenting the constant term of the

equation. This type of variable can also be used to include qualitative factors in a regression.

Economic Activity: Any activity resulting in the production of goods and services that add value to national product is considered economic activity. Such activities include producing goods and services for the market (market activities), i.e. production for pay or profit, and the production of primary commodities for own consumption and own account production of fixed assets, among the non-market activities. *(Source: NSSO)*

Economic Development: The process of improving the standard of living and well-being of the population by raising per capita income.

Economic Growth: Typically taken to mean an increase in the real level of net national product. The measure is sensitive to the way in which national product is measured. Thus, an economy with a large sector containing bartered goods or unrecorded consumption of its own products (e.g., farmers' consumption of their own produce) may raise its level of national product without the recorded level showing an increase.

Economies of Scale: Reduction in the average cost of a product in the long run, resulting from an expanded level of output. Also known as long-run increasing returns.

Elasticity of Demand: It is the proportionate change in demand due to change in price.

Employed: *See 'Worker(s)'.*

Employee: A worker who is hired to perform a job.

Employment: The state of being employed or having a job *(Source: NSSO).*

Endogenous Variable: A variable whose value is determined within the framework of an economic or econometric model. Thus, if a variable appears as a dependent variable in an equation, it is an endogenous variable.

Enterprise: It is an undertaking which is engaged in the production and/or distribution of some goods and/or services meant mainly for the purpose of sale, whether fully or partly. An enterprise may be owned and operated by a single household, or by several households jointly, or by an institutional body. *(Source: NSSO)*

Establishment: Those enterprises which have got at least one hired worker on a 'fairly regular basis' are called establishments. *(Source: NSSO)*

Exogenous Variable: A variable whose value is not determined within an economic model, but which plays a role in the determination of the values of endogenous variable. Thus, an exogenous variable is an explanatory variable but never appears as a dependent variable in the model.

Explanatory Variable: A variable which plays a part in 'explaining' the variation in a dependent variable in a regression analysis.

Expressway: A highway with divided carriageway, controlled access, generally provided with grade separations at intersections and permitting only fast-moving vehicles.

Externalities: Externalities are variously known as external effects, external economies and diseconomies, spillovers and neighbourhood effects. Externalities involve an interdependence of utility and/or production function. For example, the upstream pulp mill which discharges effluent in the river, thus reducing the scope of fishing downstream, is said to impose an externality on the fishermen. A beneficial externality, known as an external economy, is where an externality-generating activity raises the production or utility of the externally-affected party. For example, a beekeeper may benefit neighbouring farmers by incidentally supplying pollination services. An external diseconomy is where the externality-generating activity lowers the production or utility of the externally-affected party. Examples of this are the numerous forms of environmental pollution.

Factor Analysis: An analytical technique for identifying the major inter-relationships between variables, frequently used in transportation demand analysis.

Factors of Production: The resources used in the process of production. These are usually divided into three main groups – land, labour, capital – but may also include entrepreneurship.

Financial Institution(s): It includes any bank, thrift institution, insurance company, investment advisory firm.

Firm: Analytical label for an institution which transforms inputs into output. Thus, a firm is viewed as an abstract entity which mainly fulfils technical role.

Fishing: An occupation category which includes: (i) ocean, sea and coastal fishing; (ii) inland water fishing; (iii) pisciculture: rearing of fish, including fish hatcheries; (iv) collection of pearls, conches, shells, sponges and other sea products; (v) cultivation of oysters for pearls; and (vi) other allied activities and services incidental to fishing not elsewhere classified. *(Source: Census of India)*

Flood: The rising of a body of water and its overflowing on to normally dry land.

Forestry: An occupation category which includes: (i) planting, replanting and conservation of forests; (ii) logging, felling and cutting of trees and preparation of rough, round, hewn or riven logs (including incidental hauling); (iii) production of firewood/fuel wood (including charcoal by burning); (iv) gathering of fodder; (v) gathering of uncultivated materials, such as gums, resins, lac, barks, munjh, herbs, honey, wild fruits, leaves, etc.; and (vi) forestry services not elsewhere classified. *(Source: Census of India)*

Gender: The term refers to the socially constructed roles ascribed to males and females and the resulting socially determined relations. These roles change over time, and vary widely within and across cultures. Gender is one of the key entry points for social analysis/assessment.

General Equilibrium: A situation where all markets in an economy are simultaneously in equilibrium (i.e. where prices and quantities don't change). Economists have traditionally adopted two approaches in analysing economic systems. The simpler approach is associated with partial equilibrium, where only a part of the equilibrium is examined, on the assumption of unchanged condition in the rest of the economy. The second approach, the general equilibrium analysis, looks at an economic system as a whole and observes the simultaneous determination of prices and quantities of all goods and services in the economic system.

Geometric Mean: It is the *n*th root of the product of a set of values. For example, the geometric average of the values 2,2,4, and 16 is the 4^{th} root of 256, which is 4. The arithmetic average of the same set of values is 6.

Government Enterprise: Enterprise owned by the state.

Gram Sabha: A body consisting of persons registered on the electoral rolls relating to a village included within the area of Panchayat.

Gross Domestic Product (GDP): A measure of the total flow of goods and services produced by the economy over a specified time period, normally a year or quarter. It is obtained by valuing the output of goods and services at market prices and then aggregating. All final consumption or investment goods or changes in the stocks are included. This is because the values of intermediate goods are implicitly included in the prices of final goods. The word 'gross' means that no deduction for the value of expenditure on capital goods for replacement purposes is made. Because the income arising from investment and possessions owned abroad is not included, only the value of the flow of goods and services produced in the country is estimated.

Hectare (ha): A unit of surface area equal to 10,000 sq.m.

Highway: A general term denoting a public way for purposes of vehicular movement; or an important road in a road system.

Highway Classes by Function: The road network in the country has been classified into: National Highways, State Highways, Major District Roads, Other District Roads and Village Roads *(see definitions under specific nomenclature).*

Hired Labour: Workers hired to perform a job.

Home-Based Trips: Trips which have one end (origin or destination) at the home of the person making trip.

Home Interview Survey: A survey in which the data are collected at home through face-to-face interviews. Such interviews usually cover information on household characteristics and travel patterns.

Hospital: Apart from primary health centres, the present organisation of health services of the government sector consists of rural hospitals, sub-divisional/tehsil/taluka hospitals, district hospitals, specialist hospitals and teaching institutions. Unlike a health centre whose services are preventive, promotive and curative, in a hospital, services provided are mostly curative. The hospital has no specified catchment area.

House: Any structure, tent, shelter, etc., is a house irrespective of its use. It may be used for residential or non-residential purposes or both or may even be vacant. *(Source: Census of India)*

Household: A group of persons normally living together and taking food from a common kitchen. The adverb 'normally' means that temporary visitors are excluded but temporary stay-aways are included. 'Living together' is given more importance than 'sharing food from a common kitchen' in drawing the boundaries of a household, in case the two criteria are in conflict. *(Source: NSSO)*

Household Industry: An industry conducted by one or more members of the household at home or within the village in rural areas, and only within the precincts of the house where the household lives in urban areas. *(Source: Census of India)*

Household Size: The total number of persons normally residing together in a household including temporary stay-aways, but excluding temporary visitors and guests.

Imperfect Competition: A generic term which may be used in two ways. The first refers to any form of market structure other than perfect competition and would thus include monopolistic competition, oligopoly and monopoly. The second definition of the term refers to any market structure other than perfect competition and monopoly.

Influence Zone (Influence Area): It is the area showing significant socio-economic impact of the project on the population (for the present study, the influence zone has been delineated as an area extending up to an approach distance of 5 km on either side of the national highway).

Informal Sector: It is broadly characterised as comprising production units that operate on a small scale and at a low level of organisation, with little or no division between labour and capital as factors of production, and with the primary objective of generating income and employment for the persons concerned. Operationally, the sector is defined on a country-specific basis as the set of unincorporated enterprises owned by households which produce at least some products for the market but which either have less than a specified number of employees and/or are not registered under national legislation referring, for example, to tax or social security obligations, or regulatory acts.

Katcha House: House built with unbrunt bricks but the roof covered with tiles.

Kharif: Agricultural season corresponding to summer months.

Labour Force: Persons who are either 'working' (or employed) or 'seeking work or available for work' (or unemployed) together constitute the labour force. Persons who are neither 'working' nor 'seeking work or available for work' for various reasons are considered 'out of labour force'. The persons under this category include students, those engaged in domestic duties, rentiers, pensioners, recipients of remittances, etc. and casual labourers not working due to sickness. *(Source: NSSO)*

Land Possessed: Land possessed means land owned (including land under owner-like possession) + land leased in – land leased out + any land possessed by the household which is neither owned nor leased-in. A plot of land is considered to be 'owned by the household' if permanent heritable possession, with or without the right to transfer the title, is vested in a member or members of the household. Land held in owner-like possession under long-term lease or assignment is also considered as land owned. As regards lease, land given to others on rent or free by owner of the land without surrendering the right of permanent heritable title is defined as leased out. Land leased-in is defined as land taken by a household on rent or free without any right of permanent or heritable possession. The lease contract may be written or oral. If the household has possession of land for which it lacks title of ownership and also does not have any lease agreement in the case of the land transacted either verbally or in writing, such land will be considered as 'neither owned nor leased-in'. *(Source: NSSO)*

Land Utilisation: It is the categorisation of land under operational holding. The broad categories are:

(a) *Net Sown Area*: This represents the total area sown with crops and orchards counting only once the area sown more than once in the same year.

(b) *Current Fallow Land*: This represents the areas of any classification which were cropped during the previous year of the reference year, but were kept fallow during the current year. If any seedling area is not cropped in the same year, it is treated as current fallow land.

(c) *Other Cultivated Land excluding Fallow Land*: This includes:

  (i) *Permanent Pastures and Grazing Lands*: All grazing land whether they were permanent pastures or meadows are included in this category.

  (ii) *Land under Miscellaneous Use:* Cultivable land which is not included in the net sown area, but is put to some agricultural use, and land under thatching grasses, bamboo bushes, casurina trees and other groves for

fuel etc., which are not included under 'orchards' are classified under this category.

(d) *Fallow Land Other than Current Fallow*: This category includes land taken up for cultivation, but have been temporarily out of cultivation for a period of more than one year and not more than five years previous to the reference year for one reason or the other.

(e) *Culturable Waste Land*: This includes land for cultivation, whether not taken up for cultivation any time or taken up for cultivation once but not cultivated during the current year and the last five years or more in succession for one reason or the other. Such land may be either fallow or covered with shrubs and jungles.

(f) *Land Not Available for Cultivation*: This includes:

(i) *Forests*: All land classed as forests under any legal enactment dealing with forests or administered as forests, whether state-owned or private, and whether wooded or maintained as potential forest land.

(ii) *Area under Non-agricultural Uses*: All land occupied by buildings and other lands put to uses other than agriculture within the operational holdings are included in this category.

(iii) *Barren and Uncultivable Land*: All barren and uncultivable land like steep hills, eroded lands, unproductive lands, etc. and the lands which are not fit for cultivation or which cannot be brought under cultivation unless at a high cost are included in this category. *(Source: Agricultural Census, 1990-91, Ministry of Agriculture, Government of India)*

Livestock Occupation: An occupation category which includes (i) cattle breeding, rearing and ranching etc., production of milk; (ii) goat breeding, rearing, ranching etc., production of milk; (iii) rearing of sheep and production of shorn wool; (iv) rearing of horses, mules, camels and other pack animals; (v) rearing of pigs and other animals not elsewhere classified; (vi) rearing of ducks, hens and other birds, production of eggs; (vii) rearing of bees, production of honey and wax; (viii) rearing of silk-worms, production of cocoons and raw silk; and (ix) rearing of livestock and production of livestock products not elsewhere classified. *(Source: Census of India)*

Local Wage Labour: Wage labour (both agricultural and non-agricultural) in a particular locality or neighbourhood.

Logit Model: *Described in the text of the report.*

Long-Run Marginal Cost (LRMC): The extra cost of producing an extra unit of output in the long run.

Long Run: A time-period relating to the process of production during which there is time to vary all factors of production, but not sufficient time to change the basic technological processes being used.

Main Worker: A worker engaged in any economically productive activity for 183 days or six months or more during the year. *(Source: Census of India)*

Major District Roads (MDR): These are branch roads of the state and national highways and serve as the main roads for intra-district movements. They traverse the length and breadth of a district connecting the areas of production and marketing in the district to one another and to the national highways.

Mandi: A market centre found in an urban area for trading agricultural products, generally having storage and warehousing facilities.

Manual Work: A job essentially involving physical labour. Jobs essentially involving physical labour but also requiring a certain level of general, professional, scientific or technical education are not termed manual work. On the other hand, jobs not involving much of physical labour and at the same time not requiring much educational (general, scientific, technical or otherwise) background are treated as 'manual work'. Thus, engineers, doctors, dentists, midwives, etc. are not considered as manual workers even though their jobs involve some amount of physical labour. But peons, watchmen, etc. are considered as manual workers even though their work may not involve much physical labour. Manual work covers the following occupational groups of the National Classification of Occupations – service workers; farmers, fishermen and related workers, and production and related workers. *(Source: NSSO)*

Manufacturing: Manufacturing is the process of transformation of raw materials into final products.

Marginal Benefit: The additional benefit obtained by consuming the last (or next) unit of a commodity.

Marginal Cost: The extra cost of producing an extra unit of output. Algebraically, it is written as: MC = (ΔC/ΔX), where Δ means 'a small change in', C is Total Cost and X is output.

Marginal Social Benefit: The benefit associated with producing one more unit of a good or service. When positive externalities are present, they must be added to marginal private benefits to obtain marginal social benefits (Hyman, 1983).

Marginal Social Cost(s): Costs that represent the total value of resources used to produce one more unit of output of a good or service (Hyman, 1983).

Median: It is the value of a series which splits an ordered list of cases into two halves, i.e. the middle value, in the sense that an equal number of cases lie above this value as below it.

Mobility: The ability of an individual/group to physically move from one place to another.

Mode: It is the value of a series that occurs most often. The term is also used to refer to a particular mode of transport.

Monopolistic Competition: The monopolistic industry is one in which there are a larger number of firms producing similar but not identical products.

Monopoly: In the strictest sense of the term, a firm is a monopoly if it is the only supplier of a homogeneous product for which there are no substitutes but many buyers.

National Highways (NH): The national highways constitute the primary network of the road system in the country. Under the Constitution, these highways are a union subject and their development and maintenance are the responsibility of the Government of India. These are the arterial roads for inter-state and strategic defence movements. They traverse the length and breadth of the country connecting the national and state capitals, major ports and rail junctions and link up with border roads and foreign highways.

Non-parametric Method: *Described in the text of the report.*

Non-Sampling Error: The errors mainly arising at the stage of acquiring, recording and processing of data are termed non-sampling errors. They are common both in complete enumeration and sample survey. Non-sampling errors include biases and mistakes.

Non-workers: Those who have not worked any time at all during the year. Non-workers include (i) those engaged in household duties at home, (ii) students, (iii) dependents, (iv) retired or rentiers, (v) beggars, (vi) inmates of institutions and (vii) other non-workers. *(Source: Census of India)*

Null Hypothesis: It is a term that statisticians often use to indicate the statistical hypothesis tested. The purpose of most statistical tests is to determine if the obtained results provide a reason to reject the hypothesis that they are merely a product of chance factors.

Nyaya Panchayat: A body of village elders constituted to mete out justice, locally.

Oligopoly: A market structure within which firms are aware of the mutual interdependence of sales, production, investment and advertising plans. Hence, manipulation by any firm of variables under its control is likely to evoke retaliation from competing firms. These features are commonly ascribed to markets in which the number of sellers is small.

Operational Holding: An operational holding is defined as all land which is wholly or partly used for agricultural production and operates as one technical unit by one person alone or with others without regard to title, legal form, size of location. It is, thus, distinct from an ownership holding. For the purposes of this definition, a 'technical unit' is the unit which under the same management has the same means of production, such as labour force, machinery and animals. The 'total area of holding' includes all the lands forming part of a unit which is under the same technical responsibility and management. It comprises all the land occupied by the farm buildings including the house of the holder, provided such buildings are within the cultivated area *(Source: Agricultural Census, Ministry of Agriculture).*

Opportunity Cost: The opportunity cost of a commodity is the value of the best alternative use to which the resources could have been put; the value of the productive opportunities foregone by the decision to use them in producing that commodity (Evans, 1984).

Other District Roads (ODR): These roads serve rural areas and provide them with outlets to market centres, taluka/tehsil headquarters, block development headquarters or other main roads.

Own Account Enterprise (OAE): It is an undertaking run by household labour, usually without any hired worker employed on a 'fairly regular basis'. By 'fairly regular basis' is meant the major part of the period of operation(s) of the enterprise during the last 365 days. *(Source: NSSO)*

Panchayati Raj Institutions: The three-tier institutions of elected local self-government for rural areas having constitutional status (Article 243B of the Constitution of India). These are Panchayat, Panchayat Samiti and Zilla Parishad.

Panchayat: It is the first tier of the institution of self-government at the village(s) level. The electoral body called Gram Sabha consists of persons registered in the electoral rolls relating to a village included within the area of Panchayat.

Panchayat Samiti: It is the tier above the Panchayat with its territorial area usually congruous with an administrative Development Block.

Panchayat Area*:* It means the territorial area of a Panchayat.

Pradhan/ Mukhia / Sarpanch: Chairperson of Panchayat.

Panel Data: A type of pooled cross-section time series data in which the same cross-section is sampled over time. Panel data are usually microeconomic data arising from individual economic agents, such as households or firms.

Parameter: A numerical property of a population, such as its mean.

Parametric Approach: Methods which test hypotheses using data samples assuming that the data comes from a normal distribution.

Participatory Rural Appraisal (PRA): PRA is a research and planning methodology for studying the community wishes and values in villages, or rural areas. It enables local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act. Many definitions have been stated by several researchers. Robert Chambers (1992) defines PRA as 'a family of approaches and methods to enable rural people to share, enhance, and analyse their knowledge of life and conditions, to plan and to act'. Eileen Kane (1997) defines PRA as 'a flexible research strategy which

draws on community expertise and involvement to get action-based, timely, cost-effective and reliable information'. James and Karen (1997) define PRA as 'a research and planning methodology in which a local community studies an issue that concerns the population, prioritises problems, evaluates options for solving the problem(s) and comes up with a Community Action Plan'. Somesh Kumar (2002) defines PRA as 'a radical personal and institutional change which is intended to enable local people to conduct their own analysis, and often to plan and take action'.

Perfect Competition: A market structure is perfectly competitive if the following conditions hold. There is a large number of firms each with an insubstantial share of the market. These firms produce a homogeneous product using an identical production process and possess perfect information. There is free entry (exit) to the industry, that is, new firms can and will enter into the industry if they observe that greater than the normal profits are being earned.

Population Density: Number of persons per square kilometre.

Population Mean: The mean of the numbers in a numerical population. For example, the population mean of a box of numbered tickets is the mean of the list compiled of all the numbers on all the tickets. The population mean is a parameter.

Population Standard Deviation: The standard deviation of the values of a variable for a population. This is a parameter, not a statistic.

Population: It is a collection of units being studied. The units can be people, places, objects, drugs, procedures, or many other things. Much of the statistics is concerned with estimating numerical properties (parameters) of an entire population from a random sample of units from the population.

Post Office: The government department responsible for mail delivery (and sometimes telecommunications).

Poverty: An unacceptable deprivation in well-being having many dimensions, both economic and non-economic, material deprivation being a critical component.

Poverty Line: The minimum norm that defines a standard of consumption, anchored in food consumption, which is socially accepted as the minimum desirable. The levels and composition of non-food items included in the minimum standard are taken to be whatever happens to go along with the fulfilment of the calorie norm. Together, they

are used to determine the value of per capita consumption expenditure which defines the national poverty line (PL). In India, per capita consumption expenditure, which meets the average calorie requirement of 2400 kcal in rural areas and 2100 kcal in urban areas along with associated quantities of non-food expenditure is the cut-off line for determining poverty. Persons having consumption expenditure below the laid down norms are treated as 'Below Poverty Line' *(Source: Planning Commission).*

Poverty Mapping: It is the spatial representation and analysis of indicators of human well-being and poverty within a region.

Poverty Ratio/Head Count Ratio: It is the ratio of persons living below the poverty line to the total number of people. In other words, if the number of persons below the poverty line is 'q' and the total number of population be 'n' then the head count ratio (H) is defined as H=q/n *(Source: Planning Commission).*

Primary Health Centre (PHC): It is a basic health unit to provide, as close to the people as possible, integrated curative and preventive healthcare to the rural population with emphasis on preventive and promotive aspects of health care. The national health plan provides for one primary health centre for every 30,000 rural population in the plains, and one PHC for 20,000 population in hilly, tribal and backward areas. The functions of PHC cover all the eight essential elements of primary health care as outlined in the Alma Ata Declaration. These include (i) medical care, (ii) maternity and child homes including family planning, (iii) safe water supply and basic sanitation, (iv) prevention and control of locally endemic diseases, (v) collection and reporting of vital statistics, (vi) education about health, (vii) natural health programmes – as relevant, (viii) referral services, (ix) training of health guides, health workers, local *dais* and health assistants, and (x) basic laboratory services. Each PHC is manned by one medical officer, one block extension educator, one health assistant (male), one health assistant (female), and supporting staff (e.g., compounder, driver, laboratory technician).

Primary Health Sub-centre: It is the peripheral outpost of the existing health delivery system in rural areas. Its function is now limited to mother and child healthcare, family planning and immunisation. A sub-centre is generally established on the basis of one unit for every 5000 population and one unit for every 3000 population in hilly, tribal and backward areas. Each sub-centre is manned by one male and one female multipurpose health worker.

Primary School: A school having classes up to IVth standard only.

Private Enterprise: Enterprises owned by individuals and firms.

Probability: A number between 0 and 1 which represents how likely an event is to occur. Events with probability equal to 0 never occur. Events with probability equal to 1 always occur.

Probit Model: *Described in the text of the report.*

Propensity Score Matching: *Described in the text of the report.*

Pucca House: House built with burnt bricks, G.I. sheets, other metal sheets, stone, cement concrete, etc. *(Source: Ministry of Rural Development).*

Rabi: Agricultural season corresponding to winter months.

Random Numbers: A set of numbers used for generating samples from a given population.

Random Sampling: A random sample is a sample in which every member of the population or some sub-set of the population being tested has an equal chance of being included in the sample.

Regional Rural Bank: A bank whose main objective is to develop rural economy by providing credit and facilities for the development of agriculture, trade, commerce, industry and other productive activities in the rural areas, particularly to small and marginal farmers, agricultural labourers, artisans and small entrepreneurs.

Regression: A mathematical technique for estimating parameters of an equation from set of data of independent and dependent variables.

Regular Salaried/Wage Employees*:* Persons working in others' farm or non-farm enterprises (both household and non-household) and, in return, receiving salary or wages on a regular basis (i.e. not on the basis of daily or periodic renewal of work contract). The category not only includes persons getting time wage but also those receiving piece wage or salary and paid apprentices, both full-time and part-time.

Rent: The income accruing to the owner for the services of durable goods, such as a piece of land, property or a computer.

Rentier: A person who is living on agricultural or non-agricultural royalty, rent or dividend is classified under this category (Source: *Census of India*).

Resource Mapping: The resource map focuses on the natural resources in the locality and depicts land, hills, rivers, fields, vegetation, etc., and may include habitation as well. It is not drawn to scale and is not done by experts, but by the local people themselves.

Response Code: It shows the quality of survey by collecting information on the type of informant, considering his co-operation and capability in providing the required information.

Retired Person: A person who has retired from service and is doing no other work, i.e. is neither employed in the same work nor engaged in some other work, such as cultivation, business, trade, etc. (Source: *Census of India*).

Returns to Scale: The proportionate increase in output resulting from proportionate increase in all inputs. If the number of workers, raw materials and machines used by the firms are all doubled, three situations can result: *decreasing returns to scale* hold if output is less than doubled; *constant returns to scale* would exist if output exactly doubled; and *increasing returns to scale* would hold if output is more than doubled.

Road: A way on land with a right of way for the public.

Paved Road (PR): A road provided with a hard pavement course, which should be at least a water-bound-macadam layer. A paved road need not necessarily be surfaced or black-topped.

Unpaved Road (UPR)/Katcha Road: A road not having a hard pavement course (which should be at least a water-bound-macadam layer). Thus, earthen road and gravel road will be unpaved roads.

Black-Topped Road (BTR): A road provided with a bituminous surfacing.

Gravel Road (GR): A road constructed using well compacted crushed rock or gravel material, which is fairly silent and does not become slippery when wet.

All-weather Road: An all-weather road is one which is negotiable during all weathers, except at major river crossings. This implies that the road-bed is drained effectively by adequate cross-drainage structures such as culverts, minor bridges and causeways. Interruptions to traffic as per permitted frequency and duration are, however, allowed. The pavement should be negotiable during all-weathers, but this does not necessarily imply that it should be paved or surfaced or black-topped.

R-squared: A statistic employed in regression analysis that measures how much variance has been explained by the regression model. Specifically, it is the proportion of the total variability (variance) in the dependent variable that can be explained by the independent variables. R-squared is also employed as a measure of goodness of fit of the model. R-squared ranges from 0 to 100 percent. If all the observations fall on the regression line, R-squared is equal to 100 percent. The variability in the dependent variable is partitioned into two component sums of squares: variability explained by the regression model and unexplained variation. To calculate R-squared, the regression sums of squares are divided by the total sums of squares. In a simple regression, R-squared can also be obtained by squaring the correlation coefficient.

$\overline{R}^2$ ***(Adjusted R-squared):*** The regression R-squared statistic 'corrected' for the number of independent variables in a multiple regression analysis. It is often used to compare models involving different numbers of coefficients. The adjusted R-squared statistic is interpreted as:

(i) a measure of the goodness of fit of the least squares regression line.

(ii) the proportion of variance in the dependent variable accounted for by the independent variables.

Rural Labour*:* Manual labour (by a person living in rural area) in agricultural and/or non-agricultural occupations in return for wages/salary paid either in cash or kind (excluding exchange labour) and living in rural areas, is taken as 'rural labour'.

Sample: A set of observations, usually taken from collection of units being studied, i.e. the population.

Sample Mean: The arithmetic mean of a random sample from a population. It is a statistic commonly used to estimate the population mean.

Sample Number: The number assigned to a household selected from the list of households.

Sample Size: The number of elements in a sample from a population.

Sampling Error: The error arising due to drawing of inference about population on the basis of a few observations (sampling). Such errors are non-existent in complete enumeration survey.

Sarpanch / Pradhan/ Mukhia: Chairperson of Panchayat.

School - Middle: A school having classes up to VIIIth standard only.

School - High: A school having classes up to standard X only.

School - Higher Secondary/ +2/ Intermediate: A school having classes up to standard XI or XII only.

Seasonal Diagramming: By major season or by month to show days and distribution of crops, agricultural labour, non-agricultural labour, animal fodder, fuel, migration, etc.

Secondary Sources: These include files, reports, maps, aerial photographs, satellite imagery, articles, journals, and books.

Seeking or Available for Work (or unemployed): Persons who owing to lack of work have not worked but have either sought work through employment exchanges, intermediaries, friends or relatives or by making applications to prospective employers or expressed their willingness or availability for work *under the prevailing conditions of work and remuneration* are considered as those who are 'seeking or available for work' (or unemployed). *(Source: NSSO)*

Self-Cultivation: Self-employed in cultivation.

Self-employed: Persons who are engaged in their own farm or non-farm enterprises or are engaged independently in a profession or trade on own account or with one or a few partners are deemed to be self-employed in household enterprises. The essential feature of the self-employed is that they have autonomy and economic independence for carrying out their operation. Self-employed persons are categorised as follows:

(i) *Own-account workers:* Self-employed persons who operate their enterprises on their own account or with one or a few partners and who, by and large, run their enterprises without hiring any labour. They may, however, have unpaid helpers to assist them in the activity of the enterprise;

(ii) *Employers:* Self-employed persons who work on their own account or with one or a few partners and, who, by and large, run their enterprises by hiring labour; and

(iii) *Helpers in household enterprise:* Self-employed persons (mostly family members) who are engaged in their household enterprises, working full or part-time and do not receive any regular salary or

wages in return for the work performed. They do not run the household enterprise on their own but assist the related person living in the same household in running the household enterprise. *(Source: NSSO)*

Self-employed in Non-agricultural and Allied Activities: Workers classified under this category are self-employed in economic activities excluding agriculture, hunting, forestry and fishing. *(Source: NSSO)*

Semi-pucca House: House built with burnt bricks, stone, concrete materials, but the roof covered with tiles.

Semi-structured Interview: It is an exercise having a mental or written checklist, but being open-ended and following up on the unexpected using participatory visuals as well as traditional verbal methods i.e. through interaction.

Short Run: The time period in the production process during which the fixed factors of production cannot be changed, but the level of utilisation of variable factors can be altered.

Simple Random Sampling: Sampling at random without replacement of sample units between the draws.

Small Business and Trade (Unorganised Sector Enterprise): It refers to those enterprises which are not registered under the Factory Act 1948.

Social Capital: The social capital of a society includes the institutions, relationships, attitudes and values that govern interactions among people and contribute to economic and social development. It includes the shared values and rules for social conduct expressed in personal relationships, trust and a common sense of 'civic' responsibility, that makes a society more than a collection of individuals.

Social Cost: It is the opportunity cost to society as a whole rather than just to one firm or individual. It differs from the private cost since it includes costs of externalities.

Social Mapping: Social mapping is a type of space-related PRA method and explores the spatial dimensions of people's realities. It helps in depicting the habitation patterns and the nature of housing and social infrastructure: roads, drainage system, schools, drinking water facilities, etc. A social map is different from other maps as it is made by local people and not by experts. It is not drawn to scale. It depicts what the

local people believe to be relevant and important for them. It reflects their perceptions of the social dimensions of their reality with a high degree of authenticity.

***Stakeholders**:* Include all individuals and/or groups who are affected by, or can affect, a given operation. Stakeholders can be individuals, interest groups, corporate organisations.

Standard Deviation: It is the measure of the dispersion of a series around the mean value.

Standard Error: It is the standard deviation of the values of a given function of the data (parameter) over all possible samples of the same size.

Standard Normal Variate: A variable (a set of data) that has normal distribution with mean = 0 and standard deviation = 1 is known as standard normal variate.

State Highways (SH): These are the arterial roads in a state for inter-district movements. They traverse the length and width of a state connecting the state capital, district headquarters and important towns and cities and link up with the national highways and adjacent state highways.

Statistic: A number that can be computed from data, involving no unknown parameters. As a function of a random sample, a statistic is a random variable. Statistics are used to estimate parameters and to test hypotheses.

Statistically Significant: A finding (for example, the observed difference between the means of two random samples) is described as statistically significant, when it can be demonstrated that the probability of obtaining such a difference by chance only, is relatively low.

Stratified Random Sampling: Sampling at random from each of the stratum or subgroup of a population.

Stratified Sampling: Sampling from each stratum or subgroup of a population.

***Subsidiary Economic Activity Status**:* A person whose principal usual status is determined on the basis of the major time criterion may have pursued some economic activity for a relatively shorter time (minor time) during the reference period of 365 days preceding the date of survey. The status in which such economic activity is pursued is the subsidiary economic activity status of the person. In case of multiple

subsidiary economic activities, the major two activities and their statuses based on the relatively long time spent criterion is considered. The engagement in work in subsidiary capacity may arise out of the following two situations:

(i) a person may be engaged for a relatively long period during the last 365 days in economic/non-economic activity and for a relatively short period in another economic activity; and

(ii) a person may be pursuing one economic activity/non-economic activity almost throughout the year in the principal usual activity status and also simultaneously pursuing another economic activity for a relatively short period in a subsidiary capacity *(Source: NSSO).*

Supply: The quantity of goods or services available for sale at any specified price.

Survey Code: It shows whether the originally selected sample household has been surveyed or a substituted household has been surveyed.

Tehsil: A unit constituted at sub-district level for the purpose of revenue administration.

Thatched House: House built with grass, leaves, bamboo, wood, and mud.

Time Line: Chronologies of events, listing major remembered events in a village with approximate dates.

Total Cost: The total cost of producing any given level of output. In the short run, total cost can be divided into two parts: fixed cost, that is, those costs which don't vary with output and variable cost, that is, those costs which vary directly with output. In the short run, output can only be changed by adjustment of the variable factor inputs. Thus the addition to total cost from any increase in output is given by the cost of the extra variable inputs required. In the long run, all factors are variable.

Track: A path on the land much trodden by persons and animals.

Trading: The commercial exchange (buying and selling on domestic or international markets) of goods and services. This includes both wholesale and retail trade.

Transit Walks: Systematically walking with informants through an area, observing, asking, listening, discussing, identifying different zones, local technologies,

introduced technologies; seeking problems, solutions and opportunities; and mapping and diagramming resources and findings.

Trip: It is a one-way person movement by any mode of transport having two trip ends, an origin or start of a trip and a destination or end of a trip for a specific purpose.

Trip Distance*:* It is the distance of one-way person movement between origin and destination.

Trip Purpose: It is the purpose of the one-way person movement. A trip may be made for any purpose like work, education, business, shopping, etc.

Trip Time: It is the time taken to complete one-way person movement between origin and destination.

Unemployed: *See 'Seeking or Available for Work'.*

Unit: A member of a population.

Urban Area: All places with a municipality, corporation or cantonment or notified town area and all other places which satisfy the following criteria:

(i) minimum population of 5,000;
(ii) at least 75 percent of male working non-agricultural population; and
(iii) a density of population of at least 400 per square km.

Usual Activity Status*:* It relates to the activity status of a person during the reference period of 365 days preceding the date of survey. The activity status on which a person spent relatively longer time (major time criterion) during the 365 days preceding the date of survey is considered the *principal usual activity status* of the person. To decide the principal usual activity of a person, he/she is first categorised as either belonging to the labour force or not belonging to the labour force, during the reference period on the basis of major time criterion. Persons thus adjudged as not belonging to the labour force, are assigned the broad activity status 'neither working nor available for work'. For the persons belonging to the labour force, the broad activity status of either 'working' or 'not working but seeking and/or available for work' is ascertained again on the basis of the relatively longer time spent in the labour force during the 365 days preceding the date of survey. Within the broad activity status so determined, the detailed activity status category of a person pursuing more

than one such activity will be determined again on the basis of the relatively longer time spent. *(Source: NSSO)*

Variance: A measure of the dispersion of a distribution from the mean. The variance of a series is the square of the standard deviation of the series, i.e. the average of the squares of the deviations of the numbers in the series from their mean.

Vehicle: A conveyance that transports people or objects.

Village: It is the smallest unit of habitation in rural areas and generally follows the limits laid down for a revenue village. The revenue village need not necessarily be a single agglomeration of habitation *(Source: Census of India*).

Village Roads (VR): These roads pass through rural areas, connecting villages to one another and serve as the feeder roads for the district roads, state highways, national highways, railways or river ghats.

Wage Paid Manual Labour*:* A person who does manual work in return for wages in cash or kind or partly in cash and partly in kind (excluding exchange labour) is a wage paid manual labour. Salaries are also counted as wages. A person who is self-employed in manual work is not treated as a wage paid manual labour *(Source: NSSO).*

Wage/Salaried Employees: An occupation category covering employees working for regular salary or wage.

Wealth Ranking or Well-being Ranking: A method commonly used for ranking and grouping households and communities on the basis of income and wealth, and other perceivable well-being criteria. Wealth ranking is a tool that helps to better understand socio-economic differences within a community. Well-being ranking is based on the perception of the local people.

Worker(s) (or Employed): Persons who are engaged in any economic activity or who, despite their attachment to economic activity, have abstained from work for reasons of illness, injury or other physical disability, bad weather, festivals, social or religious functions or other contingencies necessitating temporary absence from work. Unpaid helpers who assist in the operation of an economic activity in the household and farm or non-farm activities are also considered as workers. All workers are assigned one of

the detailed activity statuses under the broad activity category 'working or being engaged in economic activity' (or employed) *(Source: NSSO).*

Worker: A 'worker' is a person who mainly participates in an economically productive activity either physically or mentally. Work includes not only involves actual work but effective supervision and direction of work as well. *(Source: Census of India).*

Workforce Participation Rate (WFPR): The number of persons/person-days employed per thousand persons/person-days is referred to as workforce participation rate (WFPR) or worker – population ratio (WPR). *(Source: NSSO)*

Zilla Parishad/District Council: It is the topmost tier with its territorial area congruous with an administrative district.

Abbreviations

AFC	:	Average Fixed Cost
AIOPL	:	All-India Official Poverty Line
ASTRA	:	Assessment of Transport Strategies
ATAP	:	Agricultural Transport Assistance Program
AVC	:	Average Variable Cost
BDO	:	Block Development Officer
BLUE	:	Best Linear Unbiased Estimator
BPL	:	Below Poverty Line
CBA	:	Cost Benefit Analysis
CEBR	:	Centre for Economics and Business Research Ltd. (London, UK)
CGE	:	Computable General Equilibrium (Model)
CPIAL	:	Consumer Price Index for Agricultural Labour
CPIMR	:	Consumer Price Index for Middle-range Rural Population
CPIMU	:	Consumer Price Index for Middle-range Urban Population
CPITR	:	Consumer Price Indices for Total Rural Population
CPITU	:	Consumer Price Indices for Total Urban Population
CSO	:	Central Statistical Organisation
CV	:	Co-efficient of Variation
DRDA	:	District Rural Development Agency
EC	:	Encompassing Communities
FSU	:	First Stage Unit
GDI	:	Gender-related Development Index
GDP	:	Gross Domestic Product
GEM	:	Gender Empowerment Measure
HDI	:	Human Development Index
HPI	:	Human Poverty Index
IAY	:	Indira Awas Yojna
ICMR	:	Indian Council of Medical Research
ILO	:	International Labour Organisation
IRDP	:	Integrated Rural Development Programme
IWW	:	Institute for Economic Policy Research (University of Karlsruhe, Germany)
JRY	:	Jawahar Rozgar Yojna
LRMC	:	Long Run Marginal Cost
LUTI	:	Land-Use/Transport Interaction

ME&P	:	Marcial Echenique & Partners Ltd. (Cambridge, UK)
MPCE	:	Monthly Per Capita Consumption Expenditure
MPCY	:	Monthly Per Capita Income
MRA	:	Multivariate Regression Analysis
NAS	:	National Accounts Statistics
NDC	:	National Development Council
NH	:	National Highway
NMT	:	Non-motorised Transport
NPRT	:	Non-parametric Regression Technique
NRA	:	Non-parametric Regression Analysis
NSS	:	National Sample Survey
NSSO	:	National Sample Survey Organisation
OAE	:	Own Account Enterprise
ODA	:	Overseas Development Administration
OLS	:	Ordinary Least Square
PCTE	:	Per Capita Total Expenditure
PCTR	:	Per Capita Trip Rate
PHC	:	Primary Health Centre
PL	:	Poverty Line
PRA	:	Participatory Rural Appraisal
PSMT	:	Propensity Score Matching Technique
RTS	:	Rural Transport Services
RTTS	:	Rural Travel and Transport Survey
SACTRA	:	Standing Advisory Committee on Trunk Road Assessment
SC/ST	:	Scheduled Castes and Scheduled Tribes
SEM	:	Simultaneous Equation Model
SJSY	:	Swarna Jayanti Swarozgar Yojna
SW	:	Social Welfare
TFP	:	Total Factor Productivity
TRT	:	Trasporti e Territorio Srl (Milano, Italy)
UTs	:	Union Territories
VLSS	:	Vietnam Living Standard Survey
WFPR	:	Workforce Participation Rate
WPI	:	Wholesale Price Index
WPR	:	Worker Population Ratio

Executive Summary

India has embarked upon a programme of upgrading of its national highway network, initially connecting the four metropolises and major maritime ports. This programme requires massive investments. Side by side, the country also carries a crushing load of poverty, which is more pronounced in the rural areas. According to latest estimates, more than one-fourth of its rural population lives below the official poverty line.

The existing level of understanding of the relationship between transport infrastructure and human well-being in general, and poverty in particular, is inadequate. Most of the evidence in this regard is anecdotal and not based on empirical results. Whilst transport is an important element in both direct and indirect intervention for poverty reduction, there has so far been little formal accounting of poverty in transport projects.

In the literature related to the impact analysis of road-related projects, there are references to studies of the socio-economic impact of rural roads. But there is virtually no discussion of the impact of a highway, particularly a nationally important trunk route. The role of a major highway has been mainly considered in traditional terms of moving intercity passenger and freight traffic. Its socio-economic impact on the rural population living in its proximity has never been studied.

Over time, perceptions of poverty have undergone a significant change. It is just not monetary income that determines the poverty levels. There are other dimensions as well. Poverty is now viewed as a level of deprivation of access to means of attaining one's potential as a human-being physically and intellectually. Thus, facilities like water, sanitation, connectivity, and educational and medical services are also recognised as important indices of human development.

Typically, investment projects in the transport sector are evaluated by cost-benefit analysis (CBA) primarily in terms of efficiency considerations. The method is, however, not even-handed in all cases. It tends to favour investment in high-return projects. Besides, there are many items of benefit and cost, for which neither there is a price nor realistic imputation is possible. There are also issues of market imperfections and externalities not captured by the conventional CBA.

The concern for poverty alleviation has led to a re-examination of the adequacy of the existing project evaluation criteria with growing interest in assessing the distributional impacts. The socio-economic impact analysis, therefore, aims at assessing the magnitude and distribution of both direct and indirect effects of a project. Keeping this in view, it was decided to undertake an evaluation of the socio-economic impact of four-laning of a stretch of a national highway being four-laned on the rural population living in its proximity.

For this, a long stretch of national highway (NH2) covering a distance of 995 km between Agra and Dhanbad and falling in the states of Uttar Pradesh, Bihar and Jharkhand, was selected. The issue of poverty alleviation is more pertinent and gains greater importance in this case because most of the areas contiguous to this stretch have a high incidence of rural poverty. This has been confirmed by the census conducted by the state governments concerned for identifying the rural poor for covering them under various poverty alleviation programmes.

Measuring the impact of a road-related project – be it a new road or widening or upgrading an existing one – is generally beset with a number of problems. Such problems are typical of this kind of projects, and are not normally encountered in the case of most other public investment projects. First, since the various services of a road together form a non-excludable public good, defining the beneficiary/ participating population of a road-related project is not simple. Secondly, the impact of a road-related project often tends to get confounded by other interventions on the relevant impact (i.e. outcome) variables. Finally, the conceptual and methodological issues in the impact measurement of a new road may be somewhat different from those arising in the case of impact analysis of a road that already exists or has been improved.

An economic-theoretic framework has been developed to explain why and how a road or its improvement is expected to affect the well-being of people living around it. The model justifies using variables related to mobility and socio-economic well-being as relevant outcome variables, examining the relationship of each of these variables with the distance from the highway, and delineating the influence zone of the project.

An important issue in assessing the impact of a road or its expansion is the identification of the influence zone, i.e. the area on either side of the road to which the

impact is supposed to be limited. Based on considerations of accessibility and connectivity, this zone has, *a priori*, been delineated to be the area lying within a distance of 5 km on either side of the chosen segment of NH2. This means the distance that can be travelled in less than 30 minutes on a bicycle or in one hour on foot.

The areas lying on both sides of the highway beyond the approach distance of 5 km and within the horizontal distance band of 7 km have been treated as the control zone. This is on the presumption that the socio-economic benefits decline sharply as the distance exceeds 5 km. The control zone enables comparison with the influence zone for the purpose of assessing the net socio-economic impact of the project. This comparison is done under two situations – before and after the implementation of the project – so as to isolate the effects of other simultaneous development initiatives or processes.

Typically, benefit analyses comprise two studies of socio-economic conditions – one based on baseline survey data (collected before the project is launched) and the other based on re-survey data (collected after the project has been completed). The *partial* effects of the project are then assessed by appropriately comparing the results of these two studies.

The methodology of impact assessment makes use of four statistical/econometric techniques: (i) propensity score matching technique (PSMT), (ii) non-parametric regression analysis (NRA), (iii) binary and multinomial logit models, and (iv) conventional multivariate regression analysis (MRA). The conventional regression modelling and the more sophisticated PSMT-double difference method are not substitutes for each other but rather serve as complementary exercises where one seeks to corroborate and improve the results in the overall framework.

The above-mentioned statistical/econometric techniques have been supplemented by participatory rural appraisal (PRA), which, *inter alia*, includes reflexive or generic controls. In reflexive comparisons, the participants themselves provide the control information by comparing themselves ‘before’ and ‘after’ receiving the intervention. With generic comparisons, the impact of the intervention on beneficiaries is compared with established norms about typical changes occurring among the target population.

The full impact study of the widening of NH2 would require pre- and post-project household and village level data in respect of possible outcome variables. The impact assessment has, therefore, been set up in two stages and relies primarily on survey-based collection of data and quantitative analysis of such data. The relevant universe comprises all households living in villages belonging to the defined influence and control zones of the selected stretches of NH2.

The area of this universe comprises seven stretches spanning the three states of Uttar Pradesh, Bihar, and Jharkhand. The representative stretches have been chosen on the basis of agro-climatic and other macro features, in particular the incidence of poverty. In these selected stretches, 1,697 villages lying in the horizontal distance band of 0-7 km on both sides of NH2 have been identified. It may be clarified that the concept of horizontal distance is different from that of approach distance. Thus, the horizontal distance band of 7 km may include villages whose actual approach distance may be much higher, extending up to 16 km.

The sample design adopted for each of these stretches is a stratified two-stage one – villages being the first stage and households the second stage. The first stage sample units have been selected using the probability proportional to size (PPS) without the replacement technique, and those in the second stage have been selected by using the circular systematic sampling technique. The sample covers 200 villages and 3,200 households.

In order to generate data on village and household characteristics, as well as different socio-economic causal factors and outcomes of the developmental intervention of the highway, extensive schedules have been prepared for the primary baseline survey. The list of variables covers, among others, transport connectivity; mobility patterns; incidence of poverty; income, employment and occupation; asset ownership; education and health facilities; and attitudinal response.

The household profiles generated attempt to capture significant demographic, social and economic characteristics of the population in the selected stretches, especially the poor, the underprivileged and the women among them. The monthly per capita income provides the basis for the identification of the poor and the non-poor households. These summary profiles help to provide contextual underpinning for

assessing the likely socio-economic impact of making the national highway four-lane. In the process, it also enables a regional comparative analysis.

The profiles clearly bring out that most socio-economic indicators show decline as one moves eastward from Uttar Pradesh to Jharkhand. They reveal that the poor households are generally larger in size, with little awareness of the benefits of a small family. This attitude is mainly due to higher incidence of poverty and a lower level of education. It is also a pointer to the fact that in the absence of social security, poor households perceive an additional member as an extra hand to earn and run chores.

A disturbing finding of the analysis is that relatively better-off households have a stronger bias against females. This could be a consequence of social customs like dowry and economic compulsions such as the prospect of fragmentation of landholdings. Literacy levels in the areas surveyed are well below the national average, with female literacy being abysmally low. Generally, women have less access to education and are also discouraged from educating themselves. The situation in this regard is worse in Bihar and Jharkhand, than in Uttar Pradesh.

The dependency ratio is quite high in the eastern states and is still higher among the poor. It implies that in these states more children and elderly persons are dependent on those in the working-age group of 15-59 years. The average landholding per household is low at 0.58 hectare, with marginally higher holdings in Bihar and Jharkhand. The average landholding of a poor household is abysmally low – one-eighth of a hectare in Uttar Pradesh and a quarter of a hectare in Bihar and Jharkhand.

In terms of poverty indicators, the proportion of households living below the poverty line is significantly higher in Bihar and Jharkhand than in Uttar Pradesh. The incidence of poverty among the weaker sections of society is much higher than among other sections. Those belonging to the scheduled castes and scheduled tribes are worse-off in the two eastern states. A poor household incurs a greater share of its expenditure on food than a non-poor household. Social and economic inequality is more severe in Bihar and Jharkhand than in Uttar Pradesh.

The share of the working population in the overall population is higher among the non-poor households than the poor households, implying that the non-poor have more employment opportunities than the poor because of their higher economic status. As

compared to non-poor households, more women in poor households have to work to supplement family income.

The overall weekly per capita trip rate is generally low (0.86). It is still lower in Bihar and Jharkhand and declines further in the case of poor households. The average distance travelled is around 7 km. It is, however, marginally higher in Uttar Pradesh. The overall per capita travel time varies between 30 and 47 minutes. The poor spend a marginally higher per capita travel time than the non-poor.

Rural road transport and travel-related issues have been analysed to understand the accessibility status and mobility patterns of the population. The connectivity issues in relation to the national highway have also been studied, so also the extent of access of the villagers to various social and physical infrastructure facilities. The relationship between mobility and defined well-being indicators has been examined while carrying out the impact analysis of the highway at the household level.

Contrary to the traditional view that a national highway mainly facilitates intercity travel and transport of goods, the analysis brings out that it is also an integral part of the road network serving the rural areas. This is borne out by the fact that more than two-fifth of the trips originating in the selected stretches involve the use of the national highway.

A large number of the surveyed villages in the selected stretches are still connected to the highway by katcha roads or roads other than all-weather ones. This is a fairly serious constraint, and brings out the need for upgrading the secondary road network to realise the full potential of the highway or its proposed upgrading to four-lane status.

Vehicles owned are predominantly cycles, which account for over 87 percent of the total number of vehicles; the share of motorised vehicles is rather low at 8.6 percent. Among the motorised vehicles, two-wheelers – scooters and motorcycles – predominate, followed by tractors. The share of motorised vehicles in the total vehicle fleet is higher in the vicinity of the highway. More than half the villages surveyed have public transport facilities. Uttar Pradesh is better endowed in this regard than Bihar and Jharkhand.

Overall, the levels of mobility in the surveyed areas are low and decline further as one travels eastwards. On average, a household makes 5.49 trips a week, which translates into a per capita trip rate of less than one. The figure is higher in Uttar Pradesh and lower in Bihar and Jharkhand. The trips related to work, education and marketing are among the most important in the daily commuting of the rural population.

People mostly travel on foot or bicycle. Together, the two account for about three-fourths of the work- and market-related trips. A higher proportion of trips in Bihar and Jharkhand are performed on foot, while the use of bicycle accounts for less than 12 percent of the total trips made.

The average trip lengths are short, indicating a limited spatial spread of socio-economic interaction in the villages. On average, more than half the trips made are within a distance of 5 km. However, in Bihar and Jharkhand, this proportion is slightly higher. The households in these states also incur higher transport costs largely owing to greater dependence on mechanised transport, than in Uttar Pradesh.

The rationale of the present study is based on the premise that, *ceteris paribus*, access to a highway provides to the population living in its appropriately defined neighbourhood opportunities that help improve their well-being. To verify this presumption empirically on the basis of village-level data, the relationship between selected village-level indicators of socio-economic well-being and the proximity of villages to NH2 has been examined.

The results firmly suggest that proximity to NH2 has a significant relationship with: (i) demographic characteristics (density of population), (ii) employment in non-farm activities (proportion of non-agricultural workers in total main workers), (iii) housing conditions (proportion of semi-pucca and pucca houses in the total number of dwellings); (iv) asset holding, (v) banking facilities, (vi) price of land (price of irrigated crop land and residential land), and (vii) price of milk.

The results of non-parametric regression analysis have brought out that the relationship of the distance from the highway with individual well-being/development indicators is generally a smooth and continuous one. More importantly, in most of the cases, the gradient of the relationship with distance has shown a marked change around a distance level of 4-5 km, indicating that the effect of NH2 on villages

located within this approach distance is qualitatively different from that on villages located at greater distances.

The basic premise underlying the household-level data analysis, as in the case of analysis of village-level data, is that proximity to NH2 would help improve a household's well-being. An improved road infrastructure, in turn, would further enhance the well-being of the population. Given that the notion of socio-economic well-being is essentially multi-dimensional, a wide array of household-level outcome variables (that are likely to reflect the well-being of the population) have been analysed to assess if proximity to NH2 leads to significant differences in the level of these variables and also to explore the nature of relationship these variables may have with the distance from NH2.

The results clearly suggest proximity to NH2 has a significant relationship with (i) incidence of poverty (proportion of poor households), (ii) transport and mobility (per capita trip rate, per capita trip rate for work, and per capita trip rate involving travel on NH2), (iii) extent of income and employment in non-farm activities (share of income from self-employment in non-agricultural activities and proportion of non-agricultural workers in the total working household members), (iv) asset holding (proportion of landless households), and (v) attitudinal responses (proportion of households which rate themselves poor or very poor and proportion of households which expect that the employment situation will improve after 4-laning of NH2).

This analysis confirms the positive role of the national highway in influencing the well-being of the rural population, including the poverty aspect. The beneficial influence extends up to an approach distance of 5 km on either side of the road and the influence declines as the distance from the highway increases. The significant positive impacts relate to incidence of poverty, employment opportunities, assets holding, levels of mobility, access to infrastructural facilities and broad indices of well-being.

