CHAPTER I

INTRODUCTION

1.1 Motivation for the study

Telecommunication provides for electronic point-to-point communication needs among groups of people or machines. As a part of communication sector, telecommunication comes under Union List of the Indian Constitution. Hence, all policies and programmes relating to it are economy wide policies and programmes. In the pre-reform years, telecommunication services in India were under the departmental provisioning (Government monopoly) and the prices were not market determined. A historically determined mix of policy and profit objectives was used to justify a set of telecom prices (Braunstein, 2003) with virtually no consumer choice. The only option available to the subscribers was to use the service at whatever price it was offered. Even when there was a connection, in many cases the provisioning of telecommunication services were limited to just one connection of low quality, with the waiting time for new connections ranging from seven to eight years and access charges (the charge paid for getting connected to the telecom network) and long distance tariffs being highest in the world (Dossani et al, 2003). The Government’s priority towards the telecommunication sector during the pre-reform years was very low. This was evident in the Approach Paper to the Sixth Plan, which stated, “The primary need of the people is food, water and shelter. Telephone development can wait. In place of doing any good, development in the telecommunications infrastructure has tended to intensify the migration of population from rural to urban areas. There is need to curb growth of telecommunication infrastructure, particularly in the urban area” [quoted in Dossani, (2003) p. 30].
Even the VII plan (1985-1990) had only a plan outlay of 3.6 per cent for communication sector, which was the highest among all plan allocations in the pre-reform years. Nevertheless, the Eighth Plan had witnessed a sustained high growth in the provisioning of basic telecom services. The demand has far exceeded supply resulting in large unmet demand. The incumbent Department of Telecommunication (DOT) was unable to introduce any of the new services for want of fund. During this period, public sector investment for expansion of telecom network for the basic service was financed by internal resources and market borrowings. The budgetary support constitutes less than one per cent of the total plan outlay.

In 1991 the Government of India introduced the new economic policy with an aim to improve India’s competitiveness in the global market, inducing rapid growth of export, attracting foreign direct investment and stimulating domestic investment. It was realised that telecommunication services were bottlenecks in the economy. By then the importance of adequate provisioning of telecommunication services and the implications of non-availability of new services like Facsimile and Xerox (FAX), mobile telephony, radio-paging etc. on economic development were well understood by the policy makers and planners.

Accordingly, the post reform years (i.e. since 1991) have witnessed an increase in plan outlay to the communication sector. In fact the sector has attracted 5.8 and 5.5 per cent of total plan outlay in eighth and ninth five-year plan, respectively. However, the Government realised that the internal resource alone would be grossly inadequate to meet with the increased requirements. In order to deal with the scarcity of telecom services, and paucity of fund faced by the incumbent monopoly and to facilitate economic growth, a series of policy initiatives were undertaken affecting the provisioning and pricing of
telecommunication services. These policies include liberalisation (i.e. corporatisation and deregulation of service delivery and prices) and privatisation (i.e. unfolding the various sub-sector of the telecommunication services to the private players), Government’s decisions of becoming a member of General Agreements on Trade in Services (GATS) under World Trade Organisation (WTO) and creation of Telecom Regulatory Authority of India (TRAI) as an independent authority to regulate the telecom sector. It is argued that in terms of timing and sequencing of reform the establishment of an independent regulator should have preceded the privatisation process. Wallsten (2001) explores the effects of privatization, competition and regulation on telecommunications performance in 30 African and Latin American countries from 1984 through 1997 and found that privatization combined with an independent regulator is positively correlated with telecom performance measures. In addition, Wallsten (2003) found that countries that established regulatory authorities prior to privatization experienced increased telecom investment and telephone penetration as compared to countries that did not. He also observed that investors paid more for telecom firms in countries that established a regulator prior to privatisation. In the case of India as well, the winning bidders for the cellular service realised that their bids would have been more realistic if a regulatory agency had existed at that time, since the regulator would have been a source of scarce information on the potential of the Indian telecommunication market (Verma, 2003). After initiation of the privatisation process, an urgent need was felt to control the fiercely feuding basic telecom operators, the greatly agitated Global System for Mobile (GSM) cellular service providers and to resolve the new challenges posed by the emerging Wireless in Local Loop (WLL) services and to settle the disputes among them. The regulator’s initiative such as tariff rebalancing for the basic service, estimation of the cost of various unbundled network elements, issuing a regulation on interconnections, fixation of interconnection user charges with the
provision of access deficit charges (ADC), developing a national numbering plan (NNP), fixation of the parameters for the quality of services, funding of universal service obligations (USO) and introduction of unified licensing scheme have brought about remarkable changes in the provisioning of telecommunication services. In addition, the New Telecom Policy 1999 (NTP-1999) was announced to provide a broad framework for the future provisioning of telecommunication services to be achieved in India. NTP-1999 was prepared keeping in view (i) the unfulfilled objectives of NTP-1994 and, (ii) the recent developments in the telecommunication and information technology (IT), consumer electronics and worldwide media industry.

Government slowly withdrew from administering the provisioning of telecom services and reduced its role to monitoring it by designing appropriate policies and programmes. Private sector participation and the resultant emergence of competition has been seen as the most expedient and reliable way of making high quality service available (provisioning that has distributive implications) through modern technology at a reduced price (pricing that has efficiency implications). The above policy changes have implications for nature and extent of provisioning and pricing of telecommunication services. At the same time, all the consumers of telecom services are affected by these changes in the supply side of the services. Moreover, these changes have implications for economic growth of India through its contribution to GDP in the manufacturing and service sectors. Thus, the policy regarding provisioning and pricing of telecommunication services and its implementations assume special significance during the post-reform years and a systematic economic analysis of the policy changes and their impact on the supply of and demand for telecommunication services is a policy imperative as well as the basic motivation for the study.
1.2 Review of Literature

Reforms for provisioning and pricing of telecommunication services raise several analytical, empirical and policy issues. These issues include the following: (i) What is the nature and extent of reforms for the provisioning and pricing of telecommunication services? (ii) What impact do such policy changes have on India’s economic development and how such changes can be determined in empirical terms? (iii) What have been the welfare implications of such policy changes on the consumers/subscribers of telecom services? (iv) Are there subsidies or cross subsidies in the provisioning of these services? If so, how have they changed through the reform years? (v) How does DOT plan to achieve the universal access facility and higher tele-density in a competitive environment? (vi) Do the policy changes help India to catch up with the global telecom service standards in terms of tele-density and quality of service? (vii) What are the norms to fix and regulate the market pricing of telecommunication services given the heterogeneity of consumers?

In order to find a plausible answer to the above research issues and to identify the research gaps, a review of the existing literature in India and outside is presented below by the role of telecommunication in economic development, theoretical principles and empirical measurement of cross subsidy in telecommunication services, and studies on demand for telecommunication services.

1.2.1 Telecommunication and Economic Development

Telecommunication is one of the important infrastructures of the economy. It serves a variety of economic wants by providing access to markets previously
barred physically by distance and costs, generating economic savings and
increased productivity for household, farms and government through substitution
of telephone usage for more expensive form of communication such as travel;
improving market efficiency and competitiveness for business and firms through
better information flow on prices, products, and attributes; and increasing
business efficiency and profitability in the areas of client/customer relations,
ordering, stock control, improved distribution channels, and the like (Kayani and
Dymond, 1997). In the process of globalisation and liberalisation, information as
a prerequisite for production process is gaining importance. Improved
communication is vital for productivity in economic activities such as
constructions, transport, trade and commerce, to mention a few. Being the
backbone of information economy, telecommunication reduces transaction costs.
Norton (1992) found that the links between transaction costs, telecommunication
and economic growth stem from two facts. First, there is a lack of readily
available information in developing countries. This would result in inability to
make and implement decisions. The presence of a well-developed
telecommunication infrastructure is a necessary condition to overcome this
difficulty. Second is the existence of an inverse relationship between the
transaction cost and output rate. Output rate increases with the fall in transaction
cost while telecommunication infrastructure helps in reducing transaction cost.

One can think of various alternative methods to evaluate the impact of
telecommunication services on economic growth. These methods can be broadly
classified under ‘Macro-Economic Approach’ and ‘General Equilibrium
Framework’. Existing studies focus on the macroeconomic approach by
describing how the country-specific growth variables (e.g. growth rate of GDP)
influence or are influenced by sector specific telecom variables (for instance,
growth rate of direct exchange lines). Studies on estimation of impact of
telecommunication on national income are only a few and include Norton (1992), Roller and Waverman (2001), Torero et al (2005) and Datta and Agrawal (2004). These empirical studies focus on two-way relationship between telecommunication and economic growth. That is, increase in economic growth depends on the telecommunication infrastructure and services, whereas increase in the telecommunication services may depend on increase in economic growth.

Norton (1992) observed that the existence of telephone stock reduces the transaction cost, as output raises when the infrastructure is present. Using the data of 47 countries for the period 1957-1977, he estimated the effects of the average stock of telephones on the mean annual growth rate of domestic/national product after controlling for the stock of telephone in 1957 (telephone population in 1957) and a number of macroeconomic variables along with the average telephone population for the period of study. He found that average stock generates powerful diagnostics. By examining the performance of telephone stock of 1957 and average telephone population he concluded that the relationship between telecommunication and rate of growth of GDP is not clearly due to reverse causality. Hence, the existence of telephone stock reduces the transaction cost as output rises. This interpretation is plausible as the coefficient for the initial stock of telecommunication as well as the average telephone population turns out to be positive and significant. This implies that countries with larger initial stock of telecommunication grow faster than the countries with low initial stock of telecommunication capital. The presence of telecommunication variable makes the negative value of coefficient for income per capita stronger and more robust supporting the convergence hypothesis. The negative value is expected for the coefficient of income per capita because countries with a lower output per capita should grow faster as a result of technology diffusion to less developed countries.
Roller and Waverman (2001) used cross-country panel data that consist of 21 OECD countries over 20 years (1970-1990) to examine the impact of telecommunication on economic growth. Their fixed effect model under a simultaneous equation framework endogenises the telecommunication sector by specifying a micro model of demand and supply and jointly estimates the macro production equation. Their data set consisted of both economic variables relating to countries characteristics and characteristics relating to telecommunication development. Given that the OECD has grown at around 1.96 per cent, their fixed effect model shows that one-third (0.59 per cent) of the growth can be attributed to the telecommunication investment. According to their estimate allowing for fixed effect, the tele density elasticity is found to be 0.045. A Telecom Penetration (TP) above 40 per cent has significant growth impact. Such a rate of TP corresponds to Universal Service with roughly 2 to 2.5 people per household. The critical mass corresponds to 40 percent TP rate. Such a TP rate exists in most of the OECD countries. Those countries that are above the critical mass would have a higher growth rate whereas others would grow much slower. Hence, they conclude that convergence in telecommunication infrastructure would offset the divergence in economic performance.