The results confirm that proximity to NH2 would help a poor rural household by giving its members a greater scope for employment thereby raising its income level, improving its well-being and ameliorating its poverty. These beneficial effects result primarily due to the fact that proximity to NH2 would enhance the mobility of the rural poor for every purpose – be it access to the job market, to the market for sale and

purchase to the health centres or to the educational institutions. These positive results gain significance more because the study area covers some of the poorest districts of rural India.

Normally, one would view NH2 or, for that matter, other such national highways, as a facility that serves as an intercity link for passenger and freight movement. However, the positive effects of NH2 on the rural poor reveal an important fact, i.e. a national highway like NH2 is not merely part of the national grid of highways, it also serves the rural areas, so that even a poor rural household living in its proximity derives considerable benefits.

However, as we have postulated and confirmed empirically, the positive impact of NH2 is geographically limited. Only the rural population living within a certain distance from NH2, which has been called the influence zone, enjoys the benefits accruing from proximity to the highway. Based on considerations of accessibility and connectivity, this zone is, *a priori*, delineated to be the area lying within an approach distance of 5 km on either side of the chosen segment of NH2 (that can be travelled in less than 30 minutes on bicycle or in an hour on foot). This delineation has been strongly supported by empirical evidence.

Two hypotheses relating to this notion of influence zone have been empirically validated in the present study. The first, called the gradient of change hypothesis, asserts that the impact of NH2 systematically declines as one moves farther away from NH2. The other, a related one, postulates that a poor household residing in the influence zone would be better-off in terms of various indicators of well-being vis-à-vis a comparable household living away from the influence zone.

The positive impacts of NH2 have become discernible in the form of improvement in a number of important socio-economic outcome variables, when villages and households of the influence zone are compared with those of the control zone. The impacts of NH2 and the gradient of change hypothesis have been examined separately in respect of several village-level and household-level socio-economic indicators, using baseline survey data.

Some of the notable impacts due to proximity to NH2 are: mobility for work increases by 32 percent and that involving the use of NH2 by 79 percent; and chances of a

household being poor decrease by 17 percent. At the village level, proximity to NH2 tends to lower the proportion of poor households by 15 percent, raise the proportion of non-agricultural workers in the total working population by as much as 50 percent, and increase the overall school enrolment by 40 percent and that for girls by 17.5 percent.

For many of the village and household level outcome variables, the expected pattern of relationships with distance from NH2 has been observed. These estimated relationships have very convincingly shown that the positive effect of NH2 is perceptible up to a distance of 4-5 km from the highway on either side, thus justifying the definition of influence zone used in the study. Beyond this distance, a divergent pattern is observed for some outcome variables. These divergences may have resulted due to the effect of other interventions. As such, these can be the subjects of further research that may yield useful insights for the anti-poverty policy formulation.

The impact of proximity to NH2 has also been analysed for three well-being indices: (i) index of overall well-being; (ii) index of well-being in respect of mobility; and (iii) index of well-being in respect of access to amenities like electricity, safe drinking water, proper sanitation, and other assets. These indices have been constructed as per the BORDA rule. The results of the analysis suggest that the gain in respect of overall well-being is 30.94 percent. The well-being in respect of mobility registers a gain of 6.51 percent while the gain in respect of access to infrastructural and other assets and amenities is of the order of 22.21 percent.

The results of this study are robust in two senses. One, these have a strong theoretical underpinning. Two, these are based on a sound statistical-econometric methodology evolved for the purpose. The methodology has used a powerful econometric tool called non-parametric regression analysis, complementarily with other conventional statistical techniques, to ensure robust results. Compared to conventional evaluation techniques like cost-benefit analysis, simulation based on the computable general equilibrium model, or the econometric technique of simultaneous equations model, this methodology is considered to be more operational, reliable and far less expensive.

The results of the study thus make explicit the positive contribution to poverty reduction that investments in highway expansion in particular and road infrastructure development in general can generate. In other words, the results of the present

exercise convincingly document and confirm that large-scale public investments in road infrastructure development can be an effective and viable policy measure for poverty alleviation.

"Never confuse a bend in the road as the end of the line"

An old adage

Introduction

Since the early days of civilisation, conditions under which man lives are largely shaped by the ease and speed with which he is able to move himself and his goods. Transport affects the daily lives of people in its myriad forms. It influences the nature and pace of economic development, population distribution, the shape of cities, energy consumption, access to markets and materials, and the pace, style and quality of life. It also contributes substantially to gross domestic product (GDP) and provides employment to millions of people.

Thus, transport and economic development are interdependent but their relationship is both complex and dynamic. Transport promotes economic activities by facilitating movements of persons and goods, which, in turn, lead to a greater demand for transport. This two-way interaction tends to relocate industries, services and labour and thereby helps shape the economic geography of a country. Indeed, Adam Smith visualised that by providing greater access to markets, transport would bring about the specialisation and division of labour and thus foster the process of economic growth.

The ultimate aim of any economic activity, including the development of transport infrastructure, is promoting human welfare. However, due to an array of reasons like the pattern of the existing socio-economic structure, geo-political and historical factors, benefits of development are not shared equitably. A variety of distributional inequalities therefore shows up at all levels, be it local, regional, or global. A large part of society often receives little or none of the benefits of development. This segment consists of the poor who mostly live in the rural areas of the developing world.

The post-Second World War period saw a great deal of conscious effort at economic development. New institutions were set up to deal with the emerging political and economic architecture. In the early phase, the approach towards economic development was rather straightforward: it was thought that a self-sustaining process of growing gross national product could be started through a proper allocation of resources across sectors in an economy, and in due course of time, it would bring in prosperity for all, notably the poor. Thus, the thrust was essentially on capital formation and investment and the ordering of alternative investment plans in

terms of their efficiency implicit in economic returns and selecting the investment(s) that would be most productive in terms of surplus generation.

Accordingly, methodologies were evolved for a better measurement of national income, on the one hand, and selection of investment projects, on the other. For the latter, mainly direct costs and benefits would be enumerated and measured for the purpose of project evaluation. Projects for which the expected benefits outweighed the expected costs would be regarded as viable and hence fit for implementation, resources permitting. With the passage of time and accumulation of experience, more and more sophisticated techniques were introduced in this art of project selection. These related to the method of quantification of intangible social costs, costs of possible externality of a project to the economy, shadow pricing, internal rate of return, and so on.

Project evaluation based on cost-benefit analysis became a routine feasibility exercise across the board, including projects relating to the transport sector – a road, a railway line, or an airport. However, despite its sophisticated nature, shortcomings of the method for evaluating the projects started getting noticed soon. For instance, the method would inherently favour the construction/development of urban, high traffic-density roads, because in this case not only the pure economic return would often be much higher, the urban population would have a greater ability and willingness to pay. The method would disfavour investments in low-traffic rural areas since it would not capture some important but hard-to-quantify benefits often generated by such roads.

In the seventies, the debate thus centred around altering the methodology while evaluating rural road projects. The case for a change rested on the need to incorporate in the cost-benefit calculation the value of induced agricultural developmental impacts that a rural road development would trigger by facilitating transportation. However, even when such impacts are taken into consideration, the method remains partial, as it ignores the impact on non-farm employment, other income opportunities, and improvements in important social aspects of well-being.

Further attempt was made to correct the inherent bias by using distributional weights. This effort could also not meet approval on several grounds. First, the distributional concerns, if any, have to be handled directly at the macro-economic

level through the instruments of a tax-subsidy mechanism. Secondly, income distribution decisions often involve value judgement issues that are essentially political responsibilities. Lastly, the use of distributional weights is vulnerable to misinterpretation and open to manipulation.

Over time, perceptions of poverty have undergone a quantum change. The phenomenon of absolute poverty is no longer viewed as the issue of a person or a household living below or above a threshold poverty line of per capita income or consumer expenditure identified as the poverty line. Today, poverty is understood as a multifaceted phenomenon reflecting deprivations in several respects like food security, shelter, health and education, command over productive assets, access to employment and earning opportunities, and so on. To put it differently, poverty is viewed as a major obstacle to attaining one's potential as a human being, physically and intellectually. That is why access to socio-economic infrastructures like availability of potable water, sanitation, connectivity and communication, educational and medical facilities are also recognised as important ingredients of human development.

The concerns about poverty in its multidimensional form in the context of impact evaluation of public investment projects would call for two things. First, a set of indicators of well-being that would sufficiently reflect the socio-economic status of the population connected with a project needs to be identified. Then, the causal link between these indicators and economic development in general and the implementation of a project in particular has to be established conceptually and empirically. Needless to mention, a firm causal link between the two would mean that sizeable public investment for transport sector improvement might serve as an effective instrument for poverty lessening and overall improvement in the well-being of the rural poor population.

The general impact of transport sector projects has hitherto been assessed essentially using the conceptual framework of a general equilibrium model. In this framework, the transport sector is taken as one of the sectors, albeit a major one, of a country's economy, and the backward and forward linkage effects of a specific transport sector investment project on the economy are enumerated and valued. Whilst transport is an important element in both direct and indirect intervention for poverty reduction, there has so far been little formal accounting of poverty in

transport projects. This is because of the prevalent supposition that distributive equity is an issue to be tackled by fiscal measures like taxation.

Accordingly, a methodology of appraisal, viz., the socio-economic impact analysis incorporating distributional issues, is being evolved for such projects. This analysis essentially aims at assessing the magnitude and distribution of both direct and indirect effects of a project. A recent World Bank study has attempted to formulate the issues involved in this regard specifically for road projects in the rural areas. The study also suggests an econometric technique for isolating the impact of the road and lists a host of potential variables for this purpose. The study, however, ends with a word of caution that the design and administration of analysis would be complex and costly and hence practical considerations will have to prevail.

In the literature related to the impact analysis of road-related projects, there are references to studies of the socio-economic impact of rural roads. But there is virtually no discussion of the impact of a highway, particularly a nationally important trunk route. The existing level of understanding of the relationship between transport infrastructure and human well-being in general, and poverty in particular, is also quite inadequate. Most of the evidence in this regard is anecdotal and not based on empirical results. The role of the highway has been mainly considered in traditional terms of moving intercity passenger and freight traffic.

India has embarked upon a programme of upgrading its national highway network, initially connecting the four metropolises and major maritime ports. This programme requires massive investments. Side by side, the country also carries a crushing load of poverty, which is more pronounced in the rural areas. According to latest estimates, more than one-fourth of its rural population live below the official poverty line. It was, therefore, decided to undertake an evaluation of the socio-economic impact of a stretch of a national highway proposed to be upgraded to a four-lane status on the rural population living in its proximity.

For this, a long stretch of national highway covering a distance of 995 km between Agra and Dhanbad and falling in the states of Uttar Pradesh, Bihar and Jharkhand, was selected. The issue of poverty alleviation is more pertinent and gains greater importance in the case of these states because most of the areas contiguous to this stretch have a high incidence of rural poverty measured according to the official

poverty line. This has been further confirmed by the census conducted by the state governments concerned for identifying the rural poor for covering them under various poverty alleviation programmes.

This study, which is perhaps the first of its kind, was faced with many challenges. These included building the required conceptual and theoretical framework, designing the baseline and post-project household surveys for the collection of relevant data, selecting the set of outcome variables, evolving an appropriate methodology of analysis and, last but not the least, estimating the impact of four-laning of NH2 on the set of chosen outcome variables.

Typically, the study of the socio-economic impact evaluation of a public investment project needs to be carried out in two phases – one based on baseline survey data (collected before the project is launched) and the other based on re-survey data (collected after the project has been completed). The partial effects of the project are then assessed by comparing the results of these two studies. The present study of the socio-economic impact evaluation of NH2 will also be carried out in two phases. The second phase will be undertaken on completion of the project. Since the full impact of the four-laning of the highway will take some time to be realised, more than one study may be required to bring out the complete range of effects of the project.

The present baseline report is structured as follows. Chapter 1 lays down the economic-theoretic framework and a methodology for evaluating the road impact on the well-being of the rural population. It also describes the use of statistical and econometric techniques for isolating the impacts from a host of other factors. Chapter 2 comprises a discussion of the survey structure and methodology, identification of representative stretches, sample design, etc. It may be mentioned here that the base-line survey covered 200 villages and 3,200 households spread over 73 blocks, 21 districts, and 3 states, involving an extensive fieldwork in the interior of the countryside.

Chapter 3 analyses the socio-economic profile of rural households separately for the poor and the non-poor. This examination, carried out perhaps for the first time in the country, helps to understand better the distributive impacts on different income groups. At the same time, it provides a comparative regional perspective.

Chapters 4 and 5 present the estimates of the impact of the highway on the set of chosen outcome variables at the village and household levels. This estimation shows the relationship between these variables and the distance from the highway. In the process, it also establishes a gradient-of-change hypothesis for most of the variables. More importantly, it validates the concept of defined influence zone of the highway.

Chapter 6 studies the rural road transport and travel-related issues to understand the accessibility status and mobility patterns of the population. The connectivity issues in relation to the national highway have also been studied, so also the extent of access of the villagers to various social and physical infrastructure facilities. The relationship between mobility and defined well-being indicators has been examined while carrying out the impact analysis of the highway at the household level. Chapter 7 summarises the main findings and also indicates the task ahead.

Chapter 1

Methodology of Impact Evaluation

The socio-economic impact analysis of a public investment project is done to assess the extent of net socio-economic benefits of the project that accrue to the population group(s) concerned, with the object of achieving poverty alleviation. Typically, such analyses comprise two studies of socio-economic conditions of the concerned population group(s) – one based on baseline survey data (collected before the project is launched) and the other based on re-survey data (collected after the project has been completed). The partial effects of the project are then assessed by appropriately comparing the results of these two studies.

The measurement of the impact of an existing road or that of a road-related project – be it a new road or widening or upgrading an existing one – is generally beset with a number of problems. Such problems are typical of this kind of projects, and are not normally encountered in the case of most other public investment projects. It is essentially because of a number of unique features that a road-related project generally has.

First, since the various services of a road together form a non-excludable public good, defining the beneficiary/participating population of a road-related project is not simple[1]. As we shall see later, defining beneficiary population for a road-related project is difficult due to a host of other reasons as well. Secondly, the impact of a road-related project often tends to get confounded by the effects of other interventions on the relevant impact (i.e. outcome) variables[2]. That makes the measurement of the partial effects of such a project a challenging proposition. Thirdly, in the case of a road-related project like the present one, which involves massive investment, apart from the partial and localised impact, strong economy-wide (general equilibrium) effects are often generated. These are also, no doubt, important, but analysing them may require technique(s) and information that may be widely different from those

1. Two things may be noted in this context. First, even when access to a road is controlled, say, through a toll, the population living in an appropriately defined neighbourhood of the road will derive non-excludable net benefit due to the presence of the road in their neighbourhood. Secondly, unlike in cases of welfare programmes like, say, participation in a food for work programme, no direct/formal participation of individuals/households is involved in the case of a road project and, therefore, participation is voluntary.
2. Henceforth, we shall use the words ‘impact variables’ and ‘outcome variables’ interchangeably to mean the variables based on which the socio-economic impact is being measured.

required for an impact analysis. Finally, the conceptual and methodological issues in the impact measurement of a new road may be somewhat different from those arising in the case of the impact analysis of a road that already exists or has been improved (by widening, say).

Given the distinguishing features of a road-related project mentioned above, evolving an appropriate impact analysis procedure would normally call for an economic theoretic framework as well as resolving some important conceptual and methodological issues. The former should explain why and how a road or its improvement is expected to affect the well-being of the population concerned. The latter, on the other hand, centres around the question whether the pure partial effect of a road or its improvement on the chosen set of outcome variables can be segregated and measured. This question arises because the variables in question may be affected by factors of which the road may be just one, albeit a major one.

In this chapter, the various conceptual and methodological problems that arise in the context of the impact analysis of a road-related project are elaborately discussed. First, an economic-theoretic framework that may serve as a rationale for the impact analysis of a road like the present one, and also for road-related projects in general, is presented. Then, the concepts and methodological issues involved are discussed[3] and the procedures that have been used for the present impact analysis of NH2 are explained.

An Economic-theoretic Framework

Designing an impact study for an existing road as the present one or that for a road-related project is immensely facilitated if an economic model providing an explanation of the economic effects of a road is available. Such a model would provide an analytical framework for the study and hence help justify the choice of the specific outcome variables considered. As far as the economic analysis of the effects of the road is concerned, Walters (1968) and Jacoby (2000) developed a simple model that explains how road development (i.e. construction of a new road or expansion/improvement of an existing one) might lead to the economic betterment of the population concerned.

3. Although the present Report is an impact analysis of an existing road – viz. the stretch between Dhanbad in Jharkhand and Agra in Uttar Pradesh – and not of a new or of one that has improved, we shall discuss here the methodological issues, etc. in a general fashion essentially because the literature on methodology for the impact study of a road-related project like the present one is rather scanty.

Briefly, as this essentially location-theoretic model demonstrates, a road development helps reduce producers' cost, increases profit, expands the size of the relevant set of production units, pushes up the opportunity cost of land, changes land use pattern in the neighbourhood of the road, etc. – all of which together result in the improvement of the level of well-being of the population living in the neighbourhood of the road. It may be noted that such a model implicitly defines an influence zone to which the impact of the road (improvement) is limited.

The Walters-Jacoby models offer a basic analytical support for designing a road-related impact analysis. Drawing on the lesson of this simple model, an analytical structure may be constructed, as has been done in the following paragraphs.

Suppose travel cost on NH2[4] is c (Rs./tonne km). Consider a representative person who lives at a distance d (km) away from NH2 along an approach road connecting his home to NH2. Let the (imputed) travel cost for reaching NH2 from interior be c' (Rs./tonne km). Thus, for one visit from home and back to a place on NH2 located at a distance of D km from the junction of the relevant approach road the unit travel cost is $T=2\{c'd+cD)\}$(Rs./tonne km). Suppose further that n visits to a place located at distance $(d+D)$ from home are made per unit of time (say, a day, week, month or year) by the person for socio-economic purposes (i.e. for trade, employment, education, health services, etc.). Let a trip involve a freight movement (i.e. man and material) of F (tonne). The total travel cost per unit time is then $TC= nFT = 2nFc'd+2nFcD=f(c, d, D, n, F)$, say.

Let us denote the gross benefit by $GB (Y (D, n, F), a (S))$, where Y and a stand for the gross earning per unit time (which may be reasonably assumed to be positively related to each of D, n and F) and a summary measure of the attributes of the household the person belongs to (like age-sex composition, health condition, literacy status, etc.). Let us assume a to depend on S, socio-economic infrastructural facilities like health, education, communication, justice, etc. accessed. It may be noted that gross earning Y may arise out of trade, manufacturing, supply of labour or other factor services, etc.

Given the travel cost and gross benefit (GB) as defined above, the net benefit (NB) function may be defined as $NB(c, d, D, n, F) = GB - TC$. Now, if it is assumed

4. For the convenience of exposition, let us call the concerned road/highway NH2.

that, *ceteris paribus*, *GB* is increasing concave in n, then there will be an optimal trip rate *n**, say, at which the net benefit of the person will be maximum. Next, let us see how this optimum trip rate will change if *d* is increased. Assuming *GB* to be decreasing in *d*, we readily have *n** inversely related to *d* – i.e. the optimal trip rate will be less for those living farther away from NH2. Arguing this way, there will be threshold distance *d** from NH2 such that *n** will be zero – i.e. the population living at a distance *d** or more will not generally access NH2 on a regular basis. One may thus, in principle, define as influence zone of NH2 the area along NH2 falling within a perpendicular distance of a few km on either side of NH2 beyond which the effect of NH2 is negligible. What value of *d** should be chosen to define the influence zone is, however, an empirical question.

Stretching the imagination a little farther, one may argue that, *ceteris paribus*, as d decreases, *n** will increase and hence *NB* will increase and a long-run effect of such a rise in *NB* will be a positive change in household well-being attributes, if it is reasonably assumed that *S* is rising in *NB*[5]. In the context of the impact assessment of a road-related project like the present one, this discussion, thus, may be taken to serve as a rationale for three things, viz. for considering variables related to mobility and socio-economic well-being as the set of relevant outcome variables, for examining the relationship of these variables with the distance from NH2 individually, and last but not the least, for defining an influence zone for the impact study to which the effect of NH2 and its widening may be limited.

As explained later, for the present impact study an appropriate influence zone of the relevant portion of NH2 has been delimited. In this context, it may be mentioned that delimitation of the influence zone automatically defines the area (lying beyond this *defined* influence zone) where the impact of the NH2 widening under consideration would be absent. As impact measurement involves comparison of the conditions (or its change between pre- and post-project situation) of the influence zone and a corresponding control zone (where the impact of NH2 or its widening is absent), such a control zone has also to be chosen appropriately. The way this choice has been done in the present case has been explained later.

5. Note that here we are implicitly assuming that the location of the socio-economic infrastructural facilities are close to the road so that persons living farther and farther away from NH2 have less access. Whether the reality will be such or otherwise will largely depend on the pattern of spatial distribution of relevant public facilities.

Some Conceptual Issues

Some conceptual issues which are likely to complicate and bias the impact assessment of an existing or an improved road facility relate to direct and indirect effects of a road, disentangling of partial effects of a road, the issue of time factor, problem of heterogeneity of effects and delineation of the influence and control zones. These are briefly discussed below.

Direct and Indirect Effects

The impact of a road (a new one or one being improved or upgraded) consists of direct or first-round effects, and indirect or a sum total of all later round effects. Direct effects are mostly observed in the influence zone in the form of increased mobility, reduced travel time to workplaces, schools, hospitals, markets, etc. and saving of fuel and other direct transport costs. The indirect effects, on the other hand, consist of income rise and improvement in other dimensions of well-being brought about by the creation/improvement of the road infrastructure. These general equilibrium effects result from a whole array of forward and backward linkage effects that the presence/expansion of a road may generate[6]. These wider effects, in turn, may affect the well-being of people living not only in the close neighbourhood of the road, but also farther away. Typically, such well-being impact is due to improvement/gain in consumption level, educational attainment, health status, etc.

Formally, a comprehensive impact assessment of a trunk road like NH2 should cover a large array of issues. These include the examination of the effect on several related indicators which may be placed in three categories: (i) direct effects related to transport project outputs, such as vehicle operating costs, duration and fares of transport, frequency of trips, (ii) direct effects related to transport project outcomes, such as communication, access to jobs, markets, health and education facilities, and (iii) indirect effects on the welfare or living standards outcomes, such as incomes, employment, consumption, prices, literacy, health status, etc. Village-level variables relating to land use, education, health, infrastructure, transport system, etc. and household-level variables like education, health, use/ownership of means of transport, mobility, etc. may be considered for the measurement of direct effects. Corresponding outcome variables which may be considered for measuring indirect effects could be a range of economic activities, markets, land prices, migration, etc. at the village level

6. In the case of a massive project, these effects may change outputs and prices across the economy and over time.

and income, consumption, farm and non-farm employment, ownership of assets, non-farm activities, migration, etc. at the household level.

The direct effects on road users can possibly be assessed in a straightforward manner. Problems are, however, likely to arise in assessing the other two types of effects – viz. the direct effects on non-users and indirect effects on all. For assessing these effects, it will be necessary, first, to specify non-users, and, second, to find out how the initial direct user effects influence transport cost and reverberate through product prices and economy-wide production, income and consumption pattern. In principle, the impact on the poor (or, for that matter, on any pre-defined population group) should be the sum total of all measured direct and indirect net benefits.

The above method of impact assessment, though comprehensive, may not be easy to adopt essentially because of the extremely high information requirement involved. As indicated later, a feasible alternative to the above approach may be to identify a set of household-level outcome variables encompassing aspects of transportation and mobility, poverty and other dimensions of well-being and estimate the partial effect of NH2 on these variables for the relevant population groups. The list of these variables may be seen at the end of this chapter (Annexure 1).

Disentangling Partial Effects

The partial effects of a new or an improved road facility on individual outcome variables may often get confounded with effects due to other interventions in respect of specific outcome variables[7]. There is always the possibility of confounding of effects of NH2 with those due to other interventions. This problem would be more serious in the case of impact analysis of a road expansion project. To avoid this, one would perhaps need to collect relevant information by asking sample households counter-factual questions like what would have been the level of a specific outcome variable had the road not been there (or had the road not been expanded). An alternative to asking counter-factual questions is to identify, corresponding to each sample household of the influence zone[8], a set of matched sample households in another zone which is very similar in nature with the influence zone, but does not

7. For example, if through deliberate planning free primary schools are set up in villages closer to NH2, then the observed higher literacy rate among children in villages of the influence zone need not be due to better mobility resulting from access to NH2 of the population living in these villages.
8. In this Report, we have referred to these zones as the influence zone and the control zone, respectively.

have the effect of NH2[9], and then compare the mean levels of each outcome variable for the two samples to get the estimate of the partial effects of NH2 or its expansion, as the case may be[10].

The Time Factor

In the case of a new road or an upgraded one, the full impact of the road intervention may take a long time to be realised. Therefore, the pre- and post-intervention observations (which may be collected at the gap of a few years, say) with respect to the outcome variables relating to capability or entitlement factors of well-being are to be compared. A method of *double difference* as elucidated in a later part of this chapter is available for comparisons. It may be noted, however, that to measure the partial effect of existing NH2, the double difference method is not required, as explained later part of this chapter.

The Problem of Heterogeneity of Effects

The impact of a road may be heterogeneous not only over space but also with respect to the different classes of population. So far as spatial heterogeneity of the effect (across population groups, say) is concerned, little is known about the distributional impacts of road investments (Gannon and Liu 1997). It is important to understand the heterogeneity of impacts at given levels of living[11]. One needs to distinguish between the short and long-term impacts as well[12].

Delineating the Influence Zone

An important issue in assessing the impact of a road or its expansion is the identification of the influence zone, i.e. the area on either side of the road to which the impact is supposed to be limited. There is a dearth of discussion in the literature on

9. Henceforth we shall call such a zone the control zone. The notion of a control zone essentially comes from the literature of non-randomised experiments (see Rosenbaum and Rubin, 1983).
10. As we shall see below, the propensity score matching technique (PSMT) is based on this line.
11. For example, if a new road leads to higher land values, there may be a tendency towards land concentration and landlessness. Those having initially greater land, education, wealth or influence will be better able to take advantage of the changes. As a result, the distributional inequality of current income and future income-earning opportunities may widen. It is quite likely that there will be a reduction in the common property resources, which may hurt the poor the most. As cheaper manufactured goods are brought in, there may be displacement of traditional craft or skill-based jobs.
12. For example, in the long term, even initial losers may win. But this is an empirical question. It is, therefore, important to collect data that allow one to distinguish impacts across groups and follow the experience of those groups long enough after the road is expanded so that the full effects can be understood. Apparently, PSMT and appropriate econometric techniques may be used profitably as complementary procedures to tackle these heterogeneity issues. Thus, while PSMT may help measure the partial effect of NH2, regression-based econometric techniques will be convenient to examine the gradient of change and thus bring out the effectiveness of the programme.

the methodology for determining such a zone. The influence zone of a road may be thought to be its natural catchment area, which may cover the entire country or even other countries connected by the road in the case of an international road facility. The concept of catchment area is based on consideration of connectivity, generally indicated by origin and destination of trips. For immediate socio-economic impact, however, the zone may be delimited up to a specified distance on either side of the road.

The encompassing distance for the influence zone of a road can be defined in different ways, depending on the nature of the road, how it is connected to the existing road network and the socio-demographic characteristics of the population living on its either side (e.g. population density, spatial dispersion of the population, type of economic activity). Accessibility (i.e. the distance to be travelled to reach the road) is also a major criterion. Accessibility implies a distance conveniently travelled by a villager to reach the highway. This approach distance may be taken to be the distance that can be covered in less than 30 minutes by bicycle or in one hour on foot, i.e. a distance of 4-5 km. Thus, households in villages lying within an approach distance of 5 km on either side of NH2 may constitute the universe of influence zone households for the present study. This, it would be appreciated, is a pragmatic way of delineating the influence zone[13].

Delineating the Control Zone

As explained later in this chapter, the impact measurement by propensity score matching technique (PSMT) uses the notion of a control zone corresponding to the influence zone. Formally, the control zone should be an area having similar agro-climatic and other macro features as the influence zone[14], but without having any effect of NH2. In other words, ideally, the intervention (i.e. presence of NH2) should be the only difference between the control zone and the influence zone.

13. It may be pointed out that for the present study households in villages lying within a band of 7 km of horizontal distance on either side of NH2 have been taken to form the universe, from which sample data have been collected. The horizontal distance of a village would normally differ from the approach distance, as villages may not be connected to NH2 by the shortest road. An investigation in one NH2 stretch revealed that the average approach distance of villages situated at a horizontal distance of 5 km was 7.5 km. The band of horizontal distance of 7 km considered for sampling, thus, covers a range of much longer approach distance, which may go even up to 16 km.
14. As per this technique, for every sample household of the influence zone, a set of matched sample households of the control zone is selected and the impact is measured by comparing the estimated average value of an outcome variable for influence zone households and that of the matched control zone households.

For an impact analysis of 4-laning of NH2 (after such broadening has been completed) using PSMT, the control zone should ideally be a similar area surrounding another road very similar to NH2 in the same region, which is not going to be 4-laned. Finding a control zone that meets these stipulated conditions may, however, be an extremely difficult proposition[15].

If it is thought reasonable to expect, like in the case of the impact of an existing road, that the impact of 4-laning will decline with distance from NH2, then, given the above discussion on the selection of the influence zone, one may consider villages lying beyond an approach distance of 5 km as the control zone under the presumption that these villages will be unaffected by the impact of 4-laning of NH2. Under this presumption, for the present study, the area (and the population living in villages) beyond 5 km of the approach distance on both sides of NH2 but lying within 7 km of the horizontal distance has been delineated as the control zone (population)[16].

Evaluation Methodology

Although the present Report is on an impact analysis of NH2 based on baseline survey data, the methodological issues involved in impact evaluation have been discussed here in a general manner. This encompasses problems that would arise in a similar study to be done for assessing the impact of widening NH2 after the completion of the project in 2005. In fact, since the full impact of widening NH2 will take some time to be realised, more than one study may be required to bring out the full impact.

Conventional methodologies for impact assessment of a public investment project include cost-benefit analysis (CBA), computable general equilibrium model (CGE) and simultaneous equations model (SEM), the last one being an econometric technique. CBA requires enumeration of the possible benefits and costs due to the project and their appropriate valuation. As discussed in the review of literature, for a project like the present one, there would be many items of benefit and cost for which there is neither a price, nor is a realistic imputation possible. Deciding proper discount rate for deriving the present value of stream of benefits would not be easy either. There are also issues of market imperfections and externalities which are not captured

15. Further, NH2 being a very old road, the villages around it must have attained a long-term social equilibrium and simply for this reason it may be impossible to find a proper control zone for measuring the impact of broadening of NH2.
16. A 7-km horizontal distance may extend up to 16 km of approach distance.

by the conventional CBA. These are well known problems of implementation of a social cost-benefit analysis, in general, and of a road-related project, in particular.

A CGE, in contrast, would compare outcomes for treatment and comparison groups (in the present case, for households of influence and control zones) through simulation. For this purpose, one has to specify a general equilibrium model capturing not only the macro effects, but also many other details, including how the distribution of well-being would be affected by NH2 or its widening. That essentially means that the causal interrelationship between the existing road/highway network, production, income and consumption and distribution of well-being, etc. have to be spelt out clearly in order that a sensible CGE model may be set up. The model should trace the operation of the real economy based on detailed social accounting matrices that are extremely information-intensive. In situations where the required databases do not readily exist, implementing impact assessment through CGE simulations is bound to become a very expensive proposition indeed.

The third technique, viz. use of SEM for the purpose of impact assessment, may prove to be a somewhat clumsy procedure in the case of a road-related project. For such a project, the impact has to be examined at the household level, for average households of relevant population groups, say. Unlike in the case of CGE simulation, in this case, one would need to specify a simultaneous equations model portraying the mechanism through which access to NH2 via its effect on mobility might affect various aspects of household well-being. The number of outcome variables in respect of which impact would be examined might turn out to be quite large. In addition, there might be many other ancillary variables through which the impact would work. These sets of variables together would form the set of endogenous variables of the relevant SEM. Since the number of endogenous variables would be large, implementing an SEM-based impact study would involve the estimation of a huge model based on a household-level data set. Such estimation, though possible, in principle, would be extremely demanding.

Considering the issue of feasibility, an alternative methodology has been devised for the present impact study that makes use of four basic statistical/ econometric techniques, viz. propensity score matching technique (PSMT), non-parametric regression analysis (NRA), binary and multinomial logit models and conventional multivariate regression analysis (MRA). The conventional regression

modelling and the more sophisticated PSMT-double difference method are not as substitutes for each other but rather serve as complementary exercises where one seeks to corroborate and improve the results in the overall framework. These techniques have been used in the following contexts:

(i) Areas lying within an approach distance of 5 km on either side of the highway have been delineated as influence zone, whereas the areas lying beyond 5 km and within the horizontal distance band of 7 km have been delineated as control zone. This delineation has been done on the presumption that the socio-economic benefits of the road sharply fall as the distance exceeds 5 km. To verify this presumption empirically, the nature of relationship between individual village-level and household-level outcome variables and the distance from NH2 has been examined using the NRA technique to examine the nature of these relationships as contained in the data. For individual household-level outcome variables, MRA has also been used to identify the factors that affect these variables. For individual village-level variables, in addition to the NRA, multinomial ordered logit analysis has been done for a closer examination of the relationship of the relevant outcome variables with the distance from NH2.

(ii) The impact analysis of NH2 has also alternatively been done by using the PSMT proposed by Rosenbaum and Rubin (1983) and the associated single difference method. The PSMT essentially required estimated probability for each sample household of it's belonging to the influence zone, irrespective of whether or not the household belonged to the influence zone. This has been done by defining a binary qualitative variable (1 if the sample household belongs to the influence zone and 0 otherwise) and using the logit analysis for explaining the (observed) sample variation of this qualitative variable. In what follows, we explain these statistical/econometric methods and discuss their relevance for the present analysis.

Propensity Score Matching Technique (PSMT)

Originally, PSMT was suggested as a device for selecting matched *control* sample units corresponding to individual *treated* sample units in a non-randomised experimental set-up for estimation of treatment effects, i.e. the impact of a controlled

intervention (see Rosenbaum and Rubin, 1983). This technique has been found convenient for measuring the impact of socio-economic welfare programmes (see Baker, 2000 and Jalan and Ravallion, 2002)[17]. It involves two major steps: (i) selection of matched control unit(s) (say, households) corresponding to every individual unit of a sample of participating units; and (ii) estimating the effects of programmes by finding out the difference between participating units and the matched control units.

To explain PSMT, let us consider a hypothetical targeted welfare project with the provision of voluntary participation. The population of households thus includes *participating* eligible households, *non-participating* eligible households and *non-eligible* households. Suppose a representative sample of eligible households is drawn from this population. Suppose further that for each sample household we have data $((y_i, z_i'), i = 1,2,...,n)$, where y_i is an indicator variable such that $y_i = 1$, if the sample household is a participating household and 0 otherwise, and $z_i' = (z_{1i}, z_{2i},..., z_{ki})$ is a vector of household attributes that determine individual household's participation decision, *n* being the sample size.

On the basis of this information and an important assumption that given the probability of participation, the indicator variable is not correlated with the individual variables that determine participation decision[18], a logit analysis[19] will provide an estimated probability function that will give estimate of *ex ante* probability of participation (i.e. the propensity score) for each sample household. This function may be written as $p\hat{r}(y_i = 1) = h(z_i'\hat{\gamma})$, where $\hat{\gamma}$ is an estimated parameter vector and $h(.)$ is a known functional form. Using this estimated function, the propensity score is calculated for each sample household. Now, by matching the propensity score of a participating sample household with those of the non-participating ones, *a few* matched sample non-participating households are identified such that the propensity scores match (given a criterion of matching) for every participating sample household[20].

17. Jalan, J., and M. Ravallion, Income Gains from Workfare: Estimates for Argentina's TRABAJAR Program Using Matching Methods, Washington D. C.: Development Research Group, World Bank, 1998.
18. This assumption is known as the assumption of *ignorability*. It guarantees the feasibility of estimating propensity score using available data on participation decision.
19. This is described later.
20. It may be noted that PSMT only requires the values of $z_i'\hat{\gamma}$ of the households being matched to be close enough, not the z vectors of the households. Although for such a matching the z vectors could have been far preferable, that would be too demanding and might make the task of finding matched household impossible.

In the present study, we have taken $y_i = 1$, if the sample household is in the influence zone, 0 otherwise. The vector of household attributes consists of a set of relevant village and household level variables. Given these, the logit analysis has been performed and estimated propensity scores have been calculated for all influence zone and control zone households in the sample. Finally, matched control zone households corresponding to each sample influence zone household have been identified using propensity scores (or the odds ratios based on these, to be precise).

A typical logit equation for the purpose of estimating propensity scores may be written as:

$$L_v = d + gZ_v + v_v \qquad \text{where} \quad L_V = Log_e \frac{P_v}{1 - P_v}$$

where P_v is the probability of a household to belong to the influence zone, Z_v is the vector of co-variates of the households characterising its socio-economic attributes and factors relating to its proximity to NH2 and V_v is the error terms for the vth observation. The explanatory variables of this regression model are supposed to determine the composite characteristics of the influence zone in terms of the logit variable, but not supposed to include any of the outcome variables of 4-laning project or their proxies, but may include some of the village-level characteristics, including some related to the distance characteristics of the household from the NH2.

The above equation will be estimated over the full sample of households from all the villages and the propensity score (predicted probability) will be calculated for each household from the predicted values of the equation. This means that the representative sample of households within and outside the influence zone will be pooled together to estimate the logit model of belonging to the influence zone or experiencing the impact of 4-laning project of NH2 as a function of all the variables in the data that are likely to determine the composite characteristics of the influence zone. The probabilities or propensity scores yielded by the estimated regression are used for matching households of the influence zone and control zone. If the range of propensity scores for the group of households in the influence zone is similar to that for the sample of households in the control zone, then the latter can be considered as valid control group for the purpose of impact assessment.

As mentioned above, the aim of matching propensity scores is to find the closest comparison group from a sample of households outside the influence zone to the sample of households in the influence zone. For any given household in the influence zone, the matching households in the control zone are defined to be the ones which are closest to it in terms of the probability (P) for the concerned household to belong to influence zone as derived from the logit model or in terms of its odds ratio. The closest matching households may be defined to be the nearest 5 households of the control zone for any given household of the influence zone, in terms of the probability P or odds ratio P/1-P as referred to above. Or, it may be alternatively defined to be households of the control zone lying within a defined interval around the value of P or P/1-P for the given household in the influence zone. The interval has been taken to be all values of such odds ratio or probability which would satisfy:

$$\left(\frac{P_i}{1-P_i}-\frac{P_c}{1-P_c}\right)^2 < 0.005 \qquad \text{or} \qquad \left|\frac{P_i}{1-P_i}-\frac{P_c}{1-P_c}\right| < 0.0707$$

where i with it P_i is given and c with its associated P_c is variable whose values are being identified for ascertaining the closest households. While in the present study, all households of all villages of the different selected stretches of NH2 have been pooled together for finding the matching group of households for any given household in the influence zone, this has been done to allow maximum flexibility of choice in matching the households.

There is an implicit assumption that the non-similarity of villages would not matter while comparing the outcome variable values of a household in the influence zone and those of its matching group in the control zone. While one may question the validity of such an assumption, there is a trade-off for making choice in favour of multistage matching options in terms of the sacrifice that the effective length of interval describing closeness in terms of probability or odds-ratio would be larger. Otherwise, a number of observations in the control zone may be left out of matching or a number of the influence zone households may not have adequate matching in the control zone. Besides, the limitedness of the sample size of the villages also does not permit efficient matching at the village level.

Single and Double Differencing

Given a set of matched non-participating sample households (i.e. control) for each participating sample household, for every outcome variable, average values for the sample of participating households and the corresponding sample of matched non-participating households are calculated and compared to estimate impact in respect of each outcome variable. In calculating the average outcome indicator of the matched control units, several weighting schemes can be used, ranging from 'nearest neighbour'[21] weights to non-parametric weights based on kernel functions of the differences in scores (Heckman, *et. al.*, 1997)[22].

In the present study, the process of averaging that is used (and has been followed for different types of variables in the present exercise) is explained below:

The estimate of the average of an outcome variable for participating households should be $\bar{y}_{IZ} = \frac{\sum_{i=1}^{n_{IZ}} y_i s_i}{\sum_{i=1}^{n_{IZ}} s_i}$, where y_i: value of the per capita variable and s_i: household size of the *i*th sample participating household, n_{IZ}: number of sample participating households[23]. The average value of the variable for the matched sample non-participating households corresponding to the *i*th sample participating household is $\bar{y}_{IZi} = \frac{\sum_{j=1}^{n_i} y_j s_j}{\sum_{j=1}^{n_i} s_j}$, where n_i: number of matched non-participating sample households for the *i*th sample participating household. A comparable average[24] of variable for control sample households is then $\bar{y}_{CZ} = \frac{\sum_{i=1}^{n_{IZ}} \bar{y}_{IZi} s_i}{\sum_{i=1}^{n_{IZ}} s_i}$. Given the two averages thus

21. For each sample participating unit closest propensity scores in the sample non-participating units are identified in terms of the absolute difference in the propensity score. This is called 'nearest neighbour'.
22. Jalan and Ravallion (2001) discuss the choice further, and find that their results for estimating income gains from an anti-poverty programme are reasonably robust to the choice.
23. One should use appropriate multiplier weights in this formula, if the sample design is not self-weighting.
24. Note that here the household sizes have been used as weights essentially to make the two averages comparable.

obtained, the impact is measured as $\bar{y}_{IZ} - \bar{y}_{CZ}$ [25], or in percentage form as $\left(\frac{\bar{y}_{IZ} - \bar{y}_{CZ}}{\bar{y}_{CZ}}\right) x100$.

The impact measurement procedure based on sample average values of an outcome variable as described above is known as single difference method. One may use this for measuring the impact of an existing road (in the case of a road upgrading impact analysis based on baseline survey data). For measuring the impact of a project, one needs to compare the levels of outcome variables in pre- and post-project periods. The relevant method, known as double difference method, seeks to find the pure partial effect of a project on the levels of individual outcome variables. For example, in the case of 4-laning of NH2, the impact of the project should be that part of the observed change in the level of an outcome variable which is solely due to the 4-laning of NH2.

Let y_j^0 be the observed pre-project period value of an outcome variable for the *j*th sample participating household and y_j^{0m} be the mean value of the variable for corresponding matched sample non-participating households. The difference $(y_j^0 - y_j^{0m})$ measures the observed pre-project difference in the level of the outcome variable[26]. The aggregate (or average) of this difference over all sample participating

25. For a quantitative variable like the share of income from self-employment in non-agriculture, the process of averaging is explained below:
Let *y* is the total income and *s* is the total income from the self-employment in non-agriculture

(i) $\overline{y_{iz}} = \frac{\sum_{i=1}^{n_{iz}} s_i}{\sum_{i=1}^{n_{iz}} y_i}$ where y_i is the total income and s_i is income from self-employment in non-agriculture in the *ith* sample IZ household , n_{iz} being the number of household in the sample.

(ii) $\overline{y_{cz}} = \frac{\sum_{i=1}^{n_{iz}} \sum_{j=1}^{m_{cz}} s_{ji}}{\sum_{i=1}^{n_{iz}} \sum_{j=1}^{m_{cz}} y_{ji}}$ where y_j is the total income and s_j is the income from self-employment in non-agriculture in the matched household of *i*th sample household in IZ, m_{cz} being the number of matched household in the *i*th sample household in IZ

(iii) Given the two averages thus, obtained, the impact is measured as: $\left(\frac{\overline{y_{iz}} - \overline{y_{cz}}}{\overline{y_{cz}}}\right) \times 100$

26. In case of the NH2 4-lanning project, one may treat this as the impact of NH2 proximity as in this case a household of the influence zone is a participating household and the corresponding matched households of the control zone are the non-participating households.

households gives a measure of the initial (i.e. pre-project) difference in the level of the outcome variable under consideration between participating and non-participating households. Formally, it is written as $D_1 = \sum_j (y_j^0 - y_j^{0m})$ [27].

The double difference method requires, in addition, a similar measure of difference in the post-project levels of outcome variables for each sample participating household and its matched non-participating ones. Let the required difference for the *j*th sample participating household be $(y_j^1 - y_j^{1m})$ where the superscript 1 is used to denote that the difference relates to the post-project situation, the set of sample households being the ones covered in the pre-project baseline survey. Based on these differences, an aggregate measure of difference exactly similar to D_1 is as $D_2 = \sum_j (y_j^1 - y_j^{1m})$ that measures the aggregate/average difference in the levels of the *j*th outcome variable of participating households and their matched non-participating counterparts. The pure partial effect of the project, in principle, is then given by $P = (D_2 - D_1)$. One may alternatively express this as $P = \sum_j (y_j^1 - y_j^0) - \sum_j (y_j^{1m} - y_j^{0m})$. It may be noted that the first term on the right-hand side of this expression measures the aggregate change in the level of outcome variable for the entire sample of participating households between the pre- and post-project situation and the second term measures the corresponding change for the matched non-participating households. This double difference, thus, in principle, gives the pure partial effect of the project in respect of an individual outcome variable.

This method requires the availability of a panel data set. In a typical impact study, households or individuals who participated in the baseline survey must be the same who participate in the follow-up survey; otherwise the differencing method would not eliminate the unobservable factors that could create bias. In practice, it is often difficult to construct such a panel, because households move or are no longer willing to participate in the second round of the survey (attrition bias). In the case of trunk roads, this problem is likely to be insignificant, since the evaluation occurs at the level of villages. It is unlikely that a village at large would refuse to participate in the follow-up survey. If individual households are not the same from one year to the next, this will not affect the validity of the method, so long as the selection of households within each village takes place randomly in each survey year.

27. It may be noted that this is basically a form of impact measured by the single difference method.

Formally, PSMT and the associated single and double differencing technique may be used to estimate the impact of a road like NH2 and its upgadation using the baseline survey and the post-project re-survey data sets and treating the sample households of the influence zone as participating households and their matched ones of the control zone as the non-participating ones. The logit analysis may be used to calculate the propensity scores required for the purpose of finding matched households for individual sample influence zone households. This exercise has been done to measure the impact of NH2 using the baseline survey data.

Many pertinent questions may, however, be raised about the appropriateness of impact analysis based on PSMT in the present case, in particular, and in a road-related project, in general. These range from the question of feasibility of finding a satisfactory control zone to the applicability of PSMT for finding matched control zone households on the basis of propensity score.

Consider first the question of finding a satisfactory control zone from where matched households are to be chosen. This issue has already been discussed and the possible difficulties involved in finding an appropriate control zone for a road-related project, in general, and for NH2, in particular, pointed out. Let us reiterate these here. NH2 upgrading is unlike any participatory welfare project for more than one reason. First, the national highways were and are the premier road network of India. Further, NH2 is on the same route as an ancient historical route connecting the north to the east. Therefore, villages located along NH2 will be in some kind of a long-term social equilibrium and, as such, these villages will, in general, be non-comparable with those along other routes and in the interior. It is, therefore, not an important empirical question as to whether PSMT based on a few observable characteristics will succeed in finding appropriate matched villages/households. There seems to be a problem of latent heterogeneity that may lead to a bias in measuring the impact.

There are a few more problems that may be relevant in the case of impact measurement of a road upgrading project like the 4-laning of NH2. First, due to upgrading, the delineations of both the influence zone and the corresponding control zone may change considerably, so that impact analysis through PSMT and associated double differencing method may become infeasible. Even if these delineations do not

change due to upgrading, problems may arise due to migration of selected sample households of the baseline survey[28].

There are certain other aspects of PSMT which need to be considered. As already stated, in case of a project with voluntary participation, the participation decision of individual eligible household will depend on a set of household variables. In case of a road-related project, however, the participation is non-voluntary, so to say, as all households of the influence zone have to be regarded as participating and those of the control zone as non-participating. Thus, the notion of participation in this case becomes somewhat artificial. To explain the data on participation (i.e. the observed values of the qualitative variable denoting whether a sample household belongs to the influence zone or control zone) one must find village/household-level variables that will be able to satisfactorily discriminate between the two types of households in question. Whether such a set of variables outside the set of outcome variables (that are designated to distinguish between the influence zone and control zone households) can be identified becomes a very important empirical question.

The conclusion that emerges from the above discussion is that there may be a case for the use of PSMT for impact study in the case of a road-related project like the present one. However, there seem to be important empirical issues involved – particularly in the context of choice of explanatory variables for the explanation of the very artificial notion of project participation decision in such a case. One has to choose very carefully an appropriate set of *discriminating* variables. How well this can be achieved in actual practice is an empirical question It would, therefore, be prudent to supplement PSMT-based impact analysis by other studies based on conventional wisdom (even though the latter may not give the pure partial effect of a project that a PSM-based technique aspires to capture).

Non-Parametric Regression Technique (NPRT)

NPRT is a convenient econometric tool that helps bring out the pattern of relationship between a pair of variables implicit in a given bi-variate data set[29] (see Härdle, 1990)[30]. The basic idea underlying this technique may be explained as follows:

28. One possible way out of this problem may be to use the non-migrating subsets of sample households of the influence zone and control zone and compute DI and D2 using relevant data for these households only.
29. This technique is well-defined for examining multiple regression relationships in multivariate data sets as well. However, its use in bi-variate data set is popular.
30. Härdle, W., Applied nonparametric regression, Chapter 1-3, Cambridge University Press, Cambridge, 1990.

Consider a bi-variate data set $(x_i, y_i, i = 1, n)$ on a pair of random variables X and Y, where x_i, y_i denote the *i*th sample observation on the explanatory and explained variables, respectively. Given this data set, one seeks to estimate the underlying regression line $y_i = m(x_i) + \varepsilon_i, i = 1,2,...,n,$ where the algebraic form of the regression curve $m(.)$ is not *a priori* specified. In other words, the NPRT generates empirical estimates $\hat{m}(x)$ of $m(x)$ for a large set of values of the variable *x* in the observed range of its values. Plotting $\hat{m}(x)$ against *x* one gets the estimated non-parametric regression line.

The NPRT works as follows: Given the range of the sample values of the variable X, *m* (≥ 2) equi-spaced values of X are taken. Let a typical specified value be denoted as *x*. Consider the interval $(x-h, x+h)$ and let n_x be the umber of observed values of X falling in this interval. Denote these values by $x_j, j = 1,2,...,n_x$. The ordinate of the non-parametric regression curve, $\hat{m}(x)$, corresponding to this value of *x* is then estimated by using the following Nadarya-Watson estimator:

$$\hat{m}_h(x) = \frac{n_x^{-1}\sum_{j=1}^{n_x} K_h(x - x_j) y_j}{n_x^{-1}\sum_{j=1}^{n_x} K_h(x - x_j)},$$

where the kernel function $K_h(.)$ is an appropriately chosen weighting function. There are a number of alternative forms of the kernel function that are frequently used. In the present exercise, the quartic kernel function has been used. For estimation, a value of *h*, the bandwidth, is to be chosen. In this context, it may be mentioned that a larger value of *h* yields a smoother estimated regression line (whereas a smaller value of *h***,** in contrast, results in a wavy estimated line). For a given data set, the optimal bandwidth *h* may be decided by using the cross-validation technique[31].

Needless to mention, being primarily data-driven and not based on any *a priori* functional form specification, the NPRT is a powerful tool of analysis. For the present analysis, this has been used mainly to examine the gradient of change

31. For a discussion on the cross-validation technique, see Härdle (1990, Ch. 5). For the present exercise the NPRT has been done using a version of STATA in which the cross-validation facility was not available. Hence, the value of h in individual cases has been chosen by visual examination of the resulting graph of the estimated non-parametric regression functions.

hypothesis, i.e. the nature of the relationship between an outcome variable and the distance from NH2[32].

Multivariate Regression Analysis (MRA)

Multivariate regression model has been set up to explain a number of variables representing socio-economic well-being indicators or socio-economic basic conditions in terms of the household-level or village-level characteristics, transport related and some other socio-economic determining factors. For quantitative outcome variables linear regression equations have been estimated using step-wise ordinary least squares method (OLS). In case the data contains a large number of zero observations for such a variable, censored regression model (tobit regression) has been estimated. For qualitative outcome variables, like landlessness or if a household owns at least one motorised transport or some other asset or if a household is below the poverty line, step-wise logit analysis has been done.

Binary and Multinomial Logit Analysis

An important ingredient of PSMT is the logit analysis used to estimate propensity scores. It is a convenient econometric tool for the analysis of a bi-variate (or multivariate) data set comprising a binary qualitative dependent variable (see Maddala (1986))[33]. This technique is briefly explained below:

Consider a population in which some units possess a particular feature (e.g., in a population of households some are poor). If a unit is picked up from the population at random, the probability that the selected unit will have the feature depends on a deterministic factor (that is a function of a set of explanatory variables) *plus* a random error. Now, suppose a random sample of n households is drawn from the population. Let $y_i = 1$, if the ith sample household is observed to have the feature and 0 otherwise, and $x_i' = (x_{1i}, x_{2i}, ..., x_{ki})$ is the observed values of the relevant explanatory variables for the ith sample unit (i = 1, 2,…, n, there being n sample households).