Even after controlling for the country-specific fixed effects, the study conducted by Roller and Waverman (2001) shows a strong causal relation between telecommunications infrastructure and economic growth in OECD countries. However, it is possible that their results were driven by the non-stationary nature of certain variables such as GDP, the investment in telecommunication infrastructure and the non-residential capital stock net of telecommunication capital.
Applying a framework and a specification as close as possible to that of Roller and Waverman (2001), Torero et al (2005) estimated a four-equation model with first difference of the variables in order to correct for the unit root problem. They found that a one per cent increase in the TP results in a 0.03 per cent increase in GDP for 95 countries. With the primary aim of examining whether the idea of critical mass is valid for a large sample of nations, they assembled a data set that includes data on 113 countries over the time period 1980-2000. They found that for poor countries, where a critical mass of telecommunication does not exist (with the mean TP rate of 0.58 per cent), a marginal increase in the TP rate would not initiate economic growth. For high middle-income countries for TP level of 5 to 11 per cent, telecommunication infrastructure has a positive and statistically significant impact on aggregate output. For the 20 countries in this group, they found that one per cent increase in the TP would result in a 0.064 per cent increase in the GDP. On the other hand, for 26 countries in the group of OECD and other high-income countries a one per cent increase in TP would result in only 0.015 per cent increase in GDP. These countries have a TP rate of about 40 per cent. Hence, they concluded that for this group of countries the growth effect is negligible.

Datta and Agarwal (2004) also investigated the long run relationship between Telecommunication infrastructure and economic growth for OECD countries. Their study employs a dynamic panel data model for a sample of 22 OECD countries for the period 1980-1992. They also found a statistically significant and positively correlated impact of telecommunication variable on the growth in real GDP. Their results were found to be robust even after controlling for investment, government consumption, population growth, and openness, past level of GDP and lagged growth. Their results further indicated that the telecommunication investment was subject to diminishing returns indicating a
higher gain for countries from investment in telecom infrastructure at an earlier stage of development.

Narayana (2005) provides a framework to estimate the contribution of Information and Communication Technology (ICT) on national and state income accounts for economies characterised by federal, open and mixed economy structure. This study distinguishes the contribution of ICT sector to economic development by manufacturing and service activities in Karnataka state. The estimation result shows that ICT services have a remarkable share in the ICT sector’s contribution to national and state income in India during 1993-94 to 2001-02. In its empirical model, the study has used total number of metered telephone calls by telecom districts as a proxy for total usage demand for ICT services and its determinants are estimated with respect to changes in per capita income, teledensity, and share of tertiary sector in State income. The results of the chosen model (i.e. log.linear fixed effects model) indicate that the changes in per capita income, teledensity, and share of tertiary sector in State income are the sources of growth of ICT services.

Thus, all the above studies investigating the impact of telecommunications on economic growth have used a macro economic framework and found positive impact of the presence of a well-developed telecommunications infrastructure in determining economic growth.

1.2.2 Pricing and Cross-subsidies in Telecom Services

Telecommunication services worldwide have been generally considered to be an essential public utility service. Hence, the nature of its pricing has been public pricing which may deviate from prices that market determines. Such public
pricing may have some higher order value judgment as formally expressed by social welfare functions. Bos (1986) has summarised the literature on public sector pricing wherein he has discussed normative as well as the positive aspect of public pricing. He has derived several important normative pricing rules from his review of pricing policies for welfare maximisation. In fact normative pricing rules such as marginal cost pricing and Ramsay pricing have actually been applied in the context of public pricing. Cross subsidy has been used as an instrument in achieving certain welfare objectives. So far as the positive aspect of public pricing is concerned, its prime objective is to maximise certain kind of managerial or political objective such as winning votes, maximising budget, minimising price indices and so on. Though the pricing rules of this positive type cannot be justified by means of higher-order value judgments, they do provide a good basis for an analytical investigation of actual public pricing policies.

Faulhaber (1975) has discussed various dimensions of cross subsidy, which is oriented towards the theoretical issues of the existence of cross subsidy than towards empirical measurement of their extent whenever they are present. Following Faulhaber, a subset of output is neither the source nor the destination of cross subsidy if it generates revenue that is less than its standalone cost and more than its incremental cost. Symbolically:

\[ R(q_j) = p_j q_j \leq c(q_j) \]

Where, \( p_j \) & \( q_j \) are the price per unit of \( j^{th} \) goods and the quantity of \( j^{th} \) goods, respectively and \( c(q_j) \) is the standalone cost of subset \( j \). In a subsidy free allocation however, no subset of output yields less revenue than its incremental costs.

\[ p_j q_j \geq c(q) - c(q_{n-j}) \]

Where, \( c(q) - c(q_{n-j}) \) is the incremental cost of producing subset \( j \).
A subset $j$ is said to be the origin of cross subsidy if a firm serving $j$ alone at price $p_j$ makes a positive producer surplus. Symbolically,

$$q_j p_j - c(q_j) > 0$$

The desirable equilibrium is in the core of the game satisfying both individual rationality and group rationality. The core of the cost allocation game may be empty so that there may not be any subsidy-free price. It is also possible that there may be many subsidy-free price vectors and choosing among them might be a problem.