To explain the observed variation of the sample y_i values, the following latent variable regression model is specified: $y_i^* = x_i'\beta + \varepsilon_i, i = 1,2,...,n,$ where y^* is an

32 In the present study, Quartic (Biweight) weights have been used to define this weighting Kernel function and have chosen the bandwidth to be 3. In order to define the grid in terms of the number of equal divisions of the range of x-variable we have taken it, i.e. n to be 3200 which happens to be the sample size pooling all the households in influence zone and control zone together. The software STATA 7 has been used to estimate these models and have obtained the results in graphic form.

33. Maddala, G. S., Limited-dependent and qualitative variables in econometrics, Chapter 2, Cambridge University Press, Cambridge, 1986.

unobservable variable, $\beta = \{\beta_1, \beta_2, ..., \beta_k\}$ is the vector of coefficients associated with *k* explanatory variables and ε_i's are random disturbances. Given this relationship, for a sample unit with a given set of values of explanatory variables $y_i = 1$ if $y_i^* > 0$ and it is 0 otherwise [34]. Now, it is assumed that the random disturbances ε_i's are identically distributed following a logistic distribution. That means, Prob ($y_i = 1$)= $p_i = \frac{1}{1+\exp(x_i'\beta)}$, or equivalently $\frac{p_i}{1-p_i} = x_i'\beta$ [35].

Given the sample observations $(y_i, x_i', i = 1,2,...,n)$, the logit model is estimated by maximum likelihood method. Once the estimation has been done, the odds ratio can be calculated for the individual sample[36].

Finally, the technique of multinomial ordered logit analysis that has been used to examine the relationship between the individual village-level outcome variables and distance from NH2 is briefed explained below to reaffirm the NPRT results relating to the test of gradient of change hypothesis based on the village-level data set.

Unlike a binary logit model, a multinomial logit model deals with a qualitative variable allowing one of more than two possible responses. If these responses can be ordered (e.g., a household may choose a location of its home at the town centre, at a distance of 2-3 km, 3-6 km or more than 6 km from the town centre), then one can define $y_i = 0$, if the *i*th sample unit has chosen the first option, $y_i = 1$, if the second option has been chosen and so on for k options, say. The ordered multinomial logit model is specified as $prob(jth\ alternative\ chosen) = p_j = \frac{\exp(x'\beta_j)}{\sum_{k=1}^{m} x'\beta_k}$, there being *j=1,2,..,k* alternatives from which the sample unit chooses one alternative. One of the

34. In other words, $y_i = 1$ if $\varepsilon_i > -x_i'\beta$.

35. Note that the latter expression shows that odds ratio is a linear function of the explanatory variables under the logit model.

36. However, before using the estimated probabilities and/or the corresponding odds ratios one should ensure that the model has fitted satisfactorily to the given data set in the sense that the classification of the sample units based on the estimated *ex ante* probabilities matches fairly well with the corresponding *observed* classification. Along with the estimated parameter values, their standard errors and the maximised log-likelihood value, values of other relevant sample statistics are provided by standard econometric software. While these may be adequate for performing standard tests of hypotheses that are often required, there does not exist any straightforward technique for visualising the performance in terms of the goodness of fit of the estimated logit model (i.e. whether the classification of sample units based on estimated probabilities would closely match the observed classification). It may, however, be possible to devise some *ad hoc* empirical devices for such goodness of fit examination.

alternatives is taken as the reference alternative. For this reference alternative $\beta = \phi$ is taken for the sake of normalisation. Given this, it can be written $\frac{p_j}{p_1} = \exp(x'\beta_j)$, where alternative 1 is taken as the reference alternative. The log odd is thus $\log(\frac{p_j}{p_1}) = x'\beta_j$. The estimated elements $\beta_{1j}, \beta_{2j}, ..., \beta_{Lj}$ for the *j*th alternative thus measure how the chances of a sample unit choosing alternative j in preference to the reference alternative will marginally change if the value of an explanatory variable is increased marginally. For example, if the estimated value of β_{1j} is positive and significant for an alternative *j*, that will mean a marginal increase of the value of the first explanatory variable will significantly increase the chance of choosing alternative *j* in preference to the reference alternative.

The above-mentioned statistical/econometric techniques are to be supplemented by participatory rural appraisal (PRA) which, *inter alia*, includes reflexive or generic controls, whereby direct questions to the respondents are asked as to how much they think their situation has improved due to the road, or whereby the observed evolution is compared to what happened region-wide or even country-wide. In reflexive comparisons, the participants themselves provide the control information by comparing themselves 'before' and 'after' receiving the intervention. With generic comparisons, the impact of the intervention on beneficiaries is compared with established norms about typical changes occurring among the target population. Shadow comparisons consist of the judgement of experts, project administrators and/or selected participants on what is ordinarily to be expected in the case of the target population as compared to actual outcomes.

Data Requirement and Sample Design

The full impact study of the widening of NH2 would require pre- and post-project household- and village-level data in respect of possible outcome variables. The impact assessment has, therefore, been set up in two stages. Further, it relies primarily on survey-based collection of data and quantitative analysis of such data. The relevant universe comprises all households living in villages belonging to the defined influence and control zones of the selected stretches of NH2.

For the purpose of the study, the area of covering this universe has been portioned into seven representative stretches in terms of agro-climatic and other

macro features. The sample design adopted for each of these stretches is a stratified two-stage one – villages being the first stage and households the second stage. The first stage sample units have been selected using the probability proportional to size (PPS) without the replacement technique, and those in the second stage have been selected by using the circular systematic sampling technique. The sample design and the sampling procedure followed have been explained in detail in chapter 2.

Conclusions

The impact evaluation of a road-related project like the 4-laning of NH2 involves challenging problems. These arise due to the very nature of such a project, which involves a virtually non-excludable public good like road infrastructure. Moreover, NH2 being a very old highway of India constructed hundreds of years ago, the impact analysis of this project involves major additional dimensions that would not be there in the case of the impact study of a new highway.

Typically, for a public investment project involving voluntary participation, beneficiary population (i.e. treated units) and corresponding matched population (i.e. the control units) required for the measurement of the pure partial impact of the project can, in principle, be identified without much difficulty. For a road-related project, however, the identification of either is beset with major contentious issues. The historical dimension due to the vintage of NH2 also adds to the set of these issues. Here, the stretch of area lying within a distance of 5 km on either side of the relevant stretches of NH2 has been identified to be influence zone and the area contiguous to the influence zone and lying within a horizontal distance of 7 km has been identified to be the control zone on the basis of both theoretical and empirical justifications.

The evaluation methodology that has been devised is a combination of several statistical and econometric techniques, viz. propensity score matching, bi-variate non-parametric regression analysis, binary and multinomial logit analysis and multivariate parametric regression analysis. This methodology has been adopted keeping in view the issue of feasibility of implementation in terms of information requirement, reliability and cost of evaluation. It uses the different techniques as complementary to each other and is such that it can be used for both pre- and post-project impact assessment.

Annexure 1: List of variables used for socio-economic impact assessment of national highway

Village variables
Demographic
V1 Population density (population per sq km)
Incidence of poverty
V2 Proportion of BPL households
Transport infrastructure
V3 Share of motorised vehicles in total transport vehicles
Employment
V4 Proportion of non-agricultural workers in total main workers
Asset ownership
V5 Number of milch animals per household
V6 Proportion of semi-pucca and pucca houses
Education and other infrastructure
V7 Number of teachers per school
V8 Number of enrolled students per school in the year 2002-03
V9 Number of girl students enrolled per school in the year 2002-03
V10 Proportion of literate population above 6 years of age
V11 Whether a village has banking facility
V12 Whether a village has cooperative society
Price of land and dairy products
V13 Price of irrigated crop land (Rs./acre)
V14 Price of unirrigated crop land (Rs./acre)
V15 Price of residential land (Rs./acre)
V16 Sale price of milk (Rs./litre)
Household variables
Incidence of poverty
H1* Whether household is poor based on poverty line measured in terms of monthly per capita income (MPCY)
H2* Whether household is poor based on poverty line measured in terms of monthly per capita consumption expenditure (MPCE)
Mobility (weekly)
H3 Per capita trip rate (PCTR)
H4 Per capita trip rate for work
H5 Per capita trip rate for marketing
H6 Per capita trip rate for education
H7 Per capita trip rate for accessing health-related services
H8 Per capita trip rate involving travel on NH2
H9 Per capita trip length for trips involving NH2
H10 Per capita travel expense for trips involving NH2
H11 Per capita travel time for trips involving NH2
H12 Travel cost per person km for trips involving NH2
Income, employment and occupation
H13 Per capita income (annual) (Rupees)
H14 Per capita consumption expenditure (monthly) (Rupees)
H15 Share of income from self-employment in non-agricultural activities
H16 Share of food in consumption expenditure
H17 Proportion of working members in a household in age group 15-59 years
H18 Proportion of working female members in a household in age group 15-59 years
H19 Proportion of non-agricultural workers in total working household members.
Asset ownership
H20* Whether a household is landless
H21* Whether a household owns at least one information related consumer durable (like TV, radio, etc.)
H22* Whether a household owns at least one motorised transport vehicle
Education and health
H23 Proportion of school-going children among all children in the household in age group 6-14 years
H24 Proportion of female school-going children among all female children in the household in age group 6-14 years
H25 Proportion of household members who availed of medical facilities during last six months
Attitudinal response
H26* Whether a household rates itself as poor
H27* Whether a household expects improvement in employment situation after 4-laning of NH2
Well-being index
H28 Index of overall well-being based on income, employment, health and education (BORDA index)
H29 Index of transport mobility (BORDA index)
H30 Index of access to infrastructural facilities, assets and amenities (BORDA index)

* *These are qualitative binary variables.*

Chapter 2

Survey Structure and Methodology

Sampling Design

Sampling is a long-established practice. The principal object of any sampling procedure is to secure a sample which will reproduce the characteristics of the population (a collection of units being studied) as closely as possible. The method results in economy of effort and at the same time provides accurate outcomes.

All rigorous sampling demands a subdivision of the material to be sampled into units, termed sampling units, which form the basis of the actual sampling procedure. In general, when a given proportion of the material is included in the sample, the smaller the sampling units employed, the more accurate and representative will be the results. This remains true even if multi-stage sampling is adopted.

The selected units must be clearly and unambiguously defined. This demands the existence or construction of a sampling frame, i.e. a list that identifies every unit within the target population. Such a list helps identifying each individual member of the population unambiguously.

A random sample is the simplest form of a rigorously selected sample and provides the basis for most of the more complicated sampling methods. In a random sample, after subdividing the material into sampling units, the requisite number of units are selected at random from the whole population of units.

In the case of a stratified sample, the population of sampling units is subdivided into groups or strata before the selection of the sample. A stratified sample is, thus, equivalent to a set of random samples on a number of sub-populations, each equivalent to one stratum. A population may be stratified for two or more different characteristics. If a selection is made from sub-strata comprising the various combinations of the main classifications, the procedure is exactly similar to ordinary stratification, the sub-strata being equivalent to the strata.

In multi-stage sampling, the material is made up of a number of first-stage sampling units, each of which, in turn, is made up of a number of second-stage units, etc. The sampling procedure is carried out in stages. In the first stage, the first-stage units are selected by a suitable method such as random or stratified sampling. In the second stage, a sample of second-stage units is selected from among the selected first-stage units by a method which may be the same or different from the method employed for selecting the first-stage units. Further stages may be added as required. Multi-stage sampling, thus, introduces an element of flexibility into sampling design and enables utilising of the existing natural divisions and subdivisions of the material.

In the choice of the sampling frame, the following considerations were also taken note of:

(i) Almost all surveys in general and surveys of households in particular are multipurpose enquiries. They are designed to estimate numerous characteristics on a variety of topics and sub-topics.

(ii) Just as a survey is seldom designed to measure a single variable, similarly, it is seldom designed to measure variables at a single level of aggregation.

Scope of the Enquiry

The scope of the enquiry was confined to the rural population.

General Design

The sample design was based on an appropriate stratification of village and household units in order to make sampling units homogeneous within each stratum. The general scheme of the sampling plan was a stratified two-stage design with census villages as the first stage units (FSUs) and households within the sample villages as the second stage units (SSUs). It may be mentioned that a stratified design takes care of the variability factors and the two-stage design addresses the problem of non-availability of a usable frame of the ultimate sampling units.

Delimiting Influence Zone

As mentioned in chapter 1, a contiguous band of 5 km on both sides of NH2 has been taken to be the influence zone[1].

1. The influence zone limits impact assessment analysis as the adaptation of the impact assessment method and the definition of a zone of influence are interdependent, because both are a function of the characteristics of the road and the surrounding area.

Identification of Representative Stretches

The national highway between Agra and Dhanbad extends over a distance of 995 km. Subjecting this entire length to a detailed survey would have involved huge resources. It was, therefore, postulated that the purpose would be adequately served if the scope of the enquiry were confined to representative stretches covering around 25 percent of the distance, i.e. 200-250 km of the road length. Thus, the foremost task was to identify homogeneous and representative stretches spanning the three states of Uttar Pradesh, Bihar and Jharkhand. The following criteria were adopted for the purposes of selecting the stretches:

(i) should essentially cover rural areas;
(ii) should have homogeneous agro-climatic characteristics;
(iii) should be representative of the incidence of poverty in the district concerned;
(iv) should form part of a single planning unit.

Rural Coverage

The national highway passes through both rural and urban areas. Since the focus of the present study is the rural population, the stretches have, essentially, to lie in the rural areas. Therefore, while selecting each stretch, care was taken to identify a contiguous segment of rural areas not having any urban habitation.

Agro-climatic Regions

The agro-climatic characteristics of a region refer to soil quality, climate, rainfall, and water resources. Based on these characteristics, the Planning Commission has divided the country into the following 15 agro-climatic regions, which have been further divided into sub-regions. The purpose of this division is to promote farming systems of optimum crop production suited to the related agro-climatic features.

(i) Western Himalayan	(ii) Eastern Himalayan	(iii) Lower Gangetic Plains
(iv) Middle Gangetic Plains	(v) Upper Gangetic Plains	(vi) Trans- Gangetic Plains
(vii) Eastern Plateau and Hills	(viii) Central Plateau and Hills	(ix) Western Plateau and Hills
(x) Southern Plateau and Hills	(xi) East Coast Plains and Hills	(xii) West Coast Plains and Ghats
(xiii) Gujarat Plains and Hills	(xiv) Western Dry	(xv) Islands

NH2 falls in three agro-climatic regions and five sub-regions. Care was taken that the chosen stretches were representative of these regions and sub-regions, as shown in Table 1.

Table 1: State and district-wise agro-climatic sub-region distribution

State	District	Agro-climatic region	Sub-region	Chosen stretches for survey purpose
Uttar Pradesh	Agra	Upper Gangetic Plain	South Western Plains	
Uttar Pradesh	Firozabad	Upper Gangetic Plain	South Western Plains	√
Uttar Pradesh	Etawah	Upper Gangetic Plain	South Western Plains	
Uttar Pradesh	Auraiya	Upper Gangetic Plain	South Western Plains	√
Uttar Pradesh	Kanpur Dehat	Upper Gangetic Plain	South Western Plains	
Uttar Pradesh	Kanpur Nagar	Upper Gangetic Plain	South Western Plains	
Uttar Pradesh	Fatehpur	Upper Gangetic Plain	Central Plains	√
Uttar Pradesh	Kaushambi	Upper Gangetic Plain	Central Plains	
Uttar Pradesh	Allahabad	Upper Gangetic Plain	Central Plains	
Uttar Pradesh	Sant Ravidas Nagar	Middle Gangetic Plain	Eastern Plains	
Uttar Pradesh	Varanasi	Middle Gangetic Plain	Eastern Plains	
Uttar Pradesh	Chandauli	Middle Gangetic Plain	Eastern Plains	√
Bihar	Bhabua	Middle Gangetic Plain	South Bihar Plains	√
Bihar	Rohtas	Middle Gangetic Plain	South Bihar Plains	
Bihar	Aurangabad	Middle Gangetic Plain	South Bihar Plains	
Bihar	Gaya	Middle Gangetic Plain	South Bihar Plains	√
Jharkhand	Chatra	Eastern Plateau & Hill Regions	Chotta Nagpur Hills	
Jharkhand	Hazaribagh	Eastern Plateau & Hill Regions	Chotta Nagpur Hills	√
Jharkhand	Giridih	Eastern Plateau & Hill Regions	Chotta Nagpur Hills	
Jharkhand	Koderma	Eastern Plateau & Hill Regions	Chotta Nagpur Hills	
Jharkhand	Bokaro	Eastern Plateau & Hill Regions	Chotta Nagpur Hills	
Jharkhand	Dhanbad	Eastern Plateau & Hill Regions	Chotta Nagpur Hills	

Source: NSSO, Government of India, 1993-94 and Alagh, Y. K, 'Land and Man: Essays in Sustainable Development', 1996.

Incidence of Poverty

Estimating poverty and identifying the poor, though closely related, are not one and the same. The first is a task assigned to the Planning Commission and is done through sample surveys on consumer expenditure conducted by the National Sample Survey Organisation (NSSO). The identification of the poor is done through door-to-door surveys with total coverage. The state governments under the overall direction of the Union Ministry of Rural Development carry out these surveys. The census results give an estimate of the percentage and number of poor households at the village, block, district and state levels, while the NSSO surveys estimate poverty at the state level.

While estimating poverty helps in assessing its magnitude, the identification of specific households living 'below the poverty line' is necessary for targeting them under various poverty alleviation programmes. We have, therefore, used the latter data while selecting the stretches. Care was taken that, as far as possible, only areas with reported higher incidence of poverty were covered. For instance, in Uttar Pradesh, the highest incidence of poverty was reported in Auraiya district where 47.96 percent of the households were enumerated as BPL. A stretch falling in this district was, therefore, included. Similarly, in Bihar, a stretch falling in Gaya district, with a

reported BPL household percentage of 69.83 and in Jharkhand, a stretch falling in the district of Hazaribagh with a reported BPL household percentage of 66.18, was included.

Planning Unit

A single planning unit was taken as one of the criteria for choosing the stretches because it would help to understand a self-sustaining region while evaluating a specific programme. Such a unit can be defined as an area having economic and administrative homogeneity. It is large enough to enable substantial changes in distribution and employment to take place within its boundaries, yet is small enough for its planning problems to be seen as a whole. In India, for the purpose of national planning, a district is taken as a planning unit. Care was, therefore, taken that a stretch fell in a single district and there was no overlap either across the districts or the states.

Formation of Basic Strata

Seven road stretches covering a total of 264 km of road length have been demarcated out of 995 km of the highway falling in the states of Uttar Pradesh, Bihar and Jharkhand. Each stretch is homogeneous with respect to agro-climatic characteristics and the incidence of poverty and is synchronised with planning and administrative geographic area. The details of the stretches are outlined in Table 2 below.

Table 2: Details of stretches

Stretch	District	State	Length (km)	District level % of poverty
Asfafabad-Mithepur	Firozabad	Uttar Pradesh	47	15.48
Lalpur-Purwa Rahat	Auraiya	Uttar Pradesh	27	47.96
Galtha-Sangaon	Fatehpur	Uttar Pradesh	37	31.73
Dahia-Naubatpur	Chandauli	Uttar Pradesh	36	34.70
Mahwaria-Khosmabad	Bhabhua	Bihar	47	43.04
Bairbigha-Barachatti	Gaya	Bihar	39	69.83
Barhi-Laimbua	Hazaribagh	Jharkhand	31	66.18

General Characteristics of the Basic Strata

The four stretches in the state of Uttar Pradesh fall in the districts of Firozabad, Auraiya, Fatehpur, and Chandauli. The two stretches in Bihar lie in the districts of Bhabhua and Gaya. The stretch in Jharkhand falls in the district of Hazaribagh. In these selected stretches, 1,697 villages lying in the horizontal distance band of 0-7 km on both sides of NH2 were identified. This distance band covers both

the influence and the control zones. Table 3 shows the stretch-wise distribution of villages, population and residential households based on the 1991 census.

Table 3: Formation of basic strata

Stretch	District	No. of villages	Population	Residential households
I	Firozabad	243	306603	46420
II	Auraiya	162	184546	27735
III	Fatehpur	170	224491	37874
IV	Chandauli	332	384630	52921
V	Bhabhua	254	230709	29237
VI	Gaya	417	323096	45084
VII	Hazaribagh	119	114028	14130
Total		1697	1768103	253401

The strata falling in the states of Uttar Pradesh and Bihar are endowed with the water resources of the rivers Yamuna and Ganga, good annual rainfall in the range of 550-900 mm, and fertile alluvial soil of the Indo-Gangetic Plain. According to the village directory of the Census of India 1991, the people living in these stretches have a fairly enough drinking water, access to educational facilities, and power supply. They are, however, poor in health facilities, and transport and communication connectivity.

Basic Strata I to IV, which fall in Uttar Pradesh, are homogeneous with respect to physiographic characteristics, irrigation, power supply, education, health and connectivity. Annual rainfall in this region is in the range of 550-700 mm and relative humidity during the driest part of the year is below 20 percent. Principal crops are wheat, rice, sugarcane, pulses and potatoes. The availability of canal and tube-well water and power supply is reasonably good.

Basic Strata V to VII falling in Bihar and Jharkhand have high rainfall (more than 700 mm in a year) and high relative humidity. The cropping pattern, therefore, changes in favour of paddy. The area is characterised by low irrigation and power supply, lower educational facilities, and still lower health facilities. In the case of Stretch VII in Jharkhand, which lies in the sub-region of Chotta Nagpur hills, the soil type changes so also the physiographic characteristics.

Further insights into the socio-economic profile of the basic strata and the infrastructural facilities available therein may be had from the details presented in Annex 1.

Sample Size and Allocation of Sample to Basic Strata

Taking into account the principle enunciated above and the details outlined in the note on the determination of sample size given in Annex 2, a sample of 200 villages spread over all the 7 basic strata was considered appropriate for the enquiry. To ensure proper spread, the principle of proportional allocation was adopted and sample villages were allocated to each basic stratum in proportion to the strata size, as indicated in Table 4.

Table 4: Allocation of sample villages to basic strata

Basic strata	District	Strata size (no. of villages)	Total population 1991	Share of population	Sample size allocated (no. of villages)
Stretch I	Firozabad	243	306603	17.34	35
Stretch II	Auraiya	162	184546	10.44	21
Stretch III	Fatehpur	170	224491	12.70	25
Stretch IV	Chandauli	332	384630	21.75	43
Stretch V	Bhabhua	254	230709	13.05	26
Stretch VI	Gaya	417	323096	18.27	37
Stretch VII	Hazaribagh	119	114028	6.45	13
Total		1697	1768103	100.00	200

The sampling proportion adopted in the survey compared favourably with that adopted by the National Sample Survey Organisation while conducting their quinquennial surveys. Table 5 shows the comparative position.

Table 5: Coverage of sample villages and sample households

	Total no. of villages	No. of sample villages	% of total villages	Total no. of households	No. of sample house-holds	% of total house-holds	Population	Population covered	% of total population
NSSO	638,365	6,208	0.97	191,963,935	165,244	0.09	1,027,015,247	819,013	0.08
Our survey	1,697	200	11.78	253,401	3,200	1.26	1,768,103	20,389	1.15

Source: (1) Census of India 2001; (2) Employment and Unemployment Situation in India, NSSO, 2001.

Further Refinements in Stratification

To take into account the variability factor further, the selected stretches were divided into four groups depending upon the nature of influence of the 4-laning of NH2 on the socio-economic conditions of the rural households. It was felt that most of the benefits would accrue to the households lying in the horizontal distance range of 0-1 km from NH2 and the least affected households would be those which are within the horizontal distance range of 5-7 km from NH2. The other two groups of households are those within the horizontal distance of 1-3 km and 3-5 km. As explained in Chapter 1, the influence of NH2 will progressively decline over these distance ranges as one moves away from the highway. Each of these distance ranges

was considered to constitute a separate stratum within the basic strata. In essence, the sample villages in each of the basic strata were grouped into the above four distance range strata forming altogether 28 effective strata. The sample sizes allocated to the basic strata were further reallocated to the distance strata, again in proportion to the size of the distance strata based on population. The details of the allocation of sample villages to distance strata are given in Table 6.

Table 6: Allocation of sample villages to distance strata within the basic strata

Basic strata	District		Distance strata				Total
			0-1 km	1-3 km	3-5 km	5-7 km	
Stretch I	Firozabad	Population	80620	89867	64247	71869	306603
		Population (%)	26.29	29.31	20.95	23.44	100.00
		No. of villages allocated	9	10	8	8	35
Stretch II	Auraiya	Population	41903	49298	50566	42779	184546
		Population (%)	22.71	26.71	27.40	23.18	100.00
		No. of villages allocated	5	5	6	5	21
Stretch III	Fatehpur	Population	53306	56495	65065	49625	224491
		Population (%)	23.75	25.17	28.98	22.11	100.00
		No. of villages allocated	6	6	7	6	25
Stretch IV	Chandauli	Population	70557	107557	98190	108326	384630
		Population (%)	18.34	27.96	25.53	28.16	100.00
		No. of villages allocated	8	12	11	12	43
Stretch V	Bhabhua	Population	57526	81173	39147	52863	230709
		Population (%)	24.93	35.18	16.97	22.91	100.00
		No. of villages allocated	7	9	4	6	26
Stretch VI	Gaya	Population	95324	86256	79459	62057	323096
		Population (%)	29.50	26.70	24.59	19.21	100.00
		No. of villages allocated	11	10	9	7	37
Stretch VII	Hazaribagh	Population	51560	24848	22624	14996	114028
		Population (%)	45.22	21.79	19.84	13.15	100.00
		No. of villages allocated	6	3	2	2	13

Selection of Sample Villages (First Stage Units)

For each of the basic strata and the distance strata within the basic strata, separate sampling frames of census villages were constructed. The selection of sample villages was done by the method of simple random sampling without replacement. The sample villages chosen are listed in Annex 3.

Selection of Sample Households (Second Stage Units)

Households within the selected villages constituted the second stage sampling units. A fresh updated list of households was prepared for each of the sample villages to facilitate selection of sample households. This opportunity of listing was utilised to prepare an updated sampling frame that helped a deeper stratification of households at the village level leading to the selection of a far more representative sample. The following aspects merit specific mention in this context.

Listing: To control the workload at the listing stage, it was postulated that a maximum of 200 households in a village would be enough to select 16 sample households (ultimate stage units). This number was considered to be fairly adequate for the purpose of using it as sampling frame. If the number of households in a village exceeded 200, the following procedure was adopted for selecting the 200 households for listing. A rough estimate of the number of households in each hamlet (tola) of a village was obtained from the head (Pradhan/Sarpanch) of the village. The number of households to be listed in a hamlet was then obtained by multiplying the share of hamlet households to the total number of village households with 200. For example, if a village had 1,000 households residing in five hamlets and in one hamlet, the number of households was 400, the proportion of households in this hamlet to the total number of households would be 400/1000 = 0.40. Thus, the number of households to be listed in that hamlet would work out to $0.40 \times 200 = 80$. Every fifth household would thus be listed in that particular hamlet.

Sub-stratification: At the time of listing, all the households in a village were classified in the categories of 'affluent households' and 'the rest'. A household was treated as affluent if it owned items like car/jeep, colour TV, telephone, consumer durables like VCR, or refrigerator; or owned a large well-maintained pucca house, or owned land in excess of 20 acres of cultivable land or 10 acres of irrigated land; or where at least one member of the household had a well-paid salaried job or was engaged in a profession with handsome income, like doctor, advocate, etc.; or was the owner of a large business establishment.

Information relating to the major sources of income of each household was also collected. The households were categorised as 'self-employed in non-agriculture' or 'rural labour' or 'others' on the basis of this information.

All the households listed in a sample village were segregated into two second stage strata, viz. 'affluent households' (forming second stage stratum 1) and 'the rest' (forming second stage stratum 2). The latter stratum was further stratified into three categories: self-employed in non-agriculture, rural labour, and others. The size of sample households in stratum 2 was in proportion to the number of households in each of these categories.

Procedure for the Selection of Households

A total of 16 households were selected from each sample village as follows:

(i) Two sample households from 'affluent households' (sub-strata 1) circular systematically with a random start.

(ii) Fourteen sample households from sub-strata 2. These were selected from the rest of the households circular systematically with a random start.

Survey Schedules

In order to generate data on village and household characteristics as well as different socio-economic causal factors and outcomes of the developmental intervention of four-laning of NH2, extensive schedules were prepared for the primary baseline survey with emphasis on the following, and the pre-testing of the schedules was done before their finalisation.

(i) Enable collection of accurate information to meet the needs in a timely manner;

(ii) Facilitate the work of data collection, processing and tabulation;

(iii) Ensure economy in data collection; and

(iv) Permit comprehensive and meaningful analysis and purposeful utilisation of data collected.

Since the present study is the first of its kind in the country, we utilised the inputs of the researchers in the World Bank in preparing detailed schedules. We also had the benefit of the advice of the National Sample Survey Organisation (NSSO), which has wide experience in undertaking socio-economic household surveys in the country. In addition, we referred to the questionnaires used by the Census of India to elicit information on economic variables and also benefited from the related surveys carried out by different research institutions.

Both the village and household schedules are fairly comprehensive and some of the information collected may not be utilised for the socio-economic impact analysis. It was, however, felt that the same would be useful as a qualitative input for the participatory rural appraisal for which a separate exercise was carried out. The data would also be useful for further research in different aspects of socio-economic conditions at the regional level. Care was, however, taken that the length of the schedules in no way fatigued the respondent and the investigator during the course of the interview.

The schedules provide detailed information relating to the coordinates of the sample villages and sample households. This would help in identifying the same set of villages and households which would be surveyed in the follow-up exercise after a lapse of 4-5 years. The schedules also show the dates when the survey was carried out so that the follow-up survey is carried out in the same period to the extent possible so as to eliminate seasonality factor bias.

A broad format of the socio-economic variables detailed in the village and household survey schedules is given in Box 1. These variables can be clubbed into three broad categories relating to transport; income and expenditure; and social aspects.

Box 1: List of variables

(i) Transport variables

Connectivity to national highway
Type of road connectivity from village to NH
Distance of the village from NH

Accessibility
Nearest distance of the village to different facilities (e.g., market, urban centre, educational institution, medical facility, etc.)

Traffic density
Availability of public transport
Frequency of public transport (bus, jeep, taxi, tempo, etc)

Fares and costs
Passenger fares
Transport cost of agricultural inputs (seeds, fertilisers, pesticides)
Transport cost of agricultural products
Transport cost of non-agricultural products

Transport patterns
Number of trips taken outside village, by purpose
Time required to reach selected destinations (nearest city, market, school, health centre, workplace.)
Main mode of transport to selected destinations

Vehicle ownership
Ownership of vehicles (motorised and non-motorised)

(ii) Income and expenditure variables

Impact on agricultural activities
Land use pattern
Ownership of land
Land devoted to different crops
Output of key crops per unit of cultivated land
Amount of harvest sold in markets
Use of improved seeds, fertilizers, herbicides, pesticides
Use of farm equipment (tractors, machines)
Farm-gate prices of key crops
Unit price of farm inputs
Number of people (household members, other) working on farm
Agricultural wage rate
Livestock ownership
Evacuation of agricultural surplus

Impact on non-agricultural activities
Number of stores/shops in village
Ownership of non-agricultural household enterprise (by type)
Number of days worked outside farm
Employment pattern (on-farm, off-farm)
Non-agricultural wage rate

Income and expenditure pattern
Level and source of income
Consumption expenditure and its composition

Markets
Distance to market
Number and type of shops in the village

Prices
Price of key traded commodities
Price of land
Price of housing

Others
Land tenure
Access to credit
Number of migrants
Number of persons/days of employment generated by road construction/ maintenance
Ownership of consumer durables
Percent of land irrigated
Institutions within the village (bank, post office, police station, etc.)
Housing condition
Energy use (use of biomass, LPG, kerosene, etc.)
Sanitation (toilet facilities)
Drinking water resources/tap water
Electrification
Number of BPL families in the village

(iii) Social variables

Education
Number of primary schools in the village
Primary school enrollment rate (by gender)
Secondary school enrollment rate (by gender)
Primary school drop-out rate (by gender)
Distance to nearest primary/secondary school
Quality of schools
- Qualifications of teachers
- Reason for absenteeism of teachers

Health
Distance to nearest health centre/hospital
Number of visits to health facilities (by age/gender)
Number of family members who could not visit health centre due to bad road conditions
Number of visits by medical practitioner to the village

Political participation
Number of visits to government officials
Membership of community or political organisations
Number of government programmes accessed
Involvement of community in road maintenance

The core of the study included, to start with, an enquiry to gather basic particulars at the village level to enable building a framework for a proper appraisal of the ground realities followed up with a comprehensive household survey focused on the rather complex content area. The following gives a brief review of the content of major topics and sub-topics of both household and village schedules and the rationale for covering these topics.

Household Schedule

Household Characteristics

The schedule provides a general overview of household characteristics such as household size, social and religious status, and inward migration. This data are relevant for the purpose of analysis and are included as basic particulars.

Roster of Household Members

The household roster records the composition of the household and collects basic socio-economic information about its members (age, gender, marital status, educational attainments, occupation, etc.). Information on place of work, travel time and modes of transport is also included under this section.

Household Economic Activities

In rural areas, members of many households are engaged in self-employment. Most of such activities are seasonal. Taking this feature into account, efforts have been made to design the survey instrument in such a way as to reflect these characteristics adequately. For this purpose, the standardised concept of activity status has been adopted as per the National Industrial Classification Code 1998 of the Central Statistical Organisation, Government of India.

Housing and Amenities

Data on housing and other amenities are necessary as supplementary information. The schedule obtains information on the type of housing and available amenities (drinking water, electricity, energy use, sanitation).

Assets Holding

Assets holding constitutes a major factor while assessing the standard of living of the people residing in the rural areas. Hence, information relating to assets holding (consumer durables, production equipment, vehicle ownership, etc.) has been collected in sufficient detail indicating, *inter alia*, the purchases during the last 12 months and the expenditure incurred on the same.

Landholding and Agricultural Production

The schedule includes information on landholding and agricultural production. This covers the total operational landholding of the household, and area under different crops and the total produce, including agricultural byproducts. To understand the role of transport in the evacuation of agricultural surplus, information was sought on modes of transport used and the cost involved for the same.

Livestock

Livestock is an important source of livelihood in the rural areas. The schedule seeks information on the livestock ownership, yield of animal products, and expenditure incurred on livestock maintenance. Special attention has been given to the role of transportation in the evacuation of animal products by collecting information on modes of transport used and the cost involved for the same.

Non-farm Sector

An important aspect of road development is to measure its impact on the non-farm sector. The schedule addresses this aspect by incorporating information on non-agricultural enterprises, employment and productivity in such enterprises. The schedule also seeks detailed information on informal units. To enable accounting without omission or duplication, efforts were made to gather separate details for entrepreneurial activities in handicraft or cottage industries and other income-generating activities in trade, transport, communication, personal services, etc. To have a better idea about the role of transportation in the growth of the non-farm sector, the process of evacuation of non-agricultural products and transportation costs involved are also incorporated in the schedule.

Household Income

Conceptually, household income is the sum of money income and income in kind and consists of receipts which, as a rule, are of a recurring nature and accrue to household members regularly at frequent intervals. It includes individual income of all household members and the combined income of the household, either in cash or kind. The schedule comprises information on income from agriculture (including livestock), self-employment in non-agriculture, salary or wage-paid employment, and income from other sources. Taking into account the difficulties and complexities involved in the measurement of income, especially in the context of the likely preponderance of self-employment activities, special efforts have been made to

provide for all possible cases through a detailed structured approach. The household income relates to a period of one year preceding the date of survey.

Consumption Expenditure

Monthly consumption expenditure is an important aspect when measuring the standard of living of the rural population. The schedule, therefore, seeks detailed information on both food and non-food items. In the case of food items, the recall period has been limited to 30 days, while in the case of non-food items, the recall period varies between 30 days and 365 days.

Education

Information on education has been collected in a detailed manner so as to assess the impact of the project on the educational attainment of the household members. In addition to the current educational status, the survey was also designed to understand the problems and prospects of children in the age-group 6-15 years in pursuing education in institutions located within and outside the village. Of special interest was the detailed recording of distance from educational institutions, time and modes of transport.

Health

Health is a principal component of social consumption. It is important to collect information about the extent to which medical and health services and facilities available in and around the village are availed of by the household members. Marginally extending the scope of health-related information, the issue of the mobility of members in availing of health facilities in terms of distance travelled, mode of transport and time taken in travel were also enquired into.

Participation in Community Affairs

Road construction and improvement may not only facilitate access to education and health facilities but may also enhance social interaction and political participation. The purpose of the schedule is also to capture the household's involvement in these aspects of community life. Social attitudes, gender discrimination, attendance at social and political events in and outside the village are some of the issues that are included in the schedule.

Diary of Travel Activity

To see the direct effects of road development in terms of the mobility of household members, special provision has been made in the schedule to obtain travel-related information through the approach of origin-destination trips. Trip has been defined as one-way movement of a person by any mode of transport having two trip ends – an origin or start of a trip and a destination or end of a trip – for a specific purpose. For the current study, only information on trips outside the village was collected; information on trips within the village was not recorded. The travel diary also seeks information on trip purpose, trip length, mode of transport used, and use of national highway in the course of a trip, travel cost and time. In order to control errors and bias creeping into the data, the reference period for capturing the details was kept at the optimal level of seven days prior to the date of enquiry.

Information on household members' preferred mode of travel, their attitudinal response to development activities in the village, their perception and opinion on the highway development project, etc. would be very significant to supplement the database. Adequate provision to gather data on these aspects has been made in the household schedule.

Village Schedule

General Characteristics

The schedule provides a general overview of the demographic characteristics of the villages (population size, social/religious composition), and their major social and economic infrastructure (including health, education, and transport infrastructure).

Economic Activities

The schedule adds the economic dimension to the general characteristics by seeking information on various economic activities in the village. It covers the main economic activities and resources of the village, and thus complements the household-level economic data.

Education

The schedule obtains information on the inventory of the educational facilities in the village (number and type of schools, classes and teachers) and indicators of quality (educational qualifications of teachers, teachers' credentials and attendance).

This information complements the enrollment and attendance data collected in the household schedule. Information on enrollment rate and drop-out rate in the schools is also elicited.

Health

Information on the inventory of the healthcare facilities in the village (number and type of facilities and healthcare personnel) and indicators of quality (attendance of doctors and nurses) is recorded in the schedule. This information was collected from village Pradhan/Health Centre Personnel.

Transport Infrastructure

The schedule seeks information on the state of the village transport infrastructure. This refers to roads that connect or pass through the village, their condition, distance from the national highway and state highway, distance to railway station and waterways (where applicable), and the extent of available transport services available. Information was also sought on difficulties experienced by the villagers due to the poor quality of infrastructure and transport services.

Markets

The effect of road projects on the accessibility of markets is a critical factor in bringing about changes in the pattern and level of income. The schedule obtains information on the frequency and type of markets.

Prices

Changes in transport costs brought about by road projects are likely to affect prices of tradable goods. The schedule records information on the prices of different commodities in the market inside the village or in the nearby village/town.

Government Programmes

There is every likelihood that the improvement in road infrastructure would result in better coverage and would in turn enhance the quality of various development programmes. Hence, information was sought on the number and type of such programmes operating in the village and the extent to which they are availed of by the residents (benefits accrued to the residents).

Land Use

Change in land use pattern is regarded as a major impact of road transport development. As such, the schedule seeks village-wise information on land use pattern. It also elicits information on the cropping pattern, price of land and tenancy pattern.

Community Activities

The schedule aims to provide an overview of the social and potential events and activities in the village. The increased mobility and communication resulting from better road connectivity may well have measurable social capital effects on villages, which this schedule attempts to capture. This section complements the household survey schedule, which covers the household participation in community affairs.

Method of Enquiry

Considering the complexity of the subject matter, the necessity of obtaining complete and consistent data and the advantages and limitations of various methods of enquiry, it was considered appropriate to use the interview method or a combination of interview and observation methods for the household enquiry.

Data Input

The data was stored in the electronic form using the software MS ACCESS. Further tabulation for analysis was done in the MS EXCEL format after appropriate mapping from MS ACCESS.

Annex 1

Socio-economic profile of the basic strata

Variable		Basic strata							Overall
		I	II	III	IV	V	VI	VII	
1.	Percentage of child population (0-6 years)	21.14	19.93	19.63	21.37	21.45	22.07	22.56	21.17
2.	Number of females per thousand males	827.66	818.89	868.59	899.07	881.7	942.85	991.09	884.83
3.	Percentage of scheduled caste/ scheduled tribe population	23.71	33.52	26.76	24.03	23.63	35.67	21.31	27.21
4.	Percentage of literates	35.05	43.43	41.27	33.10	34.72	25.42	23.18	33.72
5.	Percentage of main workers from total population	27.50	27.81	32.33	31.09	28.87	33.00	28.20	30.16
6.	Percentage of working population (main + marginal)	27.70	27.83	35.98	33.99	30.31	34.68	34.52	32.19
7.	Percentage of cultivators from main workers	50.96	55.07	54.09	37.99	42.64	47.42	62.36	47.81
8.	Percentage of agricultural labourers from main workers	22.56	26.90	26.76	37.09	43.74	43.20	18.62	33.35
9.	Percentage of fishing and livestock workers from main workers	0.56	0.75	1.12	0.54	0.19	0.03	0.53	0.50
10.	Percentage of mining and quarrying workers from main workers	0.01	0.00	0.02	0.18	0.02	0.07	0.32	0.08
11.	Percentage of manufacturing workers (household industry) from main workers	0.72	0.76	1.41	4.79	0.99	1.35	1.73	1.95
12.	Percentage of manufacturing workers in non-household industry from main workers	12.83	2.83	2.71	3.60	0.77	0.40	0.50	3.68
13.	Percentage of construction workers from main workers	1.00	0.88	0.96	2.49	0.32	0.17	0.36	1.03
14.	Percentage of trade and commerce from main workers	3.31	3.07	3.72	3.13	2.81	0.53	1.37	2.57
15.	Percentage of transport and communication workers from main workers	1.40	1.17	1.33	3.35	0.31	0.11	0.74	1.37
16.	Percentage of workers engaged in other services from main workers	6.66	8.58	7.88	6.83	8.22	6.71	2.86	7.03

Source: Census of India, 1991.

Availability of basic amenities

Sl. No	Facility	Basic strata							Overall
		I	II	III	IV	V	VI	VII	
Educational facilities									
1.	Educational institution	70.78	75.93	81.18	53.01	66.14	53.00	66.39	63.46
i.	Primary school	65.02	66.67	70.59	47.89	63.39	49.40	61.34	58.04
ii.	Middle school	12.35	20.99	18.24	7.83	16.14	8.63	7.56	12.20
iii.	High school	3.70	4.94	2.35	0.90	4.33	3.36	5.04	3.24
iv.	PU college	2.88	4.32	2.94	0.90	0.00	0.00	0.00	1.30
v.	Graduate college	0.00	0.00	0.00	0.30	0.79	0.72	0.00	0.35
vi.	Adult literacy centre	0.82	0.62	22.94	7.23	0.39	0.00	0.00	3.95
vii.	Industrial school	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.06
viii.	Training school	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ix.	Other school	0.41	0.00	0.00	11.75	1.18	4.56	5.04	4.01
Health facilities									
2.	Medical institution	99.18	100.00	32.94	100.00	13.39	16.07	15.97	53.68
i.	Hospital	2.88	0.00	2.94	2.11	1.18	0.48	1.68	1.53
ii.	Maternity and child welfare centre	3.70	10.49	5.88	3.92	0.39	0.00	2.52	3.12
iii.	Maternity home	0.41	0.00	1.18	0.30	0.00	0.48	0.84	0.41
iv.	Child welfare centre	9.05	0.62	8.24	1.81	0.00	0.96	1.68	2.89
v.	Primary health centre	0.82	3.70	7.06	3.31	1.18	2.40	2.52	2.77
vi.	Health centre	2.88	0.00	2.94	2.11	1.18	0.48	1.68	1.53
vii.	Primary health sub-centre	0.82	0.00	2.35	19.88	7.48	5.76	4.20	7.07
viii.	Dispensary	1.23	0.62	1.76	0.30	0.39	1.44	0.84	0.94
ix.	Family planning centre	4.53	0.62	2.35	0.00	2.36	2.40	2.52	2.06
x.	Tuberculosis clinic	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.06
xi.	Nursing home	0.41	0.00	0.59	0.30	0.00	0.24	0.00	0.24
xii.	Community health workers	82.30	87.65	9.41	72.89	0.39	0.24	0.00	35.47
xiii.	Registered private practitioners	2.47	1.23	7.06	2.41	0.00	0.00	0.00	1.65
xiv.	Subsidiary medical practitioners	0.00	0.00	0.00	0.00	3.15	4.56	6.72	2.06
xv.	Other medical centres	0.00	0.62	0.59	0.30	0.00	0.24	0.00	0.24
Drinking water facilities									
3.	Drinking water	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
i.	Tap water	38.27	72.84	19.41	8.73	1.97	0.48	1.68	16.62
ii.	Well water	44.44	27.16	81.18	85.54	100.00	99.28	100.00	80.20
iii.	Tank water	0.00	0.00	14.12	18.07	17.32	11.27	56.30	14.26
iv.	Tube-well water	6.17	0.00	7.65	25.90	15.35	8.87	2.52	11.37
v.	Hand pump	65.43	27.16	65.29	74.10	98.03	91.37	87.39	76.25
vi.	River water	33.74	72.84	3.53	3.31	14.57	18.71	39.50	22.33
vii.	Fountain water	33.74	72.84	1.18	0.30	0.00	0.96	3.36	12.43
viii.	Canal	0.00	0.00	0.59	13.55	13.39	13.19	2.52	8.13
ix.	Nala	0.00	0.00	0.00	1.51	0.79	8.63	16.81	3.71
x.	Other drinking water sources	0.00	0.00	0.00	0.30	0.00	0.96	3.36	0.53
Post and telegraph facilities									
4.	Post and telegraph facilities	10.70	22.84	12.35	10.24	12.60	10.07	14.29	12.32
i.	Post office	10.29	22.84	18.24	10.84	11.02	8.87	11.76	12.26
ii.	Telegraph office	0.00	0.62	2.94	0.60	0.00	0.00	0.00	0.47
iii.	Post and telegraph office	0.41	0.00	2.35	0.00	1.57	1.20	1.68	0.94
iv.	Telephone connections	0.00	0.62	0.59	0.00	1.18	0.00	0.00	0.29
Transport connectivity									
5.	Communication facilities	24.28	7.41	26.47	34.04	12.60	18.47	20.17	21.33
i.	Bus stop	24.28	7.41	28.24	33.73	12.60	18.47	20.17	21.45
ii.	Taxi/ tempo stand	0.00	0.00	6.47	0.00	0.00	0.00	0.00	0.65
iii.	Railway station	0.82	0.00	4.12	0.00	1.97	0.00	0.00	0.82

Contd. ...

Sl. No	Facility	Basic strata							Overall
		I	II	III	IV	V	VI	VII	
Approach to village									
iv.	Pucca road	37.45	40.74	30.59	56.02	14.57	27.34	28.57	34.18
v.	Katcha road	59.26	58.64	70.59	55.42	93.70	99.28	84.87	76.37
vi.	Navigable river	0.00	0.00	8.82	1.20	0.00	2.16	2.52	1.83
vii.	Navigable canal	0.00	0.00	0.59	0.30	1.18	0.00	0.00	0.29
viii.	Footpath	3.70	0.62	34.12	12.05	0.00	0.00	7.56	6.89
Power supply									
6.	Power supply	83.95	51.23	85.29	90.06	83.07	46.76	33.61	69.36
i.	Power supply for domestic purpose	30.04	35.80	44.12	62.35	22.44	1.20	14.29	28.99
ii.	Power supply for agriculture	60.08	29.01	42.35	48.80	72.05	27.58	8.40	43.31
iii.	Power supply for industrial/ commercial purpose	2.06	0.00	0.00	0.00	0.39	0.48	1.68	0.59
iv.	Power for all purposes	25.93	3.09	28.24	17.77	10.63	17.51	11.76	17.03
Irrigation facilities									
7.	Irrigation facilities by								
i.	Well without electricity	0.78	0.01	0.52	0.00	5.69	11.53	30.64	4.00
ii.	Well with electricity	1.66	2.45	0.32	0.29	28.60	2.98	1.88	5.10
iii.	Tube-well with electricity	13.40	14.75	23.79	0.25	4.54	6.89	4.20	9.86
iv.	Tube-well without electricity	54.87	9.71	30.62	0.89	14.03	1.20	0.15	19.25
v.	Government canal	29.11	71.83	41.82	98.57	33.82	19.52	8.99	46.31
vi.	Private canal	0.00	0.42	0.00	0.00	0.36	3.05	2.17	0.77
vii.	River irrigation	0.05	0.00	0.00	0.00	1.61	2.91	17.31	1.17
viii.	Tank irrigation	0.00	0.07	2.25	0.00	3.43	10.03	15.67	3.18
ix.	Other source	0.13	0.75	0.69	0.00	7.92	41.89	18.99	10.35
Market facilities									
8.	Availability of market facilities	3.29	4.94	5.88	3.31	1.18	5.76	12.61	4.66

Source: Census of India, 1991.

Annex 2

Note on Determination of Sample Size

The prime objective of a sample survey is to make estimates of certain values for a population using the observations obtained from the limited number of units (sample) of the population. The accuracy of the survey estimate is generally taken to mean the closeness of the estimate to an exact or true value. The true value, which is always unknown, is the value that would be obtained if data would be collected and processed, without error, for all units in the population. The error of a particular estimate is the difference between the estimate and the true value of the quantity being estimated. This type of error arises from the fact that the operation is confined to a sample of population rather than the whole population. The statistical concept refers to this deviation of the estimate from the true value it is supposed to estimate as sampling error. Most of the methods of determination of sample size are associated with the expected margin of uncertainty of the estimate from its true value, expressed generally in terms of 'permissible margin'.

In planning a sample survey for estimating the population parameters, it is important to determine the size of a sample. It is well known that in a simple random sample of size *n*, the sample mean is an unbiased estimator of the population mean. The standard deviation of the mean is inversely proportional to the square root of sample size, $\sigma/\sqrt{n}$. This measure is indicative of the sampling error. Clearly, the sampling error decreases with increase in the sample size. But the increase in the sample size involves additional cost of investigation. There, thus, is a (negative) trade-off between precision to be attained, in other words reduction in sampling error and higher cost of sample survey.

The size of the sample can be determined by specifying the degree of risk in terms of permissible loss of accuracy and the level of confidence. A generalised solution for the estimation of a sample size is as follows:

- Let *z* be the amount of error by taking the estimate and let *l* (*z*) be the loss incurred by taking it. For a given sampling method, the theory will provide the density function. Thus, the expected value of the loss for a given sample size is obtained by:

$$L(n) = E[l(z)] \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

- In its most simplified form, the cost function for a sample of size *n* can be denoted by

  $$C(n) = a+cn \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

  where *a* is the over-head cost, and *c* is the cost per unit in the sampling method.

- By combining equations (1) and (2), we get the total loss which is given by:

  $$\phi(n) = L(n) + \lambda C(n) \quad \ldots\ldots\ldots (3)$$

  where λ is some constant quantity.

- Since the purpose in taking the sample is to minimise the total loss, *n* should be so chosen that equation (3) is minimised. By differentiating $\phi(n)$ with respect to *n* and equating $\partial \phi / \partial n = 0$, the optimum value of *n* can be determined.

Thus, the optimum sample size is constrained by cost considerations and the nature of important variable to be estimated, its co-efficient of variation, the desired accuracy of measurement together with the level of significance associated to it. Once these factors are known, the sample size (n) may be computed by the following formula.

$$n = CV^2 Z_\alpha^2 / E^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where CV is the co-efficient of variation, E is the level of accuracy (expressed as a proportion) and Z_α is the value of the standard normal variate for the confidence level (α) required[2].

Since in the present case, CV was not known before the sample survey was conducted, various sample sizes were estimated, using different sampling proportions. It was considered that a sampling fraction of around 12 percent covering 3200 households would adequately represent the total population. In the case of two-stage design, as the variability between the first stage units would be more pronounced than the variability within the first stage units, specific advantages would accrue in selecting a higher number of first stage units and spreading the sample households comparatively thinly over them. This consideration weighed in the choice of 200 first stage units and 16 second stage units per first stage unit.