The cost concepts developed by Faulhaber (1975) although theoretically attractive may not be estimable for want of data that are sometime not observable, (Curien, 1991). For instance, it may be difficult to conceptualise the standalone cost of access without usage or vice versa. In addition, the cost function is often poorly estimated at points far from the current conditions of production, so that the stand alone cost $C(q_j)$ for at least some subset $j$ are difficult to determine. Moreover, the cross subsidies do not add up to zero and cannot be considered as cross payments in zero sum game between groups of users.

As a result of above limitations, alternative concepts and methods such as revenue trade-off approach, which are not strictly related to the theoretical notion of cross subsidy, is gaining popularity among the telecommunications regulators and companies. Applying revenue trade-off in terms of cost per dollar of revenue in case of Bell Canada and British Columbia telecom for the year 1986, Curien (1991) showed that access is the major destination of cross subsidy, the source being monopoly services like trunk and, to a lesser extent, local call. Moreover,
the study found competitive activities such as network and terminal to be neither source nor destination of any significant trade-off. Curien’s analysis of the trade-off in France telecom for 1984 found the following: (a) Rural areas benefited from a global trade-off of FF. 6.8 billion, the sources of which are large cities (FF. 5.6 billion) and, to a lesser extent, medium size cities (FF. 1.2 billion); (b) Service industries (FF. 6.4 billion) and manufacturing industries (FF. 2.1 billion) are identified as the major source of subsidy. On the other hand, households (FF. 6.5 billion), second dwellings (FF. 0.8 billion), professionals (FF. 0.7 billion) and coin telephones (FF. 0.05 billion) are the major beneficiaries from the trade off; and (c) Traffic as a whole pays for access up to FF. 26 billion; the contribution of trunk traffic is FF. 19.5 billion and that of local traffic FF. 6.5 billion only, so that trunk traffic pays to local traffic a subsidy of FF.13 billion. In short, Curien’s analysis identified rural areas as beneficiaries from a global trade-off - the source being large cities and, to a lesser extent, medium size cities. Moreover, households, second dwellings, professionals, coin telephones and overall access are the major beneficiaries from the trade off while the source is service industries and manufacturing industries.

Kaserman et al (1990) examine the theoretical and empirical support for the belief that the traditional system of cross-subsidizing the local rate by long distance has served to promote the goal of universal service. They found that the cross-subsidization mechanism bears no causal relationship to the policy goal of universal service. Instead, both subsidy levels and subscription rates appear to be determined by other economic variables, such as those suggested by the economic theory of regulation.

The major problem that comes across while subsidising is to identify the low-income recipient of subsidies and high-income donor. No serious attempt has
been made to identify these groups for subsidising the telephone services. Rather, in order to keep the access of telecommunication services affordable, the rental and the local call charges are subsidised by the long distance calls. Perhaps, this policy led Manikutty (1999) to assume that long distance (STD and ISD) calls are basically made by the richer section of society and need to be charged heavily in order to cross subsidise the local calls and to keep the connection charges low.

The Expert Committee on the Commercialisation of Infrastructure Projects [GOI (1996)] headed by Rakesh Mohan pointed out that the long distance tariff has been used as an instrument of cross subsidisation of telecommunication services in rural areas and in areas where it is financially unviable. According to the Committee’s report, this has helped the Government in its programme of expansion of telecommunication services to the economically backward areas and the integration of rural telecom in the national stream. In fact, while summarising issues relating to cross subsidy in the provisioning of telecommunication services in India, the Committee’s report has brought out the following points:

a) The cross subsidy between local calls, national long distance and international calls in effect translate into cross subsidy between business and residential customers in any exchange area.

b) On an average, 70-75 per cent of the revenue from an exchange area is generated by 20 per cent of the subscribers constituting the highest paying bracket.

c) Urban areas highly subsidised rural areas throughout as the cost of producing a rural line is much higher than that of an urban line.

d) The tariff structure for basic services in India was the same for commercial and non-residential subscribers. The then tariff structure, though not desirable, was still manageable as long as cross
subsidisation is contained within the jurisdiction of a single operator i.e. DOT.

e) Recommended for a more cost oriented tariff structure and prescribed for a detailed tariff rebalancing exercise in order to provide better rates to the bulk users and at the same time, to provide transparent subsidies to the rural and less profitable areas.

The use of implicit cross subsidy makes entry into many local markets untenable because prices were held below cost by regulatory fiat (Rosston and Wimmer, 2003). This might be an important reason for the slow growth of the private operators, before the long distance calls were opened up. It is only recently the inter circle long distance calls (since 13th August 2000), followed by the international long distance calls (since 31st March 2002) have been opened up to competition. In a multi operator environment the provisioning of interconnection facility between various providers of telecommunication services assumes a special significance because it ensures that subscribers of a particular telecom service provider can be accessed by the subscribers of any other provider of telecommunication services. In order to connect one subscriber of telecommunications service with another subscriber, the essential function needs to be performed by the service providers are origination, carriage and termination. When the subscriber making the call and the subscriber receiving the call belong to two different service providers; there is the requirement of interconnection. Under the circumstance, the total amount collected from the call needs to be shared between the providers in proportion of the work done. TRAI (2003c), has provided the distance zone wise revenue share of each functions performed by different providers [WLL (M), Cellular, Fixed]. In order to ensure that the traditional sources of financing cross-subsidy are not getting affected due to competitions, TRAI has recently, loaded the burden of Access Deficit on inter-
circle, intra circle and international long distance calls in terms of an explicit Access Deficit Charge (ADC). This is a mark up over and above the Interconnection Users Charge (IUC) to finance the deficit that occurs in the provisioning of access and local usages.

1.2.3 Demand for Telecom Services

In the context of demand for telecommunication services, often a distinction is made between the access and usage demand. The access demand is the demand for connecting to the telecommunication network. Usage demand, on the other hand, is the demand to use the telecommunication services such as making outgoing calls. The subscriber can have the option of making and receiving calls only when access is provided. Thus, there must be access to the telecommunication network before it can be used.

Another distinguishing feature of the demand for telecom service is that a network is involved in its consumption. This gives rise to the issue of interdependence and externalities in telecommunication demand modeling. Two types of externalities namely, network externalities and call externalities are generally discussed in the context of demand for telecommunication services. The network externalities arise when a new subscriber joins the network whereas call externalities associated with the usage demand are the gratuitous effect of a completed telephone call on the receiving party (Taylor, 2003).

The existing theoretical and empirical literature relating to the demand for telecom services pertain to estimation of demand relation and evaluation of welfare implications of price changes. In his path-breaking article, Mitchell (1978) has examined the efficiency implications of alternative local telephone
service pricing approaches. His study gives a contrast between the welfare effects of a flat monthly rate with measured service pricing under an optimal two part tariff with an access line charge and a per call charge. The research on telecommunications demand is well documented by Taylor (1994) and Taylor (2003). Taylor (1994) provides the theoretical development as well as the empirical applications of telecommunications demand. In fact, the first few chapters in Taylor (1994) provide an excellent theoretical review on the residential demand for telephone access and usage. The basic theoretical structure is based on standard consumer’s problem of constrained utility maximization from which the general expressions are derived for aggregate telephone access and usage demand. So far as access demand is concerned, Taylor (1994) finds that residential access price elasticities have fallen somewhat during the 1980s due to higher penetration rates. Observing the small price elasticity and a moderate, but yet decidedly inelastic income elasticity of access demand for basic telephone service, Taylor (1994), concludes that the access for the telephone system has become a basic necessity for all income groups. Taylor (1994) also provides an excellent review of thirteen studies estimating price and/or income elasticity of the demand for local use and local services. In these studies the price elasticity varies from -0.02 to -0.35 in the short run whereas it varies from -0.07 to -0.38 in the long-run. With regard to income elasticity the variation ranges from 0.10 to 0.99 in the short-run and 0.14 to 2.68 in the long-run. However, Taylor (1994) observes that the demand for local service is primarily to be identified with the demand for access. With regard to interstate toll demand, Taylor (1994) reviews several pre 1980’s studies in details and concludes from the evidence that the long-run elasticity is at least 1 for income and in the neighborhood of -1 for price. In general, the models that have been used for toll demand are similar to those that have been used for local service, and two broad classes of models can be identified. The first class approaches the dependence of toll volume on the stock
of telephones in a distributed-lag framework. In the second class of models, the stock of telephone appears explicitly either as a deflator of toll volume or directly as an independent variable.

Gassner (1998) has analysed the impact of price variation on household access in the context of UK using Pseudo-panel data model. For the overall sample, Gassner (1998) found price elasticity with respect to the rental charge of -0.033. The study finds a very high difference in the elasticity measured between high-and low-income groups.

Taylor (2003) has summarised the present state of the art in telecommunications demand modeling. His review finds that the use of quantal choice models, the analysis of toll demand on a point to point basis, and the application of random coefficient methods to a system of toll demand equations were common in practice in 1980s and 1990s. Fildes and Kumar (2002) also provides an excellent review on telecommunication demand forecasting.

In the context of India a few studies have attempted to project the demand for fixed and cellular telecom services in terms of number of connections. GOI (1996) provides the demand estimation models used in telecommunications demand projection. First, the time series regression methods used by DOT’s Economic Research Unit (ERU), where projections of the demand for basic telecom service was based on past growth rates and expressed demand (the sum of DEL and waitlisted demand) in various circles and metro districts. Second, telecom revenue as a percentage of GDP which starts from GDP, then getting the revenues from telecom as a percentage of GDP, and finally the number of DELs to support such telecom revenues, under the various assumption of average revenue per DEL. Third, Ability to pay models which is based on the assumption
that the households above a certain income level are potential telecom subscribers and the ratio of households to non-households subscribers is a predictable number which may differ for rural and urban subscribers. Fourth, Waiting time and Expectations model for a supply constrained market is based on the following assumptions a) Registration of demand depends on income and the potential subscriber’s expectation about the waiting period (which is based on observations of past rates of clearance of the waiting list); b) There is a cost of waiting as registration needs a cash down payment; c) Any reduction in waiting time caused by increasing supply will have a cumulative effect on demand. Fifth, the cross country regression models suggested by UTI where the estimation of teledensity is based on the per capita GDP. Under ITU approach, teledensity was regressed on the per capita GDP of 98 countries for the year 1992. The regression coefficient thus obtained was used to estimate the teledensity in India in the future, based on the projected per capita GDP.