2. See Sith (1979).

Annex 3

List of sample villages

S. No.	Census code 1991	Name of the village	Block	District	State
1	210030008000150158	Dharmai	Araon	Firozabad	Uttar Pradesh
2	210030008000160159	Sarai Haibatpur	Araon	Firozabad	Uttar Pradesh
3	210030008000160162	Kithaut	Araon	Firozabad	Uttar Pradesh
4	210030008000160163	Karahara	Araon	Firozabad	Uttar Pradesh
5	210030008000170172	Shekhupur	Araon	Firozabad	Uttar Pradesh
6	210010002000150135	Mondha	Firozabad	Firozabad	Uttar Pradesh
7	210010002000160148	Jahangirpur	Firozabad	Firozabad	Uttar Pradesh
8	210010002000160153	Nurpur Kutubpur	Firozabad	Firozabad	Uttar Pradesh
9	210010002000170170	Matsena	Firozabad	Firozabad	Uttar Pradesh
10	210030007000010005	Dargapur-Mohanipur	Firozabad	Firozabad	Uttar Pradesh
11	210020005000140168	Lalai	Khergarh	Firozabad	Uttar Pradesh
12	210020005000150175	Dhunpai	Khergarh	Firozabad	Uttar Pradesh
13	210020005000160190	Keshopur	Khergarh	Firozabad	Uttar Pradesh
14	210020005000160191	Prathavipur	Khergarh	Firozabad	Uttar Pradesh
15	210020005000170207	Hasanpur Garia	Khergarh	Firozabad	Uttar Pradesh
16	210030009000190199	Ujraikhera	Madanpur	Firozabad	Uttar Pradesh
17	210030009000220223	Bithauli	Madanpur	Firozabad	Uttar Pradesh
18	210030009000220227	Bachhmai	Madanpur	Firozabad	Uttar Pradesh
19	210030009000220230	Naglator	Madanpur	Firozabad	Uttar Pradesh
20	210030009000270272	Sujanipur	Madanpur	Firozabad	Uttar Pradesh
21	210030009000280286	Semra Atikabad	Madanpur	Firozabad	Uttar Pradesh
22	210030007000010002	Jinjauli	Shikohabad	Firozabad	Uttar Pradesh
23	210030007000010004	Naoli	Shikohabad	Firozabad	Uttar Pradesh
24	210030007000020014	Mohamdpur Labhna	Shikohabad	Firozabad	Uttar Pradesh
25	210030007000020019	Dewaechi	Shikohabad	Firozabad	Uttar Pradesh
26	210030007000020024	Maiyamai	Shikohabad	Firozabad	Uttar Pradesh
27	210030007000020026	Shaijalpur	Shikohabad	Firozabad	Uttar Pradesh
28	210030007000030030	Basudeomai	Shikohabad	Firozabad	Uttar Pradesh
29	210030007000030032	Nagla Saidlal	Shikohabad	Firozabad	Uttar Pradesh
30	210030007000040046	Bakalpur	Shikohabad	Firozabad	Uttar Pradesh
31	210030007000050050	Jaslai	Shikohabad	Firozabad	Uttar Pradesh
32	210030007000050053	Mohabatpur Ahir	Shikohabad	Firozabad	Uttar Pradesh
33	210030007000050056	Jahagirpur Gulrai	Shikohabad	Firozabad	Uttar Pradesh
34	210030007000010001	Makhanpur	Sikohabad	Firozabad	Uttar Pradesh
35	210010002000170163	Undani	Friozabad	Friozabad	Uttar Pradesh
36	350040012000100074	Ailchipur	Ajitmal	Auraiya	Uttar Pradesh
37	350040012000110086	Shekhupur Jainpur	Ajitmal	Auraiya	Uttar Pradesh
38	350040012000120093	Bahadurpur Uncha	Ajitmal	Auraiya	Uttar Pradesh
39	350040012000130106	Purwadori	Ajitmal	Auraiya	Uttar Pradesh
40	350040012000130109	Jagatpur	Ajitmal	Auraiya	Uttar Pradesh
41	350040012000130110	Turkipur Bhagwandas	Ajitmal	Auraiya	Uttar Pradesh
42	350040014000310275	Akbarpur	Auraiya	Auraiya	Uttar Pradesh
43	350040014000350316	Takpura	Auraiya	Auraiya	Uttar Pradesh
44	350040014000360324	Hasuliya	Auraiya	Auraiya	Uttar Pradesh
45	350040014000370332	Parariya	Auraiya	Auraiya	Uttar Pradesh
46	350040014000370333	Garha Manik Chandra	Auraiya	Auraiya	Uttar Pradesh
47	350040014000370334	Salaiya	Auraiya	Auraiya	Uttar Pradesh
48	350040014000380342	Tilakpur	Auraiya	Auraiya	Uttar Pradesh
49	350040014000380344	Inguthiya	Auraiya	Auraiya	Uttar Pradesh

50	350040014000380348	Rajandajpur	Auraiya	Auraiya	Uttar Pradesh
51	350040014000390354	Sainpur	Auraiya	Auraiya	Uttar Pradesh
52	350040014000390362	Rautiyapur	Auraiya	Auraiya	Uttar Pradesh
53	350040014000420392	Bamuripur	Auraiya	Auraiya	Uttar Pradesh
54	350040014000420394	Narottampur	Auraiya	Auraiya	Uttar Pradesh
55	350040014000420397	Kakhantoo	Auraiya	Auraiya	Uttar Pradesh
56	350040013000230222	Sherpur Sariya	Bhagya Nagar	Auraiya	Uttar Pradesh
57	610050019000290480	Dundra	Devmai	Fatehpur	Uttar Pradesh
58	610050019000270464	Kechakpur	Malwan	Fatehpur	Uttar Pradesh
59	610050019000280471	Mawaiya	Malwan	Fatehpur	Uttar Pradesh
60	610050018000110149	Subedar Khera	Malwan	Fatehpur	Uttar Pradesh
61	610050018000110150	Habibpur	Malwan	Fatehpur	Uttar Pradesh
62	610050018000110152	Madanpur	Malwan	Fatehpur	Uttar Pradesh
63	610050018000120157	Khanpur	Malwan	Fatehpur	Uttar Pradesh
64	610050018000120159	Rari Khurd	Malwan	Fatehpur	Uttar Pradesh
65	610050018000120166	Malwan	Malwan	Fatehpur	Uttar Pradesh
66	610050018000120167	Baroora	Malwan	Fatehpur	Uttar Pradesh
67	610050018000120168	Davatpur	Malwan	Fatehpur	Uttar Pradesh
68	610050018000140199	Dharami Khera	Malwan	Fatehpur	Uttar Pradesh
69	610050018000140201	BeniHarsinghpur	Telyani	Fatehpur	Uttar Pradesh
70	610050018000140202	Ojhi Kharagsenpur	Telyani	Fatehpur	Uttar Pradesh
71	610050018000140207	Barmatpur	Telyani	Fatehpur	Uttar Pradesh
72	610050018000150224	Vahidpur	Telyani	Fatehpur	Uttar Pradesh
73	610050018000180280	Husanapur Sani	Telyani	Fatehpur	Uttar Pradesh
74	610050018000180282	Manjhupur	Telyani	Fatehpur	Uttar Pradesh
75	610050018000190301	Ghanshyampur	Telyani	Fatehpur	Uttar Pradesh
76	610050017000030037	Sangoan	Telyani	Fatehpur	Uttar Pradesh
77	610050017000040045	Sachauli	Telyani	Fatehpur	Uttar Pradesh
78	610050017000040048	Dhodhiyahi	Telyani	Fatehpur	Uttar Pradesh
79	610050017000060068	Umedpur	Telyani	Fatehpur	Uttar Pradesh
80	610050017000060070	Kandhi	Telyani	Fatehpur	Uttar Pradesh
81	610050017000060081	Udairajpur	Telyani	Fatehpur	Uttar Pradesh
82	610050017000070100	Teduhan	Barahani	Chandauli	Uttar Pradesh
83	610050017000080110	Maharani	Barhani	Chandauli	Uttar Pradesh
84	610050017000090119	Kinauli	Barhani	Chandauli	Uttar Pradesh
85	610050017000090124	Madhupur	Chandauli	Chandauli	Uttar Pradesh
86	610050017000020027	Dhurikot	Chandauli	Chandauli	Uttar Pradesh
87	610050017000060076	Jasori	Chandauli	Chandauli	Uttar Pradesh
88	610050017000080108	Bichhiya Khurd	Chandauli	Chandauli	Uttar Pradesh
89	610040016000300365	Bichhiya Kala	Chandauli	Chandauli	Uttar Pradesh
90	610040016000300376	Majhwar Khas	Chandauli	Chandauli	Uttar Pradesh
91	610040016000310385	Negura	Chandauli	Chandauli	Uttar Pradesh
92	610040016000320413	Nawahi	Chandauli	Chandauli	Uttar Pradesh
93	610040016000340433	Marhar	Chandauli	Chandauli	Uttar Pradesh
94	610040016000340439	Bhadalpura	Chandauli	Chandauli	Uttar Pradesh
95	610040016000350445	Fatehpur	Chandauli	Chandauli	Uttar Pradesh
96	610040016000350457	Mathpurawa	Chandauli	Chandauli	Uttar Pradesh
97	610040016000380487	Bahera	Chandauli	Chandauli	Uttar Pradesh
98	610050017000020021	Miradadpur	Chandauli	Chandauli	Uttar Pradesh
99	610040016000330420	Urgawan	Chandauli	Chandauli	Uttar Pradesh
100	430010001000050061	Sohadwar	Chandauli	Chandauli	Uttar Pradesh
101	430010002000090104	Jalalapur	Niamatabad	Chandauli	Uttar Pradesh
102	430010002000100119	Dihawa	Niamtabad	Chandauli	Uttar Pradesh
103	430010002000120136	Chakiya	Niamtabad	Chandauli	Uttar Pradesh
104	430010002000120138	Mannapur	Niamtabad	Chandauli	Uttar Pradesh
105	430010002000130153	Dariyapur	Niamtabad	Chandauli	Uttar Pradesh

106	430010002000150179	Hamidpur	Niamtabad	Chandauli	Uttar Pradesh
107	430010002000150183	Bharchha	Niamtabad	Chandauli	Uttar Pradesh
108	430010002000160196	Godhna	Niamtabad	Chandauli	Uttar Pradesh
109	430010002000160199	Kharagipur	Niamtabad	Chandauli	Uttar Pradesh
110	430010002000170210	Rohara	Niamtabad	Chandauli	Uttar Pradesh
111	430010002000170212	Hinauni	Niyantabad	Chandauli	Uttar Pradesh
112	430020005000010002	Jiwadhipur	Niyantabad	Chandauli	Uttar Pradesh
113	430020005000010004	Mahewa	Niyantabad	Chandauli	Uttar Pradesh
114	430020005000010007	Sai	Sakal Diha	Chandauli	Uttar Pradesh
115	430020005000020013	Khuchama	Sakal Diha	Chandauli	Uttar Pradesh
116	430020005000030031	Kakarahi Kala	Sakal Diha	Chandauli	Uttar Pradesh
117	430020005000030033	Basaratiya	Sakal Diha	Chandauli	Uttar Pradesh
118	430020005000040036	Sevakhar Khurd	Sakal Diha	Chandauli	Uttar Pradesh
119	430020005000040042	Farsand Mohanpur	Sakal Diha	Chandauli	Uttar Pradesh
120	430020005000070076	Bahorikpur	Sakal Diha	Chandauli	Uttar Pradesh
121	430020005000070080	Madhuban	Sakal Diha	Chandauli	Uttar Pradesh
122	430020005000090089	Nadara	Sakal Diha	Chandauli	Uttar Pradesh
123	430020005000090090	Muhammadpur	Sakal Diha	Chandauli	Uttar Pradesh
124	430020005000100102	Gaherpura	Sakaldiha	Chandauli	Uttar Pradesh
125	040060006000600247	Monihari	Bhabhua	Bhabhua	Bihar
126	040060006000600526	Kushihara	Bhabhua	Bhabhua	Bihar
127	040060006000600556	Timara Ghat	Bhabhua	Bhabhua	Bihar
128	040060006000600560	Panshi	Bhabhua	Bhabhua	Bihar
129	040060006000600565	Natti	Bhabhua	Bhabhua	Bihar
130	040060006000600566	Dughara	Bhabhua	Bhabhua	Bihar
131	040060006000600576	Kathaura	Bhabhua	Bhabhua	Bihar
132	040060006000600581	Khanethi Gurudas	Bhabhua	Bhabhua	Bihar
133	040060006000600587	Miria	Bhabhua	Bhabhua	Bihar
134	040060006000600636	Mohuat	Bhabhua	Bhabhua	Bihar
135	040060006000600554	Machiwan	Kaimer	Bhabhua	Bihar
136	040070007000700621	Nado Khar	Kudra	Bhabhua	Bihar
137	040070007000700622	Sonawan	Kudra	Bhabhua	Bihar
138	040070007000700645	Patti	Kudra	Bhabhua	Bihar
139	040070007000700647	Aharauliya	Kudra	Bhabhua	Bihar
140	040070007000700648	Patkhaulia	Kudra	Bhabhua	Bihar
141	040070007000700659	Sakri	Kudra	Bhabhua	Bihar
142	040070007000700694	Barka Nimdihra	Kudra	Bhabhua	Bihar
143	040070007000700695	Gora	Kudra	Bhabhua	Bihar
144	040080008000800126	Usari	Mohania	Bhabhua	Bihar
145	040080008000800131	Mohania	Mohania	Bhabhua	Bihar
146	040080008000800165	Bamhaurkhas	Mohania	Bhabhua	Bihar
147	040080008000800473	Baghni	Mohania	Bhabhua	Bihar
148	040080008000800489	Adhwar	Mohania	Bhabhua	Bihar
149	040080008000800128	Sadatpur	Mohania	Bhabhua	Bihar
150	040080008000800542	Pakrihar	Mohania	Bhabhua	Bihar
151	070160016001600443	Banahi	Amas	Gaya	Bihar
152	070160016001600447	Bazidpur	Amas	Gaya	Bihar
153	070160016001600448	Kurasin	Amas	Gaya	Bihar
154	070160016001600493	Komal Khap	Amas	Gaya	Bihar
155	070160016001600501	Tilaia	Amas	Gaya	Bihar
156	070160016001600520	Dharampur	Amas	Gaya	Bihar
157	070160016001600539	Mircha	Amas	Gaya	Bihar
158	070160016001600544	Rampur	Amas	Gaya	Bihar
159	070160016001600545	Bishunpur	Amas	Gaya	Bihar
160	070160016001600278	Jamura Khurd	Banke Bazar	Gaya	Bihar
161	070130013001300103	Belghoghar	Barachatti	Gaya	Bihar

162	070130013001300108	Manjhuali	Barachatti	Gaya	Bihar
163	070130013001300130	Makhdumpur	Barachatti	Gaya	Bihar
164	070130013001300139	Sonbarsa	Barachatti	Gaya	Bihar
165	070130013001300146	Dharamthan	Barachatti	Gaya	Bihar
166	070130013001300173	Kalua Khurd	Barachatti	Gaya	Bihar
167	070130013001300180	Rohi	Barachatti	Gaya	Bihar
168	070130013001300181	Bhaghar	Barachatti	Gaya	Bihar
169	070130013001300184	Mankumhari	Barachatti	Gaya	Bihar
170	070130013001300185	Bhat Bigha	Barachatti	Gaya	Bihar
171	070130013001300144	Jodha Bigha	Dobhi	Gaya	Bihar
172	070130013001300156	Bundabigha	Dobhi	Gaya	Bihar
173	070130013001300159	Kaleyanpur	Dobhi	Gaya	Bihar
174	070130013001300168	Mushehani	Dobhi	Gaya	Bihar
175	070130013001300201	Kurmawan	Dobhi	Gaya	Bihar
176	070130013001300212	Gangi	Dobhi	Gaya	Bihar
177	070140014001400781	Ghorwadih	Dobhi	Gaya	Bihar
178	070140014001400787	Darioaura	Dobhi	Gaya	Bihar
179	070140014001400805	Wari	Dobhi	Gaya	Bihar
180	070140014001400837	Marha	Dobhi	Gaya	Bihar
181	070150015001500500	Morahar	Gurva	Gaya	Bihar
182	070150015001500578	Hasanpur	Gurva	Gaya	Bihar
183	070150015001500599	Pakari	Gurva	Gaya	Bihar
184	070140014001400418	Bhikhanpur	Sherghati	Gaya	Bihar
185	070140014001400749	Kalendara	Sherghati	Gaya	Bihar
186	070140014001400756	Majhanpur	Sherghati	Gaya	Bihar
187	070140014001400773	Bhus Bhusia	Sherghati	Gaya	Bihar
188	340160016001600167	Ranichunwa	Burhi	Hazaribagh	Jharkhand
189	340160016001600142	Pipra Ghoghar	Barhani	Hazaribagh	Jharkhand
190	340160016001600166	Mahugarha	Barhani	Hazaribagh	Jharkhand
191	340160016001600072	Konra	Burhi	Hazaribagh	Jharkhand
192	340160016001600136	Malkoko	Burhi	Hazaribagh	Jharkhand
193	340040004000400050	Tuio	Barkatha	Hazaribagh	Jharkhand
194	340040004000400053	Buchai Pathauria	Barkatha	Hazaribagh	Jharkhand
195	340040004000400079	Jhurjhuri	Barkatha	Hazaribagh	Jharkhand
196	340040004000400103	Masipirhi	Barkatha	Hazaribagh	Jharkhand
197	340040004000400096	Ghanghari	Barkatha	Hazaribagh	Jharkhand
198	340040004000400109	Lemua	Barkatha	Hazaribagh	Jharkhand
199	340040004000400118	Dumardiha	Barkatha	Hazaribagh	Jharkhand
200	340160016001600123	Karma	Burhi	Hazaribagh	Jharkhand

Chapter 3

Socio-economic Profile of Rural Households

This chapter attempt to capture significant demographic, social and economic characteristics of the population in the selected stretches, especially the poor, the underprivileged and the women. These summary profiles help to provide the contextual underpinning for assessing the likely socio-economic impact of the four-laning of the national highway on the target inhabitants. In the process, it also enables a regional comparative analysis. The analysis is based on the data collected during the survey of 3,200 households. The monthly per capita income (MPCY) provides the basis for the identification of the poor and the non-poor households.

The household outlines include the demographic profile of the selected households, including their size and sex ratio (number of females per 1,000 males). The social profile covers the literacy level of the households surveyed (including the literacy level of females), besides patterns of schooling (including the trend among female children), the availability of health and medical facilities, patterns of landholding, the ownership of consumer durables, income from agriculture, and expenditure trends. The survey also documents the share of the working population in the total population, the proportion of females in the working population, and the pattern of their occupation. Besides, poverty indicators and the share of poor households among the scheduled castes and scheduled tribes have also been documented.

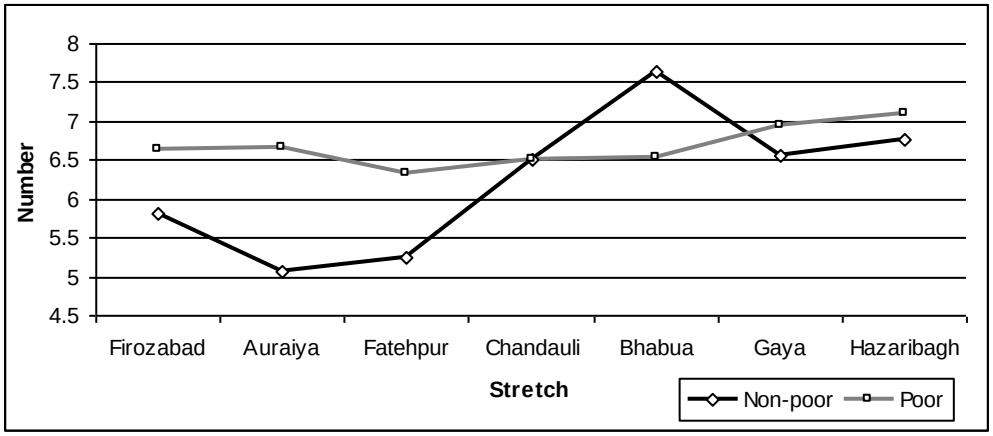
Demographic Profile

Household Size

The average household size in the selected stretches in the three states is 6.37 persons. It is, however, higher in Bihar and Jharkhand, and lower in Uttar Pradesh. A poor household generally has a larger size than a non-poor household. Poverty and low education are responsible for this. Besides, the poor view an extra member in the family as a source of additional earning or an additional hand to run chores.

Table 1: Average household size (no. of family members) among the poor and the non-poor

Stretch (District)	Poor	Non-poor	Combined
Firozabad	6.64	5.80	6.06
Auraiya	6.65	5.07	5.50
Fatehpur	6.33	5.25	5.50
Chandauli	6.52	6.52	6.52
Uttar Pradesh	6.55	5.80	6.01
Bhabua	6.53	7.65	7.24
Gaya	6.95	6.55	6.75
Hazaribagh	7.09	6.76	6.97
Bihar & Jharkhand	6.87	7.04	6.96
Overall	6.71	6.18	6.37



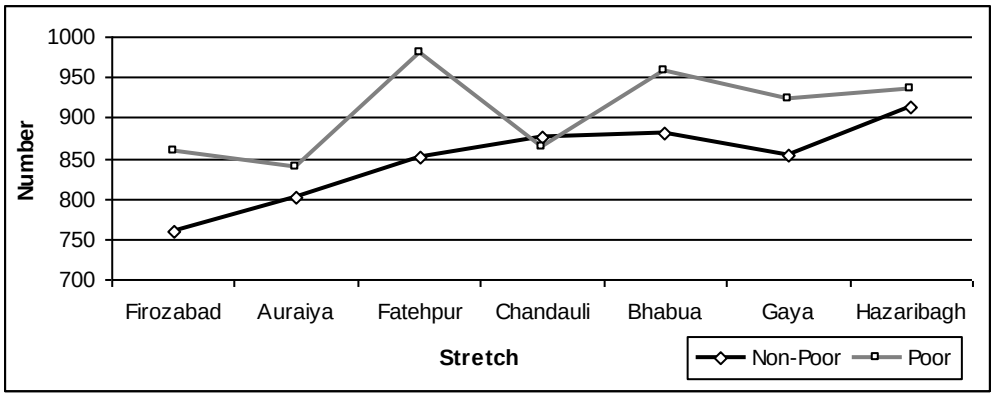
Sex Ratio

The overall sex ratio (number of females per 1000 males) in the surveyed stretches is 866. This ratio is higher in Bihar and Jharkhand than in Uttar Pradesh. It is still higher in case of the poor, as compared to the non-poor. This situation implies that the better-off communities have a stronger gender bias against females than poor households. This is the result of prevalent social customs as well as economic compulsions such as expenses on dowry or the prospect of fragmentation of land holdings.

Table 2: Sex ratio among the poor and non-poor

Stretch (District)	Non-poor	Poor	Combined
Firozabad	759	859	792
Auraiya	802	838	814
Fatehpur	852	979	883
Chandauli	876	863	872
Uttar Pradesh	827	875	841
Bhabua	882	958	906
Gaya	853	924	889
Hazaribagh	912	936	927
Bihar & Jharkhand	873	935	902
Overall	843	905	866

Sex ratio among the poor and non-poor



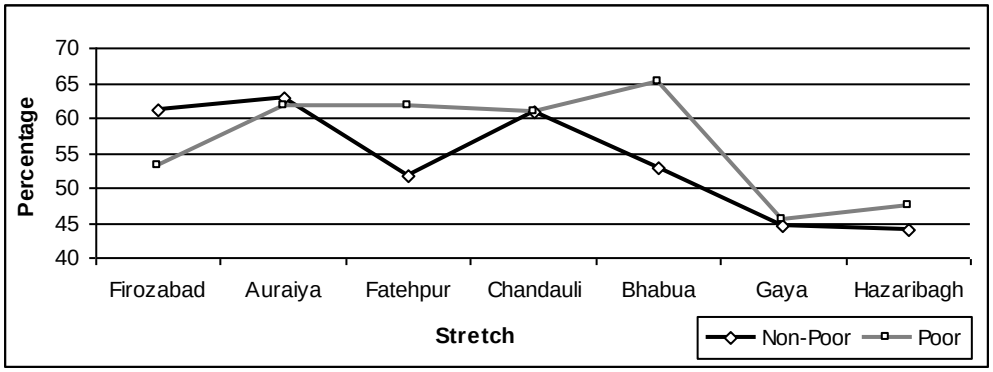
Social Profile

Literacy Level

The overall literacy level of 55.58 percent in the areas surveyed is much lower than the national average (59.21 percent). It is still lower in Bihar and Jharkhand. The overall literacy level of the poor and the non-poor does not show any marked variation. However, in Bihar and Jharkhand, the literacy level of the poor is higher than the non-poor. It is due to the fact that while the poor aspire for a better life through access to education, the non-poor believe the status quo would continue and the prevalence of feudal/semi-feudal power relations would help them improve their economic condition, not education alone.

Table 3: Literacy level among poor and non-poor households (percent)

Stretch (District)	Non-Poor	Poor	Combined
Firozabad	61.04	53.28	58.36
Auraiya	62.93	61.83	62.55
Fatehpur	51.78	61.70	55.51
Chandauli	60.85	60.85	60.85
Uttar Pradesh	59.59	59.13	59.42
Bhabua	52.72	65.26	58.91
Gaya	44.47	45.33	45.00
Hazaribagh	44.02	47.40	46.31
Bihar & Jharkhand	47.96	51.78	50.18
Overall	55.86	55.25	55.58

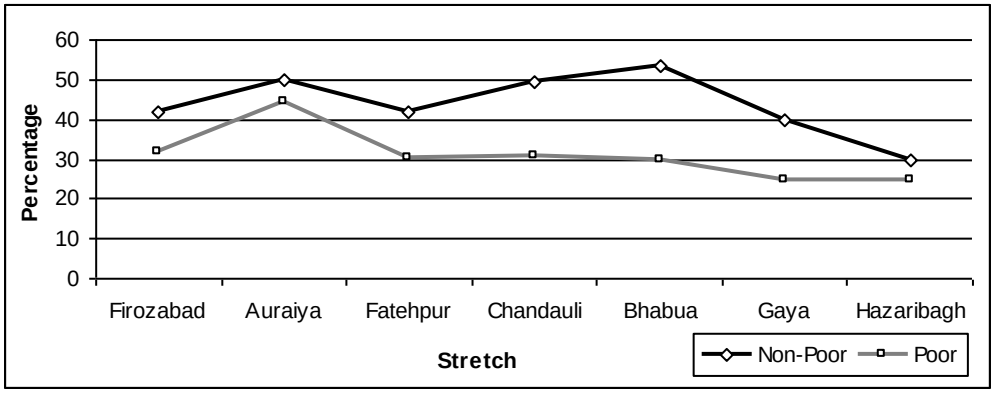


Female Literacy Level

The average literacy level among females across the surveyed stretches is as low as 39.73 percent. It is still lower in Bihar and Jharkhand and abysmally low (25.87 percent) among the poor households. This finding confirms that women have less access to education or are discouraged from pursuing education.

Table 4: Female literacy among poor and non-poor households (percent)

Stretch (District)	Non-poor	Poor	Combined
Firozabad	41.63	31.57	38.19
Auraiya	50.00	44.24	48.20
Fatehpur	41.96	30.50	39.17
Chandauli	49.39	30.89	44.56
Uttar Pradesh	46.03	33.33	42.37
Bhabua	53.37	30.00	46.08
Gaya	40.05	24.51	32.12
Hazaribagh	29.52	24.71	26.55
Bihar & Jharkhand	44.74	25.87	36.08
Overall	45.57	29.34	39.73



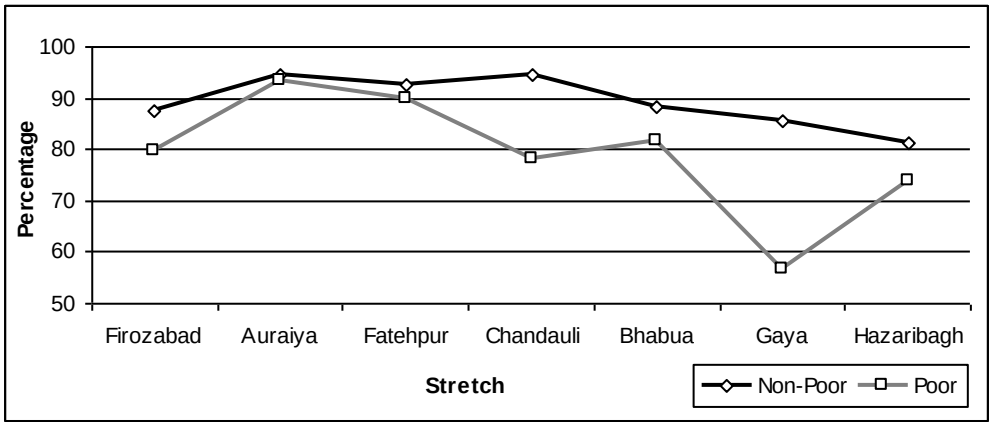
Schooling

The overall percentage of children attending school in the surveyed stretches is 83.40. It is lower in the case of Bihar and Jharkhand and still lower among the poor households (67 percent). This situation can be largely explained by higher incidence of poverty and lack of awareness about the benefits of education.

Table 5: School enrolment among children of poor and non-poor households

Stretch (District)	Percentage of school-going children		
	Non-poor	Poor	Combined
Firozabad	87.47	79.88	84.30
Auraiya	94.69	93.51	94.19
Fatehpur	92.5	89.67	91.47
Chandauli	94.44	78.16	88.42
Uttar Pradesh	92.16	83.26	88.67
Bhabua	88.45	81.64	85.82
Gaya	85.52	56.67	68.32
Hazaribagh	81.37	73.75	76.02
Bihar & Jharkhand	86.4	66.8	75.77
Overall	*90.19*	*75.22*	*83.40*

School enrolment among children of poor and non-poor households

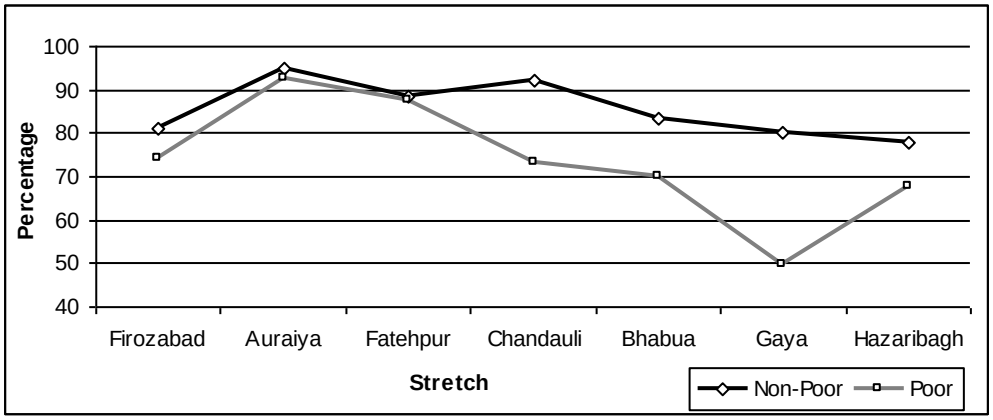


Schooling among Girls

The percentage of school-going female children is lower than the overall percentage of children going to school. Their enrolment rate in Bihar and Jharkhand is still lower and declines further in the case of the poor.

Table 6: Female school-going children in poor and non-poor households

Stretch (District)	Percentage of female school going children		
	Non-poor	Poor	Combined
Firozabad	80.98	73.97	77.88
Auraiya	94.78	92.59	93.88
Fatehpur	88.44	87.36	88.03
Chandauli	92.23	73.41	85.29
Uttar Pradesh	89.08	79.26	85.19
Bhabua	83.51	70.00	78.34
Gaya	80.34	49.80	62.53
Hazaribagh	77.78	67.52	70.76
Bihar & Jharkhand	86.30	69.17	78.51
Overall	87.38	72.53	80.95

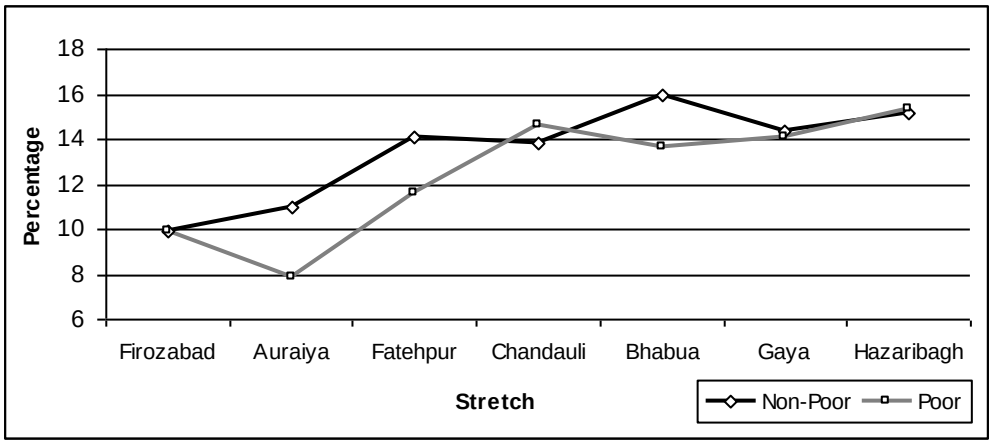


Health and Medical Facilities

Only 13.21 percent of the population avail of the medical facilities in the surveyed stretches. The proportion is marginally higher in the case of the non-poor because of their higher level of income and wealth. The poor apparently prefer to go to traditional healers, seek home remedies for ailments and illnesses.

Table 7: Share of people who visited the doctor among the poor and non-poor (percent)

Stretch (District)	Non-poor	Poor	Combined
Firozabad	9.89	9.90	9.89
Auraiya	11.00	7.84	9.96
Fatehpur	14.13	11.58	13.47
Chandauli	13.83	14.58	14.05
Uttar Pradesh	12.40	11.50	12.12
Bhabua	15.96	13.67	15.22
Gaya	14.32	14.11	14.21
Hazaribagh	15.16	15.31	15.25
Bihar & Jharkhand	15.17	14.27	14.75
Overall	13.37	12.94	13.21



Economic Profile

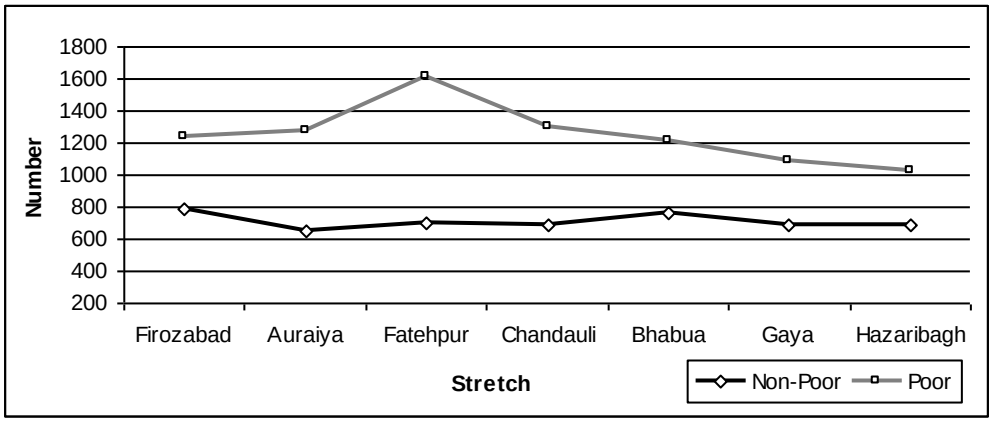
Dependency Ratio

The overall dependency ratio in the areas surveyed is estimated to be 868*. It is higher in Bihar and Jharkhand and still higher among the poor. This implies that in this case more children and elderly persons are dependent on those in the working-age group of 15 to 59 years.

Table 8: Dependency ratio among poor and non-poor households

Stretch (District)	Non-poor	Poor	Combined
Firozabad	786	1243	920
Auraiya	646	1275	812
Fatehpur	694	1615	864
Chandauli	691	1302	834
Uttar Pradesh	709	1321	860
Bhabua	759	1216	884
Gaya	685	1091	875
Hazaribagh	691	1027	887
Bihar & Jharkhand	718	1105	880
Overall	712	1204	868

** Note: Dependency ratios are calculated as (T-W)/W*1000, where 'T' is the total number of persons surveyed, and 'W' is number of persons in the working-age group (15 - 59 years).*



Landholding

The average landholding per household is low at 0.58 ha; marginally higher in Bihar and Jharkhand than in Uttar Pradesh. The average landholding of a poor household is abysmally low, i.e. 0.13 ha in Uttar Pradesh and 0.26 ha in Bihar and Jharkhand. The non-poor households are better-off in Bihar and Jharkhand with an average landholding of 0.97 ha, as compared to 0.72 ha in Uttar Pradesh. This implies that social and economic inequality is higher in Bihar and Jharkhand than in Uttar Pradesh.

Ownership of Consumer Durables

The average number of consumer durables per household is as low as 1.84. It is lower in Bihar and Jharkhand than in Uttar Pradesh. It is still lower among the poor households (0.84), compared to the non-poor households (2.39), indicating a high level of inequality.

Income from Agriculture

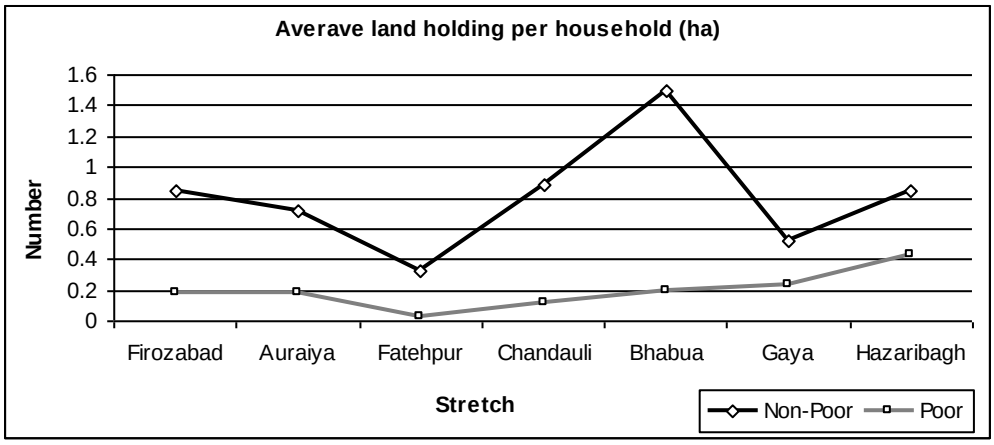
The overall share of income from agriculture across the three states is estimated at 42.65 percent. It is much higher in Uttar Pradesh than in Bihar and

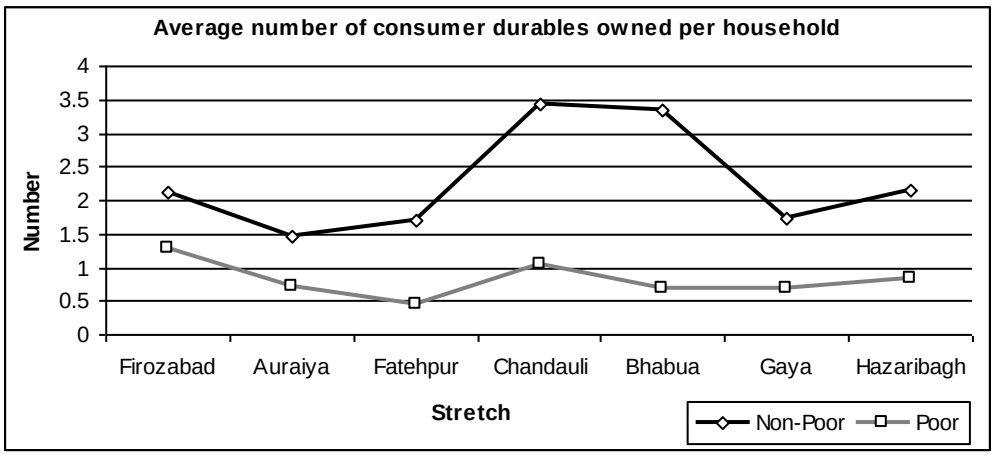
Jharkhand. The non-poor households have a higher share of income from agriculture in comparison to the poor households.

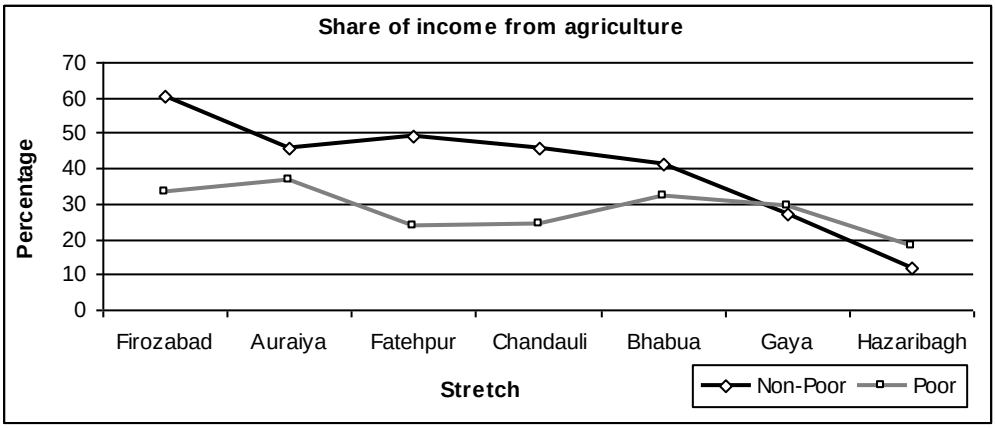
Table 9: Asset ownership among poor and non-poor households

Stretch (District)	Non-poor			Poor			Combined		
	Ave. land holding per household (ha)	Ave. no. of consumer durables owned per household	Share of income from agriculture	Ave. land holding per household (ha)	Ave. no. of consumer durables owned per household	Share of income from agriculture	Ave. land holding per household (ha)	Ave. no. of consumer durables owned per household	Share of income from agriculture
Firozabad	0.84	2.12	60.32	0.18	1.29	33.39	0.63	1.86	56.84
Auraiya	0.71	1.46	45.7	0.18	0.71	36.57	0.56	1.26	44.41
Fatehpur	0.32	1.69	49.31	0.03	0.44	23.74	0.26	1.41	46.71
Chandauli	0.88	3.42	45.65	0.12	1.03	24.29	0.66	2.72	43.71
Uttar Pradesh	0.72	2.36	50.09	0.13	0.96	29.11	0.55	1.97	47.80
Bhabua	1.49	3.35	41.11	0.19	0.7	32.01	1.03	2.40	40.09
Gaya	0.52	1.73	27.19	0.23	0.69	29.52	0.37	1.20	27.79
Hazaribagh	0.84	2.16	11.82	0.43	0.83	17.89	0.59	1.34	13.81
Bihar & Jharkhand	0.97	2.46	32.69	0.26	0.72	27.67	0.63	1.63	31.69
Overall	0.80	2.39	44.92	0.20	0.84	28.45	0.58	1.84	42.65

Asset ownership among poor and non-poor households





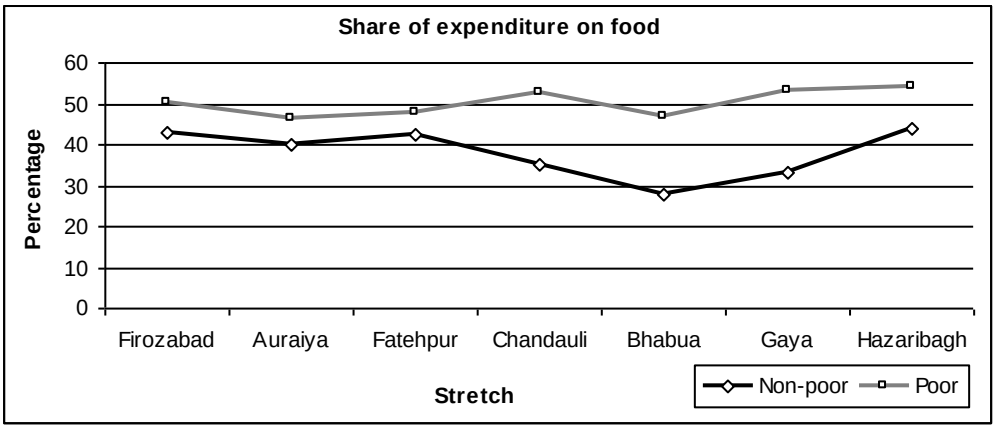


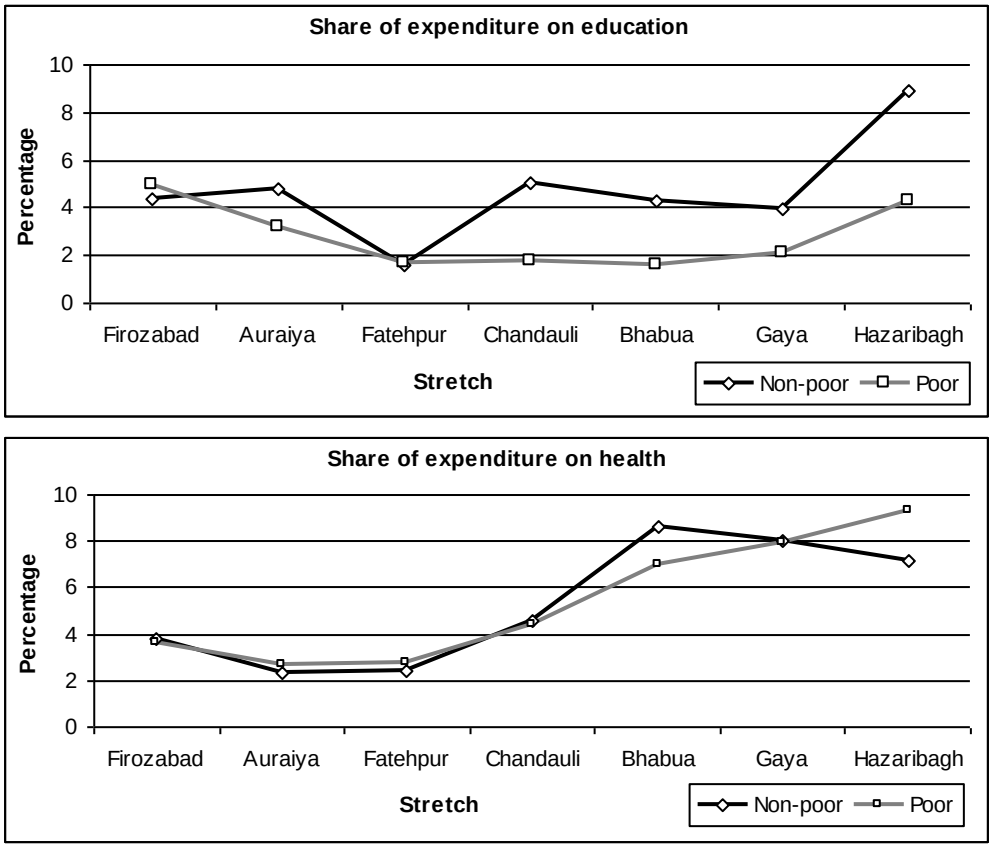
Expenditure Patterns

Overall, a household allocates 39.38 percent of its expenditure on food, 4.02 percent on education, and 5.41 percent on health. A poor household allocates a greater share of its expenditure for food than a non-poor household. In Uttar Pradesh, the poor spend a far higher proportion (50 percent) of their total income on food than the non-poor (39 percent).

Table 10: Share of expenditure on food items among poor and non-poor households

Stretch (District)	Share of expenditure on food			Share of expenditure on education			Share of expenditure on health		
	Poor	Non-poor	Combined	Poor	Non-poor	Combined	Poor	Non-poor	Combined
Firozabad	50.07	42.93	44.62	4.99	4.40	4.54	3.61	3.79	3.74
Auraiya	46.48	39.97	41.39	3.18	4.76	4.41	2.68	2.36	2.43
Fatehpur	48.04	42.46	43.32	1.68	1.63	1.64	2.77	2.42	2.47
Chandauli	52.69	34.98	37.60	1.80	5.07	4.58	4.41	4.60	4.58
Uttar Pradesh	49.98	39.05	41.05	3.13	4.24	4.04	3.58	3.68	3.66
Bhabua	46.88	27.81	30.92	1.57	4.26	3.82	6.95	8.63	8.36
Gaya	53.31	33.14	39.73	2.10	3.98	3.37	7.92	8.06	8.02
Hazaribagh	54.05	43.78	48.55	4.28	8.92	6.76	9.31	7.17	8.16
Bihar/Jharkhand	51.64	31.25	36.70	2.41	4.57	3.99	7.94	8.28	8.19
Overall	50.78	36.24	39.38	2.79	4.36	4.02	5.66	5.34	5.41





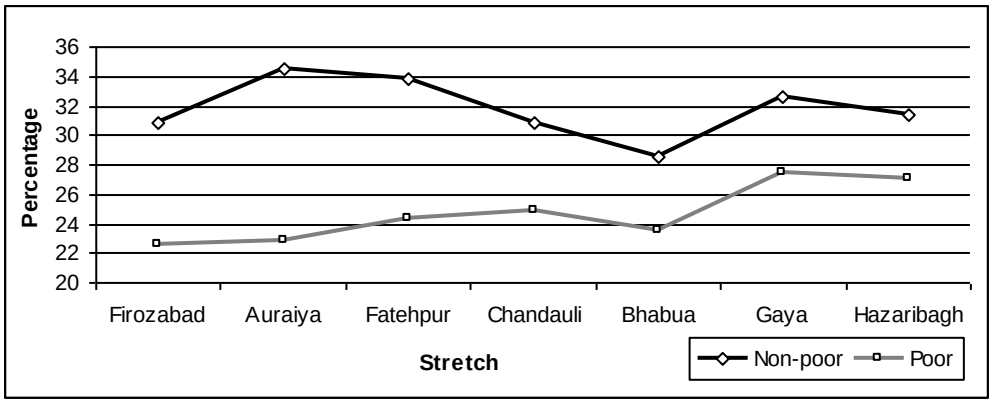
Working Population

The share of the working population in the overall population is 29.12 percent. It is marginally higher in Uttar Pradesh than in Bihar and Jharkhand. It is higher among the non-poor households than among the poor households. This implies that the non-poor have more employment opportunities than the poor because of their higher economic status.

Table 11: Proportion of working population among poor and non-poor households (percent)

Stretch (District)	Non-poor	Poor	Combined
Firozabad	30.80	22.63	28.00
Auraiya	34.55	22.88	30.68
Fatehpur	33.85	24.39	31.39
Chandauli	30.87	24.83	29.10
Uttar Pradesh	31.99	23.74	29.45
Bhabua	28.50	23.54	26.90
Gaya	32.67	27.50	29.96
Hazaribagh	31.42	27.09	28.71
Bihar & Jharkhand	30.62	26.44	28.66
Overall	31.51	25.14	29.12

Proportion of working population among poor and non-poor households (percent)

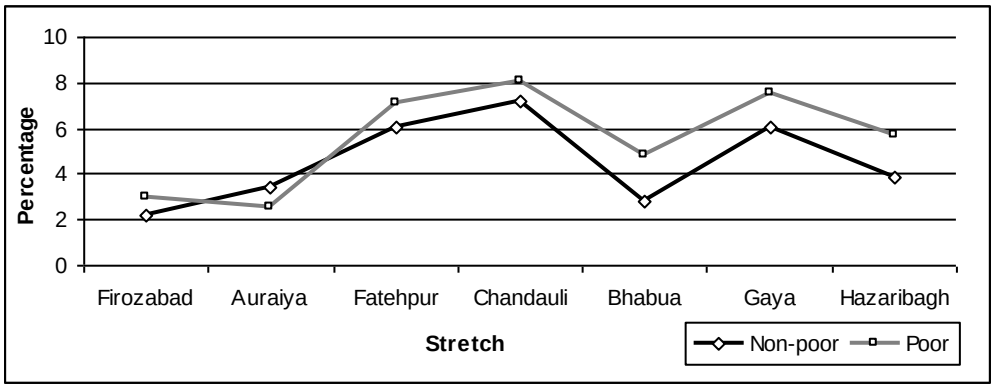


Female Working Population

The overall share of working women in the total female population is 5.26 percent. However, this percentage is higher in the case of poor households than non-poor households. In other words, more women belonging to poor households have to work in order to supplement the income of the household/family.

Table 12: Proportion of working women in the female population (percent)

Stretch (District)	Non-poor	Poor	Combined
Firozabad	2.18	2.98	2.47
Auraiya	3.45	2.51	3.14
Fatehpur	6.01	7.09	6.30
Chandauli	7.23	8.03	7.47
Uttar Pradesh	5.13	5.39	5.21
Bhabua	2.82	4.83	3.49
Gaya	6.04	7.57	6.85
Hazaribagh	3.88	5.69	5.02
Bihar & Jharkhand	4.30	6.46	5.33
Overall	4.83	5.96	5.26



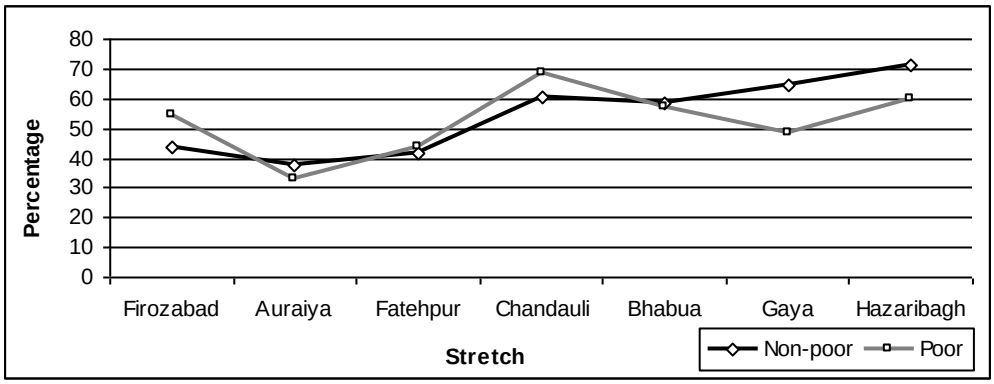
Occupational Pattern

The share of the working population in non-agricultural activities is 53.5 percent. It is higher in the case of Bihar and Jharkhand than in Uttar Pradesh. In Uttar Pradesh, such share is higher among the poor as compared to the non-poor. The position reverses in the case of Bihar and Jharkhand, where the share of the poor in

non-agricultural activities (53.14 percent) is much lower than that of the non-poor (62.69 percent). This implies that employment in non-agricultural activities in these states generally benefits the non-poor more than the poor.

Table 13: Proportion of working population in non-agricultural activities (percent)

Stretch (District)	Non-poor	Poor	Combined
Firozabad	43.75	54.75	46.79
Auraiya	37.7	32.86	36.51
Fatehpur	41.56	43.88	42.03
Chandauli	60.43	68.5	62.45
Uttar Pradesh	48.49	54.66	50.01
Bhabua	58.25	57.21	57.95
Gaya	64.53	48.52	56.84
Hazaribagh	71.18	60.16	64.66
Bihar & Jharkhand	62.69	53.14	58.56
Overall	53.35	53.83	53.50

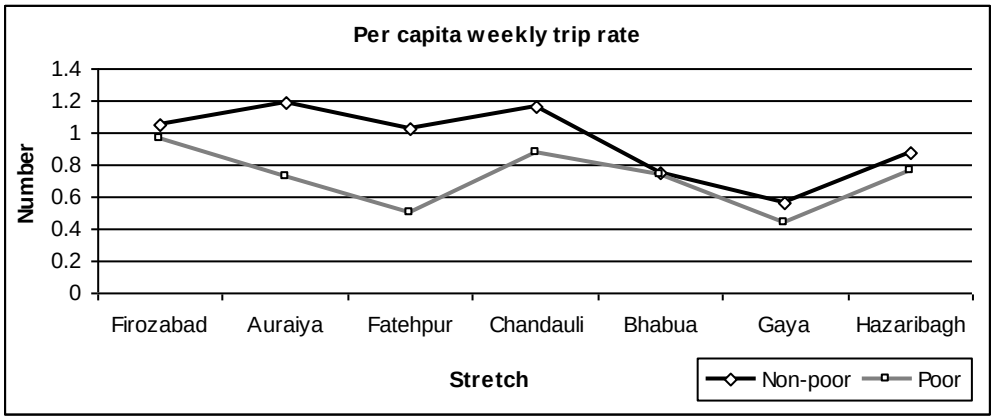


Travel Characteristics

The overall weekly per capita trip rate (PCTR) is low at 0.86. It is still lower in Bihar and Jharkhand and declines further in the case of poor households. The average distance travelled is 7.11 km. It is, however, marginally higher in Uttar Pradesh. The overall per capita travel time is 40.05 minutes; Uttar Pradesh – 46.76 minutes; and Bihar and Jharkhand – 30.59 minutes. The poor spend a marginally higher per capita travel time than the non-poor.

Table 14: Travel characteristics among poor and non-poor households

Stretch (District)	Per capita trip rate (weekly)			Per capita weekly trip length (km)		
	Non-poor	Poor	Combined	Non-poor	Poor	Combined
Firozabad	1.05	0.96	1.02	9.21	8.55	8.99
Auraiya	1.19	0.73	1.04	6.21	5.72	6.05
Fatehpur	1.02	0.50	0.89	5.85	8.11	6.43
Chandauli	1.16	0.88	1.07	9.41	9.81	9.53
Uttar Pradesh	1.11	0.82	1.02	8.18	8.46	8.26
Bhabua	0.75	0.74	0.75	5.97	7.63	6.51
Gaya	0.56	0.44	0.49	3.45	4.31	3.90
Hazaribagh	0.88	0.76	0.80	9.84	6.34	7.64
Bihar & Jharkhand	0.68	0.59	0.64	5.37	5.59	5.47
Overall	0.96	0.70	0.86	7.19	6.97	7.11



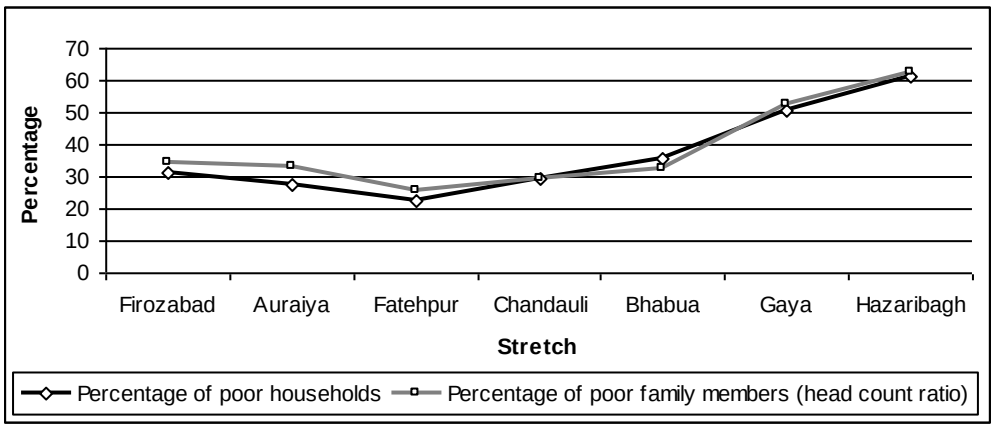
Poverty Indicators

The Poverty Ratio

On the basis of monthly per capita income, 35.53 percent households in the surveyed stretches are below the poverty line. The percentage is significantly higher in Bihar and Jharkhand (47.53) and lower in Uttar Pradesh (28.18).

Table 15: Distribution of households according to the poverty ratio based on monthly per capita income (MPCY)

Stretch (District)	Number of households surveyed	Number of poor households	Percentage of poor households	Number of members in the surveyed households	Number of poor members in the surveyed households	Percentage of poor family members (head count ratio)
Firozabad	560	175	31.25	3396	1162	34.22
Auraiya	336	92	27.38	1848	612	33.12
Fatehpur	400	90	22.50	2198	570	25.93
Chandauli	688	202	29.36	4485	1317	29.36
Uttar Pradesh	1984	559	28.18	11927	3661	30.70
Bhabua	416	149	35.82	3015	973	32.27
Gaya	592	301	50.84	3998	2091	52.30
Hazaribagh	208	128	61.54	1449	908	62.66
Bihar& Jharkhand	1216	578	47.53	8462	3972	46.94
Overall	3200	1137	35.53	20389	7633	37.44

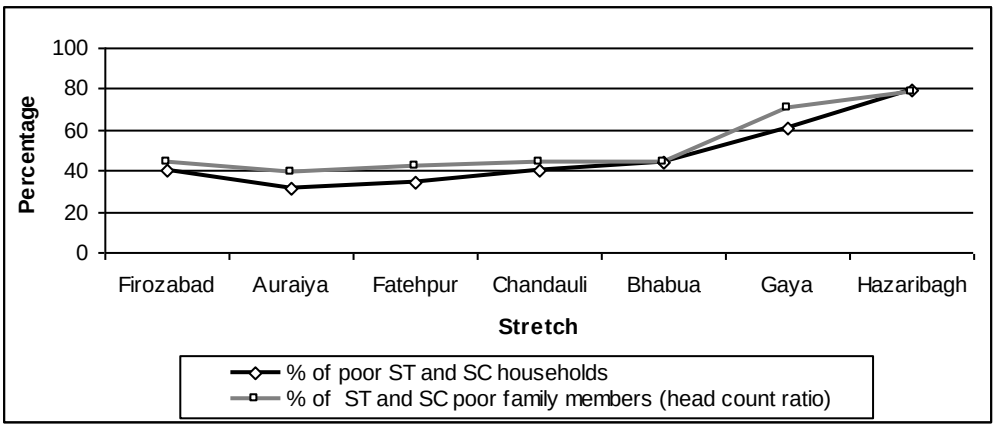


Scheduled Castes and Scheduled Tribes (SC/ST)

Poverty among the scheduled caste and scheduled tribe households is much higher (50.35 percent) than the overall poverty level (44.95 percent). It is still higher in Bihar and Jharkhand (56.89 percent). It is distressing to note that the poverty ratio among SC/ST households increases progressively as one moves eastward from Agra. The data shows that poverty among the weaker sections of society is much higher than among other sections. Those belonging to the SC/ST sections are worse-off in Bihar and Jharkhand than in Uttar Pradesh.

Table 16: Proportion of poor households among the scheduled castes and scheduled tribes

Stretch (District)	Number of households surveyed	Number of poor households	% of poor households	Number of members in the surveyed households	Number of poor members in the surveyed households	% of poor family members (head count ratio)
Firozabad	198	79	39.90	1110	494	44.50
Auraiya	151	47	31.13	769	298	38.75
Fatehpur	176	61	34.66	914	385	42.12
Chandauli	231	93	40.26	1320	579	43.86
Uttar Pradesh	756	280	37.04	4113	1756	42.69
Bhabua	183	81	44.26	1099	488	44.40
Gaya	264	161	60.98	1434	1009	70.36
Hazaribagh	54	43	79.63	335	262	78.21
Bihar/Jharkhand	501	285	56.89	2868	1759	61.33
Overall	1257	565	44.95	6981	3515	50.35



Conclusions

The study clearly brings out that most socio-economic indicators show decline as one moves eastward from Agra and Firozabad districts of Uttar Pradesh towards Bhabua and Gaya districts of Bihar and Hazaribagh district of Jharkhand. It reveals that the poor households are generally larger in size with little awareness of the benefits of a small family. This attitude is mainly due to a higher incidence of poverty and a lower level of education – a pointer to the fact that, in the absence of social

security, poor households perceive an additional member as an extra hand to earn and run chores.

A disturbing finding of the analysis is that better-off households have a stronger bias against females. This could be a consequence of social customs like dowry and economic compulsions such as the prospect of fragmentation of landholdings. Literacy levels in the areas surveyed are well below the national average, with female literacy being abysmally low. Generally, women have less access to education and are also discouraged from educating themselves. The situation in this regard is worse in Bihar and Jharkhand than in Uttar Pradesh.

While the non-poor have greater access to healthcare facilities, the gap between the poor and the non-poor is narrow in terms of percentage of individuals visiting doctors. This is perhaps due to the fact that the poor prefer to go to traditional healers instead of registered and qualified medical practitioners or, alternatively, try home remedies for ailments and illnesses.

The dependency ratio is quite high in the eastern states and is still higher among the poor. It implies that in these states more children and elderly persons are dependent on those in the working-age group of 15-59 years. The average landholding per household is low at 0.58 hectare, with marginally higher holdings in Bihar and Jharkhand. The average landholding of a poor household is abysmally low – one-eighth of a hectare in Uttar Pradesh and a quarter of a hectare in Bihar and Jharkhand.

In terms of poverty indicators, the proportion of households living below the poverty line is significantly higher in Bihar and Jharkhand than in Uttar Pradesh. The incidence of poverty among the weaker sections of society is much higher than among other sections. Those belonging to the scheduled castes and scheduled tribes are worse-off in the two eastern states. A poor household incurs a greater share of its expenditure on food than a non-poor household. Social and economic inequality is more severe in Bihar and Jharkhand than in Uttar Pradesh.

The share of the working population in the overall population is higher among the non-poor households than the poor households, implying that the non-poor have more employment opportunities than the poor because of their higher economic

status. As compared to non-poor households, more women in poor households have to work to supplement family income.

As far as travel characteristics are concerned, roughly half the trips undertaken are within a distance of 5 km. Trips related to work, education and market are among the most important. Nearly 80 percent of the trips made are either on foot or on bicycle, indicating the poor economic conditions obtaining in the areas surveyed. Less than half the trips made involve travel on NH2. Mobility declines as one moves eastward. Besides, mobility is lower among poor households as compared to non-poor households.

Chapter 4

Impact Evaluation at Village Level

As mentioned elsewhere in the report, the socio-economic impact analysis of a public investment project (like the present one of 4-laning of NH2) is done to determine the extent of net socio-economic benefits of the project that accrue to the population group(s) concerned, with a focus on poverty alleviation. Typically, such analysis comprises two studies of the socio-economic conditions of these group(s) – one based on baseline survey data (collected before the project is launched) and the other based on re-survey data (collected after the project has been completed). The partial effects of the project are then assessed by appropriately comparing the results of these two studies. The present report presents the results of a study of the socio-economic conditions of the population living around the stretch of NH2 being widened based on baseline survey data.

The rationale of the present study is based on the premise that, *ceteris paribus*, access to a highway provides to the population living in its appropriately defined neighbourhood opportunities that help improve their well-being. To verify this presumption empirically on the basis of village-level data, the relationship between selected village-level indicators of socio-economic well-being and the proximity of villages to NH2 has been examined. Four different statistical/econometric techniques, viz., correlation analysis, comparison of means, non-parametric regression analysis and multinomial ordered logit analysis, have been used for this purpose. In what follows, the results of these analyses are presented.

Village Level Variables

For the present analysis, 16 village-level socio-economic variables that are likely to be influenced directly or indirectly by the proximity of the villages to NH2 have been considered (Table 1). These variables may be categorised into seven groups. Of these, five groups, viz., incidence of poverty, transport infrastructure, employment, asset ownership and education and other infrastructure, relate to the well-being of the population. Another group relates to demographic characteristics which reflect the role of better economic opportunities arising from proximity to NH2. The last group of variables relating to land prices indicates an important indirect economic effect due to a rent element generated by NH2 and its 4-laning. It may be noted that all these variables alternatively reflect the level of economic development of a village.

Table 1: List of variables used to study impact of proximity to NH2 based on the village-level data

Variables	
Demographic	**Education and other infrastructure**
V1 Population density (population per sq km)	**V7** Number of teachers per school
Incidence of poverty	**V8** Number of enrolled students per school in the year 2002-03
V2 Proportion of BPL households	**V9** Number of girl students enrolled per school in the year 2002-03
Transport infrastructure	**V10** Proportion of literate population above 6 years of age
V3 Share of motorised vehicles in total transport vehicles	**V11** Whether a village has banking facilities
Employment	**V12** Whether a village has cooperative society
V4 Proportion of non-agricultural workers in total main workers	**Price of land and dairy products**
Asset ownership	**V13** Price of irrigated crop land (Rs./acre)
V5 Number of milch animals per household	**V14** Price of unirrigated crop land (Rs./acre)
V6 Proportion of semi-pucca and pucca houses	**V15** Price of residential land (Rs./acre)
	V16 Sale price of milk (Rs./litre)

Summary Statistics

The village-level data relating to the above-mentioned variables have been summarised in Table 2 showing the number of observations, their mean values and coefficient of variation. It may be mentioned that the variation in the number of observations across variables is due to the fact that some of the variables have not been observed due to their non-existence, in the case of certain sample villages. The coefficient of variation shows relative the dispersion of the variable as reflected by the sample value.

Table 2: Summary of selected demographic and socio-economic impact indicators at village level

Variables	Number of observations	Mean value	Coefficient of variation (percent)
V0 Approach distance from NH2 (in km)	200	4.34	79.26
Demographic			
V1 Population density	200	564.34	59.72
Incidence of poverty			
V2 Proportion of BPL households	200	38.23	62.43
Transport infrastructure			
V3 Share of motorised vehicles in total transport vehicles	200	8.56	80.16
Employment			
V4 Proportion of non-agricultural workers in total main workers	200	19.56	127.73
Asset ownership			
V5 Number of milch animals per household	200	1.87	67.98
V6 Proportion of semi-pucca and pucca houses	200	60.31	60.25
Education and other infrastructure			
V7 Number of teachers per school	151	3.28	60.80
V8 Number of enrolled students per school in the year 2002-03	151	55.43	118.30
V9 Number of girl students enrolled per school in the year 2002-03	151	23.14	105.84
V10 Proportion of literate population above 6 years of age	200	43.27	44.27
V11 Whether a village has banking facilities	200	12.00	36.83
V12 Whether a village has cooperative society	200	19.50	203.69
Price of land and dairy products			
V13 Price of irrigated crop land (Rs./acre)	200	186243.75	63.09
V14 Price of unirrigated crop land (Rs./acre)	187	117940.00	85.58
V15 Price of residential land (Rs./acre)	200	427005.00	114.99
V16 Sale price of milk (Rs./litre)	200	10.46	22.47

Note: The demographic indicators data is based on Census of India, 1991.

Correlation Analysis

For a preliminary analysis, the pattern of interdependence among the various chosen variables has been examined using the simple correlation coefficient between pairs of variables. As is well known, the correlation coefficient is an index of the degree of linear dependence of a pair of variables as present in a given data set. The computed correlation matrix is presented in Table 2.

Table 2: Correlation among selected socio-economic indicators at village level

	V0	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16
V0	1.000																
V1*	-0.221	1.000															
V2	0.064	-0.098	1.000														
V3	-0.017	0.036	-0.119	1.000													
V4*	-0.268	0.469	-0.192	-0.022	1.000												
V5	0.022	-0.096	0.408	-0.069	-0.178	1.000											
V6*	-0.166	0.195	-0.577	0.092	0.292	-0.329	1.000										
V7	-0.130	0.175	-0.201	-0.025	0.156	-0.181	0.136	1.000									
V8	-0.037	0.241	-0.110	-0.100	0.117	-0.043	0.145	0.467	1.000								
V9	-0.030	0.174	-0.136	-0.079	0.134	-0.015	0.138	0.330	0.730	1.000							
V10	-0.034	0.239	-0.466	0.259	0.208	-0.264	0.479	0.251	0.088	0.038	1.000						
V11*	-0.203	0.225	0.095	-0.081	0.112	-0.041	0.042	0.187	0.321	0.270	0.016	1.000					
V12	-0.062	-0.009	0.233	-0.139	-0.071	0.230	-0.137	0.109	0.151	0.069	-0.091	0.207	1.000				
V13*	-0.216	0.273	-0.126	0.208	0.281	-0.136	0.109	0.119	0.114	0.128	0.148	0.094	-0.067	1.000			
V14	-0.069	0.170	0.094	0.137	0.071	0.012	-0.008	0.039	0.150	0.135	-0.022	0.119	-0.042	0.523	1.000		
V15*	-0.195	0.193	-0.078	0.107	0.157	-0.072	0.040	0.161	0.239	0.068	0.136	0.038	0.119	0.426	0.236	1.000	
V16*	-0.196	0.062	0.458	-0.010	0.050	0.359	-0.381	0.010	0.105	0.008	-0.457	0.229	0.264	0.065	0.166	0.112	1.000

*Note: * are significant at 1 percent level with the distance from NH2 V0: denotes approach distance of the village from NH2 (km)*

As the above results suggest, the degree of pair-wise association with V0 (i.e. distance from NH2) is significant with the expected sign for seven of the sixteen chosen well-being indicator variables – population density (V1), proportion of non-agricultural workers in total main workers (V4), proportion of semi-pucca and pucca houses (V6), whether a village has banking facilities (V11), and prices of irrigated crop land (V13), residential land (V15), and milk (V16). For the remaining variables, the observed correlation has not been found to be statistically significant.

Table 2 also provides information on the degree of correlation between pairs of chosen well-being indicators. It may be noted that, except in a few cases, such correlation is not very strong. This suggests that, by and large, the chosen well-being indicators reflect diverse aspects of well-being which are not closely related to one another. The cases of strong correlation include the association between the proportion of semi-pucca and pucca houses, and the proportion of BPL households (-0.577), between prices of irrigated and unirrigated land (0.523), between population density and the proportion of non-agricultural workers in total main workers (0.469), and between the proportion of literate population and the proportion of semi-pucca and pucca houses (0.479).

Comparison of Means Analysis

As a preliminary analysis, it has been examined whether the mean values of a variable for the influence and control zones are equal. This has been done by testing for each variable the null hypothesis that population means for two zones are the same[1]. The comparison of means provides a benchmark measurement of the differences in the average levels of various impact variables in the influence and control zones. Table 3 presents the mean values of the 16 selected village-level indicators of well-being separately for the two groups of villages, one each in the influence and control zones.

Table 3: Mean values of selected village-level socio-economic indicators separately for influence and control zone

Variable		Mean value	
		Influence zone	Control zone
Demographic			
V1	Population density*	626.04	462.6
Incidence of poverty			
V2	Proportion of BPL households*	37.54	39.78
Transport infrastructure			
V3	Share of motorised vehicles in total transport vehicles	8.52	8.66
Employment			
V4	Proportion of non-agricultural workers in total main workers*	22.93	12.57
Asset ownership			
V5	Number of milch animals per household	1.84	1.94
V6	Proportion of semi-pucca and pucca houses*	63.46	53.29
Education and other infrastructure			
V7	Number of teachers per school	3.39	3.11
V8	Number of enrolled students per school in the year 2002-03	51.55	61.53
V9	Number of girl students enrolled per school in the year 2002-03	21.86	25.15
V10	Proportion of literate population above 6 years of age*	43.91	41.83
V11	Whether a village has banking facilities*	15.15	5.88
V12	Whether a village has cooperative society	21.97	14.71
Price of land and dairy products			
V13	Price of irrigated crop land (Rs./acre)*	469655.3	344213.24
V14	Price of unirrigated crop land (Rs./acre)*	118140.15	117551.47
V15	Price of residential land (Rs./acre)*	197178.03	165018.38
V16	Sale price of milk (Rs./litre)*	10.73	5.12

** Means of IZ and CZ are significantly different at a 5 percent level of significance.*

As would be seen from Table 3 above, for ten of the sixteen variables, the null hypothesis of equality of the mean value for the two zones is rejected. The significant variables showing pronounced difference in mean values between the influence and control zones are population density (V1), proportion of BPL households (V2), proportion of non-agricultural workers in total main workers (V4), share of semi-pucca and pucca houses (V6), proportion of literate population in the total population above 6 years of age (V10), proportion of villages having banking facilities (V11), price of irrigated crop land (V13), price of unirrigated crop land (V14), price of

[1] The significance of means has been tested using t-statistics.

residential land (V15), and price of milk (Rs./litre) (V16). These results, thus, on the whole, tend to validate the basic *neighbourhood* premise for studying the effects of proximity to NH2 on the well-being of the population.

Non-parametric Regression Analysis

For a more rigorous examination of the extent and nature of the association of selected well-being indicators with distance from the highway based on the available village-level data, we have used the bi-variate non-parametric regression analysis (see chapter 1 for an explanation of this econometric technique). To be more specific, for each of the sixteen well-being indicator variables, the graphs of the estimated non-parametric regression of the variable concerned on the distance from the highway have been obtained. It may be mentioned that these graphs are expected to show the gradient of change of a specific well-being indicator in relation to distance from NH2. This non-parametric regression analysis has been done using the data for sample villages whose approach distance from NH2 is 8 km or less. This data censoring has been done essentially to ensure that the statistical quality of the estimated non-parametric regression lines does not get unduly affected by the very few sample observations, with distance from NH2 greater than this chosen cut-off point that are present in the whole data set.

The results of the non-parametric regression analysis have brought out the well- behaved relationship with distance from NH2 for 10 of the 16 well-being indicator variables implicit in the village-level data set. In each of these cases, the estimated relationship is observed to be a monotonic one over the entire stretch. For most of the remaining variables, a monotonically increasing/decreasing relationship is observed up to a distance of 4-5 km, and beyond that the direction of relationship is mostly found to change. The graphs of the estimated non-parametric regression relationships are presented and explained in a later part of the chapter.

Multinomial Ordered Logit Analysis

As a supplement to the analyses mentioned above, the econometric technique of multinomial logit analysis has been applied to the village-level data set available. The basic objective of this analysis has been to identify village well-being characteristics that co-vary with the distance from NH2. For the purpose of such analysis, the distance of a sample village from NH2 has been treated as a polychotomous qualitative variable having four alternative ordered responses, viz., the dependent variable (y) is assigned the value 1 if the observed distance is 0-1 km, and

the values 2, 3 and 4 if the observed distance is 1-3 km, 3-5 km, and more than 5 km, respectively. A set of explanatory variables determining the ex ante probability of a sample village falling in a distance category is specified. As per the multinomial ordered logit model, the probabilities of a sample village falling in the various distance categories are:

$$\text{Prob}(y_i = 1) = F(\alpha_1 - x_i'\beta),$$
$$\text{Prob}(y_i = 2) = F(\alpha_2 - x_i'\beta) - F(\alpha_1 - x_i'\beta),$$
$$\text{Prob}(y_i = 3) = F(\alpha_3 - x_i'\beta) - F(\alpha_2 - x_i'\beta) \text{ and finally}$$
$$\text{Prob}(y_i = 4) = 1 - F(\alpha_3 - x_i'\beta),$$

where x_i is the vector of observed values of the explanatory variables for the *i*th sample village, β is the corresponding coefficient vector, α_1, α_2, α_3 are other model parameters, and F(.) denotes the logistic distribution function (see chapter 1 for a formal description of the multinomial ordered logit regression model).

The estimated value b_j of β_j measures the sensitivity of the probability of a village falling in the 1st distance category (and analogously in the last distance category) with respect to a change in the value of the corresponding explanatory variable. If b_j turns out to be positive/negative and significant, that means that the probability of a village falling in the 1st distance category will decrease/increase (and hence the probability of its falling in the last distance category will increase/decrease) if the value of the corresponding explanatory variable is increased marginally. The results of the estimation of the multinomial ordered logit regression model based on the village-level data is presented in Table 4.

Table 4. Estimated multinomial ordered logit regression model

Explanatory variable/parameter	Estimated coefficient	Std. error	Z value	P>|z|	[95% conf interval]	
Price of irrigated crop land	-0.000004	0.000002	-2.40	0.017	-0.000008	-0.000001
Whether a village has banking facilities	-0.974902	0.494876	-1.97	0.049	-1.944841	-0.004962
Proportion of non-agricultural workers in total main workers	-0.029293	0.009754	-3.00	0.003	-0.048411	-0.010175
Whether a village has cooperative society	-0.872270	0.410454	-2.13	0.034	-1.676746	-0.067795
α_1	-3.106974	0.467040				
α_2	-1.712092	0.407774				
α_3	-0.796389	0.389702				
Log likelihood	-175.67275					
Pseudo R2	0.0742					

Note: (1) Distance from NH2 is the dependent variable.
(2) This model has been estimated by using the step-wise estimation technique taking all the 16 explanatory variables in the beginning. Of these, 4 variables turned out to be significant in the final step.

As the above results show, four well-being indicators, viz., price of irrigated land, availability of banking facilities, existence of a cooperative society within the

village and proportion of non-agricultural workers in total working population, are the significant co-variates of the distance of a village from NH2. More importantly, all the estimated coefficients have the expected sign. The large standard errors of the estimates of α_2 and α_3 parameters suggest that the population values of these parameters are not significantly different from zero and, hence, the true value of Prob(yi=3) is small relative to the other probability values.

Comparison of Results

It may be mentioned that since our basic premise is that the socio-economic well-being of a household can be significantly affected by its proximity to a highway, the objective of the present village-level data analysis has been identification of village-level well-being indicators that co-vary with distance from NH2. Given this objective, the four different types of analyses, the results of which have been presented above, are meant to be supplementary to each other. These may together help ascertain whether or not proximity to a highway is generally associated with perceptible well-being improvements of the population living on either side of a highway, and if it does, then in which way. In Table 5, we summarise the results obtained from these different analyses.

Table 5: List of village-level well-being indicators that are observed to be significantly related to the distance from NH2 in different analyses

Well-being indicator	Method of analysis			
	Correlation analysis	Comparison of means	Non-parametric regression	Multinomial ordered logit
Demographic				
V1 Population density	√	√	√	
Incidence of poverty				
V2 Proportion of BPL households		√	√ (up to 4 km)	
Transport infrastructure				
V3 Share of motorised vehicles in total transport vehicles			√	
Employment				
V4 Proportion of non-agricultural workers in total main workers	√	√	√	√
Asset ownership				
V5 Number of milch animals per household			√	
V6 Proportion of semi-pucca and pucca houses	√	√	√	
Education and other infrastructure				
V7 Number of teachers per school			√ (up to 5 km)	
V8 Number of enrolled students per school in the year 2002-03			√ (up to 5 km)	
V9 Number of girl students enrolled per school in the year 2002-03			√ (up to 5 km)	
V10 Proportion of literate population above 6 years of age		√	√ (up to 3 km)	
V11 Whether a village has banking facilities	√	√	√	√
V12 Whether a village has cooperative society			√	√
Price of land and dairy products				
V13 Price of irrigated crop land	√	√	√	√
V14 Price of unirrigated crop land		√	√ (up to 4.5 km)	
V15 Price of residential land	√	√	√	
V16 Sale price of milk	√	√	√	

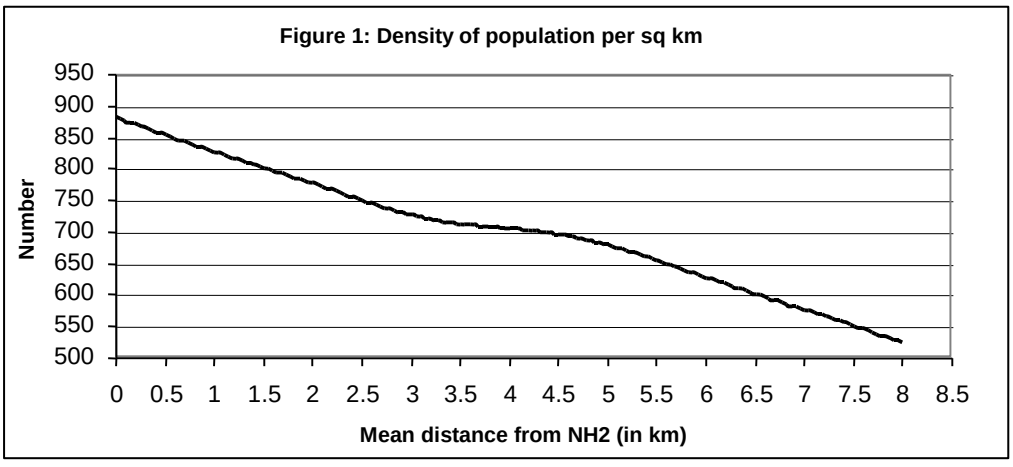
The above summary of results firmly suggests that proximity to NH2 has a significant relationship with: (i) demographic characteristics (density of population), (ii) employment in non-farm activities (proportion of non-agricultural workers in total main workers), (iii) housing conditions, (iv) asset holding (proportion of semi-pucca and pucca houses in the total number of dwellings), (v) banking facilities, (vi) price of land (price of irrigated crop land and residential land), and (vii) price of milk.

Developmental Implications of Proximity to NH2

The development implications of proximity to a highway of a village/locality can be validated conveniently using the results of the bi-variate non-parametric regression analysis that we have done using the village-level data. In what follows, we explain the various developmental implications of proximity to NH2 in terms of the graphs of estimated bi-variate non-parametric regression of each of the 16 village-level well-being indicators that we have considered in the present analysis.

Demographic Implications

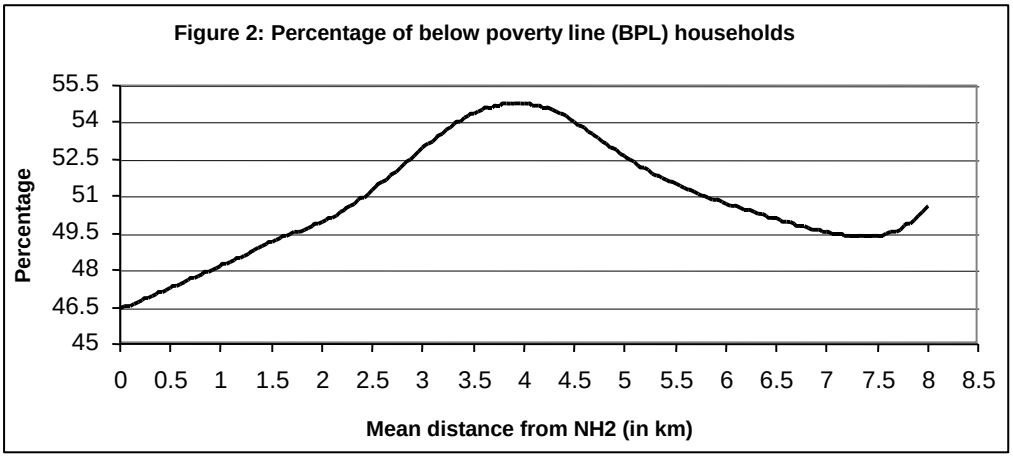
As Figure 1 shows, the population density of a village tends to decline monotonically as the distance from NH2 increases. Such a pattern is suggestive of the possibility that villages in the vicinity of the highway have a much better prospect of having diversified economic activities which, among other things, induce a higher population density (Figure 1).



Incidence of Poverty

As Figure 2 indicates, the percentage of households living below the poverty line (BPL) monotonically increases up to a distance of 4 km and then declines. Such a pattern may be a reflection of the greater prospects of service-oriented economic activities in the vicinity of the highway. It may be mentioned that the BPL data relate to the BPL census conducted at the village level by the rural development agencies for identifying poor households for the purpose of implementing various poverty alleviation programmes. The declining portion of the curve possibly suggests that moving away from NH2 may improve the prospects of agriculture-related economic activities and thus reverse the nature of relationship.

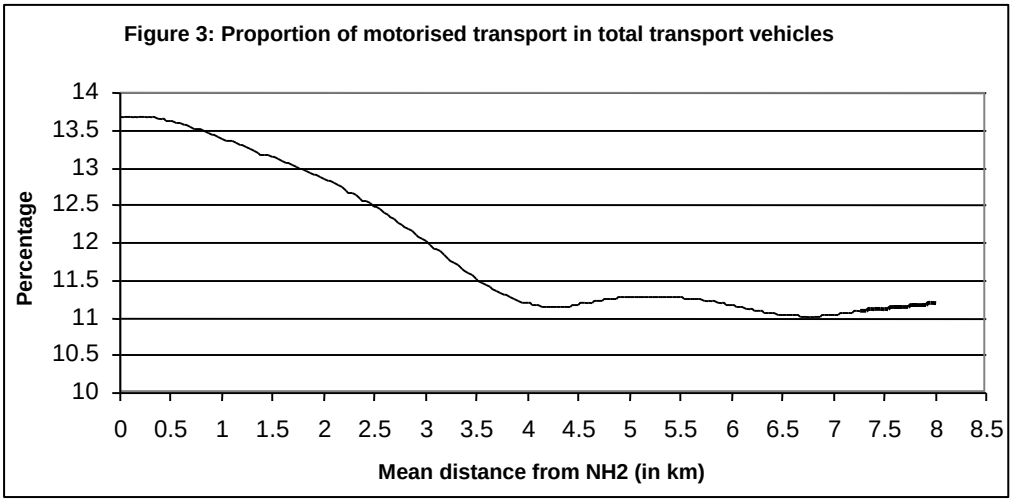
Figure 2: Percentage of below poverty line (BPL) households



Transport Infrastructure

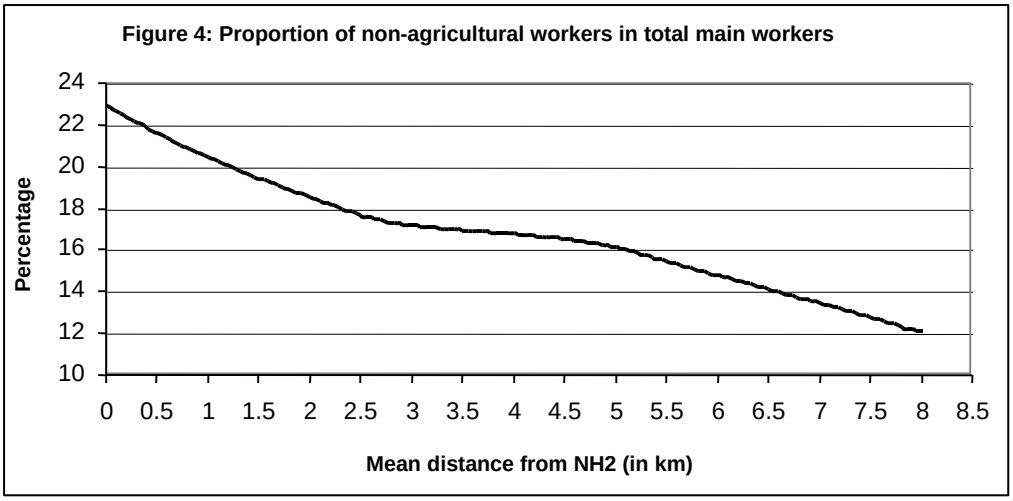
The graph for the proportion of motorised vehicles shows a declining trend up to 4.5 km, beyond which it stabilises. This is as expected since the people living in the vicinity of the highway have better economic opportunities and are better endowed with resources (Figure 3).

Figure 3: Proportion of motorised transport in total transport vehicles



Employment

As Figure 4 shows, the relationship of the proportion of non-agricultural workers in total main workers with the distance from NH2 is also a monotonically inverse one with a more or less flat segment in the 3-5 km distance range. This is quite expected, since more non-farm activities generally develop in the vicinity of a national highway.

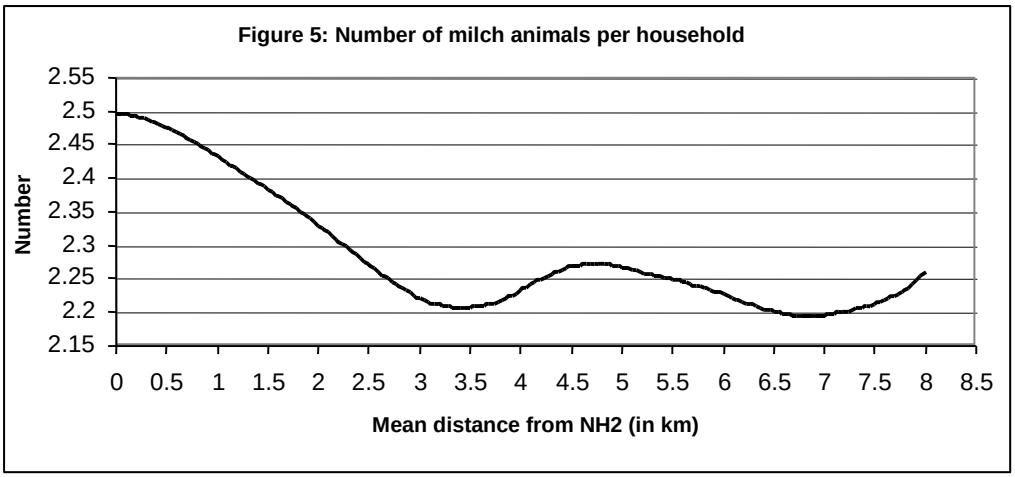


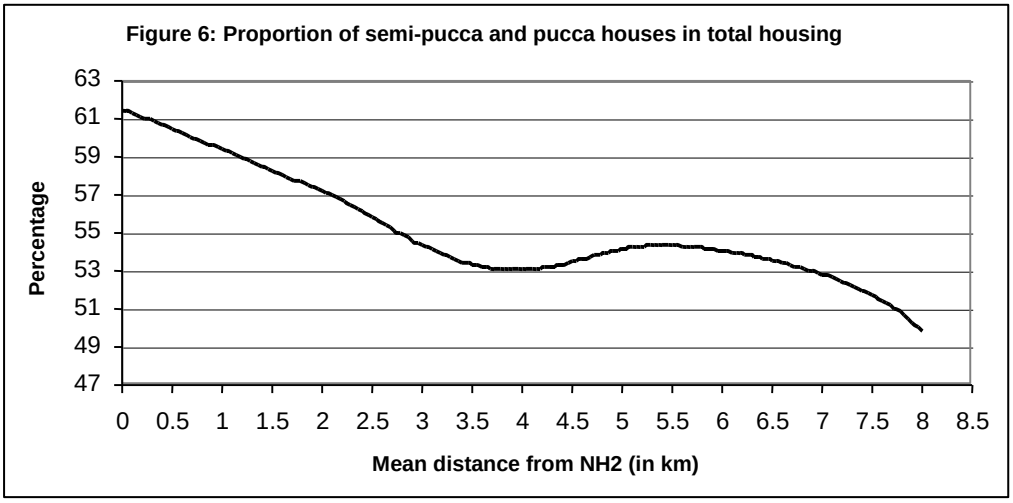
Asset Ownership

The ownership of milch animals may be regarded as an indicator of the spread of allied agricultural activities in a village. As Figure 5 shows, the ownership of milch animals per household declines monotonically up to a distance of 3.5 km and then follows an undulating pattern of movement, thus suggesting a flattening of the curve beyond 3.5 km, on average. This is clearly indicative of the positive role that allied agricultural activities play in income generation in villages located in the close neighbourhood of a highway.

Figure 6 presents the graph of the estimated non-parametric regression for the proportion of semi-pucca and pucca houses. The graph tends to decline monotonically up to a distance of around 4 km and then flattens, on average.

If both these variables are accepted as indicators of the ownership of assets, then the above graphs may be interpreted as reflecting how ownership/access to assets (and hence economic prosperity) tends to go down as the distance of a village from NH2 increases.





Education and Other Infrastructure

Figures 7-9 present the graphs that describe the relationship between the distance from NH2 and the various education-related variables. As regards the relationship between the state of educational development and the distance from NH2, the number of teachers per school is seen to decline up to a distance of 5 km. The enrolment rate of students also displays the same pattern. The enrolment rate of girl students shows a declining trend up to the same distance. These observed patterns could be due to a number of phenomena – greater social awareness and social development of villages in proximity to the highway being a major one. Figure 10 for the incidence of literacy, however, presents a peculiar pattern. In this case, an inverse relationship is observed up to 3 km, followed by a rising relationship up to 5.5-6 km, and then again an inverse relationship.

As far as the availability of banking facilities is concerned (Figure 11), the curve declines monotonically up to 4.5 km, and then considerably flattens, showing a very mild rising tendency at higher distance levels. For the existence of a cooperative society (Figure 12), on the other hand, the curve declines monotonically all through.

Figure 7: Number of teachers per school

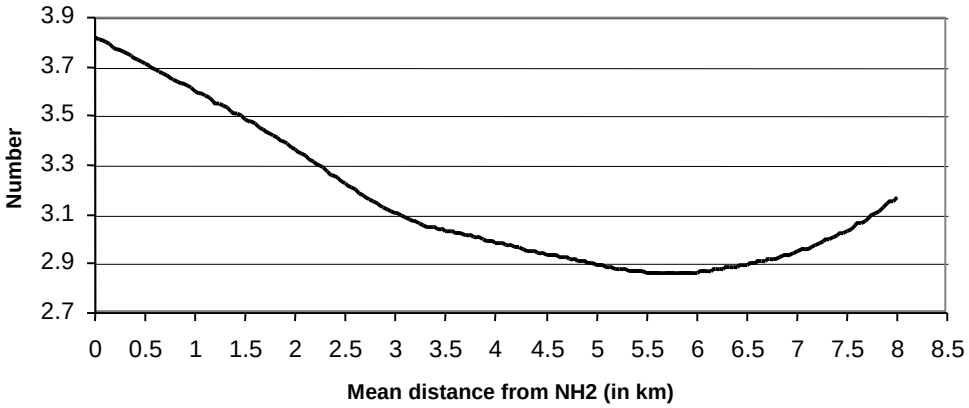


Figure 8: Number of enrolled students per school in 2002-03

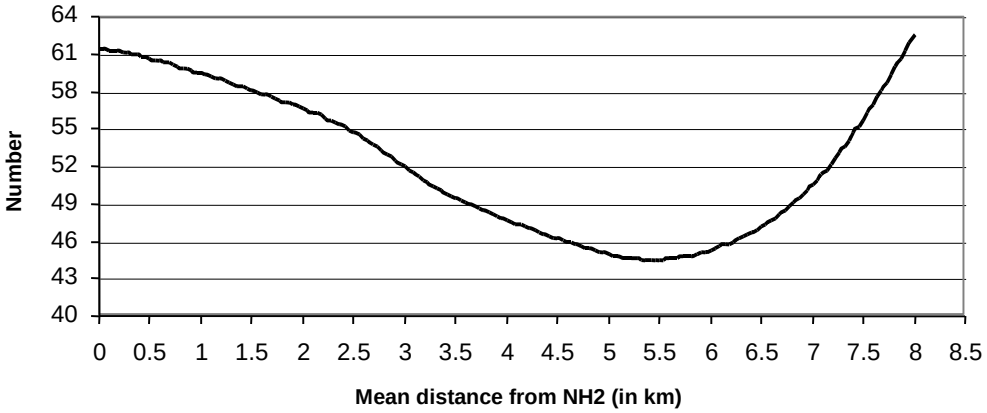
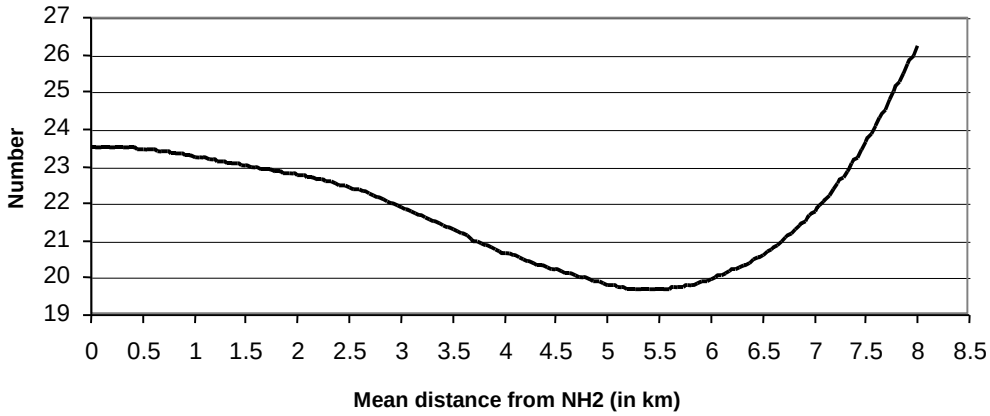
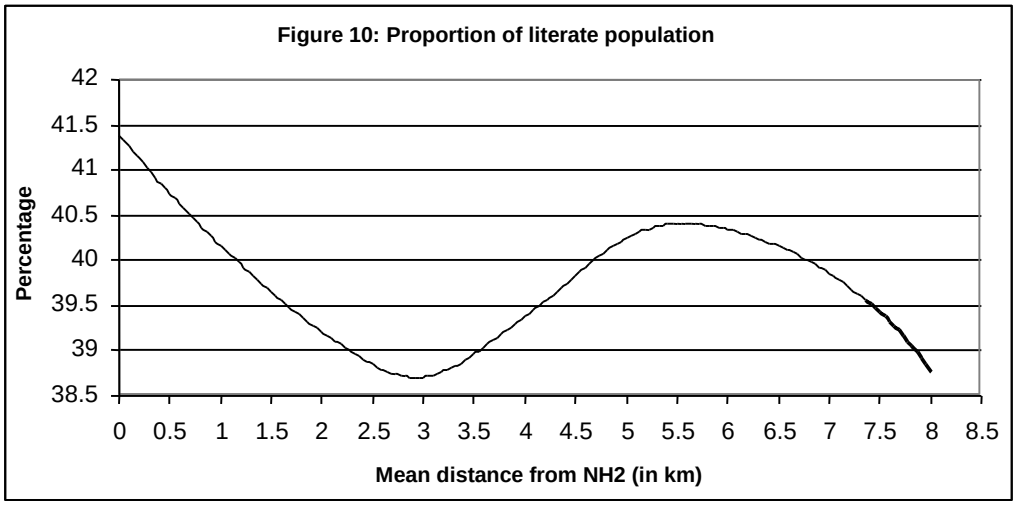
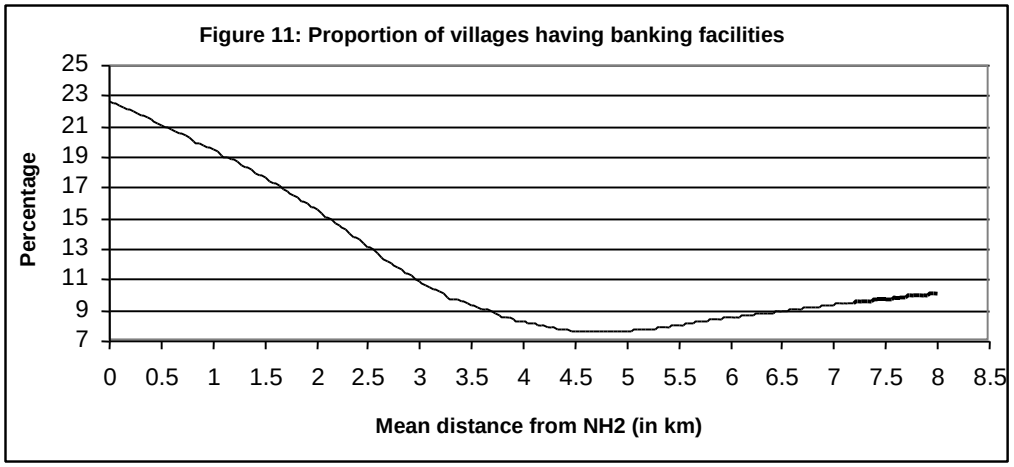
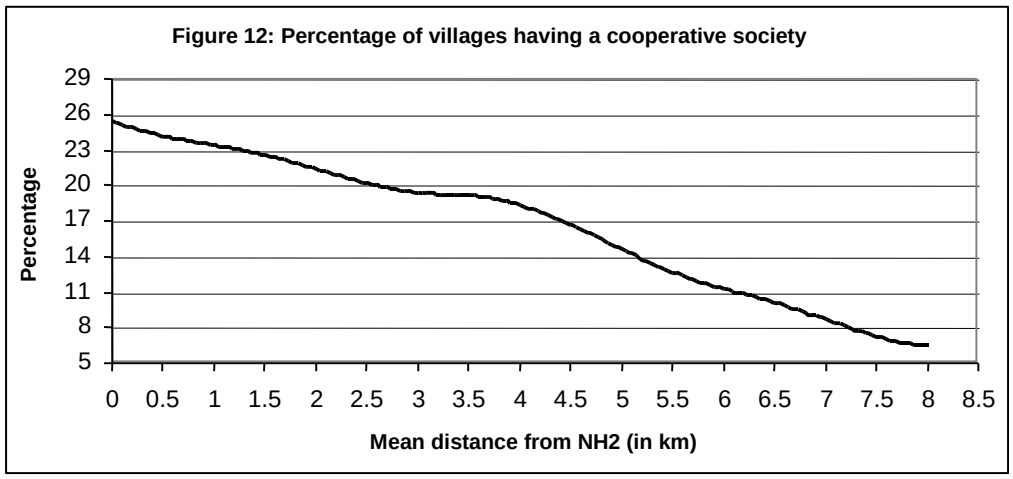


Figure 9: Number of girl students enrolled per school in 2002-2003









Price of Land

Figures 13-15 show the nature of variation in the price of residential land, unirrigated land and irrigated land, in relation to the distance from NH2. Note that for

all the graphs there is a marked change of slope at the 4.5-km distance level. In the case of price of residential land (Figure 13), the graph monotonically declines, but the curve flattens at the 4.5-km distance level. This suggests that the sensitivity of residential land price to the distance from NH2 is perceptibly stronger for villages located within 4.5 km from NH2. For irrigated crop land, a pattern very similar to that observed for the price of residential land is observed – in this case, the price becomes, more or less, constant for distance greater than 4.5 km. Finally, in the case of price of unirrigated crop land, on the other hand, the curve declines up to 4.5 km but again rises – a pattern which is not easily explainable.

Finally, in Figure 16, the graph shows how the sale price of milk varies with distance from NH2. As is to be expected, this curve is also a monotonically declining one, showing a tendency to get flattened beyond 6 km. While one possible explanation of this phenomenon may be the transport cost involved in bringing the supply to the ultimate supply point, this may also be a reflection of the possibility that the sellers located in the vicinity of the highway have better information regarding the market and the ultimate sale price.