Using the time series regression model the DOT had projected for 46.3 million telephones by the end of 2005. Even this revised estimate is far below the demand projected by many independent organisations, which vary from 52 million to 90 million lines in 2006 [GOI (1996)].

The demand for cellular mobile connection in India by the year 2005 as projected by several organisations namely JP Morgan, Iridium, DRI McGraw and Licence Fee Party is provided are 4.9, 4.6, 12.5 and 12.3 million, respectively (GOI, 1996). Thus the projected demand figures in 2005 range from 4.6 to 12.5 million. However, India has witnessed a phenomenal growth in the demand for cellular mobile services. The actual subscriber base for cellular mobile services in India by the end of March 2003 was 12.99 million, which is closer to the DRI McGraw projection of 12.5 million for the same period. Since then the growth in the
subscriber base of mobile services has left all projections far behind. By the end of March 2004 the total mobile subscriber base was 33.69 million and by the end of October 2005 it was 44.49 million (GOI, 2005), which is approximately 3.5 times more than the highest projected figure for 2005.

There are very few empirical studies even in the context of developed countries that estimates the usage demand for telecommunication services. These include Park et al (1983) estimation of price elasticities for local telephone calls in the context of USA, the study by Lang and Lundgren (1991) using Swedish data and Trotter (1996) using data obtained from the telephone system in Hull (UK). Lang and Lundgren (1991) is based on two assumptions; (i) different recipients of the calls are not substitutes for each other and (ii) the elasticity is proportional to price as in Park et al (1983), where the expected calling time in a distance zone ‘d’ at a time period ‘t’ is a function of the complete telephone tariff for all prices representing various time and distance zones. Using Swedish data they estimated elasticity, which is equal to –0.16 for lowest price category (local calls) and –1.63 for the highest price category calls (which is used to represent long distance calls). Trotter (1996) estimates short-run access elasticity of 0.6 with respect to income and of -0.1 with respect to rental charge of the main residential tariff. Martins-Filho and Mayo (1993) provides the empirical estimates of the magnitude of the change in both demand response and consumer surplus associated with extended area telephone services (EAS) for the metropolitan areas of Tennessee. His empirical findings indicate that demand is quite responsive to the implementation of EAS and that the consumer surplus consequence of EAS is quite significant. For the EAS plan adopted in Tennessee, the estimated net annual welfare gains for the two-way EAS varied from approximately $22 million to $41 million for three different models specified in this study.
Studies on usage demand for telecommunication in India are few that include Muralikannan (1996) and Das and Srinivasan (1999). Muralikannan (1996) has used the cross section data of residential telephone subscribers for a bi-monthly period from Haddous Road II E10B digital Exchange at Nungambakkam in the city of Madras. By applying non-linear least square with the functional form, as used in Lang and Lundgren (1991), Muralikannan (1996) estimated the price elasticities at -0.01 and -0.02 for the low and high-income groups, respectively, in case of residential subscribers. For the non-residential subscribers, the estimated elasticities are -0.45 and -0.15 for the low and high sales turnover groups, respectively. He found that educational and occupational dummies have positive influence on STD calls while business categories’ dummy and age of phone connection do not influence call demand significantly.

In their study of eight STD PCOs of Tiruverambur (a small town that falls within the Tiruchchirapalli) in Tamilnadu state during November 1993 to January 1994, Das and Srinivasan (1999) found that for the lowest price category (Rs 1.64 per minute call) the price elasticity estimates vary from –0.11 to –0.31. For the highest price category (Rs. 39.30 per minute per call) elasticity vary between -2.75 to -7.47. For the middle level price category (19.65 per minute per call) they vary from -1.37 to -3.70. Average call duration is obtained for each of the 18 price categories (6 distance zones × 3 time slots), separately. They obtained a range of price elasticities for each price category by allowing the elasticity to vary along with price by specifying a semi log functional form where the price elasticities are obtained by multiplying the price coefficient with the price.

In addition, Das and Srinivasan (1999) have estimated the price elasticity of telephone usages by using time series data for the period 1964-1997, and panel
data by pooling state level data for 19 states from 1992-93 to 1996-97. In both the estimations they have used log of Metered Call Unit (MCU) per capita as the dependent variable. In the time series model, the log of highest rate applicable according to the tariff schedule (price variable) and the log of the share of service sector to GDP were used as the explanatory variables. In order to obtain price relative to other prices, the above variable is deflated by the general consumer price index. The estimated price elasticity of usages is equal to –0.58 and the growth of the service sector has a positive impact on the telephone usages with a very high elasticity of 10.8.

For the panel data model, the explanatory variable is the log of highest rate applicable according to the tariff schedule (price variable). The region specific consumer price index has been used as the deflator to obtain the price relative to other prices. The price elasticity obtained from the panel data model i.e. random effect model is –0.55. The coefficient of telephone density, which is greater than unity (1.09) indicates the presence of network and call externalities. The elasticity of usages demand with respect to the share of services to State Domestic Product is 0.51.