Figure 13: Price of land for residential purpose (Rs./ acre)

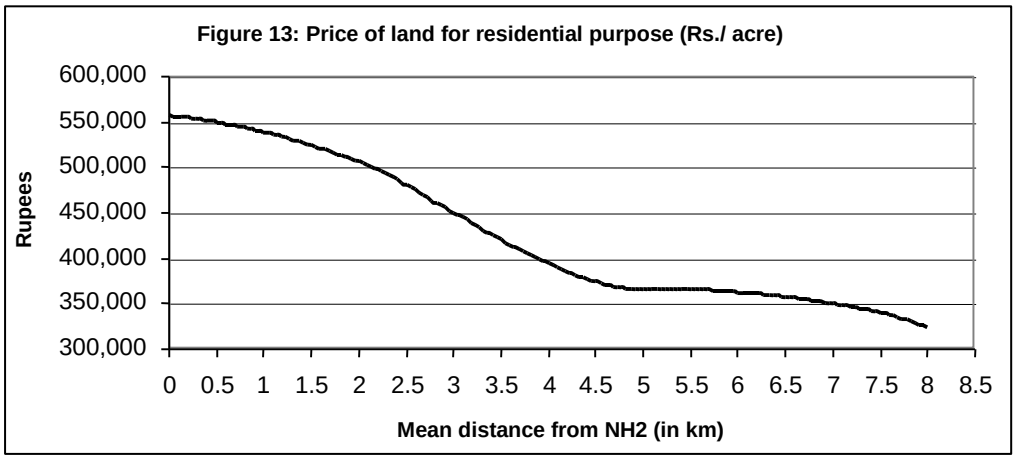
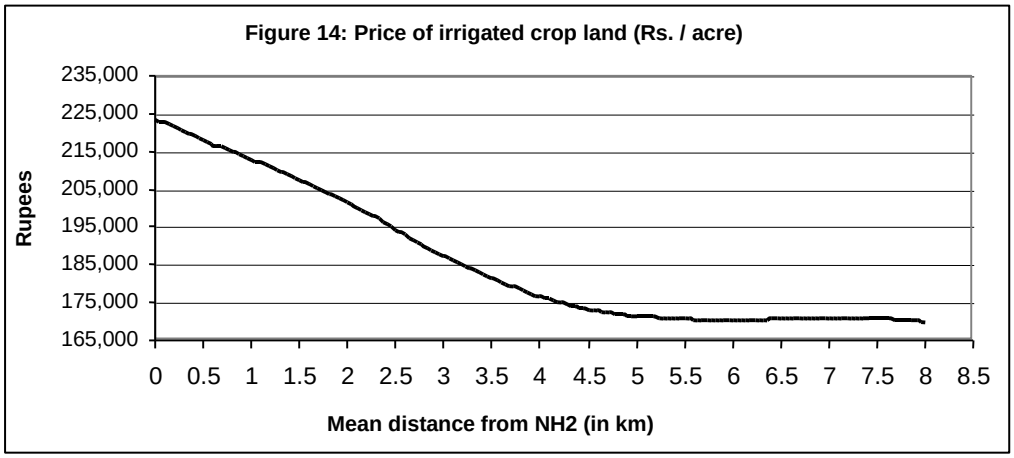
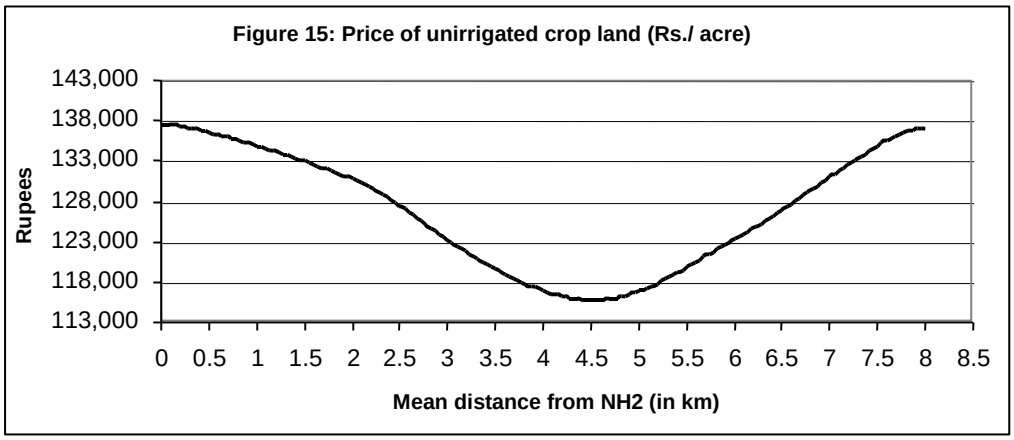
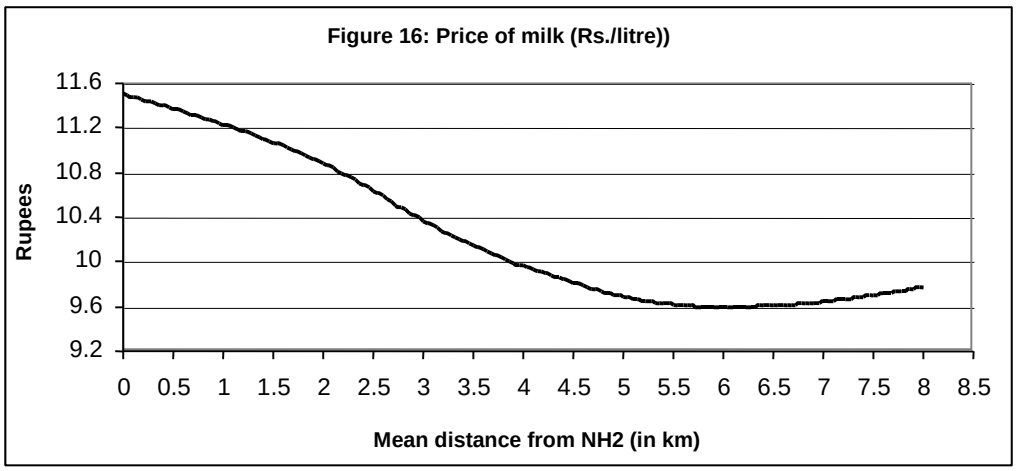


Figure 14: Price of irrigated crop land (Rs. / acre)







Concluding Remarks

In this chapter, some results of the impact analysis of NH2 based on the village-level data available have been presented. A total number of 16 village-level indicators of well-being have been used in the analysis, and whether or not the levels of these indicators systematically vary with the approach distance of a village from NH2 has been examined using four different techniques, viz., correlation analysis, comparison of means, non-parametric regression analysis, and multinomial ordered logit analysis. Overall, the following observations emerge.

Proximity to NH2 seems to have a perceptible effect on the well-being of the population living on either side of NH2. Of the 16 well-being/development indicators used, at least for 7 indicators (viz., population density, proportion of non-agricultural workers in total main workers, proportion of semi-pucca and pucca houses in total housing, price of residential and irrigated crop land, availability of banking facilities

and price of milk), the results of alternative analyses have matched and the significant relationship with distance from NH2 with the expected sign has been observed. As the results of non-parametric regression analysis have brought out, the relationship of the distance from NH2 with individual well-being/development indicators is generally a smooth and continuous one. More importantly, in most of the cases, the gradient of the relationship with distance has shown a marked change around a distance level of 4-5 km, indicating that the effect of NH2 on villages located within this approach distance is qualitatively different from that on villages located at greater distances. These results thus justify the use of 5 km approach distance from NH2 in the delineation of influence zone for the impact analysis based on household-level data.

Chapter 5

Impact Evaluation at Household Level

This chapter presents a comprehensive analysis of the household-level data using different statistical/econometric methods. These methods are complementary to one another; hence, their simultaneous use may help in getting robust results. The basic premise underlying the household-level data analysis, as in the case of analysis of village-level data, is that proximity to NH2 would help improve a household's well-being. An improved road infrastructure, in turn, would further enhance the well-being of the population.

Given that the notion of socio-economic well-being is essentially multi-dimensional, a wide array of household-level variables (that are likely to reflect the well-being of the population[1]) have been analysed to assess if proximity to NH2 leads to significant differences in these variables and also to explore the nature of their individual relationship with distance from NH2. Poverty being the single most important manifestation of lack of well-being, in the present analysis, a major stress has been laid on the poverty aspect.

Five different techniques have been used for the household-level data analysis – viz., correlation analysis, comparison of means, PSMT[2]-based single difference analysis (SDA), non-parametric analysis (NRA), and multivariate regression analysis (MRA). Of these, the first two constitute the preliminary data analysis. PSMT-based SDA has been employed to measure impact by comparing average values of outcome variables for households in the influence and control zones. NRA, on the other hand, has been used to explore the nature of relationship of individual outcome variables with distance from NH2. The results of MRA are supposed to bring out the set of explanatory variables other than the distance from NH2, which significantly affect the individual outcome variables.

Household Level Variables

As mentioned above, proximity to NH2 is expected to affect a household's well-being directly by enhancing mobility and reducing the time and cost of travel for

1. Henceforth, we shall refer to these variables as outcome variables.
2. It may be mentioned here that since the present analysis is based on benchmark survey data, the impact analysis based on the propensity score matching technique (PSMT) is essentially a single difference analysis that compares the average value of an outcome variable for households living in the influence zone, i.e. a defined neighbourhood of NH2 with that of a matched group of households living in the control zone which is away from NH2.

various activities and also indirectly by broadening the scope for various socio-economic opportunities. As a result, both the entitlement to and capability of attaining greater well-being of the household members may improve. Keeping this in mind, seven different groups of outcome variables have been considered for the present analysis. These include a set each of (i) alternative measures of the incidence of poverty, (ii) measures of mobility, (iii) some measures of income, employment and occupation, (iv) variables relating to housing and asset ownership, (v) indicators of access to health, education and other infrastructural facilities, (vi) attitudinal variables recording a household's perception about its own poverty status and about the possibility of improvement in the range of its employment opportunities due to the proposed expansion of NH2, and, finally, (vii) household-level indices of well-being compiled by combining the relevant outcome variables. The total number of variables falling under these seven groups is 30. The list of these variables is given in Table 1.

Table 1: List of variables used to study impact of proximity to NH2 based on the household-level data

Incidence of poverty	
H1*	Whether household is poor based on poverty line measured in terms of monthly per capita income (MPCY)
H2*	Whether household is poor based on poverty line measured in terms of monthly per capita consumption expenditure (MPCE)
Mobility (weekly)	
H3	Per capita trip rate (PCTR)
H4	Per capita trip rate for work
H5	Per capita trip rate for marketing
H6	Per capita trip rate for education
H7	Per capita trip rate for accessing health-related services
H8	Per capita trip rate involving travel on NH2
H9	Per capita trip length for trips involving NH2
H10	Per capita travel expense for trips involving NH2
H11	Per capita travel time for trips involving NH2
H12	Travel cost per person km for trips involving NH2
Income, employment and occupation	
H13	Per capita income (annual) (Rupees)
H14	Per capita consumption expenditure (monthly) (Rupees)
H15	Share of income from self-employment in non-agricultural activities
H16	Share of food in consumption expenditure
H17	Proportion of working members in a household in age group 15-59 years
H18	Proportion of working female members in a household in age group 15-59 years
H19	Proportion of non-agricultural workers in total working household members.
Asset ownership	
H20*	Whether a household is landless
H21*	Whether a household owns at least one information related consumer durable (like TV, radio, etc.)
H22*	Whether a household owns at least one motorised transport vehicle
Education and health	
H23	Proportion of school-going children among all children in the household in age group 6-14 years
H24	Proportion of female school-going children among all female children in the household in age group 6-14 years
H25	Proportion of household members who availed of medical facilities during last six months
Attitudinal response	
H26*	Whether a household rates itself as poor
H27*	Whether a household expects improvement in employment situation after 4-laning of NH2
Well-being index	
H28	Index of overall well-being based on income, employment, health and education (BORDA index)
H29	Index of transport mobility (BORDA index)
H30	Index of access to infrastructural facilities, assets and amenities (BORDA index)

* *These are qualitative binary variables.*

Correlation Analysis

For a preliminary analysis, the pattern of interdependence among the chosen variables has been examined using the simple correlation coefficient between pairs of variables. The computed correlation matrix is presented in Table 2. It shows that the degree of pair-wise association with H0 (i.e. distance from NH2) is significant with the expected sign for 13 out of 30 variables. One variable relates to the incidence of poverty (H2); six to mobility (H3, H4, H8-H11); two to employment in non-agricultural activities (H15, H19); one to landholding (H20); one to attitudinal response (H26); and two to well-being indices (H29, H30). It also shows that the correlation between pairs of chosen outcome variables is not strong, which suggests that, by and large, the chosen outcome variables reflect aspects of well-being that are not related to one another.

The pattern of correlation between pairs of outcome variables also provides useful insights. The mobility-related variables per capita trip rate (H3) and per capita trip rate for work (H4) are positively correlated, suggesting that trips are mostly made for work purposes. The variables H8-H11, all of which involve travel on NH2, are also positively correlated with one another signifying that proximity to NH2 leads to more frequent and longer trips.

In the group of variables relating to income, employment and occupation, two systematic relations may be noticed. The pattern of pair-wise correlation for per capita income (H13), per capita consumption expenditure (H9) and share of food in consumption expenditure (H16) on expected lines. The correlation between the proportion of working members in a household in the age group 15-59 years (H17) and the corresponding variable for female household members (H18) is also positive, suggesting that a higher female workforce participation would lead to a higher overall labour force participation.

The variables relating to education, viz., proportion of school-going children among children in the age group 6-14 years (H23) and the corresponding variable relating to education of female children (H24) are highly correlated positively. This is only to be expected, because a higher schooling rate for female children would push up the overall schooling rate. Finally, the three well-being indices (H28-H30) do not appear to be strongly correlated. This is indicative of the fact that these indices are complementary to one another as measures of well-being.

Table 2: Correlation among selected outcome variables at household level

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24	H25	H26	H27	H28	H29	H30
H0	1.000																														
H1	0.012	1.000																													
H2*	0.036	0.317	1.000																												
H3*	-0.060	-0.118	-0.141	1.000																											
H4*	-0.069	-0.106	-0.083	0.819	1.000																										
H5	-0.018	-0.001	-0.021	-0.017	-0.178	1.000																									
H6	0.007	-0.052	-0.106	0.471	-0.067	-0.076	1.000																								
H7	0.011	0.019	-0.053	0.016	-0.058	-0.043	-0.011	1.000																							
H8*	-0.142	-0.122	-0.088	0.563	0.515	-0.041	0.199	0.011	1.000																						
H9*	-0.058	-0.087	-0.075	0.373	0.366	-0.057	0.089	0.025	0.635	1.000																					
H10*	-0.052	-0.014	-0.063	0.108	0.113	-0.031	0.005	0.058	0.173	0.495	1.000																				
H11*	-0.045	-0.091	-0.070	0.442	0.427	-0.060	0.124	0.007	0.772	0.846	0.250	1.000																			
H12	-0.047	0.015	-0.042	0.213	0.204	0.097	-0.029	0.037	0.165	0.055	0.189	0.066	1.000																		
H13	-0.029	-0.260	-0.329	0.128	0.108	0.070	0.029	0.016	0.122	0.114	0.100	0.069	0.182	1.000																	
H14	0.014	-0.124	-0.316	0.098	0.071	0.017	0.046	0.035	0.070	0.099	0.088	0.077	0.170	0.369	1.000																
H15*	-0.075	-0.015	0.005	0.009	0.011	0.029	-0.018	-0.001	-0.003	0.025	0.086	-0.006	0.043	0.044	0.049	1.000															
H16	0.007	0.243	0.533	-0.099	-0.053	0.013	-0.084	-0.079	-0.078	-0.106	-0.112	-0.085	-0.041	-0.262	-0.465	-0.030	1.000														
H17	-0.009	0.021	0.071	0.092	0.162	0.057	-0.121	0.023	0.060	0.010	-0.056	0.052	0.094	-0.031	-0.061	-0.043	0.124	1.000													
H18	0.001	0.052	0.080	0.046	0.057	0.002	-0.007	-0.005	-0.001	-0.016	-0.025	-0.002	0.090	-0.079	-0.033	-0.012	0.070	0.743	1.000												
H19*	-0.102	0.013	0.161	0.137	0.194	-0.038	-0.048	-0.065	0.132	0.100	0.036	0.112	0.018	-0.026	-0.060	0.249	0.039	-0.084	-0.116	1.000											
H20*	-0.048	-0.003	0.193	0.026	0.093	0.002	-0.101	0.000	0.024	-0.033	-0.063	0.001	0.009	-0.214	-0.143	0.025	0.139	0.167	0.109	0.205	1.000										
H21	-0.020	-0.147	-0.225	0.020	-0.006	0.002	0.049	-0.004	0.030	0.089	0.122	0.026	0.010	0.288	0.167	0.074	-0.201	-0.182	-0.083	0.039	-0.236	1.000									
H22	0.007	-0.113	-0.199	0.014	0.003	-0.032	0.025	0.030	0.021	0.081	0.177	0.013	0.053	0.374	0.206	0.091	-0.214	-0.159	-0.081	-0.033	-0.191	0.391	1.000								
H23	0.012	-0.279	-0.198	0.109	0.047	-0.001	0.102	0.012	0.070	0.069	0.062	0.052	0.061	0.172	0.111	0.044	-0.202	-0.132	-0.061	-0.061	-0.142	0.153	0.131	1.000							
H24	0.006	-0.266	-0.182	0.105	0.037	0.028	0.095	0.020	0.068	0.077	0.069	0.047	-0.021	0.169	0.099	0.051	-0.171	-0.133	-0.049	-0.050	-0.116	0.166	0.150	0.897	1.000						
H25	-0.021	0.016	-0.069	0.100	0.061	0.116	0.013	0.074	0.017	0.029	-0.016	0.048	0.031	0.041	0.052	0.024	-0.058	0.101	0.080	0.022	0.066	-0.066	-0.060	-0.007	0.000	1.000					
H26*	0.051	0.084	0.217	0.013	0.041	-0.024	-0.031	0.015	0.002	-0.041	-0.067	-0.008	-0.049	-0.255	-0.121	-0.045	0.137	0.129	0.059	0.069	0.279	-0.285	-0.226	-0.164	-0.162	0.082	1.000				
H27	0.002	-0.176	-0.153	0.056	0.050	-0.082	0.052	-0.004	0.065	0.053	0.028	0.048	-0.020	0.098	0.086	-0.018	-0.149	-0.073	-0.046	-0.022	-0.053	0.080	0.106	0.076	0.037	-0.082	0.085	1.000			
H28	-0.025	-0.347	-0.341	0.120	0.082	0.106	0.045	0.059	0.087	0.069	0.078	0.048	0.055	0.427	0.213	0.357	-0.263	0.166	0.118	0.035	-0.174	0.305	0.251	0.317	0.328	0.423	-0.249	0.021	1.000		
H29*	-0.077	-0.095	-0.142	0.674	0.486	0.403	0.294	0.105	0.405	0.273	0.121	0.314	0.082	0.114	0.084	0.056	-0.121	0.040	0.033	0.111	0.003	0.097	0.053	0.106	0.122	0.092	-0.053	0.033	0.207	1.000	
H30*	-0.064	-0.288	-0.331	0.074	0.031	0.023	0.073	0.006	0.037	0.057	0.074	0.026	0.057	0.370	0.212	0.060	-0.281	-0.205	-0.152	-0.079	-0.286	0.305	0.267	0.292	0.260	-0.090	-0.339	0.094	0.322	0.106	1.000

*Note: * correlation coefficients are significant at 5 percent level with H0. H0 denotes approach distance of the household from NH2 (in km)*

Comparison of Means

As a preliminary analysis, it has been examined whether the mean values of a variable for the influence and control zones differ significantly. This has been done by testing for each variable the null hypothesis that population means for the two zones are the same. Table 3 presents the sample mean values of individual outcome variables for the influence and control zones. In this Table, the cases in which the difference in the two means is significant have been marked with an asterisk[3].

Table 3: Mean values of the selected socio-economic variables at household level separately for influence and control zone

Variable		Mean value	
		Influence zone	Control zone
Incidence of poverty			
H1*	Proportion of poor households based on poverty line measured in terms of MPCY	34.61	37.32
H2*	Proportion of poor households based on poverty line measured in terms of MPCE	43.89	44.30
Mobility			
H3	Per capita trip rate (PCTR)	0.89	0.81
H4*	Per capita trip rate for work	0.55	0.42
H5	Per capita trip rate for marketing	0.09	0.09
H6	Per capita trip rate for education	0.21	0.26
H7*	Per capita trip rate for accessing health-related services	0.01	0.02
H8*	Per capita trip rate involving travel on NH2	0.42	0.24
H9	Per capita trip length for trips involving travel on NH2	3.75	3.33
H10	Per capita travel expenses for trips involving travel on NH2	1.17	0.93
H11	Per capita travel time for trips involving travel on NH2	18.24	15.82
H12	Travel cost per person km for trips involving travel on NH2	0.000023	0.000040
Income, employment and occupation			
H13	Per capita income (annual)	8223	7906
H14	Per capita consumption expenditure (monthly)	556	598
H15*	Share of income from self-employment in non-agricultural activities	14.84	8.31
H16*	Share of food in consumption expenditure	40.37	37.59
H17	Proportion of working members in a household in age group 15-59 years	49.38	48.45
H18	Proportion of working female members in a household in age group 15-59 years	8.76	8.25
H19*	Proportion of non-agricultural workers in total working household members.	56.09	48.4
Asset ownership			
H20*	Proportion of landless households	46.59	42.1
H21*	Proportion of households owning at least one information related consumer durable	25.80	25.28
H22*	Proportion of households owning at least one motorised transport vehicle	7.24	7.54
Education and health			
H23	Proportion of school-going children among all children in age group 6-14 years	82.73	84.76
H24	Proportion of female school-going children among all female children in age group 6-14 years	78.18	79.20
H25	Proportion of household members who availed of medical facilities during last six months	13.40	12.85
Attitudinal response			
H26*	Proportion of households who rate themselves poor or very poor	45.28	50.64
H27*	Proportion of households who expect improvement in employment situation after 4-laning of NH2	75.52	76.19
Well-being index			
H28	Index of overall well-being based on income, employment, health and education	1056.48	1017.74
H29*	Index of transport mobility	1625.27	1529.37
H30*	Index of access to infrastructural facilities, assets and amenities.	1604.21	1483.63

* *Significant at 5 percent level*

[3] The significance of means has been tested using t-statistics.

As these results show, for 15 out of 30 variables, the null hypothesis of equality of the mean value for the two zones is rejected. Of the variables for which the difference in means turns out to be significant, two relate to the incidence of poverty (H1, H2); three to mobility (H4, H7, H8); three to income and employment (H15, H16, H19); three to asset ownership (H20, H22); two to attitudinal response (H26, H27); and two to well-being indices (H29, H30). These results, thus, on the whole, tend to support the basic neighbourhood premise for studying the effects of proximity to NH2 on the well-being of the population.

Single Difference Analysis based on PSMT

As explained in chapter 1, the propensity score matching technique (PSMT) may help measure the impact in respect of individual outcome variables. Briefly, for every sample household in the influence zone, PSMT identifies a (set of) matched (i.e., comparable) sample household(s) in the control zone and computes and compares the average values of each outcome variable for the population of the influence zone and the corresponding matched population of the control zone[4].

PSMT involves two steps. In the first step, a binary logit analysis is performed (based on the entire sample) to estimate for each individual sample household (irrespective of whether it belongs to the influence zone or the control zone) the probability of its being located in the influence zone, given the observed values of relevant household characteristics, etc. Using these estimated probabilities and an appropriate distance criterion, a set of matched control zone households for each influence zone household is identified[5]. In the second step, for every outcome variable, the averages of observed values for the influence zone sample and the corresponding control zone *matched* sample are computed. The difference between these two computed averages for an outcome variable is taken as a measure of impact in respect of the particular variable. The estimated logit model, based on which PSMT has been performed, is presented in Appendix 1.

It may be noted that the set of explanatory variables of the above-mentioned estimated logit model mostly includes household attributes. Some of these may be

4. See Chapter 1 on Methodology for a more detailed explanation.
5. To be specific, for each influence zone sample household, the corresponding matched sample households of the control zone have been identified by using the odds ratio for a household for being an influence zone household. Suppose P is the estimated propensity score of an influence zone sample household and P_c is that for a control zone sample household. Denote the corresponding odds ratios as $\pi = P/(1-P)$ and $\pi_c = P_c/(1-P_c)$. If $(\pi - \pi_c)^2 \leq 0.005$, then the control zone sample household is chosen as the matched household for the influence zone household under consideration. Using this criterion, for each influence zone household, matched households have been found out.

regarded as endogenous variables in the sense that these are partly determined by the category to which a sample household belongs (in the present case, these categories are whether a household is in the influence zone or control zone). Normally, such endogeneity problems of explanatory variables would bias the impact estimator. If the households had the option to choose their location, the ideal set of explanatory variables for the logit model would have been the variables inducing that choice. However, in the present case, households have not chosen their location, but happen to be located where they are. Since a choice is absent, the cause-effect relationship between the qualitative dependent variable and whatever explanatory variables are chosen is bound to be blurred. For example, whether a household is poor because it is in the control zone or it is in the control zone because it is poor cannot be ascertained. Given the artificiality of PSMT in the present case, the endogeneity issue appears to be somewhat ill-defined.

The estimated gain (loss) for individual outcome variables is presented in Table 4. It may be mentioned that for an outcome variable, the value of which is expected to be smaller for influence zone households compared to that of their matched control zone counterparts (e.g., proportion of poor), the gain due to proximity of NH2 is defined to be $[(v_{cz} - v_{iz})/v_{cz}] \times 100$, where v_{iz} and v_{cz} denote average value of the variable for influence zone households and corresponding matched control zone households, respectively. On the other hand, for an outcome variable, the value of which is expected to be larger for influence zone households compared to that of their matched control zone counterparts (e.g., per capita income), the gain due to proximity to NH2 is defined to be $[(v_{iz} - v_{cz})/v_{cz}] \times 100$.

Table 4: Percentage gain (loss) of selected socio-economic impact variables due to proximity to NH2 of the households in influence and control zones by using propensity score matching technique

Variable		Percentage gain (loss) due to proximity to NH2
Incidence of poverty		
H1	Proportion of poor households based on poverty line measured in terms of MPCY	17.07
H2	Proportion of poor households based on poverty line measured in terms of MPCE	-0.17
Mobility		
H3	Per capita trip rate (PCTR)	9.14
H4	Per capita trip rate for work	31.54
H5	Per capita trip rate for market	2.48
H6	Per capita trip rate for education	-12.52
H7	Per capita trip rate for accessing health related services	-5.8
H8	Per capita trip rate involving travel on NH2	79.1
H9	Per capita trip length for trips involving travel on NH2	13.81
H10	Per capita travel expenses for trips involving travel on NH2	15.79
H11	Per capita travel time for trips involving travel on NH2	16.61
H12	Travel cost per person km for trips involving travel on NH2	1.74
Income, employment and occupation		
H13	Per capita income (annual)	3.22
H14	Per capita consumption expenditure (monthly)	-7.27

H15	Share of income from self-employment in non-agricultural activities	68.34
H16	Share of food in consumption expenditure	11.83
H17	Proportion of working members in a household in age-group 15-59 years	1.76
H18	Proportion of working female members in a household in age-group 15-59 years	0.72
H19	Proportion of non-agricultural workers in total working household members	14.36
Asset ownership		
H20	Proportion of landless households	8.09
H21	Proportion of households owning at least one information-related consumer durable	23.02
H22	Proportion of households owning at least one motorised transport vehicle	58.22
Education and health		
H23	Proportion of school-going children among all children in age-group 6-14 years	-2.67
H24	Proportion of female school-going children among all female children in age-group 6-14 years	-2.51
H25	Proportion of household members who availed of medical facilities during last six months	4.05
Attitudinal response		
H26	Proportion of households who rate themselves poor or very poor	20.67
H27	Proportion of households who expect improvement in employment situation after 4-laning of NH2	3.43
Well-being index		
H28	Index of overall well-being based on income, employment, health and education	30.94
H29	Index of transport mobility	6.51
H30	Index of access to infrastructural facilities, assets and amenities	22.21

It would be seen from the above Table that the results show a positive gain in most of the variables except a few which relate to the incidence of poverty measured in terms of poverty line based on MPCE (H2); mobility(H6, H7); per capita consumption expenditure (H14); and access to educational facilities (H23, H24). However, the results are positive when the incidence of poverty is measured using the poverty line based on MPCY(H1). As far as access to educational facilities is concerned, one would expect to see a positive gain for the variables concerned, as access to the highway should improve human well-being, of which access to education is a major component. However, these results may not appear unrealistic, if one recognises the fact that scope for child employment is likely to be greater in the neighbourhood of NH2.

Non-parametric Regression Analysis (NRA)

A working hypothesis running through the present exercise has been the gradient of change postulate. NRA provides a convenient and objective procedure for verifying this kind of hypothesis. This technique supplements the impact results based on PSMT. There is, however, a basic qualitative difference between PSMT and NRA procedure. The impact measured for an individual outcome variable by PSMT is, in principle, an estimate of the pure partial effect of proximity to NH2 (because of the use of matched sets of households while computing the impact). NRA, on the other hand, being essentially a bi-variate procedure, can only measure the total effect, rather than the partial effect, of proximity to NH2 on the variable concerned. A summary of the NRA results is presented in Appendix 2. The results, along with related non-parametric regression curves, have been discussed in detail in a later part of this chapter.

The NRA results support the gradient of change hypothesis for most of the outcome variables. The non-parametric regression curves show a systematic relationship with distance from NH2. However, it may be noted that the distance from NH2 may not be the only explanatory variable influencing the set of outcome variables. There may be other variables like household and village-level characteristics that together with the distance variable affect these outcome variables. Multivariate regression analysis using these as explanatory variables may help in understanding the partial effect of distance from NH2 for individual outcome variables.

Multivariate Regression Analysis (MRA)

MRA has been used as a supplementary exercise to explain the individual outcome variables in terms of the household-level and village-level characteristics, mobility-related variables, etc. For quantitative outcome variables, linear regression equations have been estimated using step-wise OLS. In case the data contains a large number of zero observations for such a variable, censored regression model (tobit regression) has been estimated. For qualitative outcome variables, like landlessness or if a household owns at least one motorised vehicle or some other asset or if a household is below the poverty line, step-wise logit analysis has been done. The results of the multivariate regression analysis are presented in Appendices 3-9.

The MRA results show that for 24 out of 30 outcome variables, a distance-related and/or a transport-related explanatory variable (such as per capita trip rate) has a significant effect with an expected sign. Of the 24 outcome variables, two relate to the incidence of poverty based on income and expenditure (H1, H2); eight to mobility (H3-H5, H8-H12); three to income and expenditure (H13, H14, H16); three to employment (H17-H19); one to asset ownership (H20); two to education (H23, H24); two to attitudinal response (H26, H27); and three to well-being indices (H28, H30).

Developmental Implications of Proximity to NH2

The developmental implications of proximity to a highway can be validated conveniently using the results of NRA and PMST based single difference analysis (SDA) of the household-level data. In what follows, the various developmental implications of proximity to NH2 in terms of NRA and SDA for each outcome variable have been discussed separately for different groups reflecting the various aspects of well-being.

Incidence of Poverty

For obvious reasons, in countries like India, the impact of a public investment project on poverty is considered to be of utmost importance. Thus, impact on poverty is a major concern for the present exercise. One would expect a gain due to proximity to NH2 because access to NH2 should promote income generation by stimulating economic activities via various linkage effects[6]. To put it differently, if one considers two households with similar attributes and resource endowments, one located in a village in the influence zone and the other in the control zone, the probability of the former being poor should be comparatively lower, because such a household would be in a position to make better utilisation of its resource endowments due to proximity to NH2.

For measuring impact on poverty, two different outcome variables have been used; one defined in terms of the poverty line based on MPCY (H1) and the other defined in terms of the poverty line based on MPCE (H2). It may be mentioned in this context that whether consumer expenditure or income should be used for poverty measurement has been a matter of intense debate in the country. Use of consumer expenditure data for this purpose is preferred by many because of two reasons: (i) consumer expenditure relates more directly to nutritional deprivation, which is a major dimension of absolute poverty in developing countries, and (ii) compared to income, consumer expenditure data collected through household survey may be more reliable as a measure of well-being. Standard arguments put forward in this context relate to greater recall lapse and the tendency to underreport in the case of income.

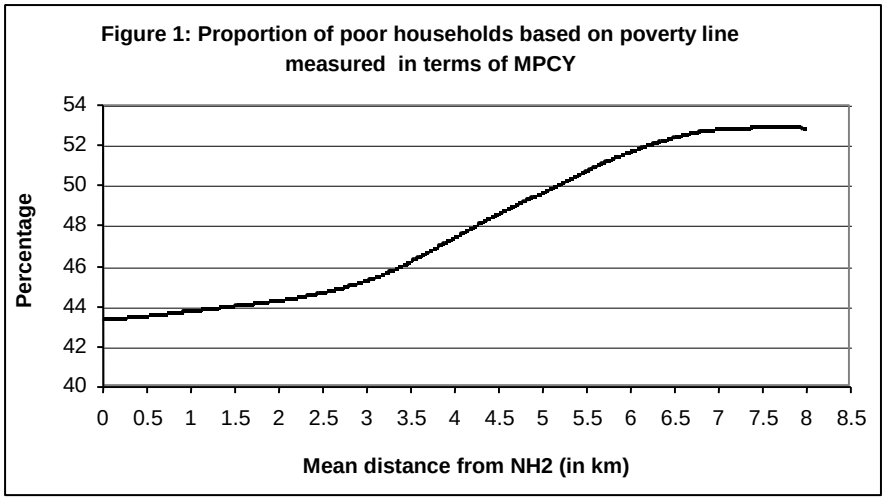
For the MPCE-based poverty variable (H2), the official poverty line has been adopted. Using this, a sample household has been classified as poor if its MPCE is found below the poverty line. The poverty lines for Uttar Pradesh, Bihar and Jharkhand as given by the Planning Commission with appropriate correction for price changes has been used. These poverty lines are Rs.357.73 for Uttar Pradesh, Rs.333.07 for Bihar, and Rs.333.07 for Jharkhand at 2002-2003 prices. Using this poverty line, the sample households have been classified either as poor or non-poor for the outcome variable H1.

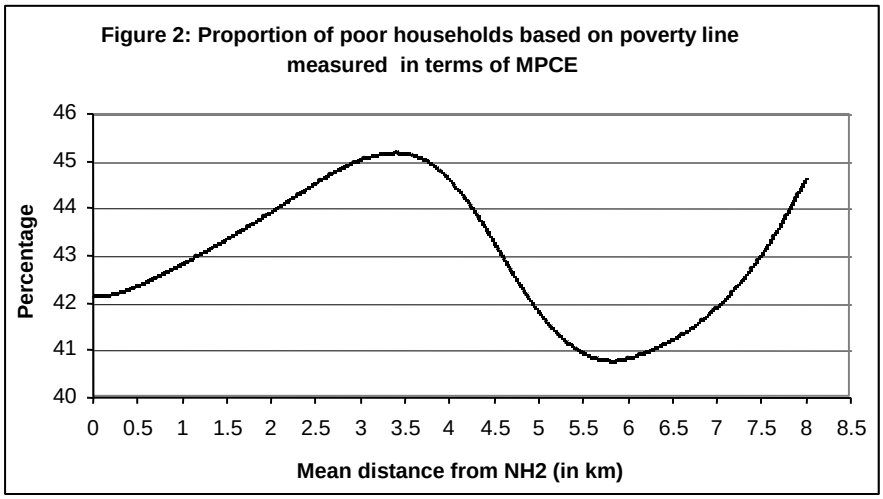
The poverty line in terms of MPCY has been estimated by inverse projection. Using the observed data on MPCE and MPCY, the log-linear consumption function has been estimated by regressing the logarithm of MPCE on the logarithm of MPCY.

6. As mentioned elsewhere, a road development is expected to generate important general equilibrium effects at the national or state level, in addition to major local effects. In an impact analysis based on household/village-level data, one may expect to find out these local effects only.

MPCY corresponding to the given poverty line in terms of MPCE has been calculated from the fitted consumption function. These estimated MPCY values have been used as poverty lines in terms of income. The poverty lines in terms of income thus estimated are Rs.377.77 for Uttar Pradesh, Rs.332.53 for Bihar and Rs.332.53 for Jharkhand at 2002-2003 prices.

The PSMT-based SDA shows that proximity to NH2 results in a gain for poverty based on MPCY, but not for the other poverty variable. In the case of MPCE-based poverty measure, a very small loss is estimated. The NRA results suggest an expected inverse relationship with distance from NH2 for poverty based on MPCY over the entire 0-8 km distance range and an inverse relationship only up to 3.5 km for the other poverty variable[7]. The results of PSMT-based SDA and NRA are thus consistent (see Figures 1 & 2 and Table 4)





7. Beyond 3.5 km, the relationship with distance from NH2 of H1 is wavy.

Mobility

The direct economic benefits of proximity to NH2 are expected to arise mostly from the enhanced mobility of the population living near NH2. For example, a household living close to NH2 should have greater movement for purposes like travel for work, business, education and health. and thus have a larger per capita trip rate, compared to a household, otherwise similar, but not having easy access to NH2. Impact on mobility has, therefore, become an important feature of the present study.

Of the 10 mobility-related outcome variables (see Table 1 for the definitions of these variables numbered H3 - H12), PSMT-based results indicate gain for all except per capita trip rate for education (H6) and for health services (H7). The corresponding NRA results are qualitatively similar, but appear to be somewhat more insightful. For example, the non-parametric regression graphs show that for all variables except H6 and H7, the relationship with distance from NH2 is a monotonic inverse one, either throughout the entire range of distance or up to a certain distance. For both H6 and H7, the relationship with distance is rising. The result for H6 is largely due to the fact that children living in the control zone have to make more trips out of the village for education, because the proportion of villages not having a school is much larger in the control zone. A similar explanation can be given for H7 relating to trips for health services. On the whole, a positive effect of proximity to NH2 is evident in these results. Importantly, this positive effect tends to decline systematically as distance from NH2 increases.

The NRA results show an inverse relationship with distance for per capita trip rate involving travel on NH2 (H8), but the relationship for per capita trip length for trips involving travel on NH2 (H9) tends to increase with distance from NH2. A similar positive relationship is also noticed for the travel time on NH2 (H11). The per capita weekly spending for travel on NH2 (H10) as well as travel cost per person km on NH2 (H12), tends to be higher for households in the influence zone. While an inverse relationship with distance is observed in the case of per capita spending for travel on NH2 (H10), the cost per person km for travel on NH2 (H12) is found to be declining only up to 4.5 km. All these imply higher use and ability and/or willingness to pay for travel along NH2 for households nearer NH2. Finally, it may be pointed out that for most of the variables, the NRA graphs display a change in shape/curvature around a distance of 4-6 km (see Figures 3-12 and Table 4).

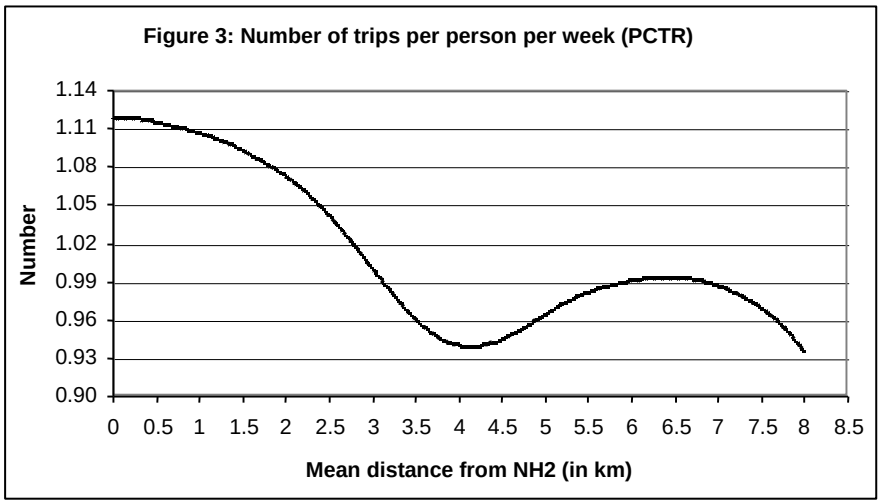


Figure 3: Number of trips per person per week (PCTR)
Number
1.14
1.11
1.08
1.05
1.02
0.99
0.96
0.93
0.90
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5
Mean distance from NH2 (in km)

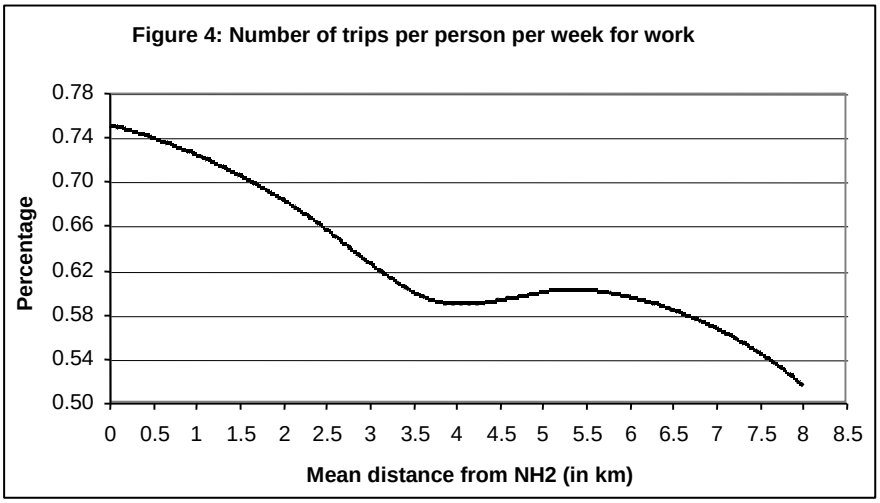


Figure 4: Number of trips per person per week for work
Percentage
0.78
0.74
0.70
0.66
0.62
0.58
0.54
0.50
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5
Mean distance from NH2 (in km)

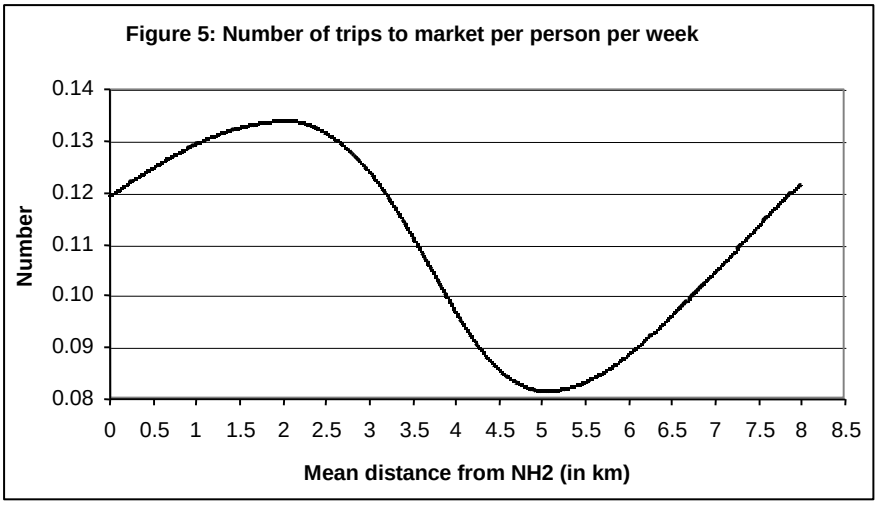


Figure 5: Number of trips to market per person per week
Number
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5
Mean distance from NH2 (in km)

Figure 6: Number of trips per person per week for education

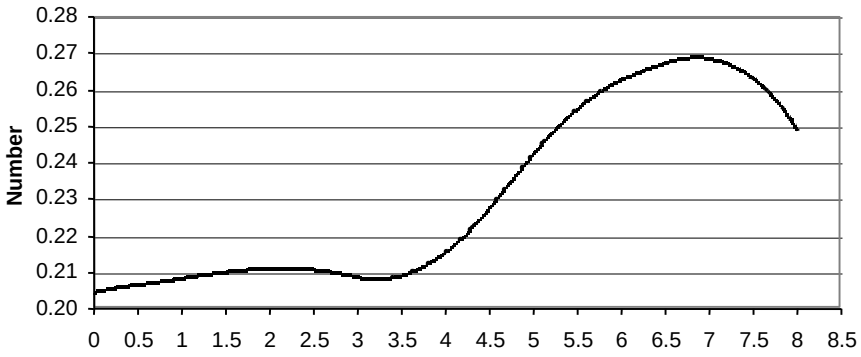


Figure 7: Number of trips per person per week for accessing health-related services

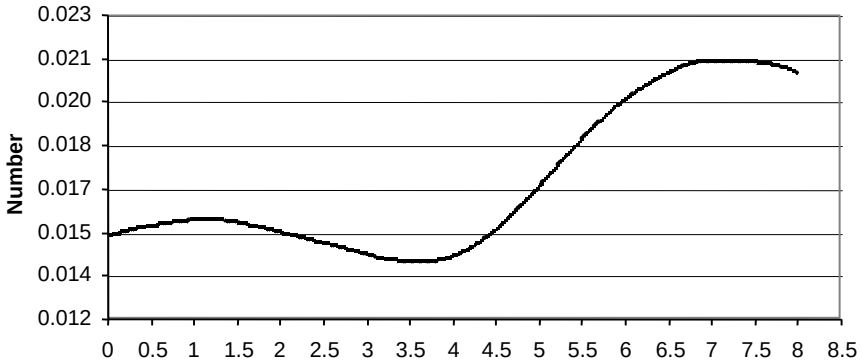


Figure 8: Number of trips per person per week involving travel on NH2

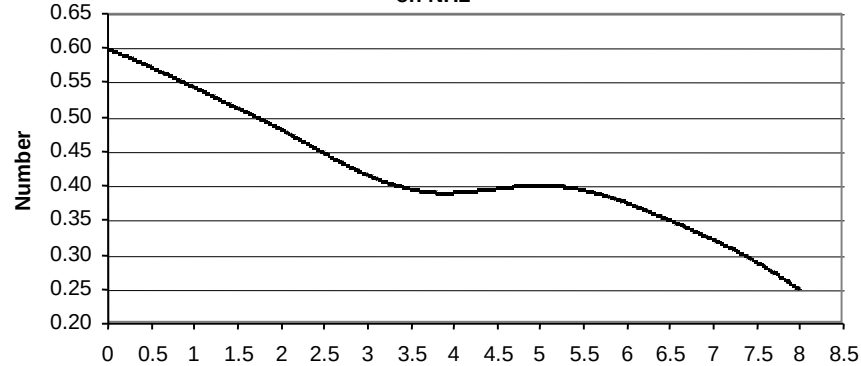


Figure 9: Per capita weekly trip length for trips involving NH2

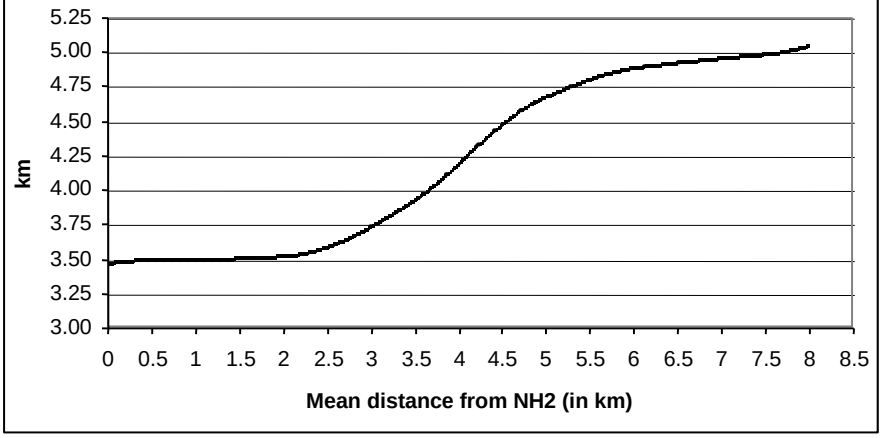


Figure 10: Per capita weekly travel expense for trips involving NH2

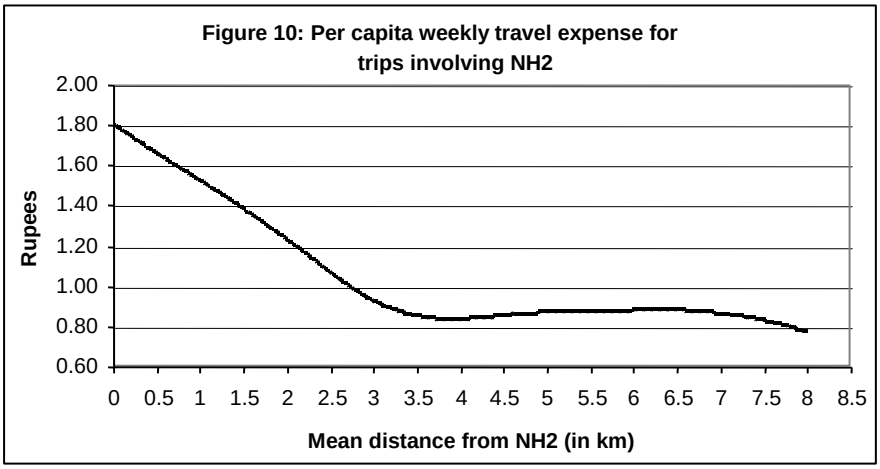
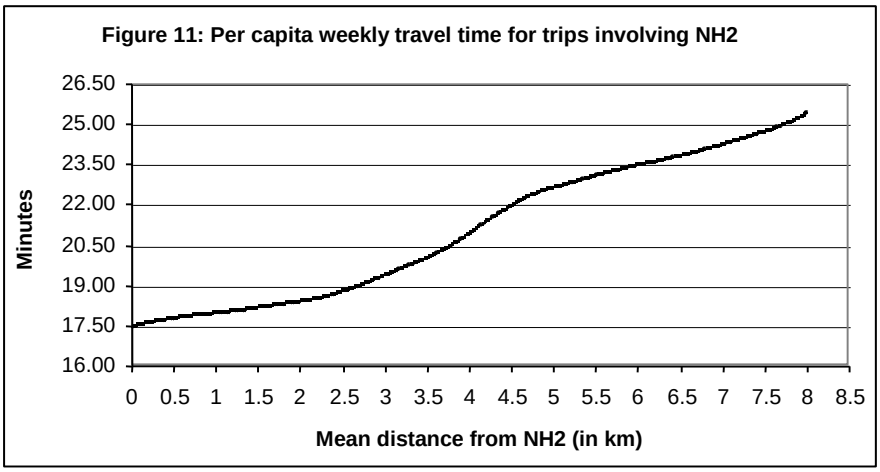
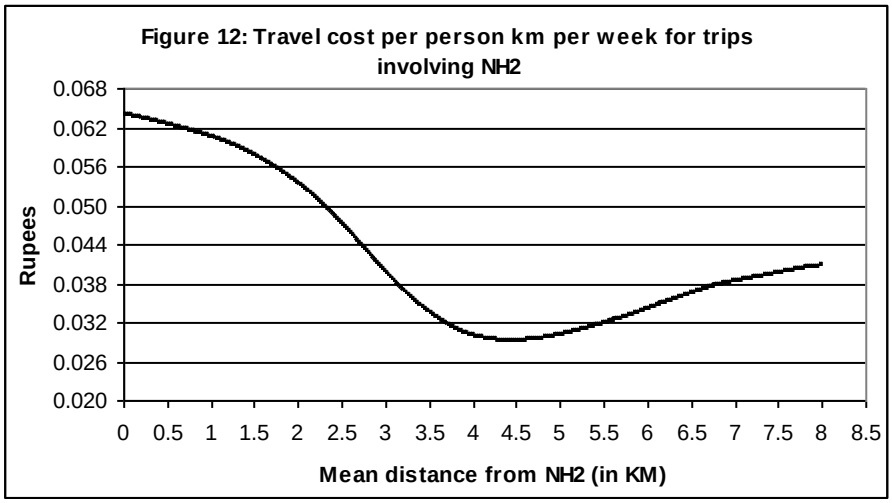


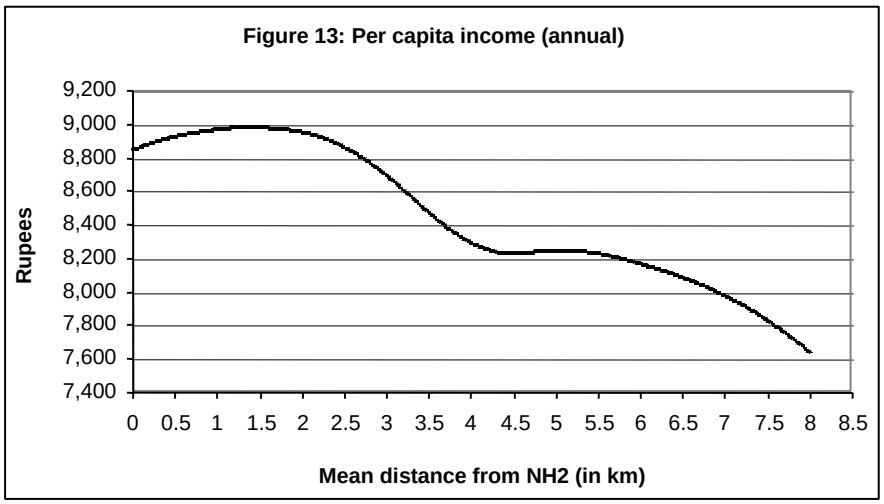
Figure 11: Per capita weekly travel time for trips involving NH2

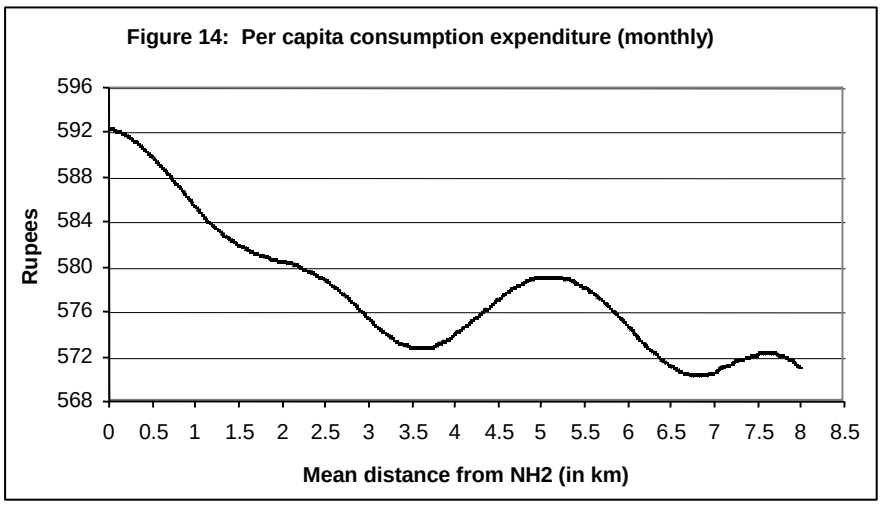




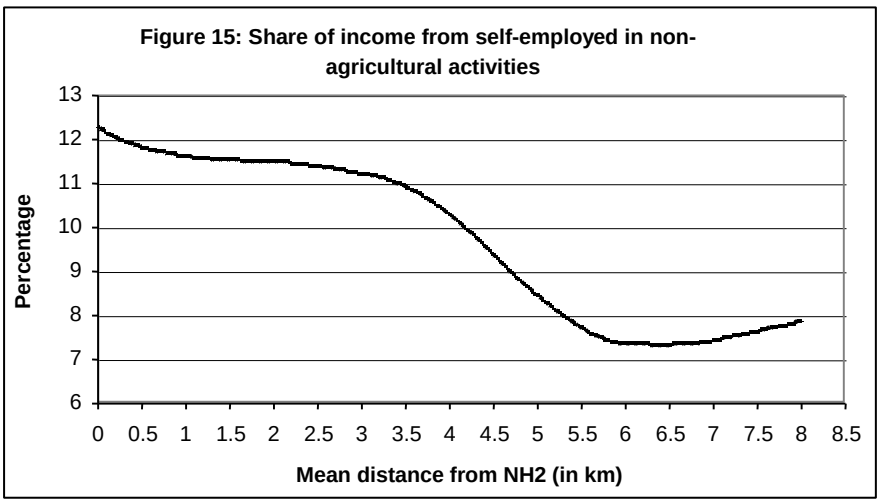
Income, Employment and Occupation

The PSMT-based results indicate gain due to proximity to NH2 for all the variables in this group except per capita consumer expenditure (H14). The NRA results also support this. Moreover, as per the NRA results, while per capita income tends to decline with distance from NH2, the relationship with consumption expenditure is a monotonically declining one up to a distance of about 3.5 km, beyond which the relationship is not so well defined (see Figures 13-14 and Table 4). The results relating to the income variable are as expected, because a major advantage of living close to a road/highway is to have a greater chance of benefiting from economic opportunities that a highway may offer.