The problem encountered in estimating price elasticities by using time series and cross section data is that the variability in telephone tariff is too small to yield estimate and most of the variation comes due to deflation in the consumer price index, (Das and Srinivasan, 1999). Moreover, the dependent variable i.e. MCU is a combination of duration of call, time of call and the distance to which the call is made. This combination changes over a period of time. That is why, one unit in time period one (say peak period) may not be same as one unit in time period two (say up peak period) for call made to a particular distance zone. For instance, assume that the price per MCU is equal to Rs. 1.20/- if in time period...
one the duration equivalence of MCU and the corresponding duration of call are 15 seconds and 14 seconds. Further in time period two if the MCU is increased to 20 seconds (per unit charge remaining same at Rs. 1.20/-), this would imply a fall in usage price. Such a fall in usage price is expected to induce an increase in duration of call. Lets assume that in response to such a fall in usage price the duration of call increase to 19 seconds. It could be clearly understood from this hypothetical example that despite a fall in usage price and a resulting increase in duration of call the dependent variable measured in terms of MCU is remaining unchanged (i.e. 1 in both the cases) and failing to capture this inverse relationship. Thus, MCU may not be a plausible measure of change in usage demand.

1.3 Research Gaps

Research on the telecom sector in India is of recent origin having started mainly as a reaction to the on-going reforms in the sector. The above literature review indicates that many of the research questions raised in the context of provisioning and pricing of telecommunication services in India earlier, remain empirically unanswered. The empirical studies investigating the role of telecommunications in economic development are based on cross-country regression using macroeconomic approach. To our knowledge, a general equilibrium approach to estimate the impact of telecommunication on economic growth by using input output framework is yet to be attempted. Similarly, most of the studies relating to estimation of price elasticities of access and usage demand pertain to developed countries. However, there are very few studies available for India estimating price elasticities of demand for the landline services. The estimation of price elasticities for new services like mobile telephony and the welfare implications of price changes on the consumers/subscribers of telecom services are yet to be attempted. In addition, despite the need for a major tariff study to understand the level of cross subsidisation is highlighted in Government of India (1996), no serious
attempts have been made to identify the low-income recipients and high-income donors to finance cross subsidies in telecom services. Rather, in order to keep the telecommunication services affordable, the rental and the local call charges are subsidised by long distance calls. Accordingly, the nature and extent of cross subsidy has remained un-estimated for India. The review of literature and the identified research gaps therefore reveal that an analysis of the issues raised therein for provisioning and pricing of telecom services in the post-reform years is yet to be systematically attempted for India. Thus, the objectives of the study are set as follows with a view to bridge these research gaps.

1.4 Objectives of the study

The objectives of the study are to:

1. Describe the changing role of telecommunication as a basic infrastructure for economic growth in India.
2. Describe and compare the nature and extent of provisioning of telecommunication services in India between pre-reform and post-reform years.
3. Describe the nature of pricing of telecom services during post-reform years.
4. Develop a simple economic framework for explaining the implication of price changes on subscribers demand for telecom services.
5. Analyse the nature and magnitude of subsidy and cross subsidy for the subscribers of telecom services in India.
6. Derive implications for current and future provisioning and pricing of telecommunication services for economic development in both rural and urban India.
1.5 **Frameworks and Techniques of Analysis**

The analytical framework, empirical methodology and computational technique used vary according to the issues being addressed in various objectives. Accordingly the following methodologies are outlined to address the above-mentioned objectives.

In order to evaluate the nature and extent of the provisioning and pricing of telecommunication services, the study uses descriptive methodology by using quantitative (such as teledensity, growth of DEL etc.) and qualitative indicators (such as call completion rate, mean time to repair etc.). The descriptive methodology includes a) comparison across telecom circles by using mean and standard deviation b) by ranking the telecom circles in terms of qualitative indicator using the rank score technique and c) establishing the relationship between quantitative and qualitative indicators by correlation coefficient.

The study examines the contribution of communication service sector (which includes telecommunication services) to GDP at factor cost [at 1993-94 prices], from 1991-92 through 2003-04 to examine the role of telecommunication sector in economic growth. Further, using input-output framework as the analytical tool the role of telecommunication in economic growth is evaluated. The information contained in the basic input output table is used to identify sectors having larger share in the inter industry demand for telecommunication services. The simple linear static open Input-Output Model is applied for the equilibrium analysis. A comparative static analysis is adopted to assess the role of telecommunication services in economic growth in terms of exogeneous changes in final demand. The analysis has been supplemented by introducing various types of the linkage effects to assign priorities to different sectors from the point of
view of development strategy. Accordingly, six different types of linkages are computed namely; 1) Direct Forward Linkages, 2) Direct Backward Linkages, 3) Direct and Indirect Forward Linkage, 4) Direct and Indirect Backward Linkage, 5) Indirect Forward Linkage and, 6) Indirect Backward Linkage. These linkages have been compared with the overall degree of interdependence of the Indian economy. A total linkage indicator has also been computed by using Schultz Index.

The study also estimates the price elasticity of usage demand and the price elasticity of outgoing usage demand for pre and post-paid mobile services by using quarterly data since March 2003 for five quarters by four categories of circles. A linear functional form is used in order to obtain the estimated quantity demand for mobile services. This allows for the price elasticity to vary with different prices as the price elasticities are computed by multiplying the price coefficient with the ratio of the observed price and corresponding estimated quantity demanded. Since different category of circles may have fixed characteristics, panel regressions have a greater flexibility in modeling differences in fixed effects across individual category of circles. Hence, the empirical examination of the demand relation has been undertaken by using three alternative panel data models, namely, Pooled Regression Model (PRM), Fixed Effect Model (FEM) and Random Effect Model (REM). Diagnostic tests such as Breush and Pagan Lagrange Multiplier Test (henceforth LM test) and the Hausman Specification Test (henceforth H test) are used to choose between panel data models.