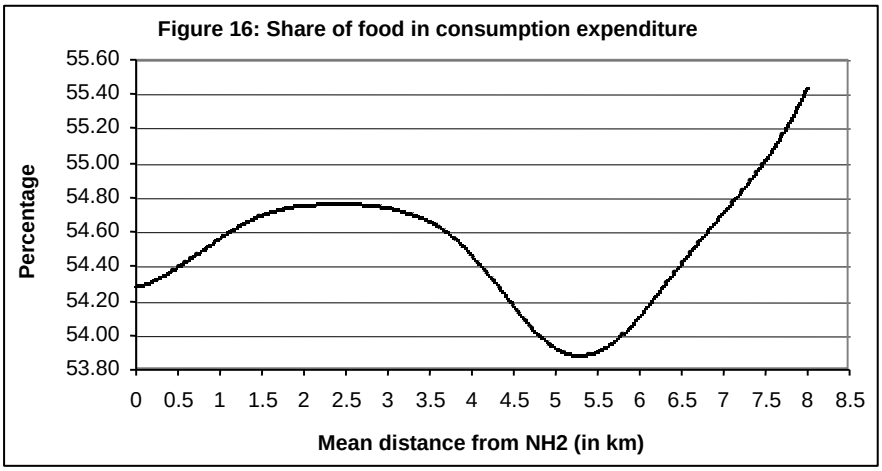




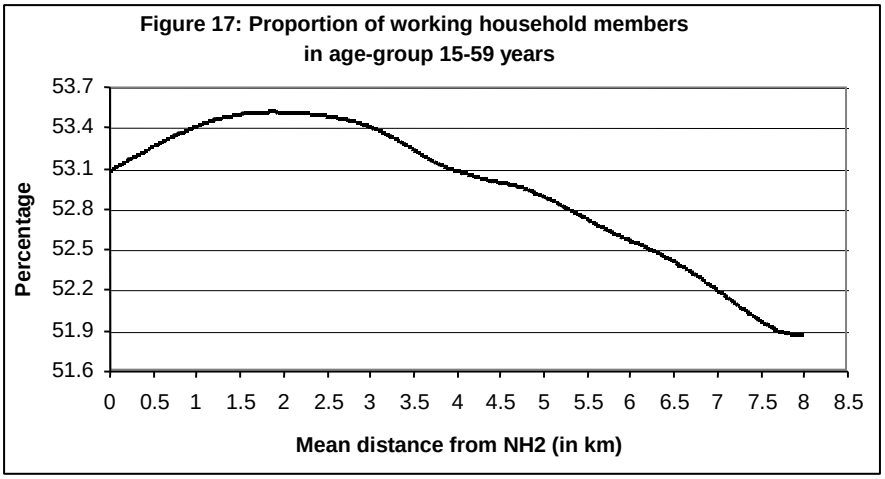
As regards the share of household income from self-employment in the non-farm sector (which is an important indicator of rural development), the estimated non-parametric regression curve shows an inverse relationship with distance from NH2 up to a distance of 5.5 km (see Figure 15 and Table 4). This is quite expected as more non-farm activities generally develop in the vicinity of a highway.

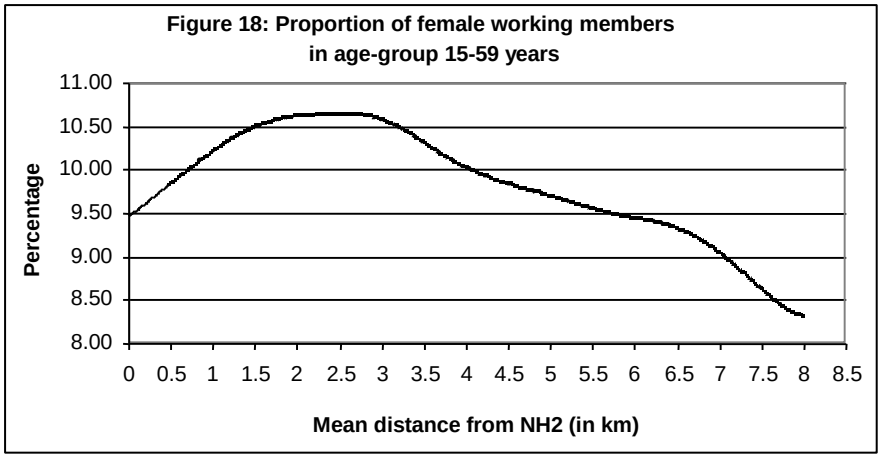


The nature of relationship between per capita food expenditure and distance from NH2 has not been brought out unequivocally in the present exercise. While the PSMT results suggest higher food expenditure for households in the influence zone, the estimated non-parametric curve of regression indicates an oscillating relationship with distance from NH2 for per capita food expenditure. The well-being implication of these results cannot, however, be fully spelt out without having a more detailed analysis of the composition of the total consumer expenditure as well as that of food expenditure (see Figure 16 and Table 4).

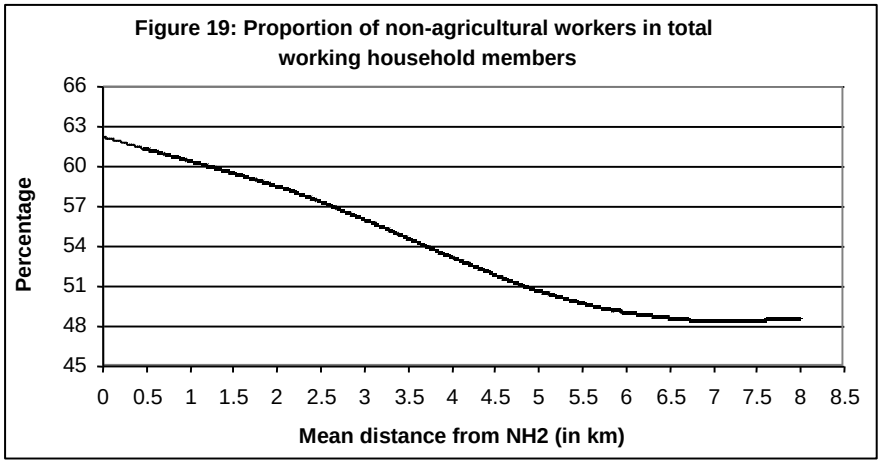


NRA results show that the labour participation rate, both overall and that for the females, tends to decline between 2 and 8 km from NH2 after an initial rise in the 0-2 km distance range. The PSMT results support the nature of relationship for these outcome variables (Note that the labour participation rate here has been measured for the population in the age-group of 15-59 years.) (see Figures 17-18 and Table 4).



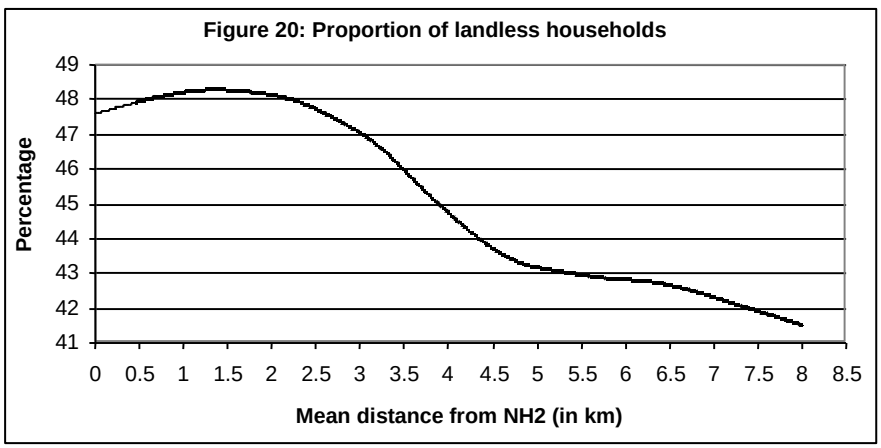


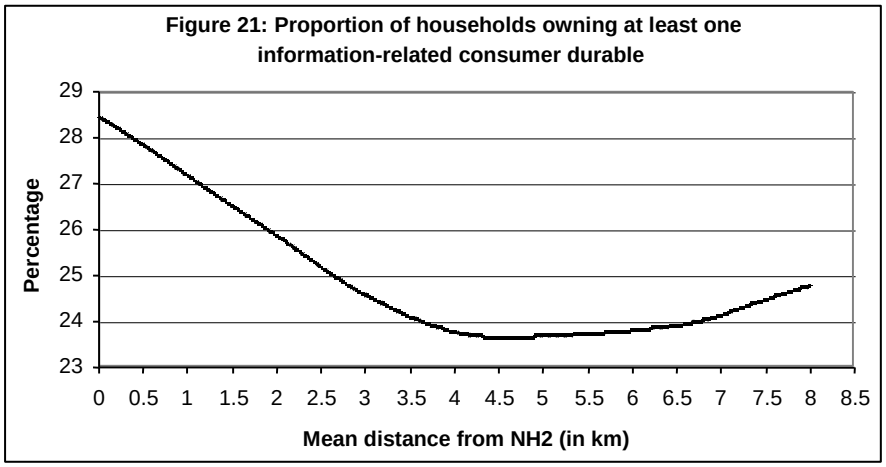
Finally, as regards the impact on the occupational pattern of household members, the NRA results show that the share of employment in non-agricultural activities declines up to a distance of 7 km from NH2. The PSMT result also shows a gain with respect to this variable as indicated by a positive gain due to the proximity to the highway (Figure 19).

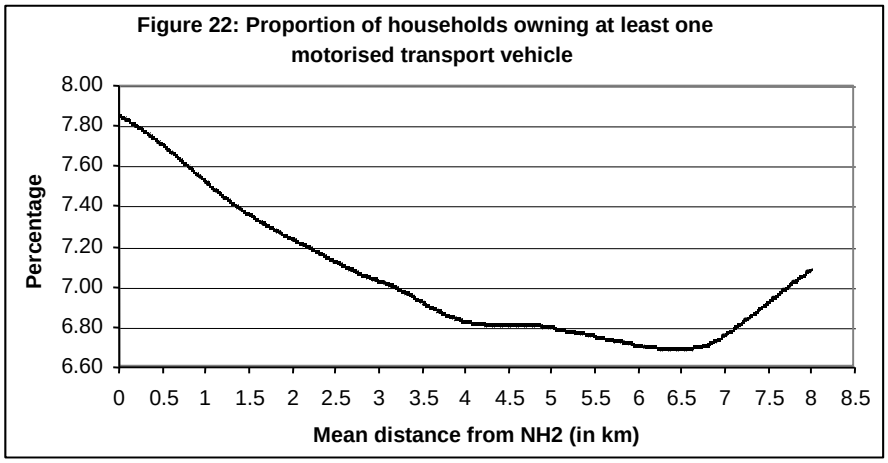


Assets and Ownership

The PSMT results show that proximity to NH2 leads to improvement/gain for all the variables. The NRA results indicate that the probability of a household being landless tends to decline with distance from NH2 between 2 km and 8 km after an initial rise in the range of 0-2 km, thus broadly corroborating the PSMT results. The observed inverse relationship for the proportion of the landless may probably be justified by the corresponding inverse relationship between land price and distance from NH2. As regards the ownership of a consumer durable (information-related), an inverse relationship with distance with a gentle wavy pattern is indicated by NRA. Such relationship in case of ownership of at least one motorised transport is clearly an inverse one up to 6.5 km (see Figures 20-22 and Table 4).







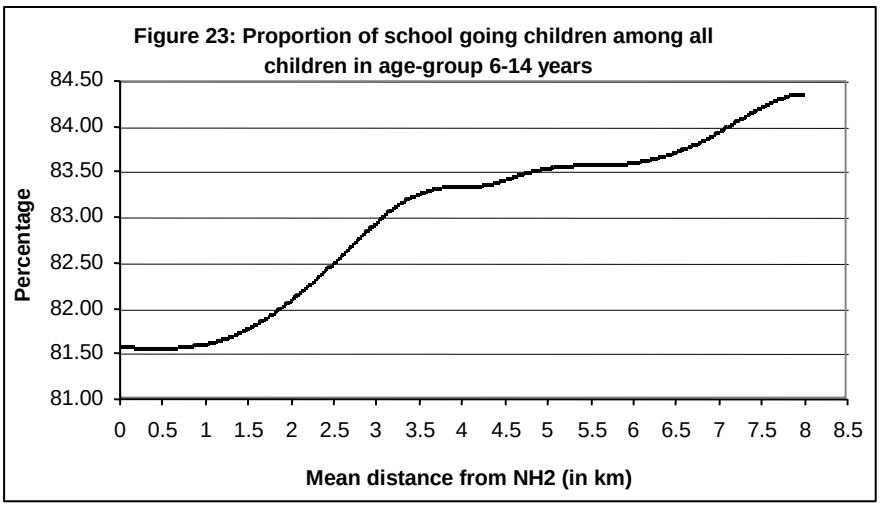
Thus, the asset ownership pattern conforms to the hypothesis that the households located nearer NH2 are better endowed with the kind of assets considered. It may, however, be pointed out that asset ownership has been considered in a very limited sense and, therefore, the findings need not be taken as all-pervasive.

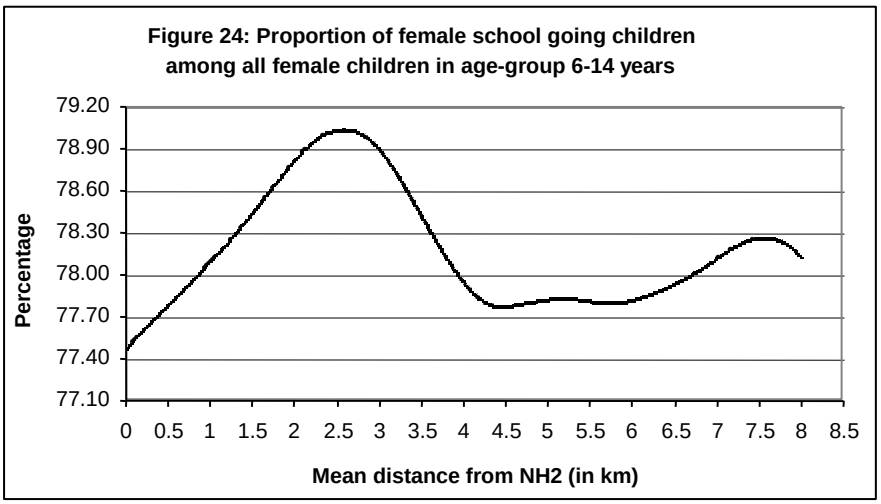
Education and Health Facilities

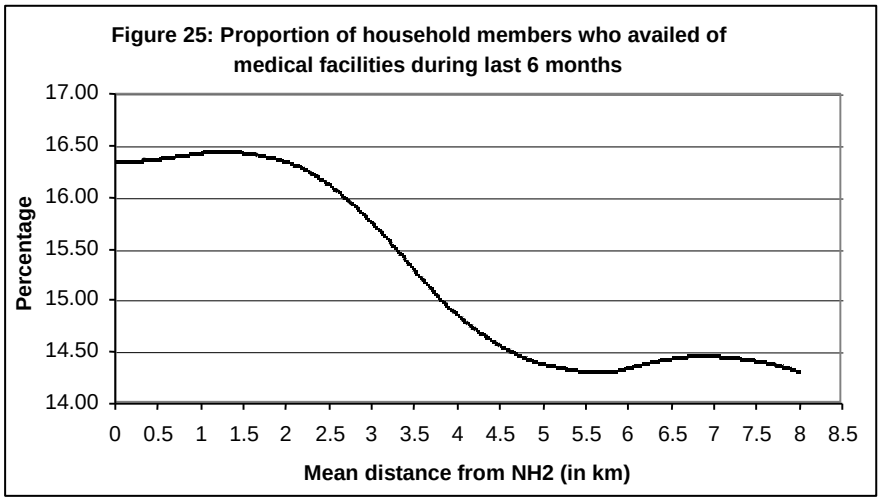
Three outcome variables relating to access to education and health facilities have been considered in the present exercise. Only for the variable proportion of family members who visited medical personnel in the last 6 months (H25), the PSMT-based results suggest a gain/improvement due to proximity to NH2. The variables for which loss/deterioration has been observed are the proportions of school-going children (H23) and female school-going children (H24). The NRA results broadly support this observation. The non-parametric regression curve for the proportion of school-going children is found to be positively related to distance and that for the

proportion of school-going female children has a positive slope up to 2.5 km, followed by a decline. These results may not appear unrealistic, if one recognises the fact that scope for child employment is much greater in the neighbourhood of NH2 (see Figures 23-24 and Table 4).

As regards access to health facilities, the NRA results show that the relationship between distance from NH2 and proportion of family members visiting medical personnel is an inverse one up to a distance of 5.5 km. This result may be suggestive of the possibility that the availability of and access to health facilities declines as distance from NH2 increases. It may be noted that these findings are also in overall conformity with those with respect to mobility for education, though not entirely in respect of mobility for health services (see Figure 25 and Table 4).

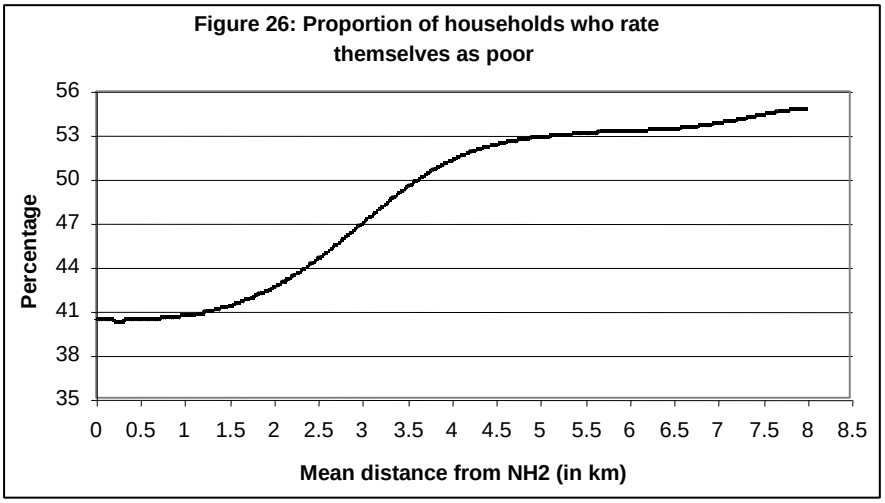


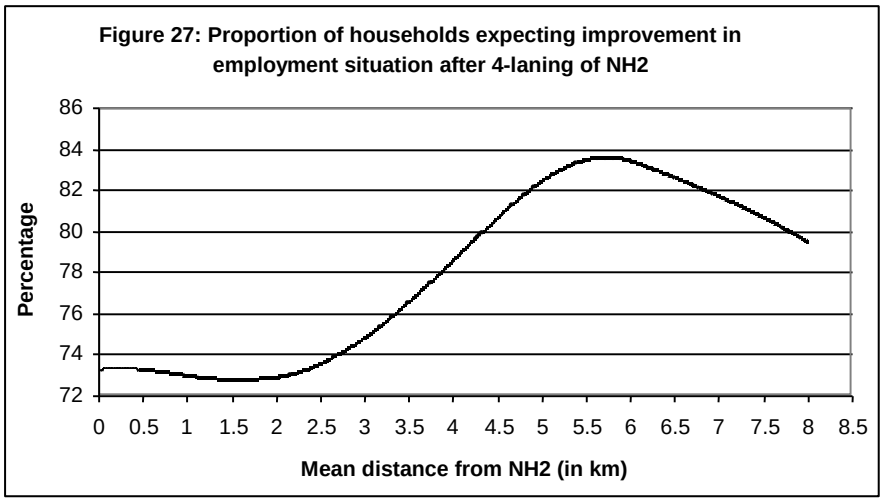




Attitudinal Response

The NRA results show that for two attitudinal variables, viz., whether a household rates itself to be poor and whether it expects higher employment opportunity after the 4-laning of NH2, the relationship with distance from NH2 is a positively sloped one over the entire distance. In other words, the proportion of households that regard themselves to be poor tends to be higher in villages farther away from NH2. The positive relationship with distance of the other response variable, on the other hand, reflects the increasing optimism of the population living farther away from NH2 in respect of improvement in employment prospects due to the expansion of the highway (see Figures 26-27 and Table 4).





Well-being Indices

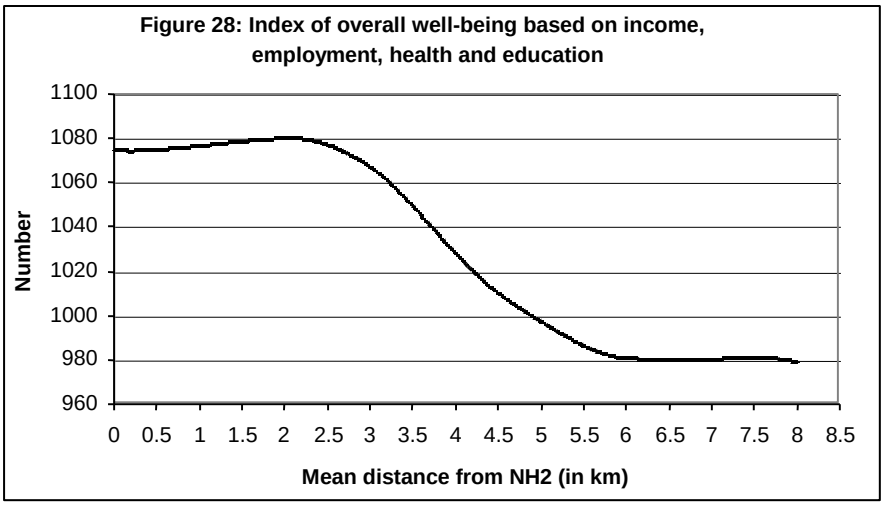
Finally, the impact of proximity to NH2 has been analysed for the three well-being indices: (i) index of overall well-being; (ii) index of well-being in respect of mobility; and (iii) index of well-being in respect of access to amenities like electricity, safe drinking water, proper sanitation, and other assets. These indices have been constructed as the BORDA index by first merit-ranking all the households according to their scores in respect of the value of the constituent items and then calculating an ordinal aggregator as per the BORDA rule. The households have been ranked according to the sum of the rank scores on the constituent counts as per this rule and have been given the overall rank in a descending order.

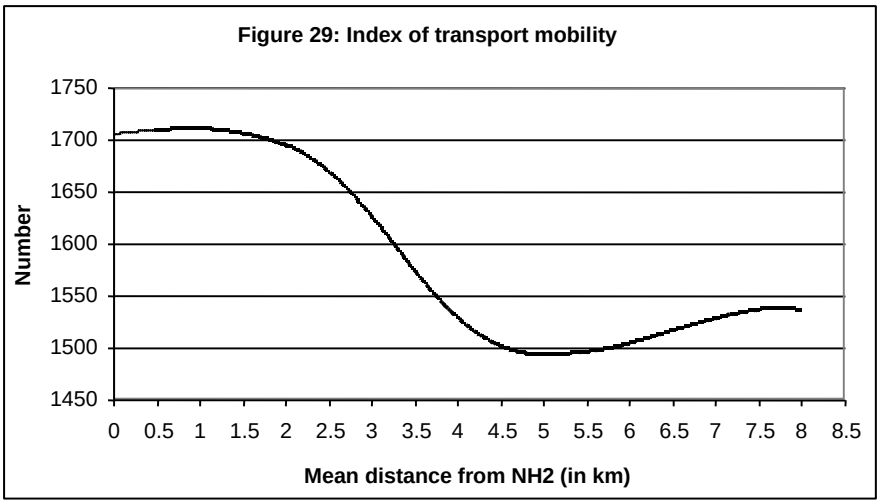
The household level overall index of well-being has been compiled using the household specific data on: (a) per capita income, (b) share of income earned from self-employment in non-agricultural activities, (c) labour participation rate, (d) proportion of family members visiting health personnel, and (e) proportion of school-going children. It may be noted that some of these variables are related to entitlement to well-being [like (a) and (c)], while others relate to capability for well-being [viz., (b), (d) and (e)]. The NRA graph for this index shows an inverse relationship with distance from NH2. The PSMT results also indicate a substantive gain of 30.94 percent because of proximity to NH2.

The second well-being index relating to mobility has been based on the mobility-related outcome variables, such as the per capita trip rate for (i) work, (ii) market, (iii) health, and (iv) education. As in the case of the overall well-being index,

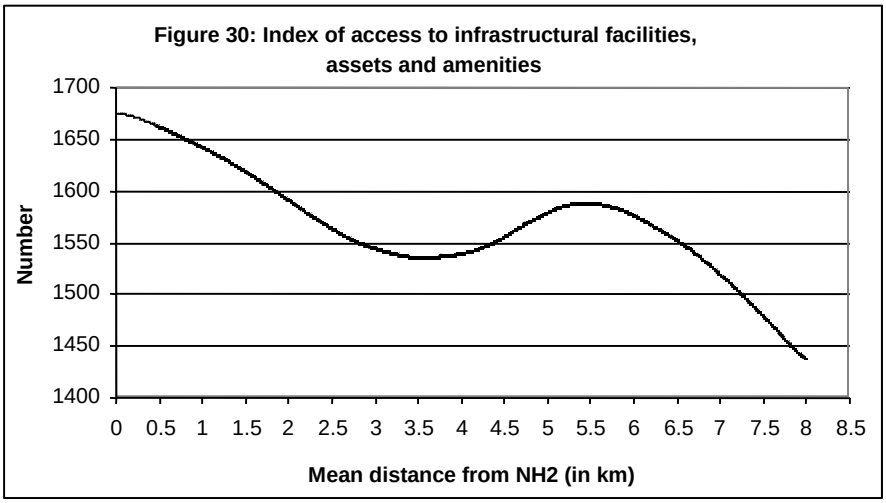
the NRA results show an inverse relationship with distance from NH2 of this index as well. The PSMT result also indicates a gain, thus supporting the NRA result.

Finally, a third well-being index has been compiled by combining household specific responses to such qualitative outcome variables as (a) whether the household has electrical connection, (b) whether it is dependent on biomass for energy[8], (c) whether it has toilet facilities, (d) whether it has access to drinking water, and (e) whether it has a semi-pucca or pucca house. As the NRA results suggest, this index, like the other two, is inversely related to distance from NH2. The PSMT results also show a gain for the households in the influence zone over the matching group of households in the control zone (see Figures 28-30 and Table 4).





8. It may be noted that a lower rank score has been given as a household's dependence on biomass increases.



Comparison of Results

The results obtained by the different methods for all the variables are presented in Table 5. The comparative position enables understanding of the robustness of the conclusions.

Table 5: List of variables that are observed to be significantly related to proximity to NH2 in different analyses

Variable		Method of analysis				
		Correlation analysis	Comparison of means	Non-parametric regression	Propensity score matching	Multi-variate regression
Incidence of poverty						
H1	Proportion of poor households based on poverty line measured in terms of MCPY		√	√	√	√
H2	Proportion of poor households based on poverty line measured in terms of MPCE	√	√	√		√
Mobility						
H3	Per capita trip rate (PCTR)	√		√	√	√
H4	Per capita trip rate for work	√	√	√	√	√
H5	Per capita trip rate for market			√	√	√
H6	Per capita trip rate for education					
H7	Per capita trip rate for accessing health related services		√			
H8	Per capita trip rate involving travel on NH2	√	√	√	√	√
H9	Per capita trip length for trips involving travel on NH2	√			√	√
H10	Per capita travel expenses for trips involving travel on NH2	√		√	√	√
H11	Per capita travel time for trips involving travel on NH2	√			√	√
H12	Travel cost per person km for trips involving travel on NH2				√	√
Income, employment and occupation						
H13	Per capita income (annual)			√	√	√
H14	Per capita consumption expenditure (monthly)			√		√
H15	Share of income from self-employment in non-agricultural activities	√	√	√	√	
H16	Share of food in consumption expenditure		√		√	√
H17	Proportion of working members in a household in age group 15-59 years			√	√	√
H18	Proportion of working female members in a household in age group 15-59 years			√		
H19	Proportion of non-agricultural workers in total working household members.	√	√	√	√	√

Asset ownership						
H20	Proportion of landless households	√	√	√	√	
H21	Proportion of households owning at least one information related consumer durable		√	√	√	
H22	Proportion of households owning at least one motorised transport vehicle		√	√	√	
Education and health						
H23	Proportion of school going children among all children in age group 6-14 years					√
H24	Proportion of female school going children among all female children in age group 6-14 years					√
H25	Proportion of household members who availed of medical facilities during last six months			√	√	
Attitudinal response						
H26	Proportion of households who rate themselves poor or very poor	√	√	√	√	√
H27	Proportion of households who expect improvement in employment situation after 4-laning of NH2		√	√	√	√
Well-being index						
H28	Index of overall well-being based on income, employment, health and education			√	√	√
H29	Index of transport mobility	√	√	√	√	√
H30	Index of access to infrastructural facilities, assets and amenities.	√	√	√	√	√

The summary of results clearly suggests that proximity to NH2 has a significant relationship with (i) incidence of poverty (proportion of poor households), (ii) transport and mobility (per capita trip rate, per capita trip rate for work, and per capita trip rate involving travel on NH2), (iii) extent of income and employment in non-farm activities (share of income from self-employment in non-agricultural activities and proportion of non-agricultural workers in the total working household members), (iv) asset holding (proportion of landless households), (v) attitudinal responses (proportion of households which rate themselves poor or very poor and proportion of households which expect that the employment situation will improve after 4-laning of NH2), and (vi) well-being indices (well-being index of transport mobility and well-being index of access to infrastructural facilities, assets and amenities).

Conclusion

This analysis confirms the positive role of the national highway in influencing the well-being of the rural population, including the poverty aspect. The beneficial influence extends up to an approach distance of 5 km on either side of the road and the influence declines as the distance from the highway increases, thus supporting the gradient of change hypothesis. The significant positive impacts relate to incidence of poverty, employment opportunities, assets holding, levels of mobility, access to infrastructural facilities and broad indices of well-being.

Appendices

Appendix 1: Estimated logit model for determining probability of a household falling in the influence zone

	Coefficient	t-statistics	p value
Village variables			
Proportion of scheduled caste and scheduled tribe population in total population	0.00455	2.13	0.03
Average land resource base including common land per household	-0.20577	-6.90	0.00
Whether there is a primary health sub-centre/ primary health centre/health centre in the village	0.70849	4.50	0.00
Whether there is a market in the village	1.10277	4.86	0.00
Whether there is Gram Sabha in the village	-0.38139	-3.94	0.00
Whether there is a primary school in the village	0.03035	0.30	0.77
Proportion of net sown area in total reported area	0.00241	0.99	0.32
Whether the village is connected with electricity	0.02205	0.19	0.85
Distance from nearest urban centre	-0.02743	-6.01	0.00
Household variables			
Operational land holding (in ha)	-0.00397	-1.37	0.17
Whether the household is availing of any poverty alleviation programme of the govt.	0.16755	1.32	0.19
Whether the household finds experience with the government officials to be non-helpful	0.29759	2.70	0.01
Whether any of the children in the household does not attend school because the household cannot afford to pay school fee	-0.25268	-1.62	0.11
Whether the main source of cooking is biomass	0.00459	0.05	0.96
Whether safe drinking water is being availed of by the household	-0.29290	-2.97	0.00
Whether the household head is illiterate	0.18692	1.61	0.11
Whether the household head has studied up to middle level	-0.09477	-0.71	0.48
Whether the household head has studied up to primary level	0.16010	1.00	0.32
Whether any of the female family members was elected as an office bearer of Panchayat	-0.30284	-1.52	0.13
Whether the household has space available for livestock	-0.23158	-2.57	0.01
Whether the household head is satisfied with the functioning of Panchayat	0.39695	4.44	0.00
Whether the households treat female members on a par with the male members for availing of educational facilities	0.17304	1.44	0.15
Whether the household has electricity	0.72581	4.31	0.00
Whether the household owns clock/ wrist watch	-0.17513	-1.87	0.06
Whether the household belongs to SC community	-0.00223	-0.02	0.98
Household size	0.00090	0.06	0.95
Whether the household belongs to ST Community	-0.42919	-1.53	0.13
Nature of house – katcha	-0.17269	-1.64	0.10
Nature of house – semi-pucca	-0.04458	-0.38	0.70
Nature of house – thatched	-0.52539	-2.82	0.01
Whether the household head was born in the village	-0.12803	-0.51	0.61
Whether any of the children in the household does not attend school because he/ she is needed for work at home/field	-0.19841	-1.16	0.25
Number of rooms in the house	0.03517	1.45	0.15
Whether the household owns bicycle	-0.12679	-1.33	0.18
Whether the household avails of PDS	-0.67521	-4.05	0.00
Proportion of females among adults	-0.00377	-1.20	0.23
Whether the household belongs to Hindu community	-0.73620	-3.64	0.00
Whether the household head rates the road development activity as very important	-0.23708	-2.65	0.01
Whether the household head is male	-0.13950	-0.52	0.61
Whether the household has access to sanitation (toilet)	0.30798	1.88	0.06
Constant	2.53394	4.17	0.00

Log Likelihood Function: -1847.35 Number of Observation: 3181

Note: In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 2: Results of household-level indicators based on non-parametric regression analysis

Variable		Gradient of change
Incidence of poverty		
H1	Proportion of poor households based on poverty line measured in terms of MPCY	Rises monotonically throughout
H2	Proportion of poor households based on poverty line measured in terms of MPCE	Rises up to 3.5 km
Mobility		
H3	Per capita trip rate (PCTR)	Declines up to 4 km
H4	Per capita trip rate for work	Declines throughout
H5	Per capita trip rate for market	Declines between 2 and 5km
H6	Per capita trip rate for education	Rises up to 6.5 km
H7	Per capita trip rate for accessing health-related services	Minor declining trend up to 3.5 km then reverses sharply thereafter
H8	Per capita trip rate involving travel on NH2	Declines throughout
H9	Per capita trip length for trips involving travel on NH2	Rises up to 7 km
H10	Per capita travel expenses for trips involving travel on NH2	Declines up to 4 km
H11	Per capita travel time for trips involving travel on NH2	Rises throughout
H12	Travel cost per person km for trips involving travel on NH2	Declines up to 4.5 km
Income, employment and occupation		
H13	Per capita income (annual)	Declines throughout
H14	Per capita consumption expenditure (monthly)	Declines up to 3.5 km
H15	Share of income from self-employment in non-agricultural activities	Declines up to 5.5 km
H16	Share of food in consumption expenditure	Wide fluctuations
H17	Proportion of working members in a household in age-group 15-59 years	Declines between 2 and 8 km
H18	Proportion of working female members in a household in age-group 15-59 years	Declines between 2 and 8 km
H19	Proportion of non-agricultural workers in total working household members	Declines monotonically up to 7 km
Asset ownership		
H20	Proportion of landless households	Declines between 2 and 8 km
H21	Proportion of households owning at least one information related consumer durable	Declines up to 4.5 km
H22	Proportion of households owning at least one motorised vehicle	Declines up to 6.5 km
Education and health		
H23	Proportion of school-going children among all children in age-group 6-14 years	Rises up to 8 km
H24	Proportion of female school-going children among all female children in age-group 6-14 years	Rises up to 2.5 km followed by decline
H25	Proportion of household members who availed of medical facilities during last six months	Sharp decline up to 5.5 km
Attitudinal response		
H26	Proportion of households who rate themselves poor or very poor	Rising trend up to 8 km
H27	Proportion of households who expect improvement in employment situation after 4-laning of NH2	Rising trend up to 5.5 km
Well-being index		
H28	Index of overall well-being based on income, employment, health and education	Declines sharply between 2 and 8 km
H29	Index of transport mobility	Declines Sharply between 2 and 5 km
H30	Index of access to infrastructural facilities, assets and amenities.	Declines up to 4.5 km

Appendix 3: Results of multivariate regression analysis (incidence of poverty)

Independent variables	Dependent variable (incidence of poverty)	
	Whether household is poor based on poverty line measured in terms of MPCY	Whether household is poor based on poverty line measured in terms of MPCE
	Coefficient	Coefficient
Village level		
Proportion of scheduled caste and scheduled tribe population in total population		
Average land resource base including common land per household		
Whether there is primary health sub-centre/ primary health centre/ health centre in the village	0.7293368	
Whether there is a market in the village		
Whether there is a Gram Sabha in the village		
Whether there is a school in the village		-0.3204395
Proportion of literate population in total population in age-group more than 6 years		
Proportion of landless households in total households		
Proportion of non-agricultural workers in total main workers		
Proportion of net sown area in total reported area		
Whether the village is connected with electricity		
Distance from nearest urban centre		0.0113488
Household level		
Whether the household falls in the influence zone	-0.4310141	
Per capita income		-0.000225
Per capita trip rate		-0.1547311
Proportion of literate members in total household members in age-group of more than 6 years	-0.010801	-0.0091598
Household size	0.077293	0.1182108
Operational landholding (in ha)	-1.29048	-0.5965643
Proportion of working members in a household in age-group 15-59 years	-0.0495017	
Whether the household head is literate		
Proportion of non-agricultural workers in total working household members	-0.0135953	
Whether the household belongs to Hindu community		
Occupation of the household head – cultivator	0.4131366	
Occupation of the household head – agricultural wage labour	0.9217122	0.3421888
Occupation of the household head – non-agricultural wage labour	0.804409	0.7164328
Occupation of the household head – self-employed or salaried class in non-agriculture		0.2662365
Constant	2.712377	1.087945
Type of regressions used	logit	logit
Pseudo R-squared	0.2284	0.2681
Log likelihood	-622.02083	-1571.5559
Number of included observations	1165	3130

Note: (1) All coefficients are significant at 0.05 levels.
(2) In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 4: Results of multivariate regression analysis (transport mobility)

Independent variables	Dependent variable (Transport mobility)									
	Per capita trip rate (PCTR)	Per capita trip rate for work	Per capita trip rate for market	Per capita trip rate for education	Per capita trip rate for accessing health related services	Per capita trip rate involving travel on NH2	Per capita trip length for trips involving travel on NH2	Per capita travel expenses for trips involving travel on NH2	Per capita travel time for trips involving travel on NH2	Travel cost per person km for trips involving travel on NH2
	- Coefficient -									
Village level										
Proportion of scheduled caste and scheduled tribe population in total population							-0.0760263		-0.3124357	
Average land resource base including common land per household		-0.1228366				-0.10812	-1.272214		-6.557724	
Whether there is primary health sub-centre/ primary health centre/ health centre in the village								4.754917		0.1522154
Whether there is a market in the village	-0.4103088					-0.5944359	-6.328		-36.33285	
Whether there is a Gram Sabha in the village										
Whether there is a school in the village				-0.4684686				4.093649		
Proportion of literate population in total population in age-group more than 6 years		-0.0125391	0.0032442			-0.0115451	-0.177319		-0.9029628	
Proportion of landless households in total households				-0.018837		-0.0094069	-0.0783246		-0.4276316	
Share of non-agricultural workers in total main workers		0.0228444	-0.0021479					0.1386406		0.0035781
Proportion of net sown area in total reported area	-0.0089501	-0.0125465			-0.0083206					
Whether the village is connected with electricity	-0.593256	-0.5056775		-1.325062		-0.3557113				
Distance from nearest urban centre		-0.0222488	0.0043027			-0.0153837	-0.1821383		-0.7657932	
Household Level										
Whether the household falls in the influence zone								-11.87822		-0.1349767
Per capita income										
Per capita trip rate										
Proportion of literate members in total household members in age-group of more than 6 years	0.0077074			0.0284395		0.0074301	0.1123433	0.1229226	0.4837626	0.0015215
Household size	-0.0380274									
Operational landholding (in ha)						0.0706076	0.9962977	1.386637		
Proportion of working family members (age > 6 years) in total family members age > 6 years	0.0116904	0.0317692	0.0024296	-0.0446483		0.0066639	0.0638393		0.4082784	0.0032331
Whether the household head is literate		0.4486979								
Proportion of working members in a household in age-group 15-59 years	0.0078384		0.0043642		-0.003953	0.0084184	0.0914144		0.4478925	
Whether the household belongs to Hindu community	0.3840786			1.120059						
Approach distance of the household from NH2	-0.0458325	-0.0564125	-0.0125322			-0.1470545	-1.41259	-2.340293	-6.235976	
Household occupation based on share of income from self employment in non-agriculture			0.1444747					7.054142		
Household occupation based on share of income from wage labour				-0.9720802				-5.363453		-0.151407
Constant	-0.6024527	-3.64579	-0.6438206	-4.456722	-1.936258	-1.550514	-17.36445	-25.30331	-83.3022	-0.1710386
Type of regressions used	tobit	tobit	tobit	tobit	tobit	tobit	tobit	tobit	tobit	tobit
Pseudo R-squared	0.0342	0.0629	0.0545	0.067	0.0272	0.0706	0.0311	0.0465	0.0255	0.1445
Log likelihood	-4926.3253	-3251.0992	-1770.4836	-1543.7494	-422.53639	-2964.2445	-5393.2529	-2100.0532	-6911.3965	-399.99406
Number of included observations	3125	3125	3125	3125	3125	3125	3125	3125	3125	971

Note: All coefficients are significant at 0.05 levels.
In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 5: Results of multivariate regression analysis (income, employment and occupation)

Independent variables	Dependent variable (income, employment and occupation)						
	Per capita income (annual)	Per capita consumption expenditure (monthly)	Share of income from self-employment in non-agricultural activities	Share of food in consumption expenditure	Proportion of working members in a household in age group 15-59 years	Proportion of female non-working members in a household in age group 15-59 years	Proportion of non-agricultural workers in total working household members
	- Coefficient -						
Village level							
Proportion of scheduled caste and scheduled tribe population in total population					0.0289158		-0.0415749
Average land resource base including common land per household							
Whether there is primary health sub-centre/ primary health centre/ health centre in the village							
Whether there is a market in the village						7.607544	
Whether there is Gram Sabha in the village							
Whether there is a school in the village						4.453584	
Proportion of literate population in total population in age-group more than 6 years	41.71617						
Proportion of landless households in total households							
Proportion of non-agricultural workers in total main workers			0.1936677			0.1832241	
Proportion of net sown area in total reported area		-2.720468					
Whether the village is connected with electricity							
Distance from nearest urban centre							
Household Level							
Whether the household falls in the influence zone	784.0291					4.45182	
Per capita income		0.0259422		-0.000222	0.0003912	0.0005042	0.0002414
Per capita trip rate	313.4798	33.79798		-0.9718349	1.289611	4.630553	
Proportion of literate family members in total family members in age-group more than 6 years							
Household size	-477.7436	-24.72396	0.4542471	-0.2054786	-1.567154	0.6385788	
Operational landholding (in ha)	3243.037	124.7144	-0.7905058	-2.069476		-5.74984	
Proportion of working members in a household in age-group 15-59 years	112.719					-0.395837	-0.656123
Whether the household head is literate	1985.947	78.55477	2.861863	-5.050946	-5.755001	3.328449	
Proportion of non-agricultural workers in total working household members	24.9152				-0.0689861		0.0353767
Whether the household belongs to Hindu community			-8.808635	2.720036		-14.81136	
Household occupation based on share of income from self-employment in non-agriculture	-4040.285			2.67018	2.012991	31.34639	
Household occupation based on share of income from wage labour		-99.67296			4.142195	20.21068	
Constant	1396.14	617.4794	14.32899	60.72179	42.96903	57.22359	112.2149
Type of regressions used	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
Adjusted R-squared/Pseudo R squared	0.3138	0.1689	0.0626	0.1582	0.2154	0.2362	0.0405
Number of included observations	3125	3125	3130	3125			-12899.905

Note: All coefficients are significant at 0.05 levels.
In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 6: Result of multivariate regression analysis (assets ownership)

Independent variables	Dependent variables (ownership)		
	Whether household is landless	Whether household owns at least one information related consumer durable	Whether household owns at least one motorised vehicle
	- Coefficient -		
Village level			
Proportion of scheduled caste and scheduled tribe population in total population	0.016188		
Average land resource base including common land per household			
Whether there is primary health sub-centre/ primary health centre/ health centre in the village	0.3799202		
Whether there is a market in the village	0.5977386		
Whether there is Gram Sabha in the village	0.2039044		
Whether there is a school in the village		0.2910516	
Proportion of literate population in total population in age-group more than 6 years			
Proportion of landless households in total households			
Proportion of non-agricultural workers in total main workers		0.0086052	0.0143972
Proportion of net sown area in total reported area			
Whether the village is connected with electricity		0.3475738	
Distance from nearest urban centre		0.0094898	
Household level			
Whether the household falls in the influence zone			
Per capita income		0.0000569	0.0000774
Per capita trip rate			
Proportion of literate family members in total family members in age group more than 6 years of age			
Household size	-0.1506828	0.1371587	0.1774117
Operational landholding (in ha)		0.2058569	0.2302184
Proportion of working members in a household in age-group 15-59 years	-0.012798		-0.0302128
Whether the household head is literate	-0.4898142	0.6592628	1.077973
Proportion of non-agricultural workers in total working household members		0.0037648	
Whether the household belongs to Hindu community	-0.4689511		
Household occupation based on share of income from self-employment in non-agriculture	1.425033		0.4638237
Household occupation based on share of income from wage labour	2.118965	-0.7702867	-1.40042
Constant	-0.0025443	-3.586307	-4.847533
Type of regressions used	logit	logit	logit
Pseudo R-squared	0.2563	0.2095	0.3793
Log likelihood	-1602.0014	-1411.9732	-513.02386
Number of included observations	3130	3125	3125

Note: All coefficients are significant at 0.05 levels.

In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 7: Results of multivariate regression analysis (attitudinal response)

Independent variables	Dependent variables (attitudinal response)	
	Whether household rates itself poor or very poor	Whether the household expects improvement in employment situation after 4-laning of NH2
	- Coefficient -	
Village level		
Proportion of scheduled caste and scheduled tribe population in total population	-0.0055728	
Average land resource base including common land per household		
Whether there is primary health sub-centre/ primary health centre/ health centre in the village		
Whether there is a market in the village	-0.7245284	-0.395013
Whether there is Gram Sabha in the village		
Whether there is a school in the village	-0.2863169	
Proportion of literate population in total population in age-group more than 6 years		
Proportion of landless households in total households		
Proportion of non-agricultural workers in total main workers	-0.0094477	-0.0251456
Proportion of net sown area in total reported area		
Whether the village is connected with electricity		
Distance from nearest urban centre		0.0141881
Household level		
Whether the household falls in the influence zone	-0.2319015	0.2645399
Per capita income	-0.0001019	0.0000187
Per capita trip rate		0.0919403
Proportion of literate family members in total family members in age-group more than 6 years		
Household size	-0.1335112	0.0756198
Operational landholding (in ha)	-0.7286268	
Proportion of working members in a household in age-group 15-59 years		
Whether the household head is literate	-0.2496055	0.3812229
Proportion of non-agricultural workers in total working household members	0.0023249	0.0024835
Whether the household belongs to Hindu community	0.3564029	
Household occupation based on share of income from self employment in non-agriculture		
Household occupation based on share of income from wage labour	0.6092669	-0.2882322
Constant	1.453389	-0.2244875
Type of regressions used	logit	logit
Pseudo R-squared	0.2263	0.1531
Log likelihood	-1671.737	-1461.3287
Number of included observations	3125	3125

Note: All coefficients are significant at 0.05 levels.
In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 8: Result for multivariate regression analysis (education and health)

Independent variables	Dependent variables (education and health)		
	Proportion of school going children among all children in the household in age group 6-14 years	Proportion of female school going children among all female children in the household in age group 6-14 years	Proportion of household members who availed of medical facilities during last six months
	- Coefficient -		
Village level			
Proportion of scheduled caste and scheduled tribe population in total population			
Average land resource base including common land per household			
Whether there is primary health sub-centre/ primary health centre/ health centre in the village			
Whether there is a market in the village			
Whether there is Gram Sabha in the village			
Whether there is a school in the village			
Proportion of literate population in total population in age-group more than 6 years	0.1511313	0.2681183	
Proportion of landless households in total households			0.0520092
Proportion of non-agricultural workers in total main workers			
Proportion of net sown area in total reported area	-0.0811305		-0.0355951
Whether the village is connected with electricity			
Distance from nearest urban centre			
Household level			
Whether the household falls in the influence zone			
Per capita income	0.0002322		
Per capita trip rate	2.257878	2.916764	0.7123354
Proportion of literate family members in total family members in age-group more than 6 years			
Household size	0.9747651	1.375032	-1.108444
Operational landholding (in ha)			
Proportion of working members in a household in age-group 15-59 years	-0.4147038	-0.3279345	0.092077
Whether the household head is literate	10.55254	17.99636	
Proportion of non-agricultural workers in total working household members	-0.0390734		
Whether the household belongs to Hindu community	-9.981673	-12.84845	
Household occupation based on share of income from self employment in non-agriculture			
Household occupation based on share of income from wage labour	-7.002962	-7.279425	
Constant	78.64926	48.78659	21.26138
Type of regressions used	Tobit	Tobit	OLS
Adjusted R-squared/ Pseudo R squared	0.0214	0.0205	0.0959
Log likelihood	-9461.1744	-6203.5578	
Number of included observations	2083	1396	3125

Note: All coefficients are significant at 0.05 levels.
In addition to the above variables seven dummies were included to control the stretch specific effects.

Appendix 9: Result for multivariate regression analysis (well-being index)

Independent variables	Independent variable (well-being index)		
	Index of overall well-being index based on income, employment, health and education	Index of transport mobility	Index of access to infrastructural facilities, assets and amenities
	- Coefficient -		
Village level			
Proportion of scheduled caste and scheduled tribe population in total population			-1.244096
Average land resource base including common land per household			
Whether there is primary health sub-centre/ primary health centre/ health centre in the village			175.2945
Whether there is a market in the village		-136.9334	269.1826
Whether there is Gram Sabha in the village			90.4117
Whether there is a school in the village	49.89534		265.3144
Proportion of literate population in total population in age-roup more than 6 years	2.052853		2.295944
Proportion of landless households in total households			-2.376089
Proportion of non-agricultural workers in total main workers			2.448375
Proportion of net sown area in total reported area		-4.129701	
Whether the village is connected with electricity		-210.4284	
Distance from nearest urban centre			-10.33769
Household level			
Whether the household falls in the influence zone			151.8733
Per capita income	0.0164826	0.0073483	0.0139621
Per capita trip rate	28.4282		31.85879
Proportion of literate family members in total family members in age-group more than 6 years			42.07568
Household size		-17.04451	20.1265
Operational landholding (in ha)	45.07471		
Proportion of working members in a household in age-group 15-59 years	22.21072		
Whether the household head is literate	117.7824	132.4401	286.3855
Proportion of non-agricultural workers in total working household members	0.5207864	1.899805	-0.4950273
Whether the household belongs to Hindu community			-270.013
Household occupation based on share of income from self employment in non-agriculture	410.5678		-160.1727
Household occupation based on share of income from wage labour	-211.4265		-661.8808
Approach distance of the household from NH2		-23.31166	
Constant	23.07058	1680.879	1098.77
Type of regressions used	OLS	OLS	OLS
Adjusted R-squared	0.5203	0.0757	0.8848
Number of included observations	2083	3125	3125

Note: All coefficients are significant at 0.05 levels.
In addition to the above variables seven dummies were included to control the stretch specific effects.

Chapter 6

Rural Accessibility and Mobility Patterns

There are two types of issues involved in rural road transport – infrastructure-related accessibility issues and socio-economic status related mobility issues. Both of these are, to some extent, inter-related, as accessibility enables mobility. Accessibility encompasses the proximity of transport services and the enabling character of the transportation system. Broadly speaking, there are three components of accessibility: (i) infrastructure, (ii) location of facilities to which access is required, and (iii) vehicle infrastructure that makes movement possible. Mobility refers to a person's ability to travel and depends on personal factors such as financial resources, constraints of gender, etc. and the range of transport facilities available.

This chapter is divided into two parts. Part I deals with issues of connectivity of the surveyed villages to the highway, including the type and nature of such connectivity. It covers the ownership pattern of different types of vehicles in these villages and the availability of public transport facilities. It also examines the access of the villages to various social and physical infrastructure facilities. Part II deals with issues of mobility of rural households covering aspects like number of trips performed, travel time, trip length, etc. The analysis maps the pattern of travel behaviour of the rural population in relation to distance from NH2.

Rural road transport and travel-related issues have also been discussed in two other chapters of the report. The issues relating to the mobility of the poor and disadvantaged population have been dealt with in Chapter 3. The relationship between mobility and defined well-being indicators has been examined in Chapter 5.

Part I: Connectivity Status

Type of Road

At an aggregate level, only a little more than half (54.5 percent) the surveyed villages are connected to NH2 by all-weather roads for their entire stretch. Though the position is somewhat better in Uttar Pradesh with an all-weather connectivity of 66 percent, it is worse in Bihar and Jharkhand where only 35 percent villages are linked to all-weather roads. This overall unsatisfactory situation clearly brings out the need for upgrading the rural road network which would help the rural population to obtain the full benefits of the national highway (Table 1).

Table 1: Distribution of villages by type of road connectivity to NH2

Stretch/ State		Type of road					
		Katcha	All-weather	Fair-weather	Katcha and all-weather	All-weather and fair-weather	Total
Firozabad	No.	8	23	0	3	1	35
	% age	22.86	65.71	0.00	8.57	2.86	100.00
Auraiya	No.	3	15	0	3	0	21
	% age	14.29	71.43	0.00	14.29	0.00	100.00
Fatehpur	No.	9	13	0	3	0	25
	% age	36.00	52.00	0.00	12.00	0.00	100.00
Chandauli	No.	5	31	2	4	1	43
	% age	11.63	72.09	4.65	9.30	2.33	100.00
Uttar Pradesh	No.	25	82	2	13	2	124
	% age	20.16	66.13	1.61	10.48	1.61	100.00
Bhabua	No.	3	11	2	9	1	26
	% age	11.54	42.31	7.69	34.62	3.85	100.00
Gaya	No.	8	14	1	14	0	37
	% age	21.62	37.84	2.70	37.84	0.00	100.00
Hazaribagh	No.	7	2	0	4	0	13
	% age	53.85	15.38	0.00	30.77	0.00	100.00
Bihar & Jharkhand	No.	18	27	3	27	1	76
	% age	23.68	35.53	3.95	35.53	1.32	100.00
Overall	No.	43	109	5	40	3	200
	% age	21.50	54.50	2.50	20.00	1.50	100.00

Road Category

In terms of categories of roads, more than two-thirds or about 68 percent of the villages are connected to NH2 by village roads, while about 14 percent are connected by other categories of roads, including state highways. While in Uttar Pradesh 75 percent of the villages are connected to NH2 by village roads, this percentage comes down to 55 in Bihar and Jharkhand (Table 2).

Table 2: Distribution of connected villages to NH2 by road category

Stretch/ State		Category of road								
		Village	ODR	MDR	SH	Village & ODR	Village & MDR	Village & SH	ODR & SH	Total
Firozabad	No.	28	4	0	0	3	0	0	0	35
	% age	80.00	11.43	0.00	0.00	8.57	0.00	0.00	0.00	100.00
Auraiya	No.	12	5	0	1	3	0	0	0	21
	% age	57.14	23.81	0.00	4.76	14.29	0.00	0.00	0.00	100.00
Fatehpur	No.	23	0	0	0	2	0	0	0	25
	% age	92.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	100.00
Chandauli	No.	30	7	0	1	4	1	0	0	43
	% age	69.77	16.28	0.00	2.33	9.30	2.33	0.00	0.00	100.00
Uttar Pradesh	No.	93	16	0	2	12	1	0	0	124
	% age	75.00	12.90	0.00	1.61	9.68	0.81	0.00	0.00	100.00
Bhabua	No.	12	0	1	3	8	0	1	1	26
	% age	46.15	0.00	3.85	11.54	30.77	0.00	3.85	3.85	100.00
Gaya	No.	21	2	1	1	9	0	3	0	37
	% age	56.76	5.41	2.70	2.70	24.32	0.00	8.11	0.00	100.00
Hazaribagh	No.	9	1	0	0	2	1	0	0	13
	% age	69.23	7.69	0.00	0.00	15.38	7.69	0.00	0.00	100.00
Bihar & Jharkhand	No.	42	3	2	4	19	1	4	1	76
	% age	55.26	3.95	2.63	5.26	25.00	1.32	5.26	1.32	100.00
Overall	No.	135	19	2	6	31	2	4	1	200
	% age	67.50	9.50	1.00	3.00	15.50	1.00	2.00	0.50	100.00

Note: ODR = Other District Road, MDR = Major District Road, SH = State Highway

Additional Connectivity

More than 43 percent of the villages surveyed have additional link road connections to NH2. Bihar and Jharkhand have more additional link roads than Uttar Pradesh. However, the condition of such roads is better in Uttar Pradesh than in Bihar and Jharkhand (Table 3).

Table 3: Distribution of villages by additional road connectivity

Stretch/State	Number and percentage of surveyed villages		Category of roads: percentage of surveyed villages		
	Number of villages	Percentage	Katcha road	All-weather road	Fair-weather road
Firozabad	13	37.14	11.43	25.71	0.00
Auraiya	7	33.33	14.29	19.05	0.00
Fatehpur	9	36.00	24.00	12.00	0.00
Chandauli	19	44.19	16.28	25.58	2.33
Uttar Pradesh	48	38.71	16.13	21.77	0.81
Bhabua	20	76.92	34.62	26.92	15.38
Gaya	15	40.54	24.32	10.81	5.41
Hazaribagh	4	30.77	15.38	15.38	0.00
Bihar & Jharkhand	39	51.32	26.32	17.11	7.89
All	87	43.50	20.00	20.00	3.50

Vehicle Infrastructure

Types of Vehicles

The survey has shown an ownership of about 38,000 vehicles of various types in the 200 selected villages, which translates into an average ownership of 190 vehicles per village. Of these, cycles have a predominant share of 87.3 percent. The motorised vehicles account for only 8.6 percent share. Among the motorised vehicles, two-wheelers (i.e. scooters and motorcycles) predominate, followed by tractors (Table 4).

Table 4: Type and number of vehicles owned by villages by their distance from NH2

Type of vehicle	Distance of village from NH2 (km)									
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7+	Total	%
Car/Jeep	116	36	20	13	8	9	14	34	250	0.66
Scooter	260	56	53	59	51	28	43	105	655	1.72
Motorcycle	300	137	93	42	204	101	108	194	1179	3.10
Three-wheeler	23	5	11	12	3	5	4	3	66	0.17
Tractor	213	134	72	54	87	81	75	198	914	2.41
Bus/Minibus	6	4	1	0	1	0	0	7	19	0.05
Tempo	11	10	4	0	5	1	1	0	32	0.08
Truck	80	9	10	3	2	1	2	7	114	0.30
Maruta	6	1	2	0	4	8	2	2	25	0.07
Cycle	8519	2664	4192	1552	5990	2407	2743	5113	33180	87.31
Cycle rickshaw	163	6	34	5	2	5	5	7	227	0.60
Bullock cart	280	22	198	22	57	118	134	230	1061	2.79
Horse/Camel/Mule cart	54	12	3	0	26	25	8	0	128	0.33
Other	7	16	7	25	4	0	7	87	153	0.40
Total	10038	3112	4700	1787	6444	2789	3146	5987	38003	100.00

Villages lying within 5 km of the highway account for more than two-thirds (68.6 percent) of the total number of vehicles. In the case of motorised vehicles, the share goes down to less than half (44.31 percent). Another noticeable feature is that villages lying within one kilometre of NH2 account for more than one-fourth (26.4 percent) of the total number of vehicles (Table 5).

Table 5: Distribution of share of motorised and other vehicles by distance from NH2

(in %)

Distance of village from NH2 (km)	Share of all vehicles	Share of motorised vehicles
0-1	26.4	10.11
1-2	8.2	12.6
2-3	12.4	5.7
3-4	4.7	10.2
4-5	16.9	5.7
5-6	7.3	8.4
6-7	8.3	8.0
7>	15.8	9.2
Overall	100.0	8.6

Public Transport Facilities

More than half (around 52 percent) the villages have public transport facilities. Villages in Uttar Pradesh are better placed in this regard as compared to Bihar and Jharkhand. While in Uttar Pradesh around 63 percent or nearly two-thirds of those in villages have public transport facilities, in Bihar and Jharkhand, this proportion is just over one-third (34 percent) (Table 6).

Table 6: Distribution of villages by availability of public transport facilities

Stretch	Number of villages having public transport facilities	Total number of villages surveyed	Percentage of villages having public transport facilities
Firozabad	19	35	54.29
Auraiya	20	21	95.24
Fatehpur	10	25	40.00
Chandauli	29	43	67.44
Uttar Pradesh	78	124	62.90
Bhabua	4	26	15.38
Gaya	13	37	35.14
Hazaribagh	9	13	69.23
Bihar & Jharkhand	26	76	34.21
Overall	104	200	52.00

Access to Various Facilities

Social infrastructure facilities such as educational institutions are accessible at distances ranging from 0.4 km (primary school) to 18.32 km (degree college), while

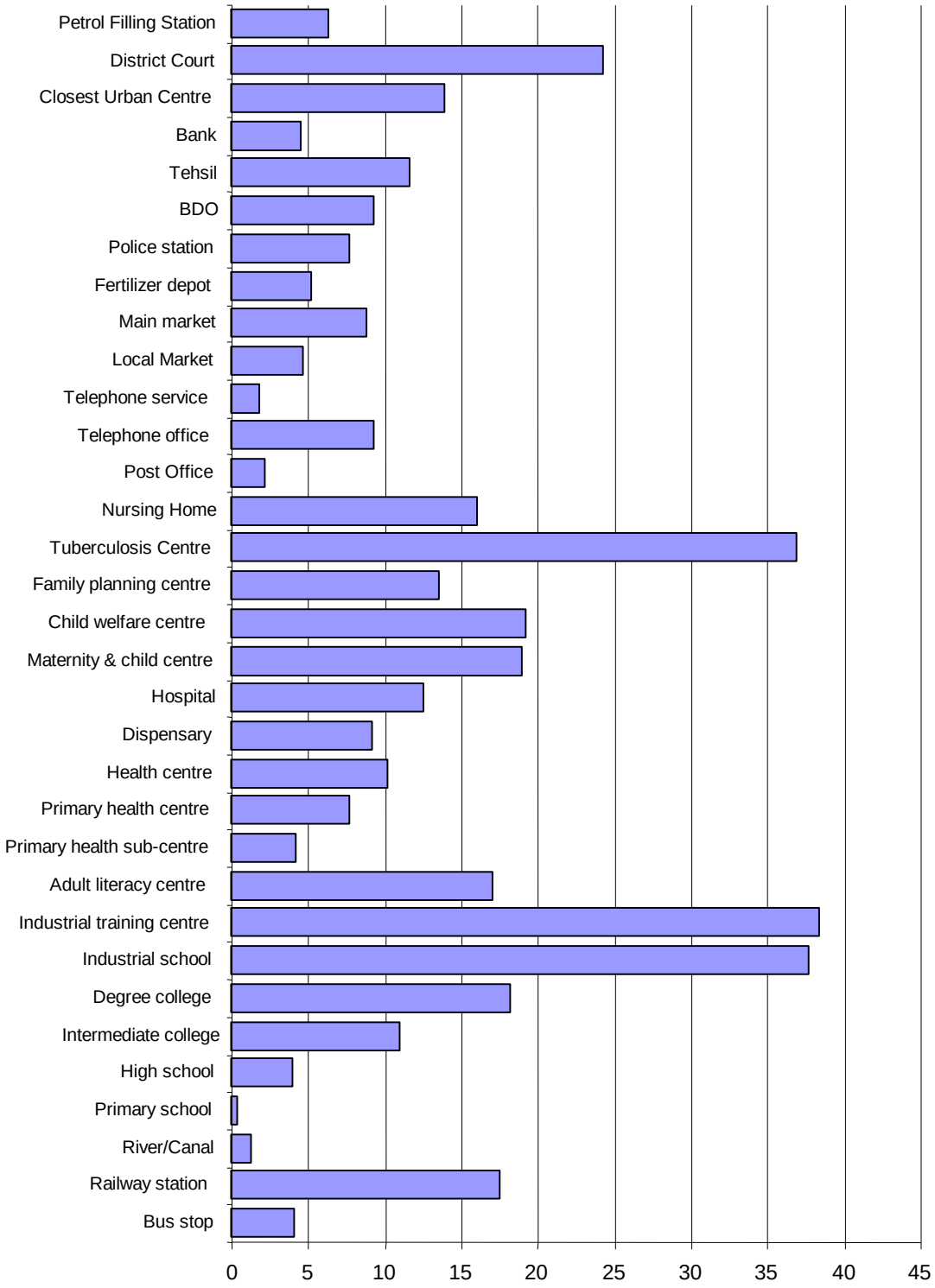
access to health facilities ranges from 4.3 km (primary health sub-centre) to 12.67 km (hospital). Physical infrastructure such as telephone services and telephone offices are accessible at average distances of 1.97 km and 9.34 km, respectively. Market and banking facilities are accessible at distances of 4.77 km (local market), 4.58 km (bank) and 8.87 km (main market). On average, the nearest urban centre is at a distance of 14 km from the village, while bus stops and railway stations are available at a distance of 4.12 km and 17.58 km, respectively (Table 7 and Figure 1).

Table 7: Average approach distance of villages by their connectivity status to various facilities

(in km)

Facility	Total
Bus stop	4.12
Railway station	17.58
River/Canal	1.38
Primary school	0.40
High school	4.11
Intermediate College	11.01
Degree college	18.32
Industrial school	37.79
Industrial training centre	38.49
Adult literacy centre	17.15
Primary health sub-centre	4.30
Primary health centre	7.75
Health centre	10.24
Dispensary	9.27
Hospital	12.67
Bank	4.58
Closest urban centre	13.98
Maternity & child centre	19.11
Child welfare centre	19.26
Family planning centre	13.69
Tuberculosis centre	37.03
Nursing home	16.13
Post office	2.31
Telephone office	9.34
Telephone service	1.97
Local market	4.77
Main market	8.87
Fertiliser depot	5.31
Police station	7.82
BDO	9.39
Tehsil	11.69
District Court	24.39
Petrol filling station	6.46

Figure 1: Average distance of facilities from the village



Part II: Mobility Status

This part of the chapter analyses the characteristics of the mobility of rural households in the selected stretches of the national highway. Mobility is usually measured in terms of the number of trips made per unit of time and is directly related to the purpose of travel. In this study, a 'trip' has been defined as a one-way movement of a person outside the village by any mode of transport for a specific purpose. The trip has origin in the village and destination outside the village. Intra-village trips have not been taken into account, since the rural population makes frequent short-distance trips within the village, which have little consequence in the assessment of the impact of the national highway.

The analysis is divided into four sections: section I deals with the defined parameters of mobility, section II investigates the relationship between these parameters, section III considers the role of the national highway in rural mobility, and section IV examines the attitudinal response of highway users.

Section I: Parameters of Mobility

Trip Rate

On average, a household makes 5.49 trips in a week, which translate into a per capita trip rate of 0.86. The figure is higher in Uttar Pradesh (1.02) and lower in Bihar and Jharkhand (0.64). The data shows an overall low level of mobility in the villages, which declines further in Bihar and Jharkhand (Table 8).

Table 8: Stretch-wise weekly trips and trip rates

Stretch	Trips	Trip rate	
	Number	Per household	Per capita
Firozabad	3472	6.18	1.02
Auraiya	1915	5.70	1.04
Fatehpur	1952	4.88	0.89
Chandauli	4817	7.00	1.07
Uttar Pradesh	12156	6.13	1.02
Bhabua	2258	5.43	0.75
Gaya	1979	3.34	0.49
Hazaribagh	1166	5.61	0.80
Bihar & Jharkhand	5403	4.44	0.64
Overall	17559	5.49	0.86

Distance Travelled

The average weekly travel involves a distance of 45 km, travel time of 254 minutes and an expenditure of about Rs. 13. The households in Bihar and Jharkhand incur a higher transport cost despite a lower overall trip length, probably on account of poor transport infrastructure (Table 9).

Table 9: Stretch-wise average trip length, travel time and travel cost per household (weekly)

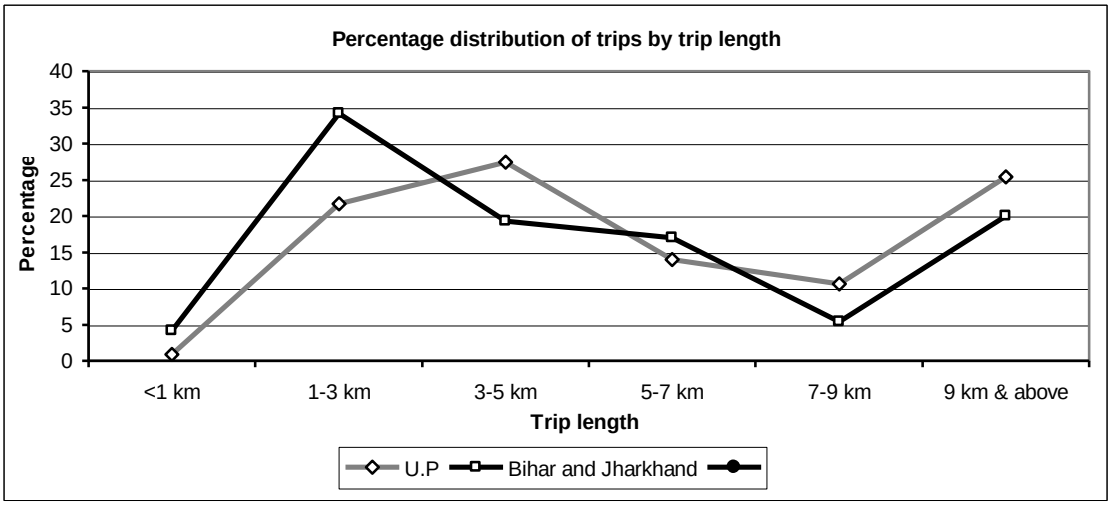
Stretch	Average trip length (km)	Average travel time (min.)	Average travel cost (Rs.)
Firozabad	54.37	316.32	8.56
Auraiya	33.34	210.99	5.87
Fatehpur	35.43	225.51	5.37
Chandauli	62.17	319.55	21.98
Uttar Pradesh	49.70	281.32	12.12
Bhabua	47.06	281.93	16.34
Gaya	26.38	149.70	10.80
Hazaribagh	51.63	244.36	19.51
Bihar & Jharkhand	37.27	211.12	14.18
Overall	45.16	254.66	12.90

Trip Length

Most of the trips are short. Table 10 shows that half the trips do not exceed 5 km. However, in Bihar and Jharkhand, this proportion is higher by 5 percentage points. The short average trip length indicates a limited spatial spread of socio-economic interaction in the villages.

Table 10: Stretch-wise distribution of weekly trips by trip length

Trip length	No. of Trips	Firoza-bad	Auraiya	Fatehpur	Chandauli	*Uttar Pradesh*	Bhabua	Gaya	Hazari-bagh	*Bihar & Jharkhand*	Total
		- Percentage -									
<1 km	333	0.00	1.04	3.38	0.50	0.90	1.33	3.18	11.15	4.13	1.90
1-3 km	4476	17.22	30.34	22.44	21.03	21.64	32.02	36.94	33.62	34.17	25.49
3-5 km	4383	21.08	31.59	23.92	31.87	27.47	22.01	19.86	13.21	19.32	24.96
5-7 km	2622	18.15	10.23	10.60	13.91	14.01	20.06	16.07	12.69	17.01	14.93
7-9 km	1580	12.36	8.20	12.40	9.55	10.60	3.28	7.02	6.78	5.40	9.00
9 km & above	4165	31.19	18.59	27.25	23.15	25.39	21.30	16.93	22.56	19.97	23.72
Total	17559	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

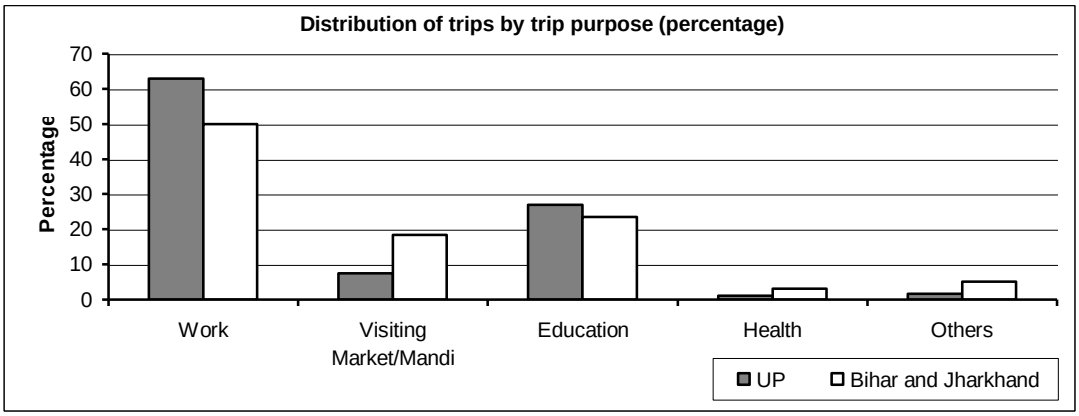


Trip Purpose

The trips related to work, education and marketing are amongst the most important in the daily commuting of the villagers. About 59 percent of the trips are work-related, 26 percent for education and 10 percent for going to the market. Uttar Pradesh has a higher share of work trips (62.9 percent) as compared to Bihar and Jharkhand (49.9 percent). Market-related trips account for a relatively high share in Bihar and Jharkhand (18.3 percent), as compared to Uttar Pradesh (7.4 percent) (Table 11).

Table 11: Stretch-wise distribution of weekly trips by trip purpose

Trip	Nos.	Firozabad	Auraiya	Fatehpur	Chandauli	*Uttar Pradesh*	Bhabua	Gaya	Hazari-bagh	*Bihar & Jharkhand*	Total
		- Percentage -									
Work	10336	66.56	48.25	61.01	66.74	62.86	54.74	46.64	45.97	49.88	58.86
Visiting Market/ Mandi	1893	3.66	7.52	10.96	8.66	7.42	22.72	19.10	8.58	18.34	10.78
Education	4558	26.81	43.19	25.00	21.69	27.07	14.66	25.16	37.56	23.45	25.96
Health	297	1.27	0.84	1.95	0.56	1.03	2.79	3.08	4.12	3.18	1.69
Religion	26	0.46	0.10	0.15	0.00	0.17	0.00	0.00	0.43	0.09	0.15
Recreation	22	0.06	0.00	0.00	0.00	0.02	0.27	0.25	0.77	0.37	0.13
Others	427	1.18	0.10	0.92	2.35	1.43	4.83	5.76	2.57	4.68	2.43
Total	17559	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

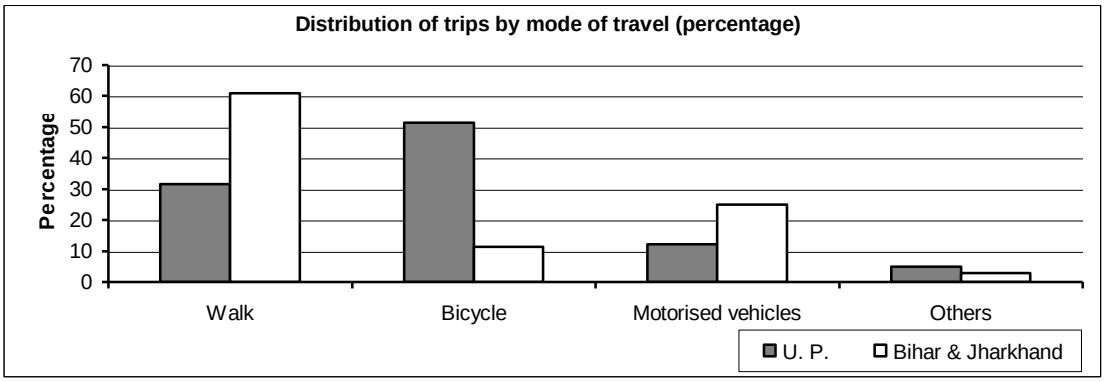


Mode of Travel

Around 80 percent of the trips are made equally either on foot or bicycle. In Bihar and Jharkhand, over 60 percent of the trips are on foot and the use of cycle accounts for a low of 11.3 percent, while in Uttar Pradesh, only 31.5 percent of the trips are performed on foot and 51.4 percent trips on bicycle. Another notable feature is that in Bihar and Jharkhand, about 21 percent, or just over one-fifth of the trips are by bus, car or jeep, as compared to only 8 percent in Uttar Pradesh. This dependence on motorised modes of transport for mobility explains the higher trip cost incurred by households in Bihar and Jharkhand (Table 12).

Table 12: Stretch-wise distribution of weekly trips by mode of travel

Mode	No. of Trips	Firozabad	Auraiya	Fatehpur	Chandauli	*Uttar Pradesh*	Bhabua	Gaya	Hazari-bagh	*Bihar & Jharkhand*	Total
		- Percentage -									
Walk	7117	25.78	39.16	32.48	32.22	31.52	57.22	64.12	62.18	60.82	40.53
Bicycle	6863	58.67	46.74	55.89	46.25	51.42	6.86	13.24	16.72	11.33	39.09
Two-wheeler	593	3.11	1.98	2.82	5.36	3.78	3.32	2.22	1.29	2.48	3.38
Tractor-trailer	166	0.29	0.52	1.64	0.79	0.74	2.44	1.06	0.00	1.41	0.95
Car/Jeep	582	0.60	0.05	0.51	6.48	2.83	3.54	1.06	11.75	4.40	3.31
Bus	1490	8.12	3.97	1.90	3.94	4.81	23.60	16.37	4.12	16.75	8.49
Animal driven cart	51	0.49	0.00	0.82	0.00	0.27	0.00	0.00	1.54	0.33	0.29
Physically carried/ palanquin	254	0.75	6.84	1.13	0.56	1.69	0.84	1.26	0.34	0.89	1.45
Other	443	2.19	0.73	2.82	4.40	2.94	2.17	0.66	2.06	1.59	2.52
Total	17559	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

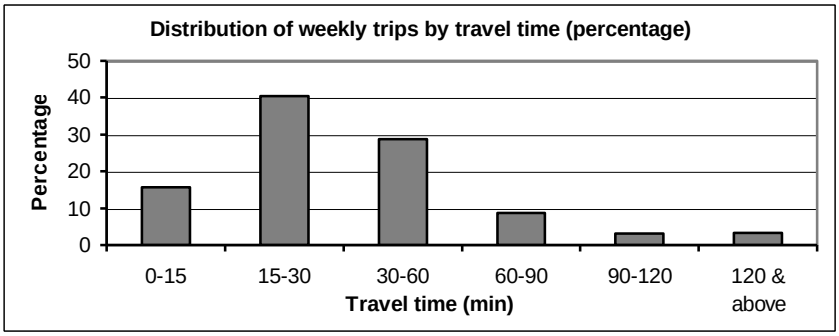


Trip Time

The distribution of weekly trips by travel time indicates that about 56 percent of the trips are made of 30 minutes' duration and another 29 percent of 30-60 minutes (Table 13).

Table 13: Distribution of trips by travel time

Time (min)	Number of trips	Percentage
0-15	2757	15.70
15-30	7091	40.38
30-60	5056	28.79
60-90	1516	8.63
90-120	549	3.13
120 & above	590	3.36
Total	17559	100.00



Carriage of Commodities

About 3.6 percent of the total weekly trips are undertaken for carrying household goods, farm produce and non-farm products. Of these household goods account for 50 percent of the share, the balance being distributed between farm produce and non-farm products. For carrying out these chores, walking is the predominant mode of transport, followed by bus for household goods and non-farm produce, and bicycle for farm products and household goods (Tables 14 and 15).

Table 14: Distribution of trips for carrying goods

Commodity	No. of trips	Percentage
Farm produce	147	22.76
Non-farm products	172	26.63
Household goods	327	50.62
Total	646	100.00

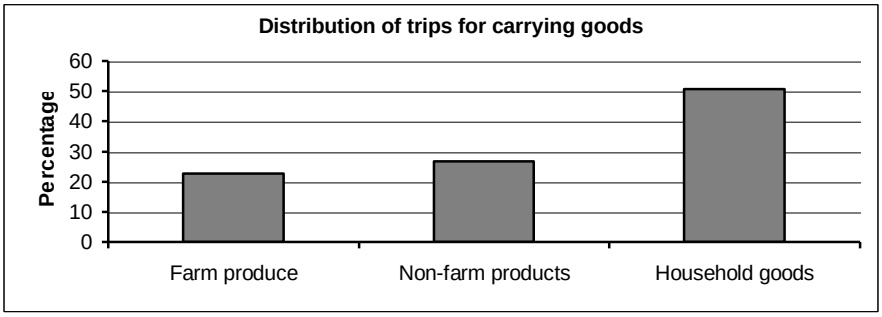


Table 15: Distribution of weekly trips by mode and commodity

Mode	Commodity							
	Farm produce		Non-farm products		Household goods		Total	
	No.	%	No.	%	No.	%	No.	%
Walk	25	32.05	42	42.42	73	32.88	14	3.51
Bicycle	25	32.05	13	13.13	49	22.07	87	21.80
Two-wheeler	1	1.28	3	3.03	3	1.35	7	1.75
Tractor trailer	7	8.97	5	5.05	7	3.15	19	4.76
Car/Jeep	8	10.26	7	7.07	21	9.46	36	9.02
Bus	6	7.69	26	26.26	56	25.23	88	22.06
Animal-driven cart	2	2.56	2.00	2.02	5	2.25	9	2.26
Physically carried/Palanquin	0	0.00	0.00	0.00	3	1.35	3	0.75
Other	4	5.13	1.00	1.01	5	2.25	1	0.25
Total	78	100.00	99	100.00	222	100.00	399	100.00

Section II: Relationship between Parameters of Travel

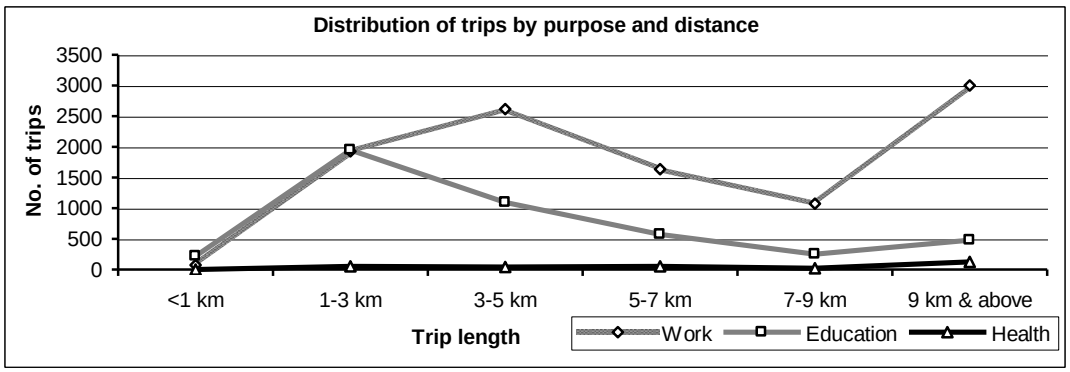
In the previous section, an attempt has been made to understand the various parameters of mobility in terms of the number of trips performed, travel time, trip length and mode of travel. This section analyses the relationship between these parameters of travel. As previously pointed out, work, education, marketing, and health are among the most important purposes of travel.

Trip Purpose and Trip Length

Work trips involve longer travels in comparison to trips for education and market purposes (Table 16).

Table 16: Distribution of trips by purpose and distance

Purpose	Trip length						
	<1 km	1-3 km	3-5 km	5-7 km	7-9 km	9 km & above	Total
Work	76	1932	2615	1637	1076	3000	10336
Visiting Market/Mandi	26	455	566	323	203	320	1893
Education	215	1946	1096	571	246	484	4558
Health	5	57	38	52	22	123	297
Religion	0	6	4	5	0	11	26
Recreation	0	8	1	0	4	9	22
Others	11	72	63	34	29	218	427
Total	333	4476	4383	2622	1580	4165	17559

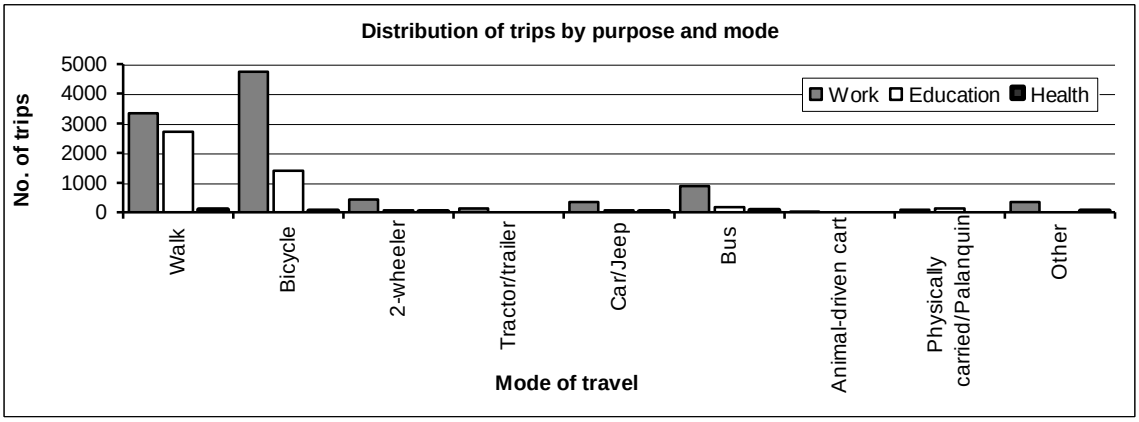


Trip Purpose and Mode of Travel

Besides travel on foot, the bicycle emerges as an important mode of commuting. Together, the two account for about three-fourths of the share in work- and market-related trips. This share goes up to 90 percent in the case of education-related trips. However, in the case of trips related to religious ceremonies, health and market, the use of motorised transport becomes evident. For instance, the share of motorised transport is as much as 50 percent in religion-related trips and about 38 percent in health-related trips. In market- and work-related trips, the share of motorised transport goes down to 22 percent and 17 percent, respectively (Table 17).

Table 17: Distribution of trips by purpose and mode

Purpose	Mode									
	Walk	Bicycle	Two-wheeler	Tractor/ trailer	Car/ Jeep	Bus	Animal-driven cart	Physically carried/ palanquin	Other	Total
Work	3341	4737	440	137	352	877	29	80	343	10336
Visiting market/mandi	792	614	59	19	85	252	20	20	32	1893
Education	2718	1391	55	1	75	175	0	137	6	4558
Health	96	41	18	3	29	62	2	10	36	297
Religion	4	0	0	0	4	9	0	0	0	26
Recreation	13	2	0	0	2	3	0	0	2	22
Others	153	69	21	6	35	112	0	7	24	427
Total	7117	6863	593	166	582	1490	51	254	443	17559

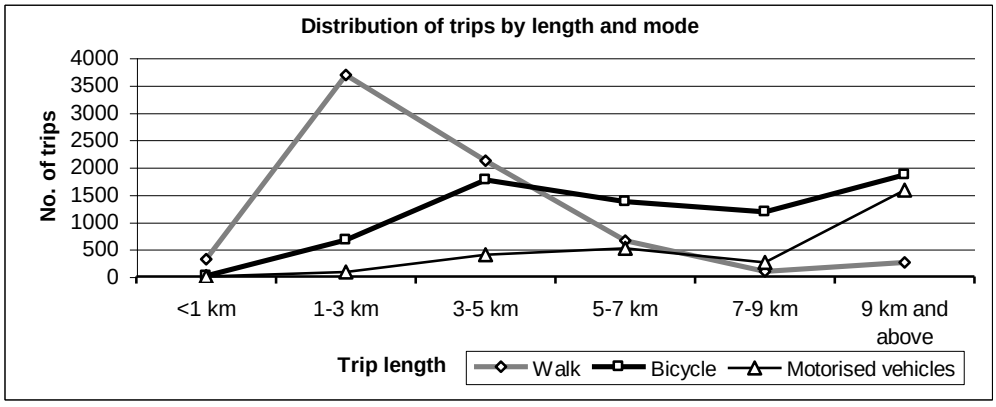


Trip Length and Mode of Travel

Travel on foot and on bicycle together account for the highest share of trips of up to 9 km. Beyond this, the share of these two transport modes decreases, while the share of motorised modes of transport (bus, car/jeep and two-wheeler) goes up. Hence, it can be inferred that mechanised modes start playing an important role in rural mobility for distances over 9 km. Another notable feature is that the trips made on foot are limited to distances of around 5 km, while bicycle is the dominant transport mode for trip lengths beyond 5 km (Table 18).

Table 18: Distribution of trips by length and mode

Trip length	Mode									
	Walk	Bicycle	Two-wheeler	Tractor/ trailer	Car/ jeep	Bus	Animal-driven cart	Physically carried/ palanquin	Other	Total
<1 km	317	16	0	0	0	0	0	0	0	333
1-3 km	3686	669	14	13	5	46	0	15	28	4476
3-5 km	2114	1764	158	34	61	143	0	27	82	4383
5-7 km	652	1374	84	5	106	316	21	21	43	2622
7-9 km	93	1182	56	10	55	141	1	12	30	1580
9 km and above	255	1858	281	104	355	844	29	179	260	4165
Total	7117	6863	593	166	582	1490	51	254	443	17559



Section III: Role of National Highway in Rural Mobility

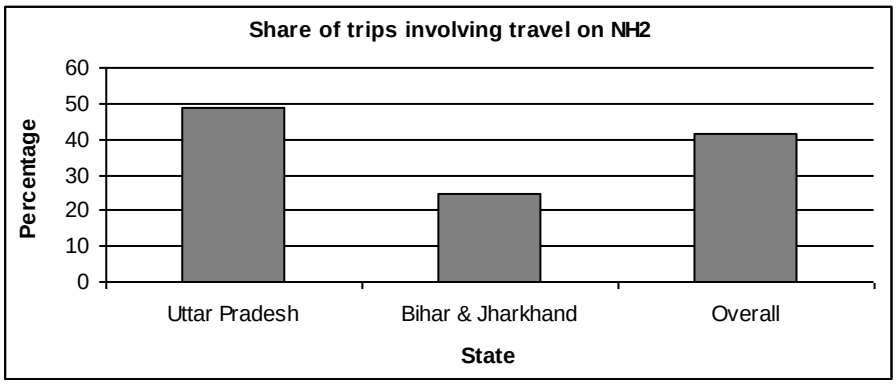
This section studies the role of NH2 in rural mobility. The analysis is based on the number of trips involving the use of the national highway. It also analyses the variation in the mobility level in relation to distance from NH2.

Trips Involving Travel on NH2

More than two-fifths, or around 41.6 percent of the total trips, involve the use of the highway although there are wide variations across different stretches surveyed: the share of trips on NH2 in Uttar Pradesh (49 percent) is almost twice that in Bihar and Jharkhand (25 percent). Table 19 shows that NH2 plays an important role as a travel artery in the surrounding villages.

Table 19: Stretch-wise distribution of trips on NH2

Stretch	Total trips	No. of trips involving travel on NH2	Share
Firozabad	3472	1815	52.28
Auraiya	1915	888	46.37
Fatehpur	1952	1052	53.89
Chandauli	4817	2199	45.65
Uttar Pradesh	12.56	59.54	48.98
Bhabua	2258	303	13.42
Gaya	1979	462	23.35
Hazaribagh	1166	577	49.49
Bihar & Jharkhand	5403	1342	24.84
Overall	17559	7296	41.55

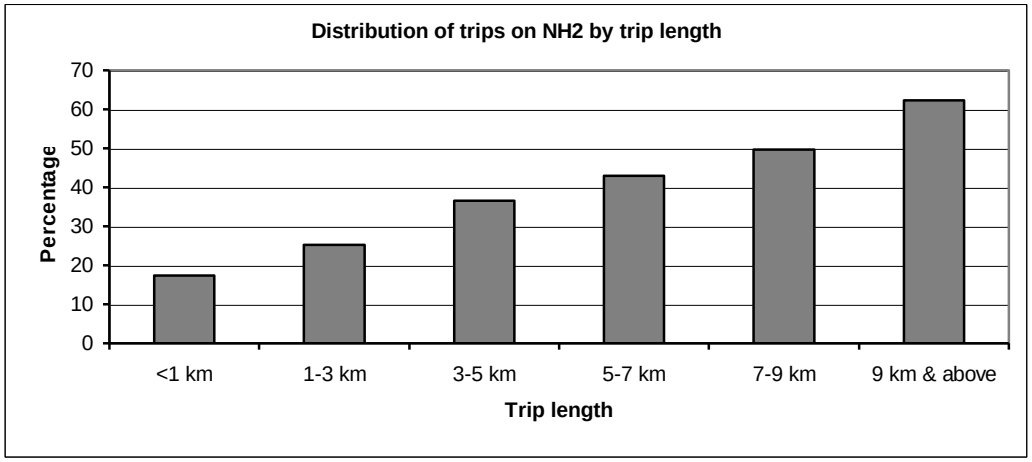


Distribution of Trips on NH2 by Trip Length

The share of trips involving travel on NH2 tends to increase consistently with increasing trip length. It increases from 17.42 percent for trips of less than 1 km to 62.3 percent for trips of above 9 km (Table 20).

Table 20: Share of trips on NH2 by trip length

Trip length (km)	Total trips	Number of trips on NH2	Percentage
<1 km	333	58	17.42
1-3 km	4476	1133	25.31
3-5 km	4383	1603	36.57
5-7 km	2622	1124	42.87
7-9 km	1580	784	49.62
9 km & above	4165	2594	62.28
All	17559	7296	41.55

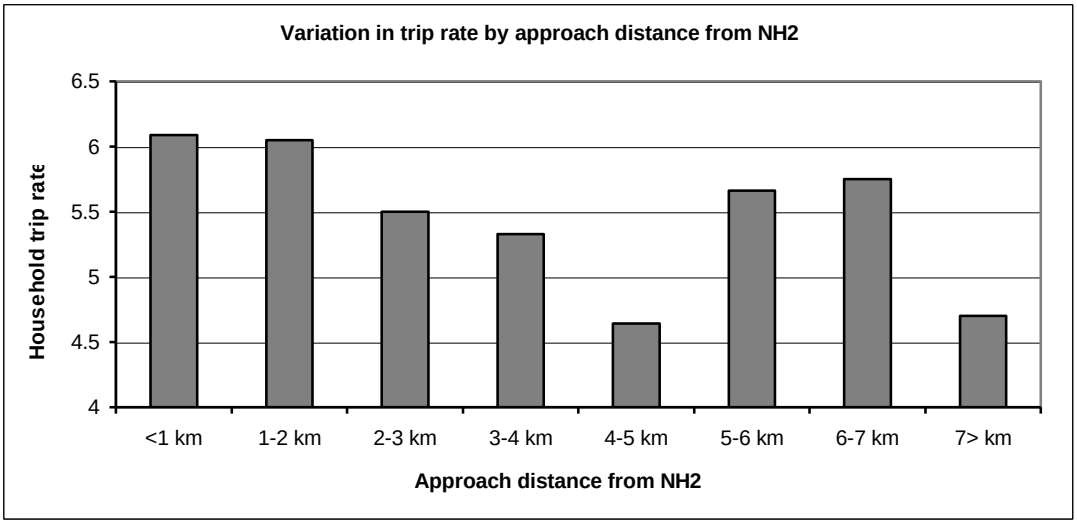


Approach Distance from NH2 and Distribution of Trips

The trip rate steadily declines with increasing distance from NH2. The trend is one of a consistent decline up to a distance of 5 km, beyond which the pattern changes (Table 21).

Table 21: Variations in household mobility parameters in relation to distance from NH2

Approach distance from NH2	Household trip rate
0-1	6.09
1-2	6.05
2-3	5.50
3-4	5.33
4-5	4.64
5-6	5.66
6-7	5.75
7>	4.70
Total	5.49



Section IV: Attitudinal Response of Highway Users

An attitudinal response survey of households was carried out to elicit their responses with respect to the preference of transport modes to access various facilities, travel attributes and the importance of road in developmental activity. The salient findings are briefly discussed below.

Preferred Mode of Travel

Travel on foot and on bicycle are the preferred modes of commuting. The use of motorised transport is generally preferred for visiting government offices and primary health centres. The modal choice is, however, largely determined by factors of cost, and long distances, followed by convenience (Table 22).

Table 22: Preferred mode of travel for access to various facilities

(in percentage)

Preferred mode	Access to facilities						
	School	Post office	BDO	Market	Primary health centre	Mandi	Bank
Foot	79.8	47.5	24.8	40.1	46.5	40.2	23.0
Bicycle	15.3	46.5	22.8	44.5	22.6	36.1	48.5
Two-wheeler	1.2	2.9	7.3	3.4	4.0	4.1	12.0
Car/Jeep	1.0	1.3	21.3	3.6	12.3	7.6	7.2
Bus	2.1	1.2	18.5	5.4	6.6	4.8	6.2
Animal-driven cart	0.1	-	1.5	0.4	-	0.7	0.4
Physically carried	0.4	-	0.9	0.9	4.0	-	0.3
Three-wheeler	0.1	0.6	2.4	1.1	2.7	1.7	2.1
Train		-	-	0.2	0.4	0.7	0.3
Tractor-trailer		-	0.5	0.4	0.9	4.1	-
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Important Travel Attributes

Around 42.8 percent of the households surveyed consider safety to be the most important travel attribute, while travel cost and travel time are the important attributes for 29.8 percent and 24.9 percent of the households, respectively (Table 23).

Table 23: Distribution of household responses relating to attributes of travel

Important attributes of travel	Number of responses	Percentage
Travel time	796	24.88
Travel cost	955	29.84
Travel distance	72	2.25
Safety	1371	42.84
Quality of transport set	6	0.19
Total	3200	100.00

Important Developmental Activities

The households regard road construction to be an important developmental activity apart from medical facilities, employment-generating activities, schooling facilities and housing (Table 24).

Table 24: Distribution of household responses relating to developmental activities

(in percentage)

Development activity	Very important	Moderate	Not important	Total
Road	65.22	18.38	16.41	100
Pond	18.41	28.16	53.44	100
Electricity	51.38	25.28	23.34	100
Phone	10.88	42.84	46.28	100
Post and telegraph	11.00	50.78	38.22	100
Drinking water	69.03	22.56	8.41	100
Housing	58.53	23.69	17.78	100
Employment	83.66	10.81	5.53	100
School facility	58.81	22.56	18.63	100
Medical facility	81.13	10.34	8.53	100
Others	23.06	2.56	74.38	100

Conclusions

Contrary to the traditional view that a national highway mainly facilitates intercity travel and transport of goods, the analysis brings out that it is also an integral part of the road network serving the rural areas. It has an important role in providing access to the rural population. This is borne out by the fact that more than two-fifths of the trips originating in the selected stretches involve the use of the national highway.

A large number of the surveyed villages in the selected stretches are still connected to the highway by katcha roads or roads other than all-weather ones. This is a fairly serious constraint, and brings out the need for upgrading the secondary road network to realise the full potential of the highway or its proposed upgrading to the four-lane status.

Vehicles owned are predominantly cycles, which account for over 87 percent of the total; the share of motorised vehicles is rather low at 8.6 percent. Among the motorised vehicles, two-wheelers – scooters and motorcycles – predominate, followed by tractors. The share of motorised vehicles in the total is higher in the vicinity of the highway. More than half the villages surveyed have public transport facilities. Uttar Pradesh is better endowed in this regard than Bihar and Jharkhand.

Overall, the levels of mobility in the surveyed areas are low and decline further as one travels eastward. On average, a household makes 5.49 trips a week, which translates into a per capita trip rate of less than one. The figure is higher in Uttar Pradesh and lower in Bihar and Jharkhand. The trips related to work, education and marketing are among the most important in the daily commuting of the rural population.

People mostly travel on foot or bicycle. Together, the two account for about three-fourths of the work- and market-related trips. A higher proportion of trips in Bihar and Jharkhand are performed on foot, while the use of bicycle accounts for less than 12 percent of the total.

The average trip is short, indicating a limited spatial spread of socio-economic interaction in the villages. More than half the trips are within a distance of 5 km. However, in Bihar and Jharkhand, this proportion is slightly higher. The households in these states also incur higher transport costs largely owing to greater dependence on mechanised transport than in Uttar Pradesh.

Chapter 7

Findings and Task Ahead

Contrary to the traditional view that a national highway mainly facilitates intercity travel and transport of goods, the study firmly brings out that it is also an integral part of the road network serving the rural areas. The road is extensively used by the rural population for various social and economic activities.

Proximity to the highway has significant influence on major aspects of socio-economic well-being of the rural population. Greater opportunities of employment and earnings in non-farm activities are generated. Access to education and health facilities improves. Household incomes rise and so do asset holdings. A poor rural household living in its vicinity thus derives considerable benefits.

The benefits of the highway extend up to a distance of 4-5 km on either side, which may be treated as the influence zone. Beyond this distance, a divergent pattern is observed for some outcome variables. Two hypotheses relating to this concept of influence zone have been empirically validated in the present study.

The first, called gradient of change hypothesis, asserts that the impact of the highway systematically declines as one moves farther away from it. The other, a related one, postulates that a poor household residing in the influence zone would be better-off in terms of various indicators of well-being vis-à-vis comparable household living away from the influence zone.

Some of the notable impacts due to proximity to the highway are: mobility for work increases by 32 percent and that involving the use of the highway by 79 percent; and chances of a household being poor decrease by 17 percent. At the village level, proximity to the highway tends to lower the proportion of poor households by 15 percent, raise the proportion of non-agricultural workers in the total working population by as much as 50 percent, increase the overall school enrolment by 40 percent and that for girls alone by 17.5 percent.

Three indices have also been used to analyse the impact: (i) index of overall well-being; (ii) index of well-being in respect of mobility; and (iii) index of well-

being in respect of access to amenities like electricity, drinking water, sanitation, and other assets. These show positive results. There is a gain of 30.94 percent in overall well-being, 6.51 percent in respect of mobility, and 22.21 percent for access to amenities.

Making the highway four-lane is expected to promote new kinds of economic activities and thus improve the socio-economic conditions of the rural population living near the highway. Improvement in secondary road network – village roads – will further enhance the effectiveness of the project.

The study helps one to understand the linkage between a public good infrastructure like road and the well-being of rural people. The results make explicit the positive contribution to poverty reduction that investments in highway expansion in particular and road infrastructure development in general can generate.

The results of the study convincingly document and confirm that among other interventions, large-scale public investments in road infrastructure development can be an effective and viable policy measure for poverty alleviation.

The Task Ahead

As explained in the report, the socio-economic impact analysis of a public investment project is done to assess the extent of net related benefits of the project that accrue to the population group(s) concerned. Typically, such analyses comprise two studies – one based on baseline survey data (collected before the project is launched) and the other based on re-survey data (collected after the project has been completed). The partial effects of the project are then assessed by appropriately comparing the results of these two studies.

The present study is based on baseline survey data. A similar study will be done to assess the impact of widening the highway after the completion of the project in 2005. In fact, since the full impact of widening the highway will take some time to be realised, more than one study may be required to bring it out.

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