Using the basic data obtained from TRAI on Minutes of Usage (MOU), Revenue per subscriber (RPS), and percentage of incoming calls, the study generates data on two combinations of demand and price variables. The first
The combination of quantity demand and price variable (defined as Model 1) is Minutes of usage (which includes both incoming and outgoing minutes of usage) and the revenue realised per minute of usage (RRPMOU). The second combination (i.e. Model 2) is the outgoing minutes of usage (OGMOU) as the quantity variable and Revenue Realised per minute of outgoing usage (RRPMOOGU) as the corresponding price variable.

Using the estimated usage demand and observed price, the welfare implications for the pre and post-paid cellular mobile service subscribers in terms of consumer surplus are computed by four categories of mobile telecom circles. The consumer surplus for each price and estimated quantity combination have been obtained by integrating the area below the ordinary demand curve less the total outlay at that price and estimated quantity combination. The difference in consumer surplus thus obtained for any two time-period for any circle gives us the change in consumer surplus for that circle during that period.

The study develops a simple computational framework to empirically examine the extent of cross subsidy financed through the differential call charges at the national level. Using basic data on interconnection users charge levied by TRAI since May 2003 and the information on the distance zone wise MOU for basic service, the extent of cross subsidy financed through differential call charges is computed for the landline services in India. Further, the computational framework is suitably adjusted to estimate the extent of cross subsidy financed through differential call charges at the exchange level.
1.6 Time Frame

The focus of the entire study is on the post-reform years i.e. all the years subsequent to the introduction of the national economic reform in July 1991. As the economic reforms are on going, and likely to be continued in future the time frame for this study is fixed from July 1991-March 2004. The empirical data used for various objectives may belong to this period constraint upon the availability of data.

1.7 Database

The study is based on secondary data from published sources. In order to describe and compare the nature and extent of provisioning of telecom services, information is collected from various sources such as a) Annual Reports of Department of Telecommunication, b) Indian Telecommunication Statistics, c) Indian Telecommunication Statistics (abridge version), d) Economic Survey of India e) Basic data on price and usage demand over various quarter is collected from the Indian Telecommunication Service performance indicators published by TRAI. To examine the role of telecommunications services in economic development, the basic data are obtained from a) various issues of National Accounts Statistics (NAS) published by CSO and b) Input Output table of India for the year 1993-94 and published by CSO (2000). This was the latest Input Output table of India available for public use and research purpose before 2004. In order to compute the extent of cross subsidy the study has used information obtained from various Consultation Papers published by TRAI. In order the supplement the analysis and extend the framework for computation of cross subsidy at sub national level, the study uses additional information obtained from filled in questioner of pilot study carried out by ISEC in the Rural and Urban
areas of Bangalore district for the estimation of consumer demand for telecom services in the state of Karnataka and Goa in 2002.

1.8 Organisation of the Thesis

The rest of the thesis is organised as follows.

Chapter two describes the historical changes in the institutional and policy framework of the telecommunication sector in India. The purpose of this chapter is to understand the developments in the telecommunications sector, the role of the newly emerging institutions and the major policy changes that have taken place in the sector which may have influenced the provisioning and pricing of telecommunication services in India.

Chapter three explains the nature of provisioning and pricing of telecommunication services in India during post reform years and expansion of telecom service provisioning in terms of spatial and demographic coverage. Further, the telecom circles are ranked in terms of their quantitative and qualitative performance in the provisioning of telecom services. The co-relation between the service quality indicators and quantity indicators is obtained. In addition, the nature of changes in access and usage price for the basic telecom services is analysed.

In chapter four an attempt is made to analyse the role of telecom sector in economic growth using a) National Income Approach and b) Input-Output Approach. Under the national income approach the contribution of communication service sector to GDP at factor cost at (1993-94 prices) during the post reform year is analysed. Under Input-Output Approach by using equilibrium
analysis, comparative static analysis and various linkage effects – the growth implications are derived.

Chapter five two measures for demand and price variables and estimates price elasticities of demand for the subscribers of pre and post-paid cellular phone services in India. Further, the welfare implications for the subscribers in terms of changes in consumer surplus are derived.

Chapter six explains the financing of access and local usages through cross-subsidised pricing. A computational framework is developed to compute the extent of cross subsidies financed through differential call charges at the national level. Moreover, the framework is extended to measure the extent of cross subsidy at the sub national level such as rural-urban exchanges. Further, the workability of the model is demonstrated by using a small sample data.

Chapter seven concludes with policy implications for current and future provisioning and pricing of telecommunication services for economic development and consumers’ welfare in both rural and urban India.

Further, tables and equations are sequentially presented and numbered by chapters. For instance, Table 3.1 indicates table number 1 in chapter 3 while equation 5.1 indicates equation 1 in chapter 5. All the references are consolidated at the end of the thesis. The abbreviations used in the text are listed and presented in the beginning of the thesis